National Institute for Health and Care Excellence

Final version

Addendum to Intrapartum care:

Care for healthy women and babies

Clinical Guideline 190.1

Appendices

February 2017

Final version

Developed by the National Guideline Alliance, hosted by the Royal College of Obstetricians and Gynaecologists

Disclaimer
Healthcare professionals are expected to take NICE clinical guidelines fully into account when exercising their clinical judgement. However, the guidance does not override the responsibility of healthcare professionals to make decisions appropriate to the circumstances of each patient, in consultation with the patient and/or their guardian or carer.

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Appendix A: Committee members and NGA team

Guideline Committee members (including co-opted members with an interest and experience in fetal monitoring during labour) are listed in Table 1.

Table 1: Guideline Committee members

Name	Role
Rhona Hughes (Chair)	Consultant Obstetrician and Clinical Director for Obstetrics and Neonatology, NHS Lothian
Alena Chong	GP Principal and Clinical Teaching Fellow, University College London
Aung Soe	Consultant Neonatologist, Medway Maritime Hospital
Bidyut Kumar (co-opted member)	Consultant Obstetrician and Gynaecologist, Wrexham Maelor Hospital.
Caroline Rice (co-opted member)	Consultant Obstetrician and Gynaecologist, Pennine Acute Hospitals NHS Trust
Charlotte Kuponiyi	Consultant Midwife, King's College London NHS Foundation Trust
Claire Davidson (co-opted member)	Maternity Intrapartum Matron, Chelsea and Westminster NHS Foundation Trust
Heidi Beddall	Consultant Midwife, Buckinghamshire Healthcare NHS Trust
Jackie Baxter (co-opted member)	Full Time Supervisor of Midwives, Imperial NHS Trust
Jacqui Bolton (co-opted member)	Guidelines Midwife/Supervisor of Midwives, Shrewsbury and Telford NHS Trust
Jenny Myers	Clinical Senior Lecturer and Honorary Consultant Obstetrician, University of Manchester/Central Manchester NHS Foundation Trust
Leanne Stamp	Lay member
Margaret Matthews	Consultant Obstetrician, Tunbridge Wells Hospital, Maidstone and Tunbridge Wells NHS Trust
Mark Kilby	Professor of Obstetrics and Fetal Medicine, University of Birmingham
Maryam Parisaei (co-opted member)	Consultant Obstetrician and Gynaecologist, Homerton University Hospital London
Myles Taylor (co-opted member)	Consultant Obstetrician and Gynaecologist, Royal Devon and Exeter NHS Foundation Trust
Philip Barclay	Consultant Anaesthetist, Chelsea and Westminster Hospital NHS Foundation Trust
Sarah Davies (co-opted member)	Midwifery Lecturer Cardiff University, Labour Ward Co-ordinator, Cardiff and Vale University Health Board
Sarah Fishburn	Lay member
Sharon Jordan (co-opted member)	Senior Coordinating Midwife North Bristol NHS Trust
Tracy Cooper	Consultant Midwife, Lancashire Teaching Hospitals NHS Foundation Trust

National Guideline Alliance (NGA) staff who supported the development of the addendum are listed in Table 2.

Table 2: National Guideline Alliance team

Name	Role
Bishal Bhandari	Assistant Systematic Reviewer (from November 2016)
Anne Carty	Project Manager (from November 2015)
Grammati Sarri	Senior Research Fellow and Guideline Lead (until February 2016)
Kate Coles	Project Manager (until October 2015)
Katie Webster	Freelance project support
Laura Kuznetsov	Systematic Reviewer (from February 2016)
Linyun Fou	Systematic Reviewer (from May until August 2016)
Maija Kallioinen	Systematic Reviewer (from February until September 2016)
May Oo Khin	Systematic Reviewer (until October 2016)
Melanie Davies	Clinical Advisor
Moira Mugglestone	Director (from March 2016)
Paul Jacklin	Senior Health Economist
Rachel Wheeler	Freelance project support
Rami Cosulich	Assistant Systematic Reviewer (from February 2016)
Shona Burman-Roy	Senior Systematic Reviewer
Taryn Krause	Senior freelance project support
Timothy Reeves	Information Scientist
Valentina Ricci	Senior Systematic Reviewer (from May until August 2016)

Some of the material presented in the addendum was prepared by staff of the former National Collaborating Centre for Women's and Children's Health (NCC-WCH) during the development of CG190. Their contributions are acknowledged here: David James, Emma Newbatt, Fiona Caldwell, Jessica Mai Sims, Katherine Cullen, Maryam Gholitabar, Rosalind Lai, Roz Ullman, Rupert Franklin, Vanessa Delgado Nunes and Zosia Beckles.

Appendix B: Declarations of interest

B.1 Members

Name	Interest declared	Type of interest	Decision
Rhona Hughes	International Fellows' representative (sub-Saharan Africa) RCOG Council Nov 2016- 2019	Personal non-financial non-specific	Declare and participate
Rhona Hughes	Lead developer RCOG Green-top guideline on prevention of neonatal group B streptococcal disease	Personal non-financial non-specific	Declare and participate
Philip Barclay	Executive Committee member of the Obstetric Anaesthetists Association, registered as a Director at Companies House	Personal non-financial non-specific	Declare and participate
Philip Barclay	Received honoraria and travel expenses from GE Healthcare for lectures about the Aisys Carestation Anaesthetic machine	Personal financial non-specific	Declare and participate
Heidi Beddall	Editorial Board Member of British Journal of Midwifery	Personal non-financial specific	Declare and participate
Heidi Beddall	Co-author of chapter about how to perform intermittent auscultation and cardiotocography in midwifery textbook (practical skills for student midwives etc.)	Personal non-financial specific	Declare and participate
Tracey Cooper	Editorial Board Member of British Journal of Midwifery	Personal non-financial non-specific	Declare and participate
Sarah Fishburn	Organises workshops for physiotherapists treating pelvic girdle pain and is paid for this work	Personal financial non-specific	Declare and participate
Sarah Fishburn	Receives payment and expenses from the Nursing and Midwifery Council as a lay panellist of the Fitness to Practise Investigating Committee	Personal financial non-specific	Declare and participate
Sarah Fishburn	Lay reviewer with the Local Supervising Authority auditing supervision of midwives and receive payment and expenses for this work	Personal financial non-specific	Declare and participate
Sarah Fishburn	Lay reviewer for the NIHR and has reviewed a number of research proposals being considered for funding (paid for carrying out these reviews)	Personal financial non-specific	Declare and participate
Sarah Fishburn	Chair of the Pelvic Partnership, a support group for women with pregnancy-related pelvic girdle pain; this	Personal non-financial non-specific	Declare and participate

Name	Interest declared	Type of interest	Decision
	is a voluntary position and no remuneration is received		
Mark Kilby	East Midlands representative of the commissioning board for NHS England	Personal non-financial non-specific	Declare and participate
Charlotte Kuponiyi	Peer reviewer for British Journal of Midwifery	Personal non-financial non-specific	Declare and participate
Charlotte Kuponiyi	Contributor on opinion pieces for the British Journal of Midwifery	Personal financial non-specific	Declare and participate
Charlotte Kuponiyi	Personal Twitter account	Personal non-financial non-specific	Declare and participate
Charlotte Kuponiyi	Co-author of an article published in The Obstetrician and Gynaecologist (TOG) 2015	Personal non-financial non-specific	Declare and participate
Charlotte Kuponiyi	MBRRACE-UK antepartum stillbirth confidential enquiry panel member	Personal non-financial specific	Declare and participate
Margaret Matthews	Member of British Maternal and Fetal Medicine Executive Committee, Labour and Delivery Representative	Personal non-financial specific	Declare and participate
Margaret Matthews	Annual organiser of the Advanced Labour Ward Practice/Labour Ward lead course at RCOG	Personal non-financial specific	Declare and participate
Jenny Myers	Consultancy work for Alere in relation to diagnostic tests for pre-eclampsia (2010 to 2013)	Personal financial non-specific	Declare and participate
Aung Soe	Member of RCOG Scientific Advisory Committee (extreme preterm birth)	Personal non-financial non-specific	Declare and participate
Aung Soe	Submitted an article to TOG which contained a small section on fetal monitoring	Personal non-financial specific	Declare and participate
Aung Soe	Clinical lead for NICE guideline on specialist neonatal care	Personal financial non-specific	Declare and participate
Leanne Stamp	As a member of the Nottingham Maternity Research Network, involved in a study about the provision of midwife-led units in England (lay advisor and co-investigator); receives an honorarium for this work	Personal financial specific	Declare and participate

B.2 Co-opted members

Name	Interest declared	Type of interest	Decision
Jacqui Bolton	Obstetric edited contributor to the obstetric guidelines with Staffordshire, Shropshire and	Personal non-financial specific	Declare and participate

Name	Interest declared	Type of interest	Decision
	Blackcountry obstetric and neonatal network		
Jacqui Bolton	West Midlands local supervising authority (LSA) appointed Supervisor of Midwives at Shrewsbury NHS (receives remuneration from the trust as an additional role)	Personal financial specific	Declare and participate
Sarah Davies	Involved in the FM ALERT trial from September to December 2011. One of two research midwives whose responsibility it was to introduce the study to staff, recruit women to the study and enter data	Personal non-financial specific	Declare and participate
Bidyut Kumar	Co-editor of Fetal Medicine – published by Cambridge University Press on behalf of the RCOG	Personal non-financial non-specific	Declare and participate
Bidyut Kumar	Deputy Editor, Ultrasound (journal of the British Ultrasound Society)	Personal non-financial non-specific	Declare and participate
Bidyut Kumar	Reviewer for TOG	Personal non-financial non-specific	Declare and participate
Bidyut Kumar	Faculty member MRCOG part 2 course at RCOG	Personal non-financial non-specific	Declare and participate
Bidyut Kumar	Co-author of Computerised antenatal fetal heart rate recordings between 24 and 28 weeks of gestation, BJOG, 2001	Personal non-financial specific	Declare and participate
Bidyut Kumar	Chair of fetal medicine service group, Betsi Cadwaladr University Health Board	Personal non-financial specific	Declare and participate
Caroline Rice	Panel member on undertaking case reviews for the 2016/17 perinatal confidential enquiry into intrapartum stillbirth and intrapartum-related neonatal death for MBRRACE-UK	Personal non-financial specific	Declare and participate
Maryam Parisaei	Teaches staff at the Homerton Hospital about cardiotocograph (CTG) interpretation and writing serious incident reports	Personal non-financial specific	Declare and participate
Maryam Parisaei	Co-organiser of London and National Labour Ward Leads Group	Personal non-financial specific	Declare and participate
Maryam Parisaei	Co-signatory of letter sent to NICE and RCOG on NICE CTG classification	Personal non-financial specific	Declare and participate
Myles Taylor	Is an expert witness for claimant and defence solicitors; produces expert medico-legal reports and provides advice and evidence	Personal financial specific	Declare and participate

Name	Interest declared	Type of interest	Decision
	for the benefit of the Court for Obstetric and Gynaecological Clinical Negligence Cases; not infrequently, cases involve the interpretation of the CTG and actions such interpretation should trigger		

Appendix C: Review protocols

C.1 Continuous cardiotocography compared with intermittent auscultation on admission and during established labour

This protocol covers two review questions (cardiotocography compared with intermittent auscultation on admission in labour and cardiotocography compared with intermittent auscultation during established labour).

Item	Details	Additional comments
Review question	What is the effectiveness of electronic fetal monitoring compared with intermittent auscultation? • On admission in labour • During established labour	PROTOCOL AS USED IN CG190 (2014) – 2016 EVIDENCE REVIEW TO BE PERFORMED IN ACCORDANCE WITH CG190 METHODS SECTION (1.10.2 AND 1.10.3) THESE QUESTIONS WERE PRIORITISED FOR HEALTH ECONOMIC ANALYSIS IN CG190 One search - weed into 2 reviews
Objectives	To determine which method of fetal monitoring is associated with better neonatal and maternal outcomes.	During labour we are looking at electronic monitoring/CTG for intermittent periods of time (e.g. 30 minutes every 2 hours) and continuous electronic fetal monitoring for the duration of labour. Record what papers report.
Language	English	
Study design	• Randomised controlled trials (RCTs) • Comparative observational studies (if no RCT data)	
Status	Published papers	
Population	Healthy pregnant women with low risk pregnancy and no detected complications of fetal heart rate during labour giving birth at term (37 to 42 weeks)	
Intervention	Electronic fetal monitoring (EFM)	Other terms: • cardiotocograph (CTG) • admission CTG
Comparator	Intermittent auscultation	Note: Important to record how intermittent auscultation is carried out in each study Possible terms: • Doppler fetal monitors (“Sonicaid”)

Item	Details	Additional comments
		• hand-held ultrasound devices • Pinard stethoscope • fetal stethoscope • listening in • non-stress test (NST)
Outcomes	Woman • Mode of birth • Women's satisfaction/experience of labour and birth including mobility Neonate • Mortality • Major neonatal morbidity (any - see opposite for GDG decision) • Admission to NICU • Cord blood gas values at birth	Major neonatal morbidity could include: • hypoxic ischaemic encephalopathy (HIE) • cerebral palsy/neurodevelopmental disability/developmental delay/ • neonatal seizures
Other criteria for inclusion/ exclusion of studies	Include all countries Exclude case reports and case series with no comparative data	
Search strategies	Search from date of last guideline	
Review strategies	Sub-group analysis by frequency and duration of intermittent EFM if possible/appropriate	

C.2 Intermittent auscultation compared with cardiotocography in the presence of meconium stained liquor

Item	Details	Additional comments
Review question	What is the effectiveness of continuous electronic fetal monitoring compared with intermittent auscultation when there is meconium-stained liquor?	PROTOCOL AS USED IN CG190 (2014) – 2016 EVIDENCE REVIEW TO BE PERFORMED IN ACCORDANCE WITH CG190 METHODS SECTION (1.10.2 AND 1.10.3)
Objectives	To determine which method of fetal monitoring is associated with the best maternal and neonatal outcomes, following the identification of meconium-stained liquor	
Language	English	
Study design	Randomised controlled trials (RCTs) and systematic reviews of RCTs Comparative observational studies (if no RCTs)	
Status	Published papers	
Population	"Low risk" women in labour at term (37-42 weeks) with meconium stained liquor	Amniotic fluid to be added as a search term Low risk women – those without medical or obstetric complications at the onset of labour

Item	Details	Additional comments
Intervention	Continuous electronic fetal monitoring	Cardiotocography (CTG) Reviewers: note if EFM is continuous as in constant (on all the time) or on and off (e.g. 30 minute intervals of continuous monitoring with breaks) Need to consider the implications of planned place of birth and need for transfer
Comparator	Intermittent auscultation	With Pinard(s) stethoscope, fetal stethoscope or hand-held Doppler device (e.g. Sonicaid)
Outcomes	Woman • Mode of birth (spontaneous vaginal, unplanned CS, instrumental) • Postpartum haemorrhage • Length of hospital stay Neonate • Mortality • Major neonatal morbidity (GDG to decide – see opposite) • Requirement for resuscitation at birth • Need for ventilator support/length of time with ventilator support • Length of stay in NICU • Metabolic acidosis at birth (cord pH less than 7.05 and base deficit greater than 12 mmol/l)	Neonatal morbidity: • meconium aspiration syndrome • hypoxic ischaemic encephalopathy (HIE) • cerebral palsy/neurodevelopmental disability/developmental delay
Other criteria for inclusion/ exclusion of studies	Include all countries Exclude case reports and case series with no comparative data	
Search strategies	Search from date of last guideline	
Review strategies	Undertake sub-group analysis by degree of meconium staining if possible (i.e. light/moderate/thick, but may depend on how consistently the grading is reported)	

C.3 Interpretation of cardiotocograph traces

Item	Details	Additional comments
Review question	What are the appropriate definitions and interpretation of the features of an electronic fetal heart rate (FHR) trace?	PROTOCOL AS USED IN CG190 (2014) – 2016 EVIDENCE REVIEW TO BE PERFORMED IN ACCORDANCE WITH CG190 METHODS SECTION (1.10.2 AND 1.10.3)

Item	Details	Additional comments
		Note: decided that EFM/FHR traces will be called cardiotocographs (CTG) throughout guideline in order to accurately reflect that they record both the fetal heart rate and labour contractions
Objectives	To determine how specific features of FHR traces should be classified, and identify those that are associated with poor neonatal outcomes	
Language	English	
Study design	• Comparative observational studies (cohort, case-control) • Prognostic/diagnostic studies	
Status	Published papers	
Population	Healthy pregnant women with low risk pregnancy in labour at term (37 to 42 weeks)	
Intervention	Electronic fetal monitoring with assessment of the trace (cardiotocograph [CTG])	Examples of characteristics of trace: • fetal heart rate (FHR) • FHR pattern/characteristics • EFM/CTG/FHR interpretation/assessment/analysis • uterine activity and relation to FHR/CTG characteristics • baseline heart rate: normal, tachy/bradycardia • variability in heart rate/beat-to-beat variability: good variability, reduced variability, excessive variability, saltatory variability • decelerations: early decelerations, late decelerations, variable decelerations, typical and atypical decelerations • accelerations • change within/of baseline • sinusoidal trace • pseudosinusoidal trace
Comparator	Not applicable	
Outcomes	Woman • Mode of birth Neonate	Major neonatal morbidity could include: • hypoxic ischaemic encephalopathy (HIE)

Item	Details	Additional comments
	• Mortality • Major neonatal morbidity (GDG to decide – see opposite) • Need for ventilator support/length of time with ventilator support • Admission to NICU • Cord blood gas values at birth • Fetal acidosis at birth	• cerebral palsy/neurodevelopmental disability • neonatal seizures • birth asphyxia • developmental delay
Other criteria for inclusion/ exclusion of studies	Include all countries Exclude case reports	
Search strategies	Search from previous guideline	
Review strategies	Need to report the stage of labour, progress in labour and maternal condition and definitions of all of the above. Note also presence of meconium	

C.4 Care in labour as a result of cardiotocography

Item	Details	Additional comments
Review question	How should care in labour be modified as a result of cardiotocograph findings?	NEW PROTOCOL 2016 – EVIDENCE REVIEW TO BE PERFORMED IN ACCORDANCE WITH CG190 METHODS SECTION (1.10.2 AND 1.10.3); ADDITIONALLY DUAL WEEDING AND STUDY SELECTION (INCLUSION/EXCLUSION) TO BE UNDERTAKEN FOR THIS QUESTION (ANY DISCREPANCIES TO BE RESOLVED THROUGH DISCUSSION BETWEEN THE FIRST AND SECOND REVIEWERS OR BY REFERENCE TO A THIRD PERSON) Outcome: based on a 10% sample of search results (n=100), there was 86% agreement between reviewers on initial weeding and 100% agreement on study selection (inclusion/exclusion) following resolution of weeding discrepancies
Objective	When a cardiotocograph trace reveals signs that cause concern, practical guidance that influences care in labour is needed. The guidance should aim to minimise unnecessary	

Item	Details	Additional comments
	action and interventions, whilst achieving optimal labour outcomes for the woman and baby. Table 93 in CG190 specifies how care for the woman and her baby should be determined based on findings of the cardiotocograph trace (and other factors). These recommendations were formulated using group consensus in the absence of any formal literature search and no reference to clinical evidence. This review aims to identify evidence that might inform an update of Table 93	
Population and directness	Women in labour at term (37 to 42 weeks)	
Intervention	A cardiotocography (CTG)-guided intervention protocol designed to improve outcomes for the woman or her baby. The following may be considered provided they are evaluated in the context of a specific CTG-guided intervention protocol: • expediting birth (for example, emergency caesarean section or instrumental vaginal birth) • changing maternal position • intravenous ephedrine (for example, due to hypotension) • starting or stopping oxytocin, prostaglandins, beta-adrenergic agonists (for example, terbutaline, salbutamol, ritodrine), nifedipine, atosiban, or nitroglycerine • oxygen • fluids (intravenous or oral) • analgesia • seeking expert advice • following usual care • discontinuing maternal pushing	Management of high temperature in the woman using anti-pyretics will not be considered as the guideline on intrapartum care for high-risk women will cover this. Fetal blood sampling and fetal scalp stimulation will not be considered as separate review questions in this guideline cover these
Comparison	• Another CTG-guided intervention protocol • Usual care	
Outcomes	• Extended perinatal death after randomisation (excluding those from congenital anomalies) • Hypoxic ischaemic encephalopathy (HIE) • Admission to NICU • Acidosis (arterial cord pH less than 7.05, base deficit of more than 12) • Need for fetal blood sampling • Mode of birth • Maternal morbidity, for example perineal trauma, postpartum haemorrhage • Women's satisfaction/experience of labour and birth including mobility	
Setting	Obstetric units	

Item	Details	Additional comments
Stratified, subgroup and adjusted analyses	Groups that will be reviewed and analysed separately: • classification of cardiotocographic trace results (for example, CTG non-reassuring versus CTG abnormal) When comparative observational studies are included for intervention reviews the following confounders will be considered: • antenatal and intrapartum risk factors • centre	
Language	English	
Study design	Only published full-text papers: • systematic reviews of randomised controlled trials (RCTs) • RCTs (including test and treat) • comparative observational studies (only if RCTs unavailable or limited data to inform decision making)	
Search strategy	Sources to be searched: Medline, Medline In-Process, CCTR, CDSR, DARE, HTA, Embase. Limits (for example, date or study design): all study designs; no limits on date of publication. Apply standard animal/non-English language filters. Supplementary search techniques: none	
Review strategy	Appraisal of methodological quality: assess at study level using NICE checklists; assess at outcome level (across studies) using GRADE. Synthesis of data: Meta-analysis will be conducted where appropriate. If comparative cohort studies are included, the minimum number of events per covariate will be recorded to ensure accurate multivariate analysis. Default minimally important differences (MIDs) will be used: 0.75 and 1.25 for dichotomous outcomes; 0.5 times standard deviation (SD) for continuous outcomes. If studies report only p-values, this information will be recorded in GRADE tables without an assessment of imprecision being made	
Equalities	Equalities considerations will be considered systematically in relation to the available evidence and draft recommendations	
Notes/additional information	None	
Key papers	FIGO consensus guidelines 2015: cardiotocography	

Item	Details	Additional comments
	http://www.sciencedirect.com/science/article/pii/S0020729215003951 Holzmann M, Wretler S, Cnattingius S, Nordström L. Neonatal outcome and delivery mode in labors with repetitive fetal scalp blood sampling. Eur J Obstet Gynecol Reprod Biol. 2015 Jan;184:97-102	

C.5 Fetal scalp stimulation

Item	Details	Additional comments
Review questions	Does the use of fetal stimulation as an adjunct to electronic fetal monitoring improve the predictive value of monitoring and clinical outcomes when compared to • Electronic fetal monitoring alone • Electronic fetal monitoring plus ECG	PROTOCOL AS USED IN CG190 (2014) – 2016 EVIDENCE REVIEW TO BE PERFORMED IN ACCORDANCE WITH CG190 METHODS SECTION (1.10.2 AND 1.10.3) This will be one search but will then be reviewed with 2, possibly 4, sub-questions depending on the evidence found.
Objectives	To determine if fetal stimulation is a useful adjunctive test to perform during labour to aid decision-making and thus improve labour outcomes	
Language	English	
Study design	• For predictive value - diagnostic/prognostic studies for predictive value • For improving clinical outcomes – randomised controlled trials (RCTs). If little RCT evidence then comparative observational studies. • Both will be reviewed for EFM alone and EFM+ECG	
Status	Published papers	
Population	Women in labour at term (37 to 42 weeks) who are having electronic fetal monitoring. Will include studies with a proportion of high risk women	Report details of population including proportion who are high risk. Do not include studies where all women are a specific high risk population or where a significant proportion (33% or more) are in preterm labour
Intervention	Fetal stimulation as an adjunct to electronic fetal monitoring	Stimulation can be digital (with the fingers during a vaginal examination) or with a needle during fetal scalp blood sampling. It is generally done while carrying out another

Item	Details	Additional comments
		procedure rather than as a single intervention in and of itself – but for research purposes this may not be the case. Can also include other external methods of fetal stimulation e.g. fibroacoustic
Comparator	• Electronic fetal monitoring alone • Electronic fetal monitoring with ECG analysis	Search terms for monitoring: • EFM • cardiotocography (CTG) • continuous monitoring • electrocardiogram (ECG) • ST wave analysis (STAN) Additional search terms for stimulation: • digital scalp stimulation • scalp stimulation with a needle/blade • acceleration (this is what is hoped to be prompted in the fetal heartrate) • fibroacoustic fetal stimulation
Outcomes	Woman • Mode of birth (and indication if operative birth) • Women's satisfaction/experience of labour and birth including mobility • Need for fetal blood sampling or even failed FBS • Length of labour Neonate • Mortality • Major neonatal morbidity (see opposite) • Admission to NICU • Cord blood gas values at birth • Fetal scalp blood gas values during labour • Trauma/injury to infant	Major neonatal morbidity could include: • hypoxic ischaemic encephalopathy (HIE) • cerebral palsy/neurodevelopmental disability/developmental delay • neonatal seizures • birth asphyxia
Other criteria for inclusion/ exclusion of studies	Include all countries Exclude case reports	
Search strategies	Search from date of previous guideline	
Review strategies	Report time interval between assessment using scalp stimulation and comparative outcome (e.g. FBS result or birth outcome)	

C.6 Fetal blood sampling

This protocol covers three review questions (fetal blood sampling as an adjunct to cardiotocography, time to result of fetal blood sampling and predictive value of fetal blood sampling).

Item	Details	Additional comments
Review questions	1. Does the use of fetal blood sampling as an adjunct to electronic fetal monitoring (EFM) improve outcomes, when compared to: • electronic fetal monitoring alone • electronic fetal monitoring plus electrocardiogram (ECG)? 2. What is the optimum time from the decision to perform a fetal blood sample to having the blood result? 3. What is the predictive value of the following measures, for maternal and neonatal outcomes: • fetal blood pH analysis • fetal blood lactate analysis • fetal acid-base status • fetal-base deficit?	PROTOCOL AS USED IN CG190 (2014) – 2016 EVIDENCE REVIEW TO BE PERFORMED IN ACCORDANCE WITH CG190 METHODS SECTION (1.10.2 AND 1.10.3) THESE QUESTIONS WERE PRIORITISED FOR HEALTH ECONOMIC ANALYSIS IN CG190 This will be one search but will then be reviewed as 3 questions. • Report indication for FBS, and how women have been previously monitored • Report failure rates of FBS
Objectives	1. To determine if fetal blood sampling is a useful test to perform during labour to aid decision-making. 2. Does performing fetal blood sampling make a difference to clinical outcomes? 3. Is there a maximum time to get a result beyond which it is not reasonable to take a fetal blood sample? 4. When performing fetal blood sampling, what biochemical analysis should be performed?	In a previous version of the guideline (2001) this question was answered by simply looking at one descriptive study of time taken to get result of FBS – 18 minutes. This then informed a recommendation about taking this length of time into account when planning management of labour
Language	English	
Study design	1. Diagnostic/prognostic studies 2. Randomised controlled trials (RCTs) 3. If little RCT evidence then comparative observational studies 3. Observational studies, including non-comparative studies	
Status	Published papers	
Population	Healthy pregnant women with low risk pregnancy giving birth at term (37 to 42 weeks)	Reviewer to report: • women may or may not have an indication for FBS

Item	Details	Additional comments
		• any use of oxytocin or induction during labour
Intervention	Fetal blood sampling	Might help to add "intrapartum" to the search to rule out antenatal fetal sampling Other possible terms for search: • fetal scalp blood pH • fetal scalp blood sampling • lactate measurement • acid-base difference • FBS • base deficit
Comparator	• Different kind of fetal blood sampling (e.g. lactate versus pH analysis) • Continuous EFM only (i.e. without fetal blood sampling) • Continuous EFM plus ECG • EFM with possibly different times (e.g. <20 minutes versus. > 20 minutes)	
Outcomes	Woman • Mode of birth (and indication if operative birth) • Women's satisfaction/experience of labour and birth including mobility • Length of labour • Trauma (psychological or physical, trauma or distress) Neonate • Mortality • Major neonatal morbidity (see opposite) • Apgar score < 7 at 5 minutes • Admission to NICU • Cord blood gas values at birth • Trauma/injury to infant	Major neonatal morbidity could include: • hypoxic ischaemic encephalopathy (HIE) • cerebral palsy/neurodevelopmental disability/developmental delay Note: also need to report how third stage was managed (where possible) to help interpret findings
Other criteria for inclusion/ exclusion of studies	Include all countries Exclude case reports	
Search strategies	Search from date of previous guideline	20.07.12 - FOR RE-RUNS – search all the way back to ensure that any observational studies that might have been missed in the original guideline are picked up
Review strategies	For question 3, we will restrict studies to those reporting outcomes/predictive value for samples taken within 1 hour of birth. For questions 3 and 4 report time interval between FBS and birth	

Item	Details	Additional comments
	For all questions also report Apgar at 1 minute as this was reported in original guideline. If there is insufficient evidence for women at low risk of complications in labour, include studies with higher risk population	

C.7 Women's experience of fetal monitoring

Item	Details	Additional comments
Review question	What are women's views and experiences of fetal monitoring in labour?	PROTOCOL AS USED IN CG190 (2014) – 2016 EVIDENCE REVIEW TO BE PERFORMED IN ACCORDANCE WITH CG190 METHODS SECTION (1.10.2 AND 1.10.3)
Objectives	To determine women's views and experiences of different types of intrapartum fetal monitoring	Main comparison would be for continuous electronic fetal monitoring versus intermittent monitoring (auscultation or hand-held Doppler devices) but any other comparison will be considered. We are also looking for any studies reporting women's views of fetal blood sampling
Language	English	
Study design	• Qualitative studies – comparative better. • Trials or comparative observational studies that report women's experiences	
Status	Published papers	
Population	Pregnant women in labour at term (37 to 42 weeks)	Will include studies where population includes women with complications. Reviewers: report study population in detail
Intervention	1. Electronic fetal monitoring/cardiotocography with/without telemetry 2. Electrocardiogram (ECG) analysis 3. Intermittent auscultation 4. Fetal blood sampling	Possible terms: • continuous electronic fetal monitoring (EFM) • CTG • ST wave analysis (STAN) • Doppler fetal monitors ("Sonicaid" - product from the UK company; "Doptone" – US term) • fetal scalp electrodes • hand-held ultrasound devices • Pinard stethoscope • a fetal stethoscope • listening in

Item	Details	Additional comments
		• no monitoring of fetal heartbeat • fetal movements • observation of amniotic fluid/liquor
Comparator	Any other type of fetal monitoring	
Outcomes	• Women's views and experiences of labour and birth • Emotional and psychological outcomes (e.g. distress, anxiety, reassurance) • Satisfaction with birth experience and care received	Other clinical outcomes have been reviewed in the other questions for this topic
Other criteria for inclusion/ exclusion of studies	Include all countries Exclude case reports	
Search strategies	Search from previous guideline	
Review strategies	Include qualitative studies from all dates RCTs and comparative observational studies – from date of previous guideline	Note: no qualitative studies were identified for inclusion in CG190; in the 2016 evidence review one qualitative study was identified for inclusion but it contained insufficient data to allow presentation of the results in a GRADE table and so a narrative evidence statement was produced instead

C.8 Cardiotocography with electrocardiogram analysis compared with cardiotocography alone

Item	Details	Additional comments
Review question	Does the use of fetal electrocardiogram (ECG) analysis with continuous electronic fetal monitoring (EFM) improve outcomes when compared with continuous EFM alone?	PROTOCOL AS USED IN CG190 (2014) – 2016 EVIDENCE REVIEW TO BE PERFORMED IN ACCORDANCE WITH CG190 METHODS SECTION (1.10.2 AND 1.10.3) THIS QUESTION WAS PRIORITISED FOR HEALTH ECONOMIC ANALYSIS IN CG190
Objectives	To determine whether the use of ECG analysis as an adjunct to continuous electronic fetal monitoring improves neonatal and maternal outcomes	
Language	English	
Study design	Randomised controlled trials (RCTs) Comparative observational studies (if no RCT data)	

Item	Details	Additional comments
Status	Published papers	
Population	Pregnant women in labour at term (37-42 weeks) with an indication for electronic fetal monitoring (EFM)	Note: need to document exact population of trials
Intervention	ECG analysis in combination with EFM	Possible search terms: • ECG analysis, could include ST wave/segment analysis (STAN) or PR interval analysis • ECG might be called EKG (the abbreviation for the German word elektrokardiogramm) • FECG • T/QRS ratio also put F and fetal in front of all search terms
Comparator	Continuous electronic fetal monitoring (alone, i.e. without additional ECG analysis)	This could be fully continuous, or 'intermittent continuous' Possible search terms: • cardiotocography - CTG • cardiotocogram • FHR trace interpretation FHR monitoring
Outcomes	Woman • Mode of birth (spontaneous, Caesarean section, instrumental) • Women's satisfaction/experience of labour and birth including mobility • Need for fetal blood sampling • Perineal trauma Neonate • Mortality • Admission to NICU • Metabolic acidosis at birth (cord pH less than 7.05 and base deficit greater than 12 mmol/l) • Requirement for resuscitation at birth/assisted ventilation (IPPV) Note: the following are second-line outcomes if no data reported for priority outcomes listed above: • meconium aspiration syndrome • fetal trauma	Document indication for birth Major neonatal morbidity could include: • hypoxic ischaemic encephalopathy (HIE) • cerebral palsy/neurodevelopmental disability/developmental delay
Other criteria for inclusion/ exclusion of studies	Include all countries Exclude case reports and case series with no comparative data	
Search strategies	Search from previous guideline	

Item	Details	Additional comments
Review strategies	Need to consider impact of the stage of labour, and record duration/frequency of monitoring	

C.9 Automated interpretation of cardiotocograph traces

Item	Details	Additional comments
Review question	Does automated interpretation of cardiotocograph traces using computer software improve consistency of interpretation and outcomes (neonatal and maternal)?	NEW PROTOCOL 2016 – EVIDENCE REVIEW TO BE PERFORMED IN ACCORDANCE WITH CG190 METHODS SECTION (1.10.2 AND 1.10.3); ADDITIONALLY DUAL WEEDING AND STUDY SELECTION (INCLUSION/EXCLUSION) TO BE UNDERTAKEN FOR THIS QUESTION (ANY DISCREPANCIES TO BE RESOLVED THROUGH DISCUSSION BETWEEN THE FIRST AND SECOND REVIEWERS OR BY REFERENCE TO A THIRD PERSON) Outcome: based on a 10% sample of search results (n=62), there was 87% agreement between reviewers on initial weeding and 100% agreement on study selection (inclusion/exclusion) following resolution of weeding discrepancies
Objective	Electronic fetal monitoring (EFM) aims to detect abnormalities of the fetal heart rate pattern which enables the birth attendant to adapt care for women in labour with a view to avoiding adverse outcomes. Interpretation of the trace can be challenging for a number of reasons and computerised interpretation offers potential for improved consistency and outcomes	
Population and directness	Women in labour at term (37 to 42 weeks)	
Intervention	Decision-support software used to interpret the cardiotocograph trace	Reviewer to note the proprietary name of any decision-support software
Comparison	Human interpretation of the cardiotocograph trace	
Outcomes	Accuracy and consistency: • sensitivity • specificity	Perinatal death is up to 28 days

Item	Details	Additional comments
	• positive likelihood ratio • negative likelihood ratio • intra-rater reliability Clinical outcomes, for example: • extended perinatal death after randomisation (excluding those from congenital anomalies) • hypoxic ischaemic encephalopathy (HIE) • admission to NICU • acidosis (arterial cord pH <7.05, base deficit of more than 12) • need for fetal blood sampling • mode of birth • Women's satisfaction/experience of labour and birth including mobility	
Setting	Obstetric units	
Stratified, subgroup and adjusted analyses	In the presence of heterogeneity, the following subgroups will be considered for sensitivity analysis: • type of decision-support software When comparative observational studies are included for intervention reviews the following confounders will be considered: • centre • software • training systems (e.g. Baby Lifeline, Prompt)	
Language	English	
Study design	Only published full-text papers: • systematic reviews of randomised controlled trials (RCTs) • RCTs (including test and treat) • cohort studies (only if RCTs unavailable or limited data to inform decision making) • diagnostic test accuracy studies	
Search strategy	Sources to be searched: Medline, Medline In-Process, CCTR, CDSR, DARE, HTA, Embase. Limits (for example, date or study design): all study designs; search from previous guideline (2006). Apply standard animal/non-English language filters. Supplementary search techniques: none	
Review strategy	Appraisal of methodological quality: assess at study level using NICE checklists; assess at outcome level (across studies) using GRADE. Synthesis of data: meta-analysis will be conducted where appropriate. If cohort studies are included, the minimum number of events per covariate will be	

Item	Details	Additional comments
	recorded to ensure accurate multivariate analysis. Default minimally important differences (MIDs) will be used: 0.75 and 1.25 for dichotomous outcomes; 0.5 times standard deviation (SD) for continuous outcomes. If studies report only p-values, this information will be recorded in GRADE tables without an assessment of imprecision being made	
Equalities	Equalities considerations will be considered systematically in relation to the available evidence and draft recommendations	
Notes/additional information	None	
Key papers	INFANT study, due to publish during 2016: https://www.ucl.ac.uk/ictm/about/cctu FM ALERT, Ayres-De-Campos (1st author) presented at European conference ECIC, Porto, 2015 Six studies included in CG190 (based on 2007 guideline) without a published review question or protocol: • [reference 495] Keith RD, Beckley S, Garibaldi JM, et al. A multicentre comparative study of 17 experts and an intelligent computer system for managing labour using the cardiotocogram. BJOG: an international journal of obstetrics & gynaecology. 1995;102(9):688–700. • [reference 496] Taylor GM, Mires GJ, Abel EW, et al. The development and validation of an algorithm for real-time computerised fetal heart rate monitoring in labour. BJOG: an international journal of obstetrics & gynaecology. 2000;107(9):1130–7. • [reference 497] Todros T, Preve CU, Plazzotta C, et al. Fetal heart rate tracings: observers versus computer assessment. European Journal of Obstetrics, Gynecology and Reproductive Biology. 1996;68(1–2):83–6. • [reference 498] Chung TK, Mohajer MP, Yang ZJ, et al. The prediction of fetal acidosis at birth by computerised analysis of intrapartum cardiotocography. BJOG: an international journal of obstetrics & gynaecology. 1995;102(6):454–60. • [reference 499] Nielsen PV, Stigsby B, Nickelsen C, et al. Computer assessment of the intrapartum cardiotocogram. II. The value of computer assessment compared with visual assessment. Acta Obstetricia et Gynecologica Scandinavica. 1988;67(5):461–4.	

Item	Details	Additional comments
	• [reference 500] Mongelli M, Dawkins R, Chung T, et al. Computerised estimation of the baseline fetal heart rate in labour: the low frequency line. BJOG: an international journal of obstetrics & gynaecology. 1997;104(10):1128–33.	

Appendix D: Search strategies

All the searches performed for the 2017 review are documented below. Those which were re-runs of searches performed for CG190 are indicated as such. Any future updates of review questions included in the addendum should use 1 April 2016 as the starting point for searching for new evidence.

D.1 Continuous cardiotocography compared with intermittent auscultation on admission and during established labour

This search covers two review questions (cardiotocography compared with intermittent auscultation on admission in labour and cardiotocography compared with intermittent auscultation during established labour).

The search strategies below are reproduced from CG190 and were re-run from January 2014 as part of the 2016 evidence review.

A health economics search was also conducted for these review questions.

Database(s): Ovid MEDLINE(R)

#	Searches
1	randomized controlled trial.pt.
2	controlled clinical trial.pt.
3	DOUBLE BLIND METHOD/
4	SINGLE BLIND METHOD/
5	RANDOM ALLOCATION/
6	or/1-5
7	((single or double or triple or treble) adj5 (blind$ or mask$)).tw,sh.
8	clinical trial.pt.
9	exp CLINICAL TRIAL/
10	exp CLINICAL TRIALS AS TOPIC/
11	(clinic$ adj5 trial$).tw,sh.
12	PLACEBOS/
13	placebo$.tw,sh.
14	random$.tw,sh.
15	or/7-14
16	or/6,15
17	META ANALYSIS/
18	META ANALYSIS AS TOPIC/
19	meta analysis.pt.
20	(metaanaly$ or meta-analy$ or (meta adj analy$)).tw,sh.
21	(systematic$ adj5 (review$ or overview$)).tw,sh.
22	(methodologic$ adj5 (review$ or overview$)).tw,sh.
23	or/17-22
24	review$.pt.
25	(medline or medlars or embase or cinahl or cochrane or psycinfo or psychinfo or psychlit or psyclit or "web of science" or "science citation" or scisearch).tw.
26	((hand or manual$) adj2 search$).tw.

#	Searches
27	(electronic database$ or bibliographic database$ or computeri?ed database$ or online database$).tw,sh.
28	(pooling or pooled or mantel haenszel).tw,sh.
29	(peto or dersimonian or der simonian or fixed effect).tw,sh.
30	or/25-29
31	and/24,30
32	exp COHORT STUDIES/
33	cohort$.tw.
34	or/32-33
35	or/16,23,31,34
36	letter.pt.
37	comment.pt.
38	editorial.pt.
39	historical article.pt.
40	or/36-39
41	35 not 40
42	comparative study.pt.
43	or/41-42
44	exp PARTURITION/
45	exp LABOR, OBSTETRIC/
46	exp DELIVERY, OBSTETRIC/
47	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
48	or/44-47
49	FETAL MONITORING/
50	UTERINE MONITORING/
51	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).ti,ab.
52	((monitor$ or test$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).ti,ab.
53	or/49-52
54	exp FETAL HEART/
55	HEART RATE, FETAL/
56	FETAL DISTRESS/
57	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).ti,ab.
58	FHR.ti,ab.
59	exp AUSCULTATION/
60	STETHOSCOPES/
61	(auscultat$ or IA or pin?ard$ or fetoscop$).ti,ab.
62	((f?etal or f?etus$) adj3 stethoscop$).ti,ab.
63	"listening in".ti,ab.
64	(non stress test$ or non?stress test$ or NST).ti,ab.
65	ULTRASONOGRAPHY, DOPPLER/
66	ECHOCARDIOGRAPHY, DOPPLER/
67	sonicaid$.ti,ab.
68	((ultraso$ or echo$ or sono$ or flowmet$ or doppler$) adj5 (f?etal or f?etus$)).ti,ab.
69	CARDIOTOCOGRAPHY/

#	Searches
70	(cardiotocogra$ or CTG or EFM).ti,ab.
71	or/54-70
72	and/48,53,71
73	((cardiotocogra$ or CTG or auscultat$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).ti,ab.
74	or/72-73
75	limit 74 to english language
76	LETTER/
77	EDITORIAL/
78	NEWS/
79	exp HISTORICAL ARTICLE/
80	ANECDOTES AS TOPIC/
81	COMMENT/
82	CASE REPORT/
83	(letter or comment* or abstracts).ti.
84	or/76-83
85	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
86	84 not 85
87	ANIMALS/ not HUMANS/
88	exp ANIMALS, LABORATORY/
89	exp ANIMAL EXPERIMENTATION/
90	exp MODELS, ANIMAL/
91	exp RODENTIA/
92	(rat or rats or mouse or mice).ti.
93	or/86-92
94	75 not 93
95	and/43,94
96	limit 95 to yr="2005 -Current"

Database(s): Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations

#	Searches
1	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
2	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).ti,ab.
3	((monitor$ or test$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).ti,ab.
4	or/2-3
5	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).ti,ab.
6	FHR.ti,ab.
7	(auscultat$ or IA or pin?ard$ or fetoscop$).ti,ab.
8	((f?etal or f?etus$) adj3 stethoscop$).ti,ab.
9	"listening in".ti,ab.
10	(non stress test$ or non?stress test$ or NST).ti,ab.
11	sonicaid$.ti,ab.
12	((ultraso$ or echo$ or sono$ or flowmet$ or doppler$) adj5 (f?etal or f?etus$)).ti,ab.
13	(cardiotocogra$ or CTG or EFM).ti,ab.

#	Searches
14	or/5-13
15	and/1,4,14
16	((cardiotocogra$ or CTG or auscultat$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).ti,ab.
17	or/15-16

Database(s): EBM Reviews - Cochrane Central Register of Controlled Trials

#	Searches
1	exp PARTURITION/
2	exp LABOR, OBSTETRIC/
3	exp DELIVERY, OBSTETRIC/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
5	or/1-4
6	FETAL MONITORING/
7	UTERINE MONITORING/
8	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).ti,ab.
9	((monitor$ or test$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).ti,ab.
10	or/6-9
11	exp FETAL HEART/
12	HEART RATE, FETAL/
13	FETAL DISTRESS/
14	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).ti,ab.
15	FHR.ti,ab.
16	exp AUSCULTATION/
17	STETHOSCOPES/
18	(auscultat$ or IA or pin?ard$ or fetoscop$).ti,ab.
19	((f?etal or f?etus$) adj3 stethoscop$).ti,ab.
20	"listening in".ti,ab.
21	(non stress test$ or non?stress test$ or NST).ti,ab.
22	ULTRASONOGRAPHY, DOPPLER/
23	ECHOCARDIOGRAPHY, DOPPLER/
24	sonicaid$.ti,ab.
25	((ultraso$ or echo$ or sono$ or flowmet$ or doppler$) adj5 (f?etal or f?etus$)).ti,ab.
26	CARDIOTOCOGRAPHY/
27	(cardiotocogra$ or CTG or EFM).ti,ab.
28	or/11-27
29	and/5,10,28
30	((cardiotocogra$ or CTG or auscultat$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).ti,ab.
31	or/29-30

Database(s): EBM Reviews - Cochrane Database of Systematic Reviews, EBM Reviews - Database of Abstracts of Reviews of Effects

#	Searches
1	PARTURITION.kw.

#	Searches
2	LABOR, OBSTETRIC.kw.
3	DELIVERY, OBSTETRIC.kw.
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).tw,tx.
5	or/1-4
6	FETAL MONITORING.kw.
7	UTERINE MONITORING.kw.
8	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).tw,tx.
9	((monitor$ or test$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).tw,tx.
10	or/6-9
11	FETAL HEART.kw.
12	HEART RATE, FETAL.kw.
13	FETAL DISTRESS.kw.
14	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).tw,tx.
15	FHR.tw,tx.
16	AUSCULTATION.kw.
17	STETHOSCOPES.kw.
18	(auscultat$ or IA or pin?ard$ or fetoscop$).tw,tx.
19	((f?etal or f?etus$) adj3 stethoscop$).tw,tx.
20	"listening in".tw,tx.
21	(non stress test$ or non?stress test$ or NST).tw,tx.
22	ULTRASONOGRAPHY, DOPPLER.kw.
23	ECHOCARDIOGRAPHY, DOPPLER.kw.
24	sonicaid$.tw,tx.
25	((ultraso$ or echo$ or sono$ or flowmet$ or doppler$) adj5 (f?etal or f?etus$)).tw,tx.
26	CARDIOTOCOGRAPHY.kw.
27	(cardiotocogra$ or CTG or EFM).tw,tx.
28	or/11-27
29	and/5,10,28
30	((cardiotocogra$ or CTG or auscultat$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).tw,tx.
31	or/29-30

Database(s): EBM Reviews - Health Technology Assessment

#	Searches
1	exp PARTURITION/
2	exp LABOR, OBSTETRIC/
3	exp DELIVERY, OBSTETRIC/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).tw.
5	or/1-4
6	FETAL MONITORING/
7	UTERINE MONITORING/
8	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).tw.
9	((monitor$ or test$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).tw.

#	Searches
10	or/6-9
11	exp FETAL HEART/
12	HEART RATE, FETAL/
13	FETAL DISTRESS/
14	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).tw.
15	FHR.tw.
16	exp AUSCULTATION/
17	STETHOSCOPES/
18	(auscultat$ or IA or pin?ard$ or fetoscop$).tw.
19	((f?etal or f?etus$) adj3 stethoscop$).tw.
20	"listening in".tw.
21	(non stress test$ or non?stress test$ or NST).tw.
22	ULTRASONOGRAPHY, DOPPLER/
23	ECHOCARDIOGRAPHY, DOPPLER/
24	sonicaid$.tw.
25	((ultraso$ or echo$ or sono$ or flowmet$ or doppler$) adj5 (f?etal or f?etus$)).tw.
26	CARDIOTOCOGRAPHY/
27	(cardiotocogra$ or CTG or EFM).tw.
28	or/11-27
29	and/5,10,28
30	((cardiotocogra$ or CTG or auscultat$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).tw.
31	or/29-30

Database(s): Embase

#	Searches
1	CLINICAL TRIAL/ or "CLINICAL TRIAL (TOPIC)"/
2	(clinic$ adj5 trial$).tw,sh.
3	SINGLE BLIND PROCEDURE/
4	DOUBLE BLIND PROCEDURE/
5	RANDOM ALLOCATION/
6	CROSSOVER PROCEDURE/
7	PLACEBO/
8	placebo$.tw,sh.
9	random$.tw,sh.
10	RANDOMIZED CONTROLLED TRIAL/ or "RANDOMIZED CONTROLLED TRIAL (TOPIC)"/
11	((single or double or triple or treble) adj (blind$ or mask$)).tw,sh.
12	randomi?ed control$ trial$.tw.
13	or/1-12
14	META ANALYSIS/
15	((meta adj analy$) or metaanalys$ or meta-analy$).tw,sh.
16	(systematic$ adj5 (review$ or overview$)).tw,sh.
17	(methodologic$ adj5 (review$ or overview$)).tw,sh.
18	or/14-17
19	review.pt.

#	Searches
20	(medline or medlars or embase).ab.
21	(scisearch or science citation index).ab.
22	(psychlit or psyclit or psychinfo or psycinfo or cinahl or cochrane).ab.
23	((hand or manual$) adj2 search$).tw.
24	(electronic database$ or bibliographic database$ or computeri?ed database$ or online database$).tw.
25	(pooling or pooled or mantel haenszel).tw.
26	(peto or dersimonian or "der simonian" or fixed effect).tw.
27	or/20-26
28	and/19,27
29	COHORT ANALYSIS/
30	LONGITUDINAL STUDY/
31	FOLLOW UP/
32	PROSPECTIVE STUDY/
33	cohort$.tw.
34	or/29-33
35	or/13,18,28,34
36	(book or conference paper or editorial or letter or note or proceeding or short survey).pt.
37	35 not 36
38	COMPARATIVE STUDY/
39	or/37-38
40	BIRTH/
41	exp CHILDBIRTH/
42	exp DELIVERY/
43	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
44	or/40-43
45	FETUS MONITORING/
46	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).ti,ab.
47	((monitor$ or test$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).ti,ab.
48	or/45-47
49	FETUS HEART/
50	FETUS HEART RATE/
51	FETUS DISTRESS/
52	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).ti,ab.
53	FHR.ti,ab.
54	exp FETUS MONITOR/
55	AUSCULTATION/ or HEART AUSCULTATION/
56	STETHOSCOPE/
57	(auscultat$ or IA or pin?ard$ or fetoscop$).ti,ab.
58	((f?etal or f?etus$) adj3 stethoscop$).ti,ab.
59	"listening in".ti,ab.
60	(non stress test$ or non?stress test$ or NST).ti,ab.
61	DOPPLER FLOWMETRY/
62	DOPPLER ECHOCARDIOGRAPHY/

#	Searches
63	sonicaid$.ti,ab.
64	((ultraso$ or echo$ or sono$ or flowmet$ or doppler$) adj5 (f?etal or f?etus$)).ti,ab.
65	CARDIOTOCOGRAPHY/
66	CARDIOTOCOGRAPH/
67	(cardiotocogra$ or CTG or EFM).ti,ab.
68	or/49-67
69	and/44,48,68
70	((cardiotocogra$ or CTG or auscultat$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).ti,ab.
71	or/69-70
72	limit 71 to english language
73	conference abstract.pt.
74	letter.pt. or LETTER/
75	note.pt.
76	editorial.pt.
77	CASE REPORT/ or CASE STUDY/
78	(letter or comment* or abstracts).ti.
79	or/73-78
80	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
81	79 not 80
82	ANIMAL/ not HUMAN/
83	NONHUMAN/
84	exp ANIMAL EXPERIMENT/
85	exp EXPERIMENTAL ANIMAL/
86	ANIMAL MODEL/
87	exp RODENT/
88	(rat or rats or mouse or mice).ti.
89	or/81-88
90	72 not 89
91	and/39,90

Database(s): CINAHL via EBSCOhost

#	Query	Limiters/Expanders
S47	S6 and S46	Limiters - English Language; Exclude MEDLINE records; Human Search modes - Boolean/Phrase
S46	S7 or S8 or S9 or S10 or S11 or S12 or S13 or S14 or S15 or S16 or S17 or S18 or S19 or S20 or S21 or S22 or S23 or S24 or S25 or S26 or S27 or S28 or S29 or S30 or S31 or S32 or S33 or S34 or S35 or S36 or S37 or S38 or S39 or S40 or S41 or S42 or S43 or S44 or S45	Search modes - Boolean/Phrase
S45	(MH "TELEMETRY")	Search modes - Boolean/Phrase
S44	TI (EFM) or AB (EFM)	Search modes - Boolean/Phrase

#	Query	Limiters/Expanders
S43	TI (cardiotocograph*) or AB (cardiotograph*)	Search modes - Boolean/Phrase
S42	AB (sonicaid* or ultraso* or echo* or sono* or flowmet* or doppler*)	Search modes - Boolean/Phrase
S41	TI (sonicaid* or ultraso* or echo* or sono* or flowmet* or doppler*)	Search modes - Boolean/Phrase
S40	MH ECHOCARDIOGRAPHY, DOPPLER	Search modes - Boolean/Phrase
S39	MH ULTRASONOGRAPHY, DOPPLER	Search modes - Boolean/Phrase
S38	TI (non stress test* or nonstress test* or NST) or AB (non stress test* or nonstress test* or NST)	Search modes - Boolean/Phrase
S37	MH NONSTRESS TESTING, FETAL	Search modes - Boolean/Phrase
S36	TI ("listening in") or AB ("listening in")	Search modes - Boolean/Phrase
S35	TI (auscultat* or IA or pin#ard* or fetoscop*) or AB (auscultat* or IA or pin#ard* or fetoscop*)	Search modes - Boolean/Phrase
S34	MH STETHOSCOPES	Search modes - Boolean/Phrase
S33	MH AUSCULTATION+	Search modes - Boolean/Phrase
S32	AB (umbilic* N3 gas*)	Search modes - Boolean/Phrase
S31	TI (umbilic* N3 gas*)	Search modes - Boolean/Phrase
S30	AB (cord N3 gas*)	Search modes - Boolean/Phrase
S29	TI (cord N3 gas*)	Search modes - Boolean/Phrase
S28	(MH "CORDOCENTESIS")	Search modes - Boolean/Phrase
S27	TI (CTG) or AB (CTG)	Search modes - Boolean/Phrase
S26	AB (ST?segment)	Search modes - Boolean/Phrase
S25	TI (ST?segment)	Search modes - Boolean/Phrase
S24	TI (QRS) or AB (QRS)	Search modes - Boolean/Phrase
S23	TI (electrocardiogr*) or AB (electrocardiogr*)	Search modes - Boolean/Phrase
S22	TI (ECG) or AB (ECG)	Search modes - Boolean/Phrase
S21	(MH "ELECTROCARDIOGRAPHY+") OR (MH "ELECTROCARDIOGRAPHY, AMBULATORY") OR (MH "QRS COMPLEX") OR (MH "ST SEGMENT") OR (MH "VECTORCARDIOGRAPHY+")	Search modes - Boolean/Phrase
S20	(MH "FETAL MONITORING, ELECTRONIC+")	Search modes - Boolean/Phrase
S19	(fetal N3 blood) or AB (fetus* N3 blood) or AB (foetal N3 blood) or AB (foetus* N3 blood)	Search modes - Boolean/Phrase

#	Query	Limiters/Expanders
S18	TI (FBS) or AB (FBS)	Search modes - Boolean/Phrase
S17	(MH "ACID-BASE IMBALANCE+")	Search modes - Boolean/Phrase
S16	(MH "FETAL HEART")	Search modes - Boolean/Phrase
S15	(MH "FETAL BLOOD")	Search modes - Boolean/Phrase
S14	TI (FHR) or AB (FHR)	Search modes - Boolean/Phrase
S13	AB (fetal N3 heart*) or AB (fetus* N3 heart*) or AB (foetal N3 heart*) or AB (foetus* N3 heart*)	Search modes - Boolean/Phrase
S12	TI (fetal N3 heart*) or TI (fetus* N3 heart*) or TI (foetal N3 heart*) or TI (foetus* N3 heart*)	Search modes - Boolean/Phrase
S11	MH HEART RATE, FETAL	Search modes - Boolean/Phrase
S10	AB (fetal N3 monitor*) or AB (fetus* N3 monitor*) or AB (foetal N3 monitor*) or AB (foetus* N3 monitor*)	Search modes - Boolean/Phrase
S9	TI (fetal N3 monitor*) or TI (fetus* N3 monitor*) or TI (foetal N3 monitor*) or TI (foetus* N3 monitor*)	Search modes - Boolean/Phrase
S8	MH UTERINE MONITORING	Search modes - Boolean/Phrase
S7	MH FETAL MONITORING+	Search modes - Boolean/Phrase
S6	S1 or S2 or S3 or S4 or S5	Search modes - Boolean/Phrase
S5	AB (partu* or birth* or childbirth* or intrapartu* or labo#r*)	Search modes - Boolean/Phrase
S4	TI (partu* or birth* or childbirth* or intrapartu* or labo#r*)	Search modes - Boolean/Phrase
S3	MH DELIVERY+	Search modes - Boolean/Phrase
S2	MH LABOR+	Search modes - Boolean/Phrase
S1	MH CHILDBIRTH+	Search modes - Boolean/Phrase

Health economics

Ovid MEDLINE(R)

#	Searches
1	ECONOMICS/
2	VALUE OF LIFE/
3	exp "COSTS AND COST ANALYSIS"/
4	exp ECONOMICS, HOSPITAL/
5	exp ECONOMICS, MEDICAL/
6	exp RESOURCE ALLOCATION/
7	ECONOMICS, NURSING/
8	ECONOMICS, PHARMACEUTICAL/
9	exp "FEES AND CHARGES"/

#	Searches
10	exp BUDGETS/
11	budget*.ti,ab.
12	cost*.ti,ab.
13	(economic* or pharmaco?economic*).ti,ab.
14	(price* or pricing*).ti,ab.
15	(financ* or fee or fees or expenditure* or saving*).ti,ab.
16	(value adj2 (money or monetary)).ti,ab.
17	resourc* allocat*.ti,ab.
18	(fund or funds or funding* or funded).ti,ab.
19	(ration or rations or rationing* or rationed).ti,ab.
20	ec.fs.
21	or/1-20
22	exp PARTURITION/
23	exp LABOR, OBSTETRIC/
24	exp DELIVERY, OBSTETRIC/
25	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
26	or/22-25
27	FETAL MONITORING/
28	UTERINE MONITORING/
29	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).ti,ab.
30	((monitor$ or test$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).ti,ab.
31	or/27-30
32	exp FETAL HEART/
33	HEART RATE, FETAL/
34	FETAL DISTRESS/
35	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).ti,ab.
36	FHR.ti,ab.
37	exp AUSCULTATION/
38	STETHOSCOPES/
39	(auscultat$ or IA or pin?ard$ or fetoscop$).ti,ab.
40	((f?etal or f?etus$) adj3 stethoscop$).ti,ab.
41	"listening in".ti,ab.
42	(non stress test$ or non?stress test$ or NST).ti,ab.
43	ULTRASONOGRAPHY, DOPPLER/
44	ECHOCARDIOGRAPHY, DOPPLER/
45	sonicaid$.ti,ab.
46	((ultraso$ or echo$ or sono$ or flowmet$ or doppler$) adj5 (f?etal or f?etus$)).ti,ab.
47	CARDIOTOCOGRAPHY/
48	(cardiotocogra$ or CTG or EFM).ti,ab.
49	or/32-48
50	and/26,31,49
51	((cardiotocogra$ or CTG or auscultat$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).ti,ab.
52	or/50-51

#	Searches
53	limit 52 to english language
54	LETTER/
55	EDITORIAL/
56	NEWS/
57	exp HISTORICAL ARTICLE/
58	ANECDOTES AS TOPIC/
59	COMMENT/
60	CASE REPORT/
61	(letter or comment* or abstracts).ti.
62	or/54-61
63	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
64	62 not 63
65	ANIMALS/ not HUMANS/
66	exp ANIMALS, LABORATORY/
67	exp ANIMAL EXPERIMENTATION/
68	exp MODELS, ANIMAL/
69	exp RODENTIA/
70	(rat or rats or mouse or mice).ti.
71	or/64-70
72	53 not 71
73	and/21,72

EBM Reviews - Cochrane Central Register of Controlled Trials

#	Searches
1	ECONOMICS/
2	VALUE OF LIFE/
3	exp "COSTS AND COST ANALYSIS"/
4	exp ECONOMICS, HOSPITAL/
5	exp ECONOMICS, MEDICAL/
6	exp RESOURCE ALLOCATION/
7	ECONOMICS, NURSING/
8	ECONOMICS, PHARMACEUTICAL/
9	exp "FEES AND CHARGES"/
10	exp BUDGETS/
11	budget*.ti,ab.
12	cost*.ti,ab.
13	(economic* or pharmaco?economic*).ti,ab.
14	(price* or pricing*).ti,ab.
15	(financ* or fee or fees or expenditure* or saving*).ti,ab.
16	(value adj2 (money or monetary)).ti,ab.
17	resourc* allocat*.ti,ab.
18	(fund or funds or funding* or funded).ti,ab.
19	(ration or rations or rationing* or rationed).ti,ab.
20	ec.fs.
21	or/1-20

#	Searches
22	exp PARTURITION/
23	exp LABOR, OBSTETRIC/
24	exp DELIVERY, OBSTETRIC/
25	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
26	or/22-25
27	FETAL MONITORING/
28	UTERINE MONITORING/
29	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).ti,ab.
30	((monitor$ or test$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).ti,ab.
31	or/27-30
32	exp FETAL HEART/
33	HEART RATE, FETAL/
34	FETAL DISTRESS/
35	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).ti,ab.
36	FHR.ti,ab.
37	exp AUSCULTATION/
38	STETHOSCOPES/
39	(auscultat$ or IA or pin?ard$ or fetoscop$).ti,ab.
40	((f?etal or f?etus$) adj3 stethoscop$).ti,ab.
41	"listening in".ti,ab.
42	(non stress test$ or non?stress test$ or NST).ti,ab.
43	ULTRASONOGRAPHY, DOPPLER/
44	ECHOCARDIOGRAPHY, DOPPLER/
45	sonicaid$.ti,ab.
46	((ultraso$ or echo$ or sono$ or flowmet$ or doppler$) adj5 (f?etal or f?etus$)).ti,ab.
47	CARDIOTOCOGRAPHY/
48	(cardiotocogra$ or CTG or EFM).ti,ab.
49	or/32-48
50	and/26,31,49
51	((cardiotocogra$ or CTG or auscultat$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).ti,ab.
52	or/50-51
53	and/21,52

EBM Reviews - Health Technology Assessment

#	Searches
1	exp PARTURITION/
2	exp LABOR, OBSTETRIC/
3	exp DELIVERY, OBSTETRIC/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).tw.
5	or/1-4
6	FETAL MONITORING/
7	UTERINE MONITORING/
8	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).tw.

#	Searches
9	((monitor$ or test$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).tw.
10	or/6-9
11	exp FETAL HEART/
12	HEART RATE, FETAL/
13	FETAL DISTRESS/
14	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).tw.
15	FHR.tw.
16	exp AUSCULTATION/
17	STETHOSCOPES/
18	(auscultat$ or IA or pin?ard$ or fetoscop$).tw.
19	((f?etal or f?etus$) adj3 stethoscop$).tw.
20	"listening in".tw.
21	(non stress test$ or non?stress test$ or NST).tw.
22	ULTRASONOGRAPHY, DOPPLER/
23	ECHOCARDIOGRAPHY, DOPPLER/
24	sonicaid$.tw.
25	((ultraso$ or echo$ or sono$ or flowmet$ or doppler$) adj5 (f?etal or f?etus$)).tw.
26	CARDIOTOCOGRAPHY/
27	(cardiotocogra$ or CTG or EFM).tw.
28	or/11-27
29	and/5,10,28
30	((cardiotocogra$ or CTG or auscultat$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).tw.
31	or/29-30

EBM Reviews - NHS Economic Evaluation Database

#	Searches
1	exp PARTURITION/
2	exp LABOR, OBSTETRIC/
3	exp DELIVERY, OBSTETRIC/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).tw.
5	or/1-4
6	FETAL MONITORING/
7	UTERINE MONITORING/
8	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).tw.
9	((monitor$ or test$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).tw.
10	or/6-9
11	exp FETAL HEART/
12	HEART RATE, FETAL/
13	FETAL DISTRESS/
14	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).tw.
15	FHR.tw.
16	exp AUSCULTATION/

#	Searches
17	STETHOSCOPES/
18	(auscultat$ or IA or pin?ard$ or fetoscop$).tw.
19	((f?etal or f?etus$) adj3 stethoscop$).tw.
20	"listening in".tw.
21	(non stress test$ or non?stress test$ or NST).tw.
22	ULTRASONOGRAPHY, DOPPLER/
23	ECHOCARDIOGRAPHY, DOPPLER/
24	sonicaid$.tw.
25	((ultraso$ or echo$ or sono$ or flowmet$ or doppler$) adj5 (f?etal or f?etus$)).tw.
26	CARDIOTOCOGRAPHY/
27	(cardiotocogra$ or CTG or EFM).tw.
28	or/11-27
29	and/5,10,28
30	((cardiotocogra$ or CTG or auscultat$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).tw.
31	or/29-30

Embase

#	Searches
1	HEALTH ECONOMICS/
2	exp ECONOMIC EVALUATION/
3	exp HEALTH CARE COST/
4	exp FEE/
5	BUDGET/
6	FUNDING/
7	RESOURCE ALLOCATION/
8	budget*.ti,ab.
9	cost*.ti,ab.
10	(economic* or pharmaco?economic*).ti,ab.
11	(price* or pricing*).ti,ab.
12	(financ* or fee or fees or expenditure* or saving*).ti,ab.
13	(value adj2 (money or monetary)).ti,ab.
14	resourc* allocat*.ti,ab.
15	(fund or funds or funding* or funded).ti,ab.
16	(ration or rations or rationing* or rationed).ti,ab.
17	or/1-16
18	BIRTH/
19	exp CHILDBIRTH/
20	exp DELIVERY/
21	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
22	or/18-21
23	FETUS MONITORING/
24	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).ti,ab.
25	((monitor$ or test$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).ti,ab.
26	or/23-25

#	Searches
27	FETUS HEART/
28	FETUS HEART RATE/
29	FETUS DISTRESS/
30	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).ti,ab.
31	FHR.ti,ab.
32	exp FETUS MONITOR/
33	AUSCULTATION/ or HEART AUSCULTATION/
34	STETHOSCOPE/
35	(auscultat$ or IA or pin?ard$ or fetoscop$).ti,ab.
36	((f?etal or f?etus$) adj3 stethoscop$).ti,ab.
37	"listening in".ti,ab.
38	(non stress test$ or non?stress test$ or NST).ti,ab.
39	DOPPLER FLOWMETRY/
40	DOPPLER ECHOCARDIOGRAPHY/
41	sonicaid$.ti,ab.
42	((ultraso$ or echo$ or sono$ or flowmet$ or doppler$) adj5 (f?etal or f?etus$)).ti,ab.
43	CARDIOTOCOGRAPHY/
44	CARDIOTOCOGRAPH/
45	(cardiotocogra$ or CTG or EFM).ti,ab.
46	or/27-45
47	and/22,26,46
48	((cardiotocogra$ or CTG or auscultat$) adj3 (admission or admit$ or select$ or routine$ or intermittent$ or universal$ or continu$ or interval$)).ti,ab.
49	or/47-48
50	limit 49 to english language
51	conference abstract.pt.
52	letter.pt. or LETTER/
53	note.pt.
54	editorial.pt.
55	CASE REPORT/ or CASE STUDY/
56	(letter or comment* or abstracts).ti.
57	or/51-56
58	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
59	57 not 58
60	ANIMAL/ not HUMAN/
61	NONHUMAN/
62	exp ANIMAL EXPERIMENT/
63	exp EXPERIMENTAL ANIMAL/
64	ANIMAL MODEL/
65	exp RODENT/
66	(rat or rats or mouse or mice).ti.
67	or/59-66
68	50 not 67
69	and/17,68

D.2 Intermittent auscultation compared with cardiotocography in the presence of meconium stained liquor

The search strategies below are reproduced from CG190 and were re-run from January 2014 as part of the 2016 evidence review.

Database(s): Ovid MEDLINE(R)

#	Searches
1	randomized controlled trial.pt.
2	controlled clinical trial.pt.
3	DOUBLE BLIND METHOD/
4	SINGLE BLIND METHOD/
5	RANDOM ALLOCATION/
6	or/1-5
7	((single or double or triple or treble) adj5 (blind$ or mask$)).tw,sh.
8	clinical trial.pt.
9	exp CLINICAL TRIAL/
10	exp CLINICAL TRIALS AS TOPIC/
11	(clinic$ adj5 trial$).tw,sh.
12	PLACEBOS/
13	placebo$.tw,sh.
14	random$.tw,sh.
15	or/7-14
16	or/6,15
17	META ANALYSIS/
18	META ANALYSIS AS TOPIC/
19	meta analysis.pt.
20	(metaanaly$ or meta-analy$ or (meta adj analy$)).tw,sh.
21	(systematic$ adj5 (review$ or overview$)).tw,sh.
22	(methodologic$ adj5 (review$ or overview$)).tw,sh.
23	or/17-22
24	review$.pt.
25	(medline or medlars or embase or cinahl or cochrane or psycinfo or psychinfo or psychlit or psyclit or "web of science" or "science citation" or scisearch).tw.
26	((hand or manual$) adj2 search$).tw.
27	(electronic database$ or bibliographic database$ or computeri?ed database$ or online database$).tw,sh.
28	(pooling or pooled or mantel haenszel).tw,sh.
29	(peto or dersimonian or der simonian or fixed effect).tw,sh.
30	or/25-29
31	and/24,30
32	exp COHORT STUDIES/
33	cohort$.tw.
34	or/32-33
35	or/16,23,31,34
36	letter.pt.
37	comment.pt.

#	Searches
38	editorial.pt.
39	historical article.pt.
40	or/36-39
41	35 not 40
42	comparative study.pt.
43	or/41-42
44	MECONIUM/
45	AMNIOTIC FLUID/
46	MECONIUM ASPIRATION SYNDROME/
47	(meconium$ or amniotic fluid or MSAF or MSL or MAS).ti,ab.
48	or/44-47
49	exp PARTURITION/
50	exp LABOR, OBSTETRIC/
51	exp DELIVERY, OBSTETRIC/
52	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
53	or/49-52
54	FETAL MONITORING/
55	UTERINE MONITORING/
56	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).ti,ab.
57	exp FETAL HEART/
58	HEART RATE, FETAL/
59	FETAL DISTRESS/
60	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).ti,ab.
61	FHR.ti,ab.
62	exp AUSCULTATION/
63	STETHOSCOPES/
64	(auscultat$ or IA or pin?ard$ or fetoscop$).ti,ab.
65	((f?etal or f?etus$) adj3 stethoscop$).ti,ab.
66	"listening in".ti,ab.
67	(non stress test$ or non?stress test$ or NST).ti,ab.
68	ULTRASONOGRAPHY, DOPPLER/
69	ECHOCARDIOGRAPHY, DOPPLER/
70	sonicaid$.ti,ab.
71	((ultraso$ or echo$ or sono$ or flowmet$ or doppler$) adj5 (f?etal or f?etus$)).ti,ab.
72	CARDIOTOCOGRAPHY/
73	(cardiotocogra$ or CTG or EFM).ti,ab.
74	or/54-73
75	and/48,53,74
76	limit 75 to english language
77	LETTER/
78	EDITORIAL/
79	NEWS/
80	exp HISTORICAL ARTICLE/
81	ANECDOTES AS TOPIC/
82	COMMENT/

#	Searches
83	CASE REPORT/
84	(letter or comment* or abstracts).ti.
85	or/77-84
86	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
87	85 not 86
88	ANIMALS/ not HUMANS/
89	exp ANIMALS, LABORATORY/
90	exp ANIMAL EXPERIMENTATION/
91	exp MODELS, ANIMAL/
92	exp RODENTIA/
93	(rat or rats or mouse or mice).ti.
94	or/87-93
95	76 not 94
96	and/43,95

Database(s): Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations

#	Searches
1	(meconium$ or amniotic fluid or MSAF or MSL or MAS).ti,ab.
2	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
3	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).ti,ab.
4	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).ti,ab.
5	FHR.ti,ab.
6	(auscultat$ or IA or pin?ard$ or fetoscop$).ti,ab.
7	((f?etal or f?etus$) adj3 stethoscop$).ti,ab.
8	"listening in".ti,ab.
9	(non stress test$ or non?stress test$ or NST).ti,ab.
10	sonicaid$.ti,ab.
11	((ultraso$ or echo$ or sono$ or flowmet$ or doppler$) adj5 (f?etal or f?etus$)).ti,ab.
12	(cardiotocogra$ or CTG or EFM).ti,ab.
13	or/3-12
14	and/1-2,13

Database(s): EBM Reviews - Cochrane Central Register of Controlled Trials

#	Searches
1	MECONIUM/
2	AMNIOTIC FLUID/
3	MECONIUM ASPIRATION SYNDROME/
4	(meconium$ or amniotic fluid or MSAF or MSL or MAS).ti,ab.
5	or/1-4
6	exp PARTURITION/
7	exp LABOR, OBSTETRIC/
8	exp DELIVERY, OBSTETRIC/
9	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
10	or/6-9
11	FETAL MONITORING/

#	Searches
12	UTERINE MONITORING/
13	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).ti,ab.
14	exp FETAL HEART/
15	HEART RATE, FETAL/
16	FETAL DISTRESS/
17	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).ti,ab.
18	FHR.ti,ab.
19	exp AUSCULTATION/
20	STETHOSCOPES/
21	(auscultat$ or IA or pin?ard$ or fetoscop$).ti,ab.
22	((f?etal or f?etus$) adj3 stethoscop$).ti,ab.
23	"listening in".ti,ab.
24	(non stress test$ or non?stress test$ or NST).ti,ab.
25	ULTRASONOGRAPHY, DOPPLER/
26	ECHOCARDIOGRAPHY, DOPPLER/
27	sonicaid$.ti,ab.
28	((ultraso$ or echo$ or sono$ or flowmet$ or doppler$) adj5 (f?etal or f?etus$)).ti,ab.
29	CARDIOTOCOGRAPHY/
30	(cardiotocogra$ or CTG or EFM).ti,ab.
31	or/11-30
32	and/5,10,31

Database(s): EBM Reviews - Cochrane Database of Systematic Reviews, EBM Reviews - Database of Abstracts of Reviews of Effects

#	Searches
1	MECONIUM.kw.
2	AMNIOTIC FLUID.kw.
3	MECONIUM ASPIRATION SYNDROME.kw.
4	(meconium$ or amniotic fluid or MSAF or MSL or MAS).tw,tx.
5	or/1-4
6	PARTURITION.kw.
7	LABOR, OBSTETRIC.kw.
8	DELIVERY, OBSTETRIC.kw.
9	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).tw,tx.
10	or/6-9
11	FETAL MONITORING.kw.
12	UTERINE MONITORING.kw.
13	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).tw,tx.
14	FETAL HEART.kw.
15	HEART RATE, FETAL.kw.
16	FETAL DISTRESS.kw.
17	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).tw,tx.
18	FHR.tw,tx.
19	AUSCULTATION.kw.

#	Searches
20	STETHOSCOPES.kw.
21	(auscultat$ or IA or pin?ard$ or fetoscop$).tw,tx.
22	((f?etal or f?etus$) adj3 stethoscop$).tw,tx.
23	"listening in".tw,tx.
24	(non stress test$ or non?stress test$ or NST).tw,tx.
25	ULTRASONOGRAPHY, DOPPLER.kw.
26	ECHOCARDIOGRAPHY, DOPPLER.kw.
27	sonicaid$.tw,tx.
28	((ultraso$ or echo$ or sono$ or flowmet$ or doppler$) adj5 (f?etal or f?etus$)).tw,tx.
29	CARDIOTOCOGRAPHY.kw.
30	(cardiotocogra$ or CTG or EFM).tw,tx.
31	or/11-30
32	and/5,10,31

Database(s): EBM Reviews - Health Technology Assessment

#	Searches
1	MECONIUM/
2	AMNIOTIC FLUID/
3	MECONIUM ASPIRATION SYNDROME/
4	(meconium$ or amniotic fluid or MSAF or MSL or MAS).tw.
5	or/1-4
6	exp PARTURITION/
7	exp LABOR, OBSTETRIC/
8	exp DELIVERY, OBSTETRIC/
9	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).tw.
10	or/6-9
11	FETAL MONITORING/
12	UTERINE MONITORING/
13	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).tw.
14	exp FETAL HEART/
15	HEART RATE, FETAL/
16	FETAL DISTRESS/
17	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).tw.
18	FHR.tw.
19	exp AUSCULTATION/
20	STETHOSCOPES/
21	(auscultat$ or IA or pin?ard$ or fetoscop$).tw.
22	((f?etal or f?etus$) adj3 stethoscop$).tw.
23	"listening in".tw.
24	(non stress test$ or non?stress test$ or NST).tw.
25	ULTRASONOGRAPHY, DOPPLER/
26	ECHOCARDIOGRAPHY, DOPPLER/
27	sonicaid$.tw.
28	((ultraso$ or echo$ or sono$ or flowmet$ or doppler$) adj5 (f?etal or f?etus$)).tw.
29	CARDIOTOCOGRAPHY/

#	Searches
30	(cardiotocogra$ or CTG or EFM).tw.
31	or/11-30
32	and/5,10,31

Database(s): Embase

#	Searches
1	CLINICAL TRIAL/ or "CLINICAL TRIAL (TOPIC)"/
2	(clinic$ adj5 trial$).tw,sh.
3	SINGLE BLIND PROCEDURE/
4	DOUBLE BLIND PROCEDURE/
5	RANDOM ALLOCATION/
6	CROSSOVER PROCEDURE/
7	PLACEBO/
8	placebo$.tw,sh.
9	random$.tw,sh.
10	RANDOMIZED CONTROLLED TRIAL/ or "RANDOMIZED CONTROLLED TRIAL (TOPIC)"/
11	((single or double or triple or treble) adj (blind$ or mask$)).tw,sh.
12	randomi?ed control$ trial$.tw.
13	or/1-12
14	META ANALYSIS/
15	((meta adj analy$) or metaanalys$ or meta-analy$).tw,sh.
16	(systematic$ adj5 (review$ or overview$)).tw,sh.
17	(methodologic$ adj5 (review$ or overview$)).tw,sh.
18	or/14-17
19	review.pt.
20	(medline or medlars or embase).ab.
21	(scisearch or science citation index).ab.
22	(psychlit or psyclit or psychinfo or psycinfo or cinahl or cochrane).ab.
23	((hand or manual$) adj2 search$).tw.
24	(electronic database$ or bibliographic database$ or computeri?ed database$ or online database$).tw.
25	(pooling or pooled or mantel haenszel).tw.
26	(peto or dersimonian or "der simonian" or fixed effect).tw.
27	or/20-26
28	and/19,27
29	COHORT ANALYSIS/
30	LONGITUDINAL STUDY/
31	FOLLOW UP/
32	PROSPECTIVE STUDY/
33	cohort$.tw.
34	or/29-33
35	or/13,18,28,34
36	(book or conference paper or editorial or letter or note or proceeding or short survey).pt.
37	35 not 36
38	COMPARATIVE STUDY/
39	or/37-38

#	Searches
40	MECONIUM/
41	exp AMNION FLUID/
42	MECONIUM ASPIRATION/
43	(meconium$ or amniotic fluid or MSAF or MSL or MAS).ti,ab.
44	or/40-43
45	BIRTH/
46	exp CHILDBIRTH/
47	exp DELIVERY/
48	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
49	or/45-48
50	FETUS MONITORING/
51	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).ti,ab.
52	FETUS HEART/
53	FETUS HEART RATE/
54	FETUS DISTRESS/
55	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).ti,ab.
56	FHR.ti,ab.
57	exp FETAL HEART MONITOR/
58	AUSCULTATION/ or HEART AUSCULTATION/
59	STETHOSCOPE/
60	(auscultat$ or IA or pin?ard$ or fetoscop$).ti,ab.
61	((f?etal or f?etus$) adj3 stethoscop$).ti,ab.
62	"listening in".ti,ab.
63	(non stress test$ or non?stress test$ or NST).ti,ab.
64	DOPPLER FLOWMETRY/
65	DOPPLER ECHOCARDIOGRAPHY/
66	sonicaid$.ti,ab.
67	((ultraso$ or echo$ or sono$ or flowmet$ or doppler$) adj5 (f?etal or f?etus$)).ti,ab.
68	CARDIOTOCOGRAPHY/
69	CARDIOTOCOGRAPH/
70	(cardiotocogra$ or CTG or EFM).ti,ab.
71	or/50-70
72	and/44,49,71
73	limit 72 to english language
74	conference abstract.pt.
75	letter.pt. or LETTER/
76	note.pt.
77	editorial.pt.
78	CASE REPORT/ or CASE STUDY/
79	(letter or comment* or abstracts).ti.
80	or/74-79
81	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
82	80 not 81
83	ANIMAL/ not HUMAN/
84	NONHUMAN/

#	Searches
85	exp ANIMAL EXPERIMENT/
86	exp EXPERIMENTAL ANIMAL/
87	ANIMAL MODEL/
88	exp RODENT/
89	(rat or rats or mouse or mice).ti.
90	or/82-89
91	73 not 90
92	and/39,91

Database(s): CINAHL via EBSCOhost

#	Query	Limiters/Expanders
S47	S6 and S46	Limiters - English Language; Exclude MEDLINE records; Human Search modes - Boolean/Phrase
S46	S7 or S8 or S9 or S10 or S11 or S12 or S13 or S14 or S15 or S16 or S17 or S18 or S19 or S20 or S21 or S22 or S23 or S24 or S25 or S26 or S27 or S28 or S29 or S30 or S31 or S32 or S33 or S34 or S35 or S36 or S37 or S38 or S39 or S40 or S41 or S42 or S43 or S44 or S45	Search modes - Boolean/Phrase
S45	(MH "TELEMETRY")	Search modes - Boolean/Phrase
S44	TI (EFM) or AB (EFM)	Search modes - Boolean/Phrase
S43	TI (cardiotocograph*) or AB (cardiotograph*)	Search modes - Boolean/Phrase
S42	AB (sonicaid* or ultraso* or echo* or sono* or flowmet* or doppler*)	Search modes - Boolean/Phrase
S41	TI (sonicaid* or ultraso* or echo* or sono* or flowmet* or doppler*)	Search modes - Boolean/Phrase
S40	MH ECHOCARDIOGRAPHY, DOPPLER	Search modes - Boolean/Phrase
S39	MH ULTRASONOGRAPHY, DOPPLER	Search modes - Boolean/Phrase
S38	TI (non stress test* or nonstress test* or NST) or AB (non stress test* or nonstress test* or NST)	Search modes - Boolean/Phrase
S37	MH NONSTRESS TESTING, FETAL	Search modes - Boolean/Phrase
S36	TI ("listening in") or AB ("listening in")	Search modes - Boolean/Phrase
S35	TI (auscultat* or IA or pin#ard* or fetoscop*) or AB (auscultat* or IA or pin#ard* or fetoscop*)	Search modes - Boolean/Phrase
S34	MH STETHOSCOPES	Search modes - Boolean/Phrase
S33	MH AUSCULTATION+	Search modes - Boolean/Phrase
S32	AB (umbilic* N3 gas*)	Search modes - Boolean/Phrase

#	Query	Limiters/Expanders
S31	TI (umbilic* N3 gas*)	Search modes - Boolean/Phrase
S30	AB (cord N3 gas*)	Search modes - Boolean/Phrase
S29	TI (cord N3 gas*)	Search modes - Boolean/Phrase
S28	(MH "CORDOCENTESIS")	Search modes - Boolean/Phrase
S27	TI (CTG) or AB (CTG)	Search modes - Boolean/Phrase
S26	AB (ST?segment)	Search modes - Boolean/Phrase
S25	TI (ST?segment)	Search modes - Boolean/Phrase
S24	TI (QRS) or AB (QRS)	Search modes - Boolean/Phrase
S23	TI (electrocardiogr*) or AB (electrocardiogr*)	Search modes - Boolean/Phrase
S22	TI (ECG) or AB (ECG)	Search modes - Boolean/Phrase
S21	(MH "ELECTROCARDIOGRAPHY+") OR (MH "ELECTROCARDIOGRAPHY, AMBULATORY") OR (MH "QRS COMPLEX") OR (MH "ST SEGMENT") OR (MH "VECTORCARDIOGRAPHY+")	Search modes - Boolean/Phrase
S20	(MH "FETAL MONITORING, ELECTRONIC+")	Search modes - Boolean/Phrase
S19	(fetal N3 blood) or AB (fetus* N3 blood) or AB (foetal N3 blood) or AB (foetus* N3 blood)	Search modes - Boolean/Phrase
S18	TI (FBS) or AB (FBS)	Search modes - Boolean/Phrase
S17	(MH "ACID-BASE IMBALANCE+")	Search modes - Boolean/Phrase
S16	(MH "FETAL HEART")	Search modes - Boolean/Phrase
S15	(MH "FETAL BLOOD")	Search modes - Boolean/Phrase
S14	TI (FHR) or AB (FHR)	Search modes - Boolean/Phrase
S13	AB (fetal N3 heart*) or AB (fetus* N3 heart*) or AB (foetal N3 heart*) or AB (foetus* N3 heart*)	Search modes - Boolean/Phrase
S12	TI (fetal N3 heart*) or TI (fetus* N3 heart*) or TI (foetal N3 heart*) or TI (foetus* N3 heart*)	Search modes - Boolean/Phrase
S11	MH HEART RATE, FETAL	Search modes - Boolean/Phrase
S10	AB (fetal N3 monitor*) or AB (fetus* N3 monitor*) or AB (foetal N3 monitor*) or AB (foetus* N3 monitor*)	Search modes - Boolean/Phrase
S9	TI (fetal N3 monitor*) or TI (fetus* N3 monitor*) or TI (foetal N3 monitor*) or TI (foetus* N3 monitor*)	Search modes - Boolean/Phrase
S8	MH UTERINE MONITORING	Search modes - Boolean/Phrase
S7	MH FETAL MONITORING+	Search modes - Boolean/Phrase

#	Query	Limiters/Expanders
S6	S1 or S2 or S3 or S4 or S5	Search modes - Boolean/Phrase
S5	AB (partu* or birth* or childbirth* or intrapartu* or labo#r*)	Search modes - Boolean/Phrase
S4	TI (partu* or birth* or childbirth* or intrapartu* or labo#r*)	Search modes - Boolean/Phrase
S3	MH DELIVERY+	Search modes - Boolean/Phrase
S2	MH LABOR+	Search modes - Boolean/Phrase
S1	MH CHILDBIRTH+	Search modes - Boolean/Phrase

D.3 Interpretation of cardiotocograph traces

The search strategies below are reproduced from CG190 and were re-run from January 2014 as part of the 2016 evidence review.

Database(s): Ovid MEDLINE(R)

#	Searches
1	exp PARTURITION/
2	exp LABOR, OBSTETRIC/
3	exp DELIVERY, OBSTETRIC/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$ or deliver$).ti,ab.
5	((pregnan$ or labo?r$) adj3 term).ti,ab.
6	or/1-5
7	exp FETAL HEART/
8	HEART RATE, FETAL/
9	FETAL DISTRESS/
10	((f?etal or f?etus$) adj3 (heart$ or distress$ or compromis$)).ti,ab.
11	FHR.ti,ab.
12	or/7-11
13	FETAL MONITORING/
14	UTERINE MONITORING/
15	((f?etal or f?etus$ or uter$) adj3 (monitor$ or observ$ or assess$)).ti,ab.
16	ELECTROCARDIOGRAPHY/
17	electrocardiogra$.ti,ab.
18	(FECG or ECG or EKG).ti,ab.
19	CARDIOTOCOGRAPHY/
20	(cardiotocogra$ or CTG or EFM).ti,ab.
21	(electronic adj (f?etal or f?etus) adj monitor$).ti,ab.
22	or/13-21
23	((FHR or EFM or CGT or cardiotocogra$) adj3 (ominous or reassur$ or non?reassur$)).ti,ab.
24	(heart$ adj3 (trac$ or pattern? or frequen$ or period? or varia$)).ti,ab.
25	exp TACHYCARDIA/
26	BRADYCARDIA/
27	(tachycardi$ or tachyarrhythmi$ or bradycardi$ or bradyarrhythmi$).ti,ab.

#	Searches
28	((baseline$ or acceleration? or deceleration?) adj10 (heart$ or f?etal or f?etus or FHR or early or late or varia$ or typical or atypical or normal or abnormal)).ti,ab.
29	(beat-to-beat adj varia$).ti,ab.
30	((sinusoidal or pseudo?sinusoidal or non?sinusoidal) adj (trac$ or pattern? or heart$)).ti,ab.
31	or/23-30
32	and/6,12,22,31
33	((f?etal or f?etus) adj3 (trac$ or monitor$ or pattern?) adj5 (characteristic? or classif$ or interpret$ or signif$ or prognos$)).ti,ab.
34	((FHR or EFM or CTG or cardiotocogra$) adj (characteristic? or classif$ or interpret$ or signif$ or prognos$)).ti,ab.
35	((f?etal or f?etus) adj heart rate? adj5 (characteristic? or classif$ or interpret$ or signif$ or prognos$ or vary or varies or varia$ or chang$ or assess$ or analy$ or predict$)).ti.
36	or/32-35
37	limit 36 to english language
38	LETTER/
39	EDITORIAL/
40	NEWS/
41	exp HISTORICAL ARTICLE/
42	ANECDOTES AS TOPIC/
43	COMMENT/
44	CASE REPORT/
45	(letter or comment* or abstracts).ti.
46	or/38-45
47	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
48	46 not 47
49	ANIMALS/ not HUMANS/
50	exp ANIMALS, LABORATORY/
51	exp ANIMAL EXPERIMENTATION/
52	exp MODELS, ANIMAL/
53	exp RODENTIA/
54	(rat or rats or mouse or mice).ti.
55	or/48-54
56	37 not 55

Database(s): Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations

#	Searches
1	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$ or deliver$).ti,ab.
2	((pregnan$ or labo?r$) adj3 term).ti,ab.
3	or/1-2
4	((f?etal or f?etus$) adj3 (heart$ or distress$ or compromis$)).ti,ab.
5	FHR.ti,ab.
6	or/4-5
7	((f?etal or f?etus$ or uter$) adj3 (monitor$ or observ$ or assess$)).ti,ab.
8	electrocardiogra$.ti,ab.
9	(FECG or ECG or EKG).ti,ab.
10	(cardiotocogra$ or CTG or EFM).ti,ab.

#	Searches
11	(electronic adj (f?etal or f?etus) adj monitor$).ti,ab.
12	or/7-11
13	((FHR or EFM or CGT or cardiotocogra$) adj3 (ominous or reassur$ or non?reassur$)).ti,ab.
14	(heart$ adj3 (trac$ or pattern? or frequen$ or period? or varia$)).ti,ab.
15	(tachycardi$ or tachyarrhythmi$ or bradycardi$ or bradyarrhythmi$).ti,ab.
16	((baseline$ or acceleration? or deceleration?) adj10 (heart$ or f?etal or f?etus or FHR or early or late or varia$ or typical or atypical or normal or abnormal)).ti,ab.
17	(beat-to-beat adj varia$).ti,ab.
18	((sinusoidal or pseudo?sinusoidal or non?sinusoidal) adj (trac$ or pattern? or heart$)).ti,ab.
19	or/13-18
20	and/3,6,12,19
21	((f?etal or f?etus) adj3 (trac$ or monitor$ or pattern?) adj5 (characteristic? or classif$ or interpret$ or signif$ or prognos$)).ti,ab.
22	((FHR or EFM or CTG or cardiotocogra$) adj (characteristic? or classif$ or interpret$ or signif$ or prognos$)).ti,ab.
23	((f?etal or f?etus) adj heart rate? adj5 (characteristic? or classif$ or interpret$ or signif$ or prognos$ or vary or varies or varia$ or chang$ or assess$ or analy$ or predict$)).ti.
24	or/20-23

Database(s): EBM Reviews - Cochrane Central Register of Controlled Trials

#	Searches
1	exp PARTURITION/
2	exp LABOR, OBSTETRIC/
3	exp DELIVERY, OBSTETRIC/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$ or deliver$).ti,ab.
5	((pregnan$ or labo?r$) adj3 term).ti,ab.
6	or/1-5
7	exp FETAL HEART/
8	HEART RATE, FETAL/
9	FETAL DISTRESS/
10	((f?etal or f?etus$) adj3 (heart$ or distress$ or compromis$)).ti,ab.
11	FHR.ti,ab.
12	or/7-11
13	FETAL MONITORING/
14	UTERINE MONITORING/
15	((f?etal or f?etus$ or uter$) adj3 (monitor$ or observ$ or assess$)).ti,ab.
16	ELECTROCARDIOGRAPHY/
17	electrocardiogra$.ti,ab.
18	(FECG or ECG or EKG).ti,ab.
19	CARDIOTOCOGRAPHY/
20	(cardiotocogra$ or CTG or EFM).ti,ab.
21	(electronic adj (f?etal or f?etus) adj monitor$).ti,ab.
22	or/13-21
23	((FHR or EFM or CGT or cardiotocogra$) adj3 (ominous or reassur$ or non?reassur$)).ti,ab.
24	(heart$ adj3 (trac$ or pattern? or frequen$ or period? or varia$)).ti,ab.

#	Searches
25	exp TACHYCARDIA/
26	BRADYCARDIA/
27	(tachycardi$ or tachyarrhythmi$ or bradycardi$ or bradyarrhythmi$).ti,ab.
28	((baseline$ or acceleration? or deceleration?) adj10 (heart$ or f?etal or f?etus or FHR or early or late or varia$ or typical or atypical or normal or abnormal)).ti,ab.
29	(beat-to-beat adj varia$).ti,ab.
30	((sinusoidal or pseudo?sinusoidal or non?sinusoidal) adj (trac$ or pattern? or heart$)).ti,ab.
31	or/23-30
32	and/6,12,22,31
33	((f?etal or f?etus) adj3 (trac$ or monitor$ or pattern?) adj5 (characteristic? or classif$ or interpret$ or signif$ or prognos$)).ti,ab.
34	((FHR or EFM or CTG or cardiotocogra$) adj (characteristic? or classif$ or interpret$ or signif$ or prognos$)).ti,ab.
35	((f?etal or f?etus) adj heart rate? adj5 (characteristic? or classif$ or interpret$ or signif$ or prognos$ or vary or varies or varia$ or chang$ or assess$ or analy$ or predict$)).ti.
36	or/32-35

Database(s): EBM Reviews - Cochrane Database of Systematic Reviews, EBM Reviews - Database of Abstracts of Reviews of Effects

#	Searches
1	PARTURITION.kw.
2	LABOR, OBSTETRIC.kw.
3	DELIVERY, OBSTETRIC.kw.
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$ or deliver$).tw,tx.
5	((pregnan$ or labo?r$) adj3 term).tw,tx.
6	or/1-5
7	FETAL HEART.kw.
8	HEART RATE, FETAL.kw.
9	FETAL DISTRESS.kw.
10	((f?etal or f?etus$) adj3 (heart$ or distress$ or compromis$)).tw,tx.
11	FHR.tw,tx.
12	or/7-11
13	FETAL MONITORING.kw.
14	UTERINE MONITORING.kw.
15	((f?etal or f?etus$ or uter$) adj3 (monitor$ or observ$ or assess$)).tw,tx.
16	ELECTROCARDIOGRAPHY.kw.
17	electrocardiogra$.tw,tx.
18	(FECG or ECG or EKG).tw,tx.
19	CARDIOTOCOGRAPHY.kw.
20	(cardiotocogra$ or CTG or EFM).tw,tx.
21	(electronic adj (f?etal or f?etus) adj monitor$).tw,tx.
22	or/13-21
23	((FHR or EFM or CGT or cardiotocogra$) adj3 (ominous or reassur$ or non?reassur$)).tw,tx.
24	(heart$ adj3 (trac$ or pattern? or frequen$ or period? or varia$)).tw,tx.
25	TACHYCARDIA.kw.
26	BRADYCARDIA.kw.

#	Searches
27	(tachycardi$ or tachyarrhythmi$ or bradycardi$ or bradyarrhythmi$).tw,tx.
28	((baseline$ or acceleration? or deceleration?) adj10 (heart$ or f?etal or f?etus or FHR or early or late or varia$ or typical or atypical or normal or abnormal)).tw,tx.
29	(beat-to-beat adj varia$).tw,tx.
30	((sinusoidal or pseudo?sinusoidal or non?sinusoidal) adj (trac$ or pattern? or heart$)).tw,tx.
31	or/23-30
32	and/6,12,22,31
33	((f?etal or f?etus) adj3 (trac$ or monitor$ or pattern?) adj5 (characteristic? or classif$ or interpret$ or signif$ or prognos$)).tw,tx.
34	((FHR or EFM or CTG or cardiotocogra$) adj (characteristic? or classif$ or interpret$ or signif$ or prognos$)).tw,tx.
35	((f?etal or f?etus) adj heart rate? adj5 (characteristic? or classif$ or interpret$ or signif$ or prognos$ or vary or varies or varia$ or chang$ or assess$ or analy$ or predict$)).ti.
36	or/32-35

Database(s): EBM Reviews - Health Technology Assessment

#	Searches
1	exp PARTURITION/
2	exp LABOR, OBSTETRIC/
3	exp DELIVERY, OBSTETRIC/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$ or deliver$).tw.
5	((pregnan$ or labo?r$) adj3 term).tw.
6	or/1-5
7	exp FETAL HEART/
8	HEART RATE, FETAL/
9	FETAL DISTRESS/
10	((f?etal or f?etus$) adj3 (heart$ or distress$ or compromis$)).tw.
11	FHR.tw.
12	or/7-11
13	FETAL MONITORING/
14	UTERINE MONITORING/
15	((f?etal or f?etus$ or uter$) adj3 (monitor$ or observ$ or assess$)).tw.
16	ELECTROCARDIOGRAPHY/
17	electrocardiogra$.tw.
18	(FECG or ECG or EKG).tw.
19	CARDIOTOCOGRAPHY/
20	(cardiotocogra$ or CTG or EFM).tw.
21	(electronic adj (f?etal or f?etus) adj monitor$).tw.
22	or/13-21
23	((FHR or EFM or CGT or cardiotocogra$) adj3 (ominous or reassur$ or non?reassur$)).tw.
24	(heart$ adj3 (trac$ or pattern? or frequen$ or period? or varia$)).tw.
25	exp TACHYCARDIA/
26	BRADYCARDIA/
27	(tachycardi$ or tachyarrhythmi$ or bradycardi$ or bradyarrhythmi$).tw.
28	((baseline$ or acceleration? or deceleration?) adj10 (heart$ or f?etal or f?etus or FHR or early or late or varia$ or typical or atypical or normal or abnormal)).tw.
29	(beat-to-beat adj varia$).tw.

#	Searches
30	((sinusoidal or pseudo?sinusoidal or non?sinusoidal) adj (trac$ or pattern? or heart$)).tw.
31	or/23-30
32	and/6,12,22,31
33	((f?etal or f?etus) adj3 (trac$ or monitor$ or pattern?) adj5 (characteristic? or classif$ or interpret$ or signif$ or prognos$)).tw.
34	((FHR or EFM or CTG or cardiotocogra$) adj (characteristic? or classif$ or interpret$ or signif$ or prognos$)).tw.
35	((f?etal or f?etus) adj heart rate? adj5 (characteristic? or classif$ or interpret$ or signif$ or prognos$ or vary or varies or varia$ or chang$ or assess$ or analy$ or predict$)).ti.
36	or/32-35

Database(s): Embase

#	Searches
1	BIRTH/
2	exp CHILDBIRTH/
3	exp DELIVERY/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$ or deliver$).ti,ab.
5	((pregnan$ or labo?r$) adj3 term).ti,ab.
6	or/1-5
7	FETUS HEART/
8	FETUS HEART RATE/
9	FETUS DISTRESS/
10	((f?etal or f?etus$) adj3 (heart$ or distress$ or compromis$)).ti,ab.
11	FHR.ti,ab.
12	or/7-11
13	FETUS MONITORING/
14	FETAL HEART MONITOR/
15	FETAL PULSE OXIMETER/
16	FETAL ULTRASOUND MONITOR/
17	((f?etal or f?etus$ or uter$) adj3 (monitor$ or observ$ or assess$)).ti,ab.
18	ELECTROCARDIOGRAPHY/
19	FETUS ELECTROCARDIOGRAPHY/
20	FETAL ELECTROCARDIOGRAPH/
21	electrocardiogra$.ti,ab.
22	(FECG or ECG or EKG).ti,ab.
23	CARDIOTOCOGRAPHY/
24	CARDIOTOCOGRAPH/
25	(cardiotocogra$ or CTG or EFM).ti,ab.
26	(electronic adj (f?etal or f?etus) adj monitor$).ti,ab.
27	or/13-26
28	((FHR or EFM or CGT or cardiotocogra$) adj3 (ominous or reassur$ or non?reassur$)).ti,ab.
29	(heart$ adj3 (trac$ or pattern? or frequen$ or period? or varia$)).ti,ab.
30	exp TACHYCARDIA/
31	exp BRADYCARDIA/
32	(tachycardi$ or tachyarrhythmi$ or bradycardi$ or bradyarrhythmi$).ti,ab.

#	Searches
33	((baseline$ or acceleration? or deceleration?) adj10 (heart$ or f?etal or f?etus or FHR or early or late or varia$ or typical or atypical or normal or abnormal)).ti,ab.
34	(beat-to-beat adj varia$).ti,ab.
35	((sinusoidal or pseudo?sinusoidal or non?sinusoidal) adj (trac$ or pattern? or heart$)).ti,ab.
36	or/28-35
37	and/6,12,27,36
38	((f?etal or f?etus) adj3 (trac$ or monitor$ or pattern?) adj5 (characteristic? or classif$ or interpret$ or signif$ or prognos$)).ti,ab.
39	((FHR or EFM or CTG or cardiotocogra$) adj (characteristic? or classif$ or interpret$ or signif$ or prognos$)).ti,ab.
40	((f?etal or f?etus) adj heart rate? adj5 (characteristic? or classif$ or interpret$ or signif$ or prognos$ or vary or varies or varia$ or chang$ or assess$ or analy$ or predict$)).ti.
41	or/37-40
42	limit 41 to english language
43	conference abstract.pt.
44	letter.pt. or LETTER/
45	note.pt.
46	editorial.pt.
47	CASE REPORT/ or CASE STUDY/
48	(letter or comment* or abstracts).ti.
49	or/43-48
50	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
51	49 not 50
52	ANIMAL/ not HUMAN/
53	NONHUMAN/
54	exp ANIMAL EXPERIMENT/
55	exp EXPERIMENTAL ANIMAL/
56	ANIMAL MODEL/
57	exp RODENT/
58	(rat or rats or mouse or mice).ti.
59	or/51-58
60	42 not 59

D.4 Care in labour as a result of cardiotocography

The search strategies below were developed specifically for the 2016 evidence review because no search strategies were published in CG190 for this question.

Database: Medline; Medline EPub Ahead of Print; and Medline In-Process & Other Non-Indexed Citations

#	Searches
1	*FETAL MONITORING/
2	*UTERINE MONITORING/
3	*HEART RATE, FETAL/
4	exp *FETAL HEART/
5	*FETAL DISTRESS/
6	*CARDIOTOCOGRAPHY/

#	Searches
7	*ELECTROCARDIOGRAPHY/ and (PERIPARTUM PERIOD/ or PARTURITION/ or exp LABOR, OBSTETRIC/ or exp DELIVERY, OBSTETRIC/ or FETUS/)
8	or/1-7
9	(care or intervention? or action?).ab. /freq=2
10	RISK ASSESSMENT/
11	or/9-10
12	8 and 11
13	((((f?etal or f?etus$ or uter$) adj3 (heart$ or monitor$ or observ$ or assess$)) or FHR or EFM or cardiotocogra$ or CTG or ((electrocardiogra$ or ECG or EKG) adj3 (labo?r or birth or childbirth or partu$ or intra?part$ or peri?part$ or f?etal or f?etus$))) adj5 (concern$ or suspic$ or abnorm$ or non-reassur$ or pathological$)).ti,ab.
14	(care or intervention? or action?).ti,ab.
15	13 and 14
16	12 or 15
17	limit 16 to english language
18	LETTER/
19	EDITORIAL/
20	NEWS/
21	exp HISTORICAL ARTICLE/
22	ANECDOTES AS TOPIC/
23	COMMENT/
24	CASE REPORT/
25	(letter or comment*).ti.
26	or/18-25
27	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
28	26 not 27
29	ANIMALS/ not HUMANS/
30	exp ANIMALS, LABORATORY/
31	exp ANIMAL EXPERIMENTATION/
32	exp MODELS, ANIMAL/
33	exp RODENTIA/
34	(rat or rats or mouse or mice).ti.
35	or/28-34
36	17 not 35

Database: Cochrane Central Register of Controlled Trials

#	Searches
1	FETAL MONITORING/
2	UTERINE MONITORING/
3	HEART RATE, FETAL/
4	exp FETAL HEART/
5	FETAL DISTRESS/
6	CARDIOTOCOGRAPHY/
7	ELECTROCARDIOGRAPHY/ and (PERIPARTUM PERIOD/ or PARTURITION/ or exp LABOR, OBSTETRIC/ or exp DELIVERY, OBSTETRIC/ or FETUS/)
8	or/1-7
9	(care or intervention? or action?).ab. /freq=2

#	Searches
10	RISK ASSESSMENT/
11	or/9-10
12	8 and 11
13	((((f?etal or f?etus$ or uter$) adj3 (heart$ or monitor$ or observ$ or assess$)) or FHR or EFM or cardiotocogra$ or CTG or ((electrocardiogra$ or ECG or EKG) adj3 (labo?r or birth or childbirth or partu$ or intra?part$ or peri?part$ or f?etal or f?etus$))) adj5 (concern$ or suspic$ or abnorm$ or non-reassur$ or pathological$)).ti,ab.
14	(care or intervention? or action?).ti,ab.
15	13 and 14
16	12 or 15

Database: Cochrane Database of Systematic Reviews

#	Searches
1	FETAL MONITORING.kw.
2	UTERINE MONITORING.kw.
3	HEART RATE, FETAL.kw.
4	FETAL HEART.kw.
5	FETAL DISTRESS.kw.
6	CARDIOTOCOGRAPHY.kw.
7	(ELECTROCARDIOGRAPHY and (PERIPARTUM PERIOD or PARTURITION or LABOR, OBSTETRIC or DELIVERY, OBSTETRIC or FETUS)).kw.
8	or/1-7
9	(care or intervention? or action?).ab. /freq=2
10	RISK ASSESSMENT.kw.
11	or/9-10
12	8 and 11
13	((((f?etal or f?etus$ or uter$) adj3 (heart$ or monitor$ or observ$ or assess$)) or FHR or EFM or cardiotocogra$ or CTG or ((electrocardiogra$ or ECG or EKG) adj3 (labo?r or birth or childbirth or partu$ or intra?part$ or peri?part$ or f?etal or f?etus$))) adj5 (concern$ or suspic$ or abnorm$ or non-reassur$ or pathological$)).ti,ab.
14	(care or intervention? or action?).ti,ab.
15	13 and 14
16	12 or 15

Database: Database of Abstracts of Reviews of Effects

#	Searches
1	FETAL MONITORING.kw.
2	UTERINE MONITORING.kw.
3	HEART RATE, FETAL.kw.
4	FETAL HEART.kw.
5	FETAL DISTRESS.kw.
6	CARDIOTOCOGRAPHY.kw.
7	(ELECTROCARDIOGRAPHY and (PERIPARTUM PERIOD or PARTURITION or LABOR, OBSTETRIC or DELIVERY, OBSTETRIC or FETUS)).kw.
8	or/1-7
9	(care or intervention? or action?).ti,kw.
10	RISK ASSESSMENT.kw.
11	or/9-10

#	Searches
12	8 and 11
13	((((f?etal or f?etus$ or uter$) adj3 (heart$ or monitor$ or observ$ or assess$)) or FHR or EFM or cardiotocogra$ or CTG or ((electrocardiogra$ or ECG or EKG) adj3 (labo?r or birth or childbirth or partu$ or intra?part$ or peri?part$ or f?etal or f?etus$))) adj5 (concern$ or suspic$ or abnorm$ or non-reassur$ or pathological$)).tw,tx.
14	(care or intervention? or action?).ti,kw.
15	13 and 14
16	12 or 15

Database: Health Technology Assessment

#	Searches
1	FETAL MONITORING/
2	UTERINE MONITORING/
3	HEART RATE, FETAL/
4	exp FETAL HEART/
5	FETAL DISTRESS/
6	CARDIOTOCOGRAPHY/
7	ELECTROCARDIOGRAPHY/ and (PERIPARTUM PERIOD/ or PARTURITION/ or exp LABOR, OBSTETRIC/ or exp DELIVERY, OBSTETRIC/ or FETUS/)
8	or/1-7
9	(care or intervention? or action?).tw.
10	RISK ASSESSMENT/
11	or/9-10
12	8 and 11
13	((((f?etal or f?etus$ or uter$) adj3 (heart$ or monitor$ or observ$ or assess$)) or FHR or EFM or cardiotocogra$ or CTG or ((electrocardiogra$ or ECG or EKG) adj3 (labo?r or birth or childbirth or partu$ or intra?part$ or peri?part$ or f?etal or f?etus$))) adj5 (concern$ or suspic$ or abnorm$ or non-reassur$ or pathological$)).tw.
14	(care or intervention? or action?).tw.
15	13 and 14
16	12 or 15

Database: Embase

#	Searches
1	*FETUS MONITORING/
2	*FETUS HEART RATE/
3	*FETUS HEART/
4	*FETUS DISTRESS/
5	*CARDIOTOCOGRAPHY/
6	(*ELECTROCARDIOGRAPHY/ or *ELECTROCARDIOGRAPHY MONITORING/) and (*PERINATAL PERIOD/ or *BIRTH/ or exp *LABOR/ or exp *DELIVERY/ or *FETUS/)
7	or/1-6
8	(care or intervention? or action?).ab. /freq=2
9	*RISK ASSESSMENT/
10	or/8-9
11	7 and 10
12	((((f?etal or f?etus$ or uter$) adj3 (heart$ or monitor$ or observ$ or assess$)) or FHR or EFM or cardiotocogra$ or CTG or ((electrocardiogra$ or ECG or EKG) adj3 (labo?r or birth

#	Searches
	or childbirth or partu$ or intra?part$ or peri?part$ or f?etal or f?etus$))) adj5 (concern$ or suspic$ or abnorm$ or non-reassur$ or pathological$)).ti,ab.
13	(care or intervention? or action?).ti,ab.
14	12 and 13
15	11 or 14
16	limit 15 to english language
17	letter.pt. or LETTER/
18	note.pt.
19	editorial.pt.
20	CASE REPORT/ or CASE STUDY/
21	(letter or comment*).ti.
22	or/17-21
23	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
24	22 not 23
25	ANIMAL/ not HUMAN/
26	NONHUMAN/
27	exp ANIMAL EXPERIMENT/
28	exp EXPERIMENTAL ANIMAL/
29	ANIMAL MODEL/
30	exp RODENT/
31	(rat or rats or mouse or mice).ti.
32	or/24-31
33	16 not 32

D.5 Fetal scalp stimulation

The search strategies below are reproduced from CG190 and were re-run from January 2014 as part of the 2016 evidence review.

Database(s): Ovid MEDLINE(R)

#	Searches
1	exp PARTURITION/
2	exp LABOR, OBSTETRIC/
3	exp DELIVERY, OBSTETRIC/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r? or labo?ring).ti,ab.
5	or/1-4
6	exp PHYSICAL STIMULATION/
7	SCALP/
8	VIBRATION/
9	((f?etal or f?etus$) adj3 (stimulat$ or stimuli or stimulus)).ti,ab.
10	((scalp or digit$ or acoustic or vibroacoustic) adj3 (stimulat$ or stimuli or stimulus or punctur$)).ti,ab.
11	((acoustic or artificial) adj laryn$).ti,ab.
12	or/6-11
13	exp FETAL HEART/
14	HEART RATE, FETAL/

#	Searches
15	((f?etal or f?etus$) adj3 (heart$ or react$ or nonreact$ or respon$ or nonrespon$ or chang$ or accelerat$ or increas$)).ti,ab.
16	(heart adj3 (accelerat$ or increas$)).ti,ab.
17	FHR.ti,ab.
18	or/13-17
19	and/5,12,18
20	((f?etal or f?etus$ or scalp or acoustic or vibroacoustic) adj3 stimulation).ti.
21	and/5,20
22	or/19,21
23	limit 22 to english language
24	LETTER/
25	EDITORIAL/
26	NEWS/
27	exp HISTORICAL ARTICLE/
28	ANECDOTES AS TOPIC/
29	COMMENT/
30	CASE REPORT/
31	(letter or comment* or abstracts).ti.
32	or/24-31
33	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
34	32 not 33
35	ANIMALS/ not HUMANS/
36	exp ANIMALS, LABORATORY/
37	exp ANIMAL EXPERIMENTATION/
38	exp MODELS, ANIMAL/
39	exp RODENTIA/
40	(rat or rats or mouse or mice).ti.
41	or/34-40
42	23 not 41

Database(s): Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations

#	Searches
1	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r? or labo?ring).ti,ab.
2	((f?etal or f?etus$) adj3 (stimulat$ or stimuli or stimulus)).ti,ab.
3	((scalp or digit$ or acoustic or vibroacoustic) adj3 (stimulat$ or stimuli or stimulus or punctur$)).ti,ab.
4	((acoustic or artificial) adj laryn$).ti,ab.
5	or/2-4
6	((f?etal or f?etus$) adj3 (heart$ or react$ or nonreact$ or respon$ or nonrespon$ or chang$ or accelerat$ or increas$)).ti,ab.
7	(heart adj3 (accelerat$ or increas$)).ti,ab.
8	FHR.ti,ab.
9	or/6-8
10	and/1,5,9
11	((f?etal or f?etus$ or scalp or acoustic or vibroacoustic) adj3 stimulation).ti.
12	and/1,11

#	Searches
13	or/10,12

Database(s): EBM Reviews - Cochrane Central Register of Controlled Trials

#	Searches
1	exp PARTURITION/
2	exp LABOR, OBSTETRIC/
3	exp DELIVERY, OBSTETRIC/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r? or labo?ring).ti,ab,hw.
5	or/1-4
6	(STIMULATION or STIMULUS).hw.
7	SCALP.hw.
8	VIBRATION.hw.
9	((f?etal or f?etus$) adj3 (stimulat$ or stimuli or stimulus)).ti,ab,hw.
10	((scalp or digit$ or acoustic or vibroacoustic) adj3 (stimulat$ or stimuli or stimulus or punctur$)).ti,ab,hw.
11	((acoustic or artificial) adj laryn$).ti,ab.
12	or/6-11
13	(FETAL HEART or FETUS HEART).hw.
14	(HEART RATE, FETAL or FETUS HEART RATE).hw.
15	((f?etal or f?etus$) adj3 (heart$ or react$ or nonreact$ or respon$ or nonrespon$ or chang$ or accelerat$ or increas$)).ti,ab.
16	(heart adj3 (accelerat$ or increas$)).ti,ab.
17	FHR.ti,ab.
18	or/13-17
19	and/5,12,18
20	((f?etal or f?etus$ or scalp or acoustic or vibroacoustic) adj3 stimulation).ti.
21	and/5,20
22	or/19,21

Database(s): EBM Reviews - Cochrane Database of Systematic Reviews, EBM Reviews - Database of Abstracts of Reviews of Effects

#	Searches
1	PARTURITION.kw.
2	LABOR, OBSTETRIC.kw.
3	DELIVERY, OBSTETRIC.kw.
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r? or labo?ring).tw,tx.
5	or/1-4
6	PHYSICAL STIMULATION.kw.
7	SCALP.kw.
8	VIBRATION.kw.
9	((f?etal or f?etus$) adj3 (stimulat$ or stimuli or stimulus)).tw,tx.
10	((scalp or digit$ or acoustic or vibroacoustic) adj3 (stimulat$ or stimuli or stimulus or punctur$)).tw,tx.
11	((acoustic or artificial) adj laryn$).tw,tx.
12	or/6-11
13	FETAL HEART.kw.

#	Searches
14	HEART RATE, FETAL.kw.
15	((f?etal or f?etus$) adj3 (heart$ or react$ or nonreact$ or respon$ or nonrespon$ or chang$ or accelerat$ or increas$)).tw,tx.
16	(heart adj3 (accelerat$ or increas$)).tw,tx.
17	FHR.tw,tx.
18	or/13-17
19	and/5,12,18
20	((f?etal or f?etus$ or scalp or acoustic or vibroacoustic) adj3 stimulation).ti.
21	and/5,20
22	or/19,21

Database(s): EBM Reviews - Health Technology Assessment

#	Searches
1	exp PARTURITION/
2	exp LABOR, OBSTETRIC/
3	exp DELIVERY, OBSTETRIC/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r? or labo?ring).tw.
5	or/1-4
6	exp PHYSICAL STIMULATION/
7	SCALP/
8	VIBRATION/
9	((f?etal or f?etus$) adj3 (stimulat$ or stimuli or stimulus)).tw.
10	((scalp or digit$ or acoustic or vibroacoustic) adj3 (stimulat$ or stimuli or stimulus or punctur$)).tw.
11	((acoustic or artificial) adj laryn$).tw.
12	or/6-11
13	exp FETAL HEART/
14	HEART RATE, FETAL/
15	((f?etal or f?etus$) adj3 (heart$ or react$ or nonreact$ or respon$ or nonrespon$ or chang$ or accelerat$ or increas$)).tw.
16	(heart adj3 (accelerat$ or increas$)).tw.
17	FHR.tw.
18	or/13-17
19	and/5,12,18
20	((f?etal or f?etus$ or scalp or acoustic or vibroacoustic) adj3 stimulation).ti.
21	and/5,20
22	or/19,21

Database(s): Embase

#	Searches
1	BIRTH/
2	exp CHILDBIRTH/
3	exp DELIVERY/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r? or labo?ring).ti,ab.
5	or/1-4

#	Searches
6	exp SENSORY STIMULATION/
7	STIMULATION/
8	STIMULUS/
9	SCALP/
10	VIBRATION SENSE/
11	exp VIBRATION/
12	((f?etal or f?etus$) adj3 (stimulat$ or stimuli or stimulus)).ti,ab.
13	((scalp or digit$ or acoustic or vibroacoustic) adj3 (stimulat$ or stimuli or stimulus or punctur$)).ti,ab.
14	((acoustic or artificial) adj laryn$).ti,ab.
15	or/6-14
16	FETUS HEART/
17	FETUS HEART RATE/
18	((f?etal or f?etus$) adj3 (heart$ or react$ or nonreact$ or respon$ or nonrespon$ or chang$ or accelerat$ or increas$)).ti,ab.
19	(heart adj3 (accelerat$ or increas$)).ti,ab.
20	FHR.ti,ab.
21	or/16-20
22	and/5,15,21
23	((f?etal or f?etus$ or scalp or acoustic or vibroacoustic) adj3 stimulation).ti.
24	and/5,23
25	or/22,24
26	limit 25 to english language
27	conference abstract.pt.
28	letter.pt. or LETTER/
29	note.pt.
30	editorial.pt.
31	CASE REPORT/ or CASE STUDY/
32	(letter or comment* or abstracts).ti.
33	or/27-32
34	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
35	33 not 34
36	ANIMAL/ not HUMAN/
37	NONHUMAN/
38	exp ANIMAL EXPERIMENT/
39	exp EXPERIMENTAL ANIMAL/
40	ANIMAL MODEL/
41	exp RODENT/
42	(rat or rats or mouse or mice).ti.
43	or/35-42
44	26 not 43

Database(s): CINAHL via EBSCOhost

#	Query	Limiters/Expanders
S47	S6 and S46	Limiters - English Language; Exclude

#	Query	Limiters/Expanders
		MEDLINE records; Human Search modes - Boolean/Phrase
S46	S7 or S8 or S9 or S10 or S11 or S12 or S13 or S14 or S15 or S16 or S17 or S18 or S19 or S20 or S21 or S22 or S23 or S24 or S25 or S26 or S27 or S28 or S29 or S30 or S31 or S32 or S33 or S34 or S35 or S36 or S37 or S38 or S39 or S40 or S41 or S42 or S43 or S44 or S45	Search modes - Boolean/Phrase
S45	(MH "TELEMETRY")	Search modes - Boolean/Phrase
S44	TI (EFM) or AB (EFM)	Search modes - Boolean/Phrase
S43	TI (cardiotocograph*) or AB (cardiotograph*)	Search modes - Boolean/Phrase
S42	AB (sonicaid* or ultraso* or echo* or sono* or flowmet* or doppler*)	Search modes - Boolean/Phrase
S41	TI (sonicaid* or ultraso* or echo* or sono* or flowmet* or doppler*)	Search modes - Boolean/Phrase
S40	MH ECHOCARDIOGRAPHY, DOPPLER	Search modes - Boolean/Phrase
S39	MH ULTRASONOGRAPHY, DOPPLER	Search modes - Boolean/Phrase
S38	TI (non stress test* or nonstress test* or NST) or AB (non stress test* or nonstress test* or NST)	Search modes - Boolean/Phrase
S37	MH NONSTRESS TESTING, FETAL	Search modes - Boolean/Phrase
S36	TI ("listening in") or AB ("listening in")	Search modes - Boolean/Phrase
S35	TI (auscultat* or IA or pin#ard* or fetoscop*) or AB (auscultat* or IA or pin#ard* or fetoscop*)	Search modes - Boolean/Phrase
S34	MH STETHOSCOPES	Search modes - Boolean/Phrase
S33	MH AUSCULTATION+	Search modes - Boolean/Phrase
S32	AB (umbilic* N3 gas*)	Search modes - Boolean/Phrase
S31	TI (umbilic* N3 gas*)	Search modes - Boolean/Phrase
S30	AB (cord N3 gas*)	Search modes - Boolean/Phrase
S29	TI (cord N3 gas*)	Search modes - Boolean/Phrase
S28	(MH "CORDOCENTESIS")	Search modes - Boolean/Phrase
S27	TI (CTG) or AB (CTG)	Search modes - Boolean/Phrase
S26	AB (ST?segment)	Search modes - Boolean/Phrase
S25	TI (ST?segment)	Search modes - Boolean/Phrase
S24	TI (QRS) or AB (QRS)	Search modes - Boolean/Phrase

#	Query	Limiters/Expanders
S23	TI (electrocardiogr*) or AB (electrocardiogr*)	Search modes - Boolean/Phrase
S22	TI (ECG) or AB (ECG)	Search modes - Boolean/Phrase
S21	(MH "ELECTROCARDIOGRAPHY+") OR (MH "ELECTROCARDIOGRAPHY, AMBULATORY") OR (MH "QRS COMPLEX") OR (MH "ST SEGMENT") OR (MH "VECTORCARDIOGRAPHY+")	Search modes - Boolean/Phrase
S20	(MH "FETAL MONITORING, ELECTRONIC+")	Search modes - Boolean/Phrase
S19	(fetal N3 blood) or AB (fetus* N3 blood) or AB (foetal N3 blood) or AB (foetus* N3 blood)	Search modes - Boolean/Phrase
S18	TI (FBS) or AB (FBS)	Search modes - Boolean/Phrase
S17	(MH "ACID-BASE IMBALANCE+")	Search modes - Boolean/Phrase
S16	(MH "FETAL HEART")	Search modes - Boolean/Phrase
S15	(MH "FETAL BLOOD")	Search modes - Boolean/Phrase
S14	TI (FHR) or AB (FHR)	Search modes - Boolean/Phrase
S13	AB (fetal N3 heart*) or AB (fetus* N3 heart*) or AB (foetal N3 heart*) or AB (foetus* N3 heart*)	Search modes - Boolean/Phrase
S12	TI (fetal N3 heart*) or TI (fetus* N3 heart*) or TI (foetal N3 heart*) or TI (foetus* N3 heart*)	Search modes - Boolean/Phrase
S11	MH HEART RATE, FETAL	Search modes - Boolean/Phrase
S10	AB (fetal N3 monitor*) or AB (fetus* N3 monitor*) or AB (foetal N3 monitor*) or AB (foetus* N3 monitor*)	Search modes - Boolean/Phrase
S9	TI (fetal N3 monitor*) or TI (fetus* N3 monitor*) or TI (foetal N3 monitor*) or TI (foetus* N3 monitor*)	Search modes - Boolean/Phrase
S8	MH UTERINE MONITORING	Search modes - Boolean/Phrase
S7	MH FETAL MONITORING+	Search modes - Boolean/Phrase
S6	S1 or S2 or S3 or S4 or S5	Search modes - Boolean/Phrase
S5	AB (partu* or birth* or childbirth* or intrapartu* or labo#r*)	Search modes - Boolean/Phrase
S4	TI (partu* or birth* or childbirth* or intrapartu* or labo#r*)	Search modes - Boolean/Phrase
S3	MH DELIVERY+	Search modes - Boolean/Phrase
S2	MH LABOR+	Search modes - Boolean/Phrase
S1	MH CHILDBIRTH+	Search modes - Boolean/Phrase

D.6 Fetal blood sampling

This search covers three review questions (fetal blood sampling as an adjunct to cardiotocography, time to result of fetal blood sampling and predictive value of fetal blood sampling).

The search strategies below are reproduced from CG190 and were re-run from January 2014 as part of the 2016 evidence review.

A health economics search was also conducted for these review questions.

Database(s): Ovid MEDLINE(R)

#	Searches
1	exp PARTURITION/
2	exp LABOR, OBSTETRIC/
3	exp DELIVERY, OBSTETRIC/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
5	or/1-4
6	BLOOD SPECIMEN COLLECTION/
7	FETAL MONITORING/
8	FETAL BLOOD/
9	((f?etal or f?etus) adj3 (lactate? or pH or scalp? or base$ or acid$ or alk#l$)).ti,ab.
10	((f?etal or f?etus) adj3 blood adj3 (gas$ or sampl$ or analy$)).ti,ab.
11	FBS.ti,ab.
12	or/7-11
13	and/6,12
14	exp BLOOD GAS ANALYSIS/
15	exp ACID-BASE IMBALANCE/
16	(blood adj3 (gas$ or oxygen or carbon dioxide) adj3 analy$).ti,ab.
17	((acid base or acid?base) adj3 (imbalance or equilibrium)).ti,ab.
18	or/14-17
19	and/7,18
20	or/13,19
21	and/5,20
22	LETTER/
23	EDITORIAL/
24	NEWS/
25	exp HISTORICAL ARTICLE/
26	ANECDOTES AS TOPIC/
27	COMMENT/
28	CASE REPORT/
29	(letter or comment* or abstracts).ti.
30	or/22-29
31	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
32	30 not 31
33	ANIMALS/ not HUMANS/
34	exp ANIMALS, LABORATORY/
35	exp ANIMAL EXPERIMENTATION/

#	Searches
36	exp MODELS, ANIMAL/
37	exp RODENTIA/
38	(rat or rats or mouse or mice).ti.
39	or/32-38
40	21 not 39
41	limit 40 to english language

Database(s): Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations

#	Searches
1	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
2	((f?etal or f?etus) adj3 (blood$ or monitor$ or check$ or assess$)).ti,ab.
3	((f?etal or f?etus) adj3 (lactate? or pH or scalp? or base$ or acid$ or alk#l$)).ti,ab.
4	((f?etal or f?etus) adj3 blood adj3 (gas$ or sampl$ or analys$)).ti,ab.
5	FBS.ti,ab.
6	or/3-5
7	(blood adj3 (gas$ or oxygen or carbon dioxide) adj3 analys$).ti,ab.
8	((acid base or acid?base) adj3 (imbalance or equilibrium)).ti,ab.
9	or/7-8
10	and/2,9
11	or/6,10
12	and/1,11

Database(s): EBM Reviews - Cochrane Central Register of Controlled Trials

#	Searches
1	exp PARTURITION/
2	exp LABOR, OBSTETRIC/
3	exp DELIVERY, OBSTETRIC/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
5	or/1-4
6	BLOOD SPECIMEN COLLECTION/
7	FETAL MONITORING/
8	FETAL BLOOD/
9	((f?etal or f?etus) adj3 (lactate? or pH or scalp? or base$ or acid$ or alk#l$)).ti,ab.
10	((f?etal or f?etus) adj3 blood adj3 (gas$ or sampl$ or analy$)).ti,ab.
11	FBS.ti,ab.
12	or/7-11
13	and/6,12
14	exp BLOOD GAS ANALYSIS/ or exp ACID-BASE IMBALANCE/
15	(blood adj3 (gas$ or oxygen or carbon dioxide) adj3 analy$).ti,ab.
16	((acid base or acid?base) adj3 (imbalance or equilibrium)).ti,ab.
17	or/14-16
18	and/7,17
19	or/13,18
20	and/5,19

Database(s): EBM Reviews - Cochrane Database of Systematic Reviews, EBM Reviews - Database of Abstracts of Reviews of Effects

#	Searches
1	PARTURITION.kw.
2	LABOR, OBSTETRIC.kw.
3	DELIVERY, OBSTETRIC.kw.
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).tw,tx.
5	or/1-4
6	BLOOD SPECIMEN COLLECTION.kw.
7	FETAL MONITORING.kw.
8	FETAL BLOOD.kw.
9	((f?etal or f?etus) adj3 (lactate? or pH or scalp? or base$ or acid$ or alk#l$)).tw,tx.
10	((f?etal or f?etus) adj3 blood adj3 (gas$ or sampl$ or analy$)).tw,tx.
11	FBS.tw,tx.
12	or/7-11
13	and/6,12
14	(BLOOD GAS ANALYSIS or ACID-BASE IMBALANCE).kw.
15	(blood adj3 (gas$ or oxygen or carbon dioxide) adj3 analy$).tw,tx.
16	((acid base or acid?base) adj3 (imbalance or equilibrium)).tw,tx.
17	or/14-16
18	and/7,17
19	or/13,18
20	and/5,19

Database(s): EBM Reviews - Health Technology Assessment

#	Searches
1	exp PARTURITION/
2	exp LABOR, OBSTETRIC/
3	exp DELIVERY, OBSTETRIC/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).tw.
5	or/1-4
6	BLOOD SPECIMEN COLLECTION/
7	FETAL MONITORING/
8	FETAL BLOOD/
9	((f?etal or f?etus) adj3 (lactate? or pH or scalp? or base$ or acid$ or alk#l$)).tw.
10	((f?etal or f?etus) adj3 blood adj3 (gas$ or sampl$ or analy$)).tw.
11	FBS.tw.
12	or/7-11
13	and/6,12
14	exp BLOOD GAS ANALYSIS/ or exp ACID-BASE IMBALANCE/
15	(blood adj3 (gas$ or oxygen or carbon dioxide) adj3 analy$).tw.
16	((acid base or acid?base) adj3 (imbalance or equilibrium)).tw.
17	or/14-16
18	and/7,17
19	or/13,18
20	and/5,19

Database(s): Embase

#	Searches
1	BIRTH/
2	exp CHILDBIRTH/
3	exp DELIVERY/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
5	or/1-4
6	FETUS BLOOD SAMPLING/
7	FETAL BLOOD SAMPLING KIT/
8	FBS.ti,ab.
9	or/6-8
10	and/5,9
11	((f?etal or f?etus) adj3 (lactate? or pH or scalp? or base$ or acid$ or alk#l$)).ti,ab.
12	((f?etal or f?etus) adj3 blood adj3 (gas$ or sampl$ or analy$)).ti,ab.
13	or/11-12
14	FETUS MONITORING/
15	exp FETAL MONITOR/
16	FETUS BLOOD/
17	FETUS ACID BASE BALANCE/
18	or/14-17
19	and/13,18
20	and/5,19
21	or/10,20
22	conference abstract.pt.
23	letter.pt. or LETTER/
24	note.pt.
25	editorial.pt.
26	CASE REPORT/ or CASE STUDY/
27	(letter or comment* or abstracts).ti.
28	or/22-27
29	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
30	28 not 29
31	ANIMAL/ not HUMAN/
32	NONHUMAN/
33	exp ANIMAL EXPERIMENT/
34	exp EXPERIMENTAL ANIMAL/
35	ANIMAL MODEL/
36	exp RODENT/
37	(rat or rats or mouse or mice).ti.
38	or/30-37
39	21 not 38
40	limit 39 to english language

Database(s): CINAHL via EBSCOhost

#	Query	Limiters/Expanders
S47	S6 and S46	Limiters - English Language; Exclude

#	Query	Limiters/Expanders
		MEDLINE records; Human Search modes - Boolean/Phrase
S46	S7 or S8 or S9 or S10 or S11 or S12 or S13 or S14 or S15 or S16 or S17 or S18 or S19 or S20 or S21 or S22 or S23 or S24 or S25 or S26 or S27 or S28 or S29 or S30 or S31 or S32 or S33 or S34 or S35 or S36 or S37 or S38 or S39 or S40 or S41 or S42 or S43 or S44 or S45	Search modes - Boolean/Phrase
S45	(MH "TELEMETRY")	Search modes - Boolean/Phrase
S44	TI (EFM) or AB (EFM)	Search modes - Boolean/Phrase
S43	TI (cardiotocograph*) or AB (cardiotograph*)	Search modes - Boolean/Phrase
S42	AB (sonicaid* or ultraso* or echo* or sono* or flowmet* or doppler*)	Search modes - Boolean/Phrase
S41	TI (sonicaid* or ultraso* or echo* or sono* or flowmet* or doppler*)	Search modes - Boolean/Phrase
S40	MH ECHOCARDIOGRAPHY, DOPPLER	Search modes - Boolean/Phrase
S39	MH ULTRASONOGRAPHY, DOPPLER	Search modes - Boolean/Phrase
S38	TI (non stress test* or nonstress test* or NST) or AB (non stress test* or nonstress test* or NST)	Search modes - Boolean/Phrase
S37	MH NONSTRESS TESTING, FETAL	Search modes - Boolean/Phrase
S36	TI ("listening in") or AB ("listening in")	Search modes - Boolean/Phrase
S35	TI (auscultat* or IA or pin#ard* or fetoscop*) or AB (auscultat* or IA or pin#ard* or fetoscop*)	Search modes - Boolean/Phrase
S34	MH STETHOSCOPES	Search modes - Boolean/Phrase
S33	MH AUSCULTATION+	Search modes - Boolean/Phrase
S32	AB (umbilic* N3 gas*)	Search modes - Boolean/Phrase
S31	TI (umbilic* N3 gas*)	Search modes - Boolean/Phrase
S30	AB (cord N3 gas*)	Search modes - Boolean/Phrase
S29	TI (cord N3 gas*)	Search modes - Boolean/Phrase
S28	(MH "CORDOCENTESIS")	Search modes - Boolean/Phrase
S27	TI (CTG) or AB (CTG)	Search modes - Boolean/Phrase
S26	AB (ST?segment)	Search modes - Boolean/Phrase
S25	TI (ST?segment)	Search modes - Boolean/Phrase
S24	TI (QRS) or AB (QRS)	Search modes - Boolean/Phrase

#	Query	Limiters/Expanders
S23	TI (electrocardiogr*) or AB (electrocardiogr*)	Search modes - Boolean/Phrase
S22	TI (ECG) or AB (ECG)	Search modes - Boolean/Phrase
S21	(MH "ELECTROCARDIOGRAPHY+") OR (MH "ELECTROCARDIOGRAPHY, AMBULATORY") OR (MH "QRS COMPLEX") OR (MH "ST SEGMENT") OR (MH "VECTORCARDIOGRAPHY+")	Search modes - Boolean/Phrase
S20	(MH "FETAL MONITORING, ELECTRONIC+")	Search modes - Boolean/Phrase
S19	(fetal N3 blood) or AB (fetus* N3 blood) or AB (foetal N3 blood) or AB (foetus* N3 blood)	Search modes - Boolean/Phrase
S18	TI (FBS) or AB (FBS)	Search modes - Boolean/Phrase
S17	(MH "ACID-BASE IMBALANCE+")	Search modes - Boolean/Phrase
S16	(MH "FETAL HEART")	Search modes - Boolean/Phrase
S15	(MH "FETAL BLOOD")	Search modes - Boolean/Phrase
S14	TI (FHR) or AB (FHR)	Search modes - Boolean/Phrase
S13	AB (fetal N3 heart*) or AB (fetus* N3 heart*) or AB (foetal N3 heart*) or AB (foetus* N3 heart*)	Search modes - Boolean/Phrase
S12	TI (fetal N3 heart*) or TI (fetus* N3 heart*) or TI (foetal N3 heart*) or TI (foetus* N3 heart*)	Search modes - Boolean/Phrase
S11	MH HEART RATE, FETAL	Search modes - Boolean/Phrase
S10	AB (fetal N3 monitor*) or AB (fetus* N3 monitor*) or AB (foetal N3 monitor*) or AB (foetus* N3 monitor*)	Search modes - Boolean/Phrase
S9	TI (fetal N3 monitor*) or TI (fetus* N3 monitor*) or TI (foetal N3 monitor*) or TI (foetus* N3 monitor*)	Search modes - Boolean/Phrase
S8	MH UTERINE MONITORING	Search modes - Boolean/Phrase
S7	MH FETAL MONITORING+	Search modes - Boolean/Phrase
S6	S1 or S2 or S3 or S4 or S5	Search modes - Boolean/Phrase
S5	AB (partu* or birth* or childbirth* or intrapartu* or labo#r*)	Search modes - Boolean/Phrase
S4	TI (partu* or birth* or childbirth* or intrapartu* or labo#r*)	Search modes - Boolean/Phrase
S3	MH DELIVERY+	Search modes - Boolean/Phrase
S2	MH LABOR+	Search modes - Boolean/Phrase
S1	MH CHILDBIRTH+	Search modes - Boolean/Phrase

Health economics

Database(s): Ovid MEDLINE(R)

#	Searches
1	ECONOMICS/
2	VALUE OF LIFE/
3	exp "COSTS AND COST ANALYSIS"/
4	exp ECONOMICS, HOSPITAL/
5	exp ECONOMICS, MEDICAL/
6	exp RESOURCE ALLOCATION/
7	ECONOMICS, NURSING/
8	ECONOMICS, PHARMACEUTICAL/
9	exp "FEES AND CHARGES"/
10	exp BUDGETS/
11	budget*.ti,ab.
12	cost*.ti,ab.
13	(economic* or pharmaco?economic*).ti,ab.
14	(price* or pricing*).ti,ab.
15	(financ* or fee or fees or expenditure* or saving*).ti,ab.
16	(value adj2 (money or monetary)).ti,ab.
17	resourc* allocat*.ti,ab.
18	(fund or funds or funding* or funded).ti,ab.
19	(ration or rations or rationing* or rationed).ti,ab.
20	ec.fs.
21	or/1-20
22	exp PARTURITION/
23	exp LABOR, OBSTETRIC/
24	exp DELIVERY, OBSTETRIC/
25	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
26	or/22-25
27	BLOOD SPECIMEN COLLECTION/
28	FETAL MONITORING/
29	FETAL BLOOD/
30	((f?etal or f?etus) adj3 (lactate? or pH or scalp? or base$ or acid$ or alk#l$)).ti,ab.
31	((f?etal or f?etus) adj3 blood adj3 (gas$ or sampl$ or analy$)).ti,ab.
32	FBS.ti,ab.
33	or/28-32
34	and/27,33
35	exp BLOOD GAS ANALYSIS/ or exp ACID-BASE IMBALANCE/
36	(blood adj3 (gas$ or oxygen or carbon dioxide) adj3 analy$).ti,ab.
37	((acid base or acid?base) adj3 (imbalance or equilibrium)).ti,ab.
38	or/35-37
39	and/28,38
40	or/34,39
41	and/26,40
42	LETTER/
43	EDITORIAL/

#	Searches
44	NEWS/
45	exp HISTORICAL ARTICLE/
46	ANECDOTES AS TOPIC/
47	COMMENT/
48	CASE REPORT/
49	(letter or comment* or abstracts).ti.
50	or/42-49
51	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
52	50 not 51
53	ANIMALS/ not HUMANS/
54	exp ANIMALS, LABORATORY/
55	exp ANIMAL EXPERIMENTATION/
56	exp MODELS, ANIMAL/
57	exp RODENTIA/
58	(rat or rats or mouse or mice).ti.
59	or/52-58
60	41 not 59
61	and/21,60
62	limit 61 to english language

Database(s): EBM Reviews - Cochrane Central Register of Controlled Trials

#	Searches
1	ECONOMICS/
2	VALUE OF LIFE/
3	exp "COSTS AND COST ANALYSIS"/
4	exp ECONOMICS, HOSPITAL/
5	exp ECONOMICS, MEDICAL/
6	exp RESOURCE ALLOCATION/
7	ECONOMICS, NURSING/
8	ECONOMICS, PHARMACEUTICAL/
9	exp "FEES AND CHARGES"/
10	exp BUDGETS/
11	budget*.ti,ab.
12	cost*.ti,ab.
13	(economic* or pharmaco?economic*).ti,ab.
14	(price* or pricing*).ti,ab.
15	(financ* or fee or fees or expenditure* or saving*).ti,ab.
16	(value adj2 (money or monetary)).ti,ab.
17	resourc* allocat*.ti,ab.
18	(fund or funds or funding* or funded).ti,ab.
19	(ration or rations or rationing* or rationed).ti,ab.
20	ec.fs.
21	or/1-20
22	exp PARTURITION/
23	exp LABOR, OBSTETRIC/

#	Searches
24	exp DELIVERY, OBSTETRIC/
25	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
26	or/22-25
27	BLOOD SPECIMEN COLLECTION/
28	FETAL MONITORING/
29	FETAL BLOOD/
30	((f?etal or f?etus) adj3 (lactate? or pH or scalp? or base$ or acid$ or alk#l$)).ti,ab.
31	((f?etal or f?etus) adj3 blood adj3 (gas$ or sampl$ or analy$)).ti,ab.
32	FBS.ti,ab.
33	or/28-32
34	and/27,33
35	exp BLOOD GAS ANALYSIS/ or exp ACID-BASE IMBALANCE/
36	(blood adj3 (gas$ or oxygen or carbon dioxide) adj3 analy$).ti,ab.
37	((acid base or acid?base) adj3 (imbalance or equilibrium)).ti,ab.
38	or/35-37
39	and/28,38
40	or/34,39
41	and/26,40
42	and/21,41

Database(s): EBM Reviews - Health Technology Assessment

#	Searches
1	exp PARTURITION/
2	exp LABOR, OBSTETRIC/
3	exp DELIVERY, OBSTETRIC/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).tw.
5	or/1-4
6	BLOOD SPECIMEN COLLECTION/
7	FETAL MONITORING/
8	FETAL BLOOD/
9	((f?etal or f?etus) adj3 (lactate? or pH or scalp? or base$ or acid$ or alk#l$)).tw.
10	((f?etal or f?etus) adj3 blood adj3 (gas$ or sampl$ or analy$)).tw.
11	FBS.tw.
12	or/7-11
13	and/6,12
14	exp BLOOD GAS ANALYSIS/ or exp ACID-BASE IMBALANCE/
15	(blood adj3 (gas$ or oxygen or carbon dioxide) adj3 analy$).tw.
16	((acid base or acid?base) adj3 (imbalance or equilibrium)).tw.
17	or/14-16
18	and/7,17
19	or/13,18
20	and/5,19

Database(s): EBM Reviews - NHS Economic Evaluation Database

#	Searches
1	exp PARTURITION/

#	Searches
2	exp LABOR, OBSTETRIC/
3	exp DELIVERY, OBSTETRIC/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).tw.
5	or/1-4
6	BLOOD SPECIMEN COLLECTION/
7	FETAL MONITORING/
8	FETAL BLOOD/
9	((f?etal or f?etus) adj3 (lactate? or pH or scalp? or base$ or acid$ or alk#l$)).tw.
10	((f?etal or f?etus) adj3 blood adj3 (gas$ or sampl$ or analy$)).tw.
11	FBS.tw.
12	or/7-11
13	and/6,12
14	exp BLOOD GAS ANALYSIS/ or exp ACID-BASE IMBALANCE/
15	(blood adj3 (gas$ or oxygen or carbon dioxide) adj3 analy$).tw.
16	((acid base or acid?base) adj3 (imbalance or equilibrium)).tw.
17	or/14-16
18	and/7,17
19	or/13,18
20	and/5,19

Database(s): Embase

#	Searches
1	HEALTH ECONOMICS/
2	exp ECONOMIC EVALUATION/
3	exp HEALTH CARE COST/
4	exp FEE/
5	BUDGET/
6	FUNDING/
7	RESOURCE ALLOCATION/
8	budget*.ti,ab.
9	cost*.ti,ab.
10	(economic* or pharmaco?economic*).ti,ab.
11	(price* or pricing*).ti,ab.
12	(financ* or fee or fees or expenditure* or saving*).ti,ab.
13	(value adj2 (money or monetary)).ti,ab.
14	resourc* allocat*.ti,ab.
15	(fund or funds or funding* or funded).ti,ab.
16	(ration or rations or rationing* or rationed).ti,ab.
17	or/1-16
18	BIRTH/
19	exp CHILDBIRTH/
20	exp DELIVERY/
21	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
22	or/18-21
23	FETUS BLOOD SAMPLING/

#	Searches
24	FETAL BLOOD SAMPLING KIT/
25	FBS.ti,ab.
26	or/23-25
27	and/22,26
28	((f?etal or f?etus) adj3 (lactate? or pH or scalp? or base$ or acid$ or alk#l$)).ti,ab.
29	((f?etal or f?etus) adj3 blood adj3 (gas$ or sampl$ or analy$)).ti,ab.
30	28 or 29
31	FETUS MONITORING/
32	exp FETAL MONITOR/
33	FETUS BLOOD/
34	FETUS ACID BASE BALANCE/
35	or/31-34
36	and/30,35
37	and/22,36
38	or/27,37
39	conference abstract.pt.
40	letter.pt. or LETTER/
41	note.pt.
42	editorial.pt.
43	CASE REPORT/ or CASE STUDY/
44	(letter or comment* or abstracts).ti.
45	or/39-44
46	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
47	45 not 46
48	ANIMAL/ not HUMAN/
49	NONHUMAN/
50	exp ANIMAL EXPERIMENT/
51	exp EXPERIMENTAL ANIMAL/
52	ANIMAL MODEL/
53	exp RODENT/
54	(rat or rats or mouse or mice).ti.
55	or/47-54
56	38 not 55
57	and/17,56
58	limit 57 to english language

D.7 Women's experience of fetal monitoring

The search strategies below are reproduced from CG190 and were re-run from January 2014 as part of the 2016 evidence review.

Database(s): Ovid MEDLINE(R)

#	Searches
1	LABOR, OBSTETRIC/
2	exp LABOR ONSET/
3	exp LABOR PRESENTATION/

#	Searches
4	"TRIAL OF LABOR"/
5	DELIVERY, OBSTETRIC/
6	(labour$ or labor$ or deliver$).ti,ab.
7	PARTURITION/
8	(birth$ or childbirth$ or partus or parturition$ or intrapartum$).ti,ab.
9	or/1-8
10	FETAL MONITORING/
11	((fetal$ or foetal$ or fetu$ or foetu$) adj3 (monitor$ or sampl$ or analy$ or lactate$ or electrod$)).ti,ab.
12	FETAL HEART/ph [Physiology]
13	HEART RATE, FETAL/
14	FETAL DISTRESS/di [Diagnosis]
15	CARDIOTOCOGRAPHY/
16	(cardiotocogra$ or cardiogra$).ti,ab.
17	(CTG or EFM).ti,ab.
18	$ECHOCARDIOGRAPHY/
19	echocardiogra$.ti,ab.
20	$ELECTROCARDIOGRAPHY/
21	electrocardiogra$.ti,ab.
22	(ECG or EKG).ti,ab.
23	AUSCULTATION/
24	HEART AUSCULTATION/
25	auscultation$.ti,ab.
26	$ULTRASONOGRAPHY, DOPPLER/
27	((ultraso$ or flowmet$ or fetal$ or foetal$ or fetu$ or foetu$ or handheld or hand-held or acoustic$) adj3 (doppler$ or device$)).ti,ab.
28	(intermittent$ adj3 auscultat$).ti,ab.
29	Sonicaid$.ti,ab.
30	Doptone$.ti,ab.
31	((Pinard$ or fetal$ or foetal$ or fetu$ or foetu$) adj3 stethoscope$).ti,ab.
32	SIGNAL PROCESSING, COMPUTER-ASSISTED/
33	(ST adj3 (analy$ or segment$ or interpret$ or monitor$)).ti,ab.
34	STAN.ti,ab.
35	(waveform$ adj3 analy$).ti,ab.
36	or/10-35
37	ATTITUDE TO HEALTH/
38	MOTHERS/px [Psychology]
39	(experience$ or belief$ or stress$ or emotion$ or anx$ or fear$ or concern$ or uncertain$ or unsure$ or thought$ or feeling$ or felt$ or view$ or opinion$ or perception$ or perspective$ or attitud$ or satisfact$ or know$ or understand$ or aware$ or compl$).ti.
40	or/37-39
41	9 and 36 and 40
42	limit 41 to english language

Database(s): Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations

#	Searches
1	(labour$ or labor$ or deliver$).ti,ab.
2	(birth$ or childbirth$ or partus or parturition$ or intrapartum$).ti,ab.
3	or/1-2
4	((fetal$ or foetal$ or fetu$ or foetu$) adj3 (monitor$ or sampl$ or analy$ or lactate$ or electrod$)).ti,ab.
5	(cardiotocogra$ or cardiogra$).ti,ab.
6	(CTG or EFM).ti,ab.
7	echocardiogra$.ti,ab.
8	electrocardiogra$.ti,ab.
9	(ECG or EKG).ti,ab.
10	auscultation$.ti,ab.
11	((ultraso$ or flowmet$ or fetal$ or foetal$ or fetu$ or foetu$ or handheld or hand-held or acoustic$) adj3 (doppler$ or device$)).ti,ab.
12	(intermittent$ adj3 auscultat$).ti,ab.
13	Sonicaid$.ti,ab.
14	Doptone$.ti,ab.
15	((Pinard$ or fetal$ or foetal$ or fetu$ or foetu$) adj3 stethoscope$).ti,ab.
16	(ST adj3 (analy$ or segment$ or interpret$ or monitor$)).ti,ab.
17	STAN.ti,ab.
18	(waveform$ adj3 analy$).ti,ab.
19	or/4-18
20	((mother$ or women$ or woman$) adj3 (experience$ or belief$ or stress$ or emotion$ or anx$ or fear$ or concern$ or uncertain$ or unsure$ or thought$ or feeling$ or felt$ or view$ or opinion$ or perception$ or perspective$ or attitud$ or satisfact$ or know$ or understand$ or aware$ or compl$)).ti,ab.
21	(experience$ or belief$ or stress$ or emotion$ or anx$ or fear$ or concern$ or uncertain$ or unsure$ or thought$ or feeling$ or felt$ or view$ or opinion$ or perception$ or perspective$ or attitud$ or satisfact$ or know$ or understand$ or aware$ or compl$).ti.
22	or/20-21
23	3 and 19 and 22

Database(s): EBM Reviews - Cochrane Central Register of Controlled Trials

#	Searches
1	LABOR, OBSTETRIC/
2	exp LABOR ONSET/
3	exp LABOR PRESENTATION/
4	"TRIAL OF LABOR"/
5	DELIVERY, OBSTETRIC/
6	(labour$ or labor$ or deliver$).ti,ab,hw.
7	PARTURITION/
8	(birth$ or childbirth$ or partus or parturition$ or intrapartum$).ti,ab,hw.
9	or/1-8
10	FETAL MONITORING/
11	((fetal$ or foetal$ or fetu$ or foetu$) adj3 (monitor$ or sampl$ or analy$ or lactate$ or electrod$)).ti,ab,hw.
12	FETAL HEART/
13	HEART RATE, FETAL/

#	Searches
14	FETAL DISTRESS/
15	CARDIOTOCOGRAPHY/
16	(cardiotocogra$ or cardiogra$).ti,ab,hw.
17	(CTG or EFM).ti,ab,hw.
18	$ECHOCARDIOGRAPHY/
19	echocardiogra$.ti,ab,hw.
20	$ELECTROCARDIOGRAPHY/
21	electrocardiogra$.ti,ab,hw.
22	(ECG or EKG).ti,ab,hw.
23	AUSCULTATION/
24	HEART AUSCULTATION/
25	auscultation$.ti,ab,hw.
26	$ULTRASONOGRAPHY, DOPPLER/
27	((ultraso$ or flowmet$ or fetal$ or foetal$ or fetu$ or foetu$ or handheld or hand-held or acoustic$) adj3 (doppler$ or device$)).ti,ab,hw.
28	(intermittent$ adj3 auscultat$).ti,ab,hw.
29	Sonicaid$.ti,ab,hw.
30	Doptone$.ti,ab,hw.
31	((Pinard$ or fetal$ or foetal$ or fetu$ or foetu$) adj3 stethoscope$).ti,ab,hw.
32	SIGNAL PROCESSING, COMPUTER-ASSISTED/
33	(ST adj3 (analy$ or segment$ or interpret$ or monitor$)).ti,ab,hw.
34	STAN.ti,ab,hw.
35	(waveform$ adj3 analy$).ti,ab,hw.
36	or/10-35
37	ATTITUDE TO HEALTH/
38	((mother$ or women$ or woman$) adj3 (experience$ or belief$ or stress$ or emotion$ or anx$ or fear$ or concern$ or uncertain$ or unsure$ or thought$ or feeling$ or felt$ or view$ or opinion$ or perception$ or perspective$ or attitud$ or satisfact$ or know$ or understand$ or aware$ or compl$)).ti,ab,hw.
39	(experience$ or belief$ or stress$ or emotion$ or anx$ or fear$ or concern$ or uncertain$ or unsure$ or thought$ or feeling$ or felt$ or view$ or opinion$ or perception$ or perspective$ or attitud$ or satisfact$ or know$ or understand$ or aware$ or compl$).ti.
40	or/37-39
41	9 and 36 and 40

Database(s): EBM Reviews - Cochrane Database of Systematic Reviews, EBM Reviews - Database of Abstracts of Reviews of Effects

#	Searches
1	LABOR, OBSTETRIC.kw.
2	LABOR ONSET.kw.
3	LABOR STAGE, FIRST.kw.
4	LABOR STAGE, SECOND.kw.
5	LABOR STAGE, THIRD.kw.
6	LABOR PRESENTATION.kw.
7	BREECH PRESENTATION.kw.
8	"TRIAL OF LABOR".kw.
9	DELIVERY, OBSTETRIC.kw.

#	Searches
10	(labour$ or labor$ or deliver$).tw,tx.
11	PARTURITION.kw.
12	(birth$ or childbirth$ or partus or parturition$ or intrapartum$).tw,tx.
13	or/1-12
14	FETAL MONITORING.kw.
15	((fetal$ or foetal$ or fetu$ or foetu$) adj3 (monitor$ or sampl$ or analy$ or lactate$ or electrod$)).tw,tx.
16	FETAL HEART.kw.
17	HEART RATE, FETAL.kw.
18	FETAL DISTRESS.kw.
19	CARDIOTOCOGRAPHY.kw.
20	(cardiotocogra$ or cardiogra$).tw,tx.
21	(CTG or EFM).tw,tx.
22	ECHOCARDIOGRAPHY.kw.
23	echocardiogra$.tw,tx.
24	ELECTROCARDIOGRAPHY.kw.
25	electrocardiogra$.tw,tx.
26	(ECG or EKG).tw,tx.
27	AUSCULTATION.kw.
28	HEART AUSCULTATION.kw.
29	auscultation$.tw,tx.
30	ULTRASONOGRAPHY, DOPPLER.kw.
31	((ultraso$ or flowmet$ or fetal$ or foetal$ or fetu$ or foetu$ or handheld or hand-held or acoustic$) adj3 (doppler$ or device$)).tw,tx.
32	(intermittent$ adj3 auscultat$).tw,tx.
33	Sonicaid$.tw,tx.
34	Doptone$.tw,tx.
35	((Pinard$ or fetal$ or foetal$ or fetu$ or foetu$) adj3 stethoscope$).tw,tx.
36	SIGNAL PROCESSING, COMPUTER-ASSISTED.kw.
37	(ST adj3 (analy$ or segment$ or interpret$ or monitor$)).tw,tx.
38	STAN.tw,tx.
39	(waveform$ adj3 analy$).tw,tx.
40	or/14-39
41	ATTITUDE TO HEALTH.kw.
42	((mother$ or women$ or woman$) adj3 (experience$ or belief$ or stress$ or emotion$ or anx$ or fear$ or concern$ or uncertain$ or unsure$ or thought$ or feeling$ or felt$ or view$ or opinion$ or perception$ or perspective$ or attitud$ or satisfact$ or know$ or understand$ or aware$ or compl$)).tw,tx.
43	(experience$ or belief$ or stress$ or emotion$ or anx$ or fear$ or concern$ or uncertain$ or unsure$ or thought$ or feeling$ or felt$ or view$ or opinion$ or perception$ or perspective$ or attitud$ or satisfact$ or know$ or understand$ or aware$ or compl$).ti.
44	or/41-43
45	13 and 40 and 44

Database(s): EBM Reviews - Health Technology Assessment

#	Searches
1	LABOR, OBSTETRIC/

#	Searches
2	LABOR ONSET/
3	LABOR STAGE, FIRST/
4	LABOR STAGE, SECOND/
5	LABOR STAGE, THIRD/
6	LABOR PRESENTATION/
7	BREECH PRESENTATION/
8	"TRIAL OF LABOR"/
9	DELIVERY, OBSTETRIC/
10	(labour$ or labor$ or deliver$).tw.
11	PARTURITION/
12	(birth$ or childbirth$ or partus or parturition$ or intrapartum$).tw.
13	or/1-12
14	FETAL MONITORING/
15	((fetal$ or foetal$ or fetu$ or foetu$) adj3 (monitor$ or sampl$ or analy$ or lactate$ or electrod$)).tw.
16	FETAL HEART/
17	HEART RATE, FETAL/
18	FETAL DISTRESS/
19	CARDIOTOCOGRAPHY/
20	(cardiotocogra$ or cardiogra$).tw.
21	(CTG or EFM).tw.
22	ECHOCARDIOGRAPHY/
23	echocardiogra$.tw.
24	ELECTROCARDIOGRAPHY/
25	electrocardiogra$.tw.
26	(ECG or EKG).tw.
27	AUSCULTATION/
28	HEART AUSCULTATION/
29	auscultation$.tw.
30	ULTRASONOGRAPHY, DOPPLER/
31	((ultraso$ or flowmet$ or fetal$ or foetal$ or fetu$ or foetu$ or handheld or hand-held or acoustic$) adj3 (doppler$ or device$)).tw.
32	(intermittent$ adj3 auscultat$).tw.
33	Sonicaid$.tw.
34	Doptone$.tw.
35	((Pinard$ or fetal$ or foetal$ or fetu$ or foetu$) adj3 stethoscope$).tw.
36	SIGNAL PROCESSING, COMPUTER-ASSISTED/
37	(ST adj3 (analy$ or segment$ or interpret$ or monitor$)).tw.
38	STAN.tw.
39	(waveform$ adj3 analy$).tw.
40	or/14-39
41	ATTITUDE TO HEALTH/
42	((mother$ or women$ or woman$) adj3 (experience$ or belief$ or stress$ or emotion$ or anx$ or fear$ or concern$ or uncertain$ or unsure$ or thought$ or feeling$ or felt$ or view$ or opinion$ or perception$ or perspective$ or attitud$ or satisfact$ or know$ or understand$ or aware$ or compl$)).tw.

#	Searches
43	(experience$ or belief$ or stress$ or emotion$ or anx$ or fear$ or concern$ or uncertain$ or unsure$ or thought$ or feeling$ or felt$ or view$ or opinion$ or perception$ or perspective$ or attitud$ or satisfact$ or know$ or understand$ or aware$ or compl$).ti.
44	or/41-43
45	13 and 40 and 44

Database(s): Embase

#	Searches
1	LABOR/
2	LABOR MANAGEMENT/
3	exp LABOR STAGE/
4	"TRIAL OF LABOR"/
5	exp DELIVERY/
6	(labour$ or labor$ or deliv$).ti,ab.
7	BIRTH/
8	CHILDBIRTH/
9	TERM BIRTH/
10	(birth$ or childbirth$ or partus or parturition$ or intrapartum$).ti,ab.
11	or/1-10
12	exp FETUS CONTROL/
13	exp FETUS MONITOR/
14	FETUS MOVEMENT/
15	FETUS OUTCOME/
16	((fetal$ or foetal$ or fetu$ or foetu$) adj3 (monitor$ or sampl$ or analy$ or lactate$ or electrod$)).ti,ab.
17	FETUS HEART/
18	FETUS HEART RATE/
19	FETUS DISTRESS/di [Diagnosis]
20	FETUS MALFORMATION/di [Diagnosis]
21	FETUS DISEASE/di [Diagnosis]
22	CARDIOTOCOGRAPHY/
23	CARDIOTOCOGRAPH/
24	(cardiotocogra$ or cardiogra$).ti,ab.
25	(CTG or EFM).ti,ab.
26	$ECHOCARDIOGRAPHY/
27	echocardiogra$.ti,ab.
28	FETUS ELECTROCARDIOGRAPHY/
29	$ELECTROCARDIOGRAPHY/
30	electrocardiogra$.ti,ab.
31	FETUS ECHOGRAPHY/
32	(ECG or EKG).ti,ab.
33	AUSCULTATION/
34	HEART AUSCULTATION/
35	auscultation$.ti,ab.
36	$DOPPLER FLOWMETRY/

#	Searches
37	((ultraso$ or flowmet$ or fetal$ or foetal$ or fetu$ or foetu$ or handheld or hand-held or acoustic$) adj3 (doppler$ or device$)).ti,ab.
38	(intermittent$ adj3 auscultat$).ti,ab.
39	Sonicaid$.ti,ab.
40	Doptone$.ti,ab.
41	((Pinard$ or fetal$ or foetal$ or fetu$ or foetu$) adj3 stethoscope$).ti,ab.
42	SIGNAL PROCESSING/
43	(ST adj3 (analy$ or segment$ or interpret$ or monitor$)).ti,ab.
44	STAN.ti,ab.
45	(waveform$ adj3 analy$).ti,ab.
46	or/12-45
47	ATTITUDE TO HEALTH/
48	ATTITUDE TO PREGNANCY/
49	((mother$ or women$ or woman$) adj3 (experience$ or belief$ or stress$ or emotion$ or anx$ or fear$ or concern$ or uncertain$ or unsure$ or thought$ or feeling$ or felt$ or view$ or opinion$ or perception$ or perspective$ or attitud$ or satisfact$ or know$ or understand$ or aware$ or compl$)).ti,ab.
50	(experience$ or belief$ or stress$ or emotion$ or anx$ or fear$ or concern$ or uncertain$ or unsure$ or thought$ or feeling$ or felt$ or view$ or opinion$ or perception$ or perspective$ or attitud$ or satisfact$ or know$ or understand$ or aware$ or compl$).ti.
51	or/47-50
52	11 and 46 and 51
53	limit 52 to (conference abstract or conference paper or "conference review")
54	52 not 53
55	limit 54 to english language

Database(s): PsycINFO

#	Searches
1	"LABOR (CHILDBIRTH)"/
2	(labour$ or labor$ or deliver$).tw.
3	exp BIRTH/
4	OBSTETRICAL COMPLICATIONS/
5	(birth$ or childbirth$ or partus or parturition$ or intrapartum$).tw.
6	or/1-5
7	FETUS/
8	MONITORING/
9	HEART RATE/
10	DISTRESS/
11	or/8-10
12	and/7,11
13	((fetal$ or foetal$ or fetu$ or foetu$) adj3 (monitor$ or sampl$ or analy$ or lactate$ or electrod$)).tw.
14	CARDIOGRAPHY/
15	(cardiotocogra$ or cardiogra$).tw.
16	(CTG or EFM).tw.
17	echocardiogra$.tw.
18	ELECTROCARDIOGRAPHY/

#	Searches
19	electrocardiogra$.tw.
20	(ECG or EKG).tw.
21	auscultation$.tw.
22	((ultraso$ or flowmet$ or fetal$ or foetal$ or fetu$ or foetu$ or handheld or hand-held or acoustic$) adj3 (doppler$ or device$)).tw.
23	(intermittent$ adj3 auscultat$).tw.
24	Sonicaid$.tw.
25	Doptone$.tw.
26	((Pinard$ or fetal$ or foetal$ or fetu$ or foetu$) adj3 stethoscope$).tw.
27	(ST adj3 (analy$ or segment$ or interpret$ or monitor$)).tw.
28	STAN.tw.
29	(waveform$ adj3 analy$).tw.
30	or/12-29
31	ATTITUDES/
32	ADULT ATTITUDES/
33	FEMALE ATTITUDES/
34	HEALTH ATTITUDES/
35	PARENTAL ATTITUDES/
36	((mother$ or women$ or woman$) adj3 (experience$ or belief$ or stress$ or emotion$ or anx$ or fear$ or concern$ or uncertain$ or unsure$ or thought$ or feeling$ or felt$ or view$ or opinion$ or perception$ or perspective$ or attitud$ or satisfact$ or know$ or understand$ or aware$ or compl$)).tw.
37	(experience$ or belief$ or stress$ or emotion$ or anx$ or fear$ or concern$ or uncertain$ or unsure$ or thought$ or feeling$ or felt$ or view$ or opinion$ or perception$ or perspective$ or attitud$ or satisfact$ or know$ or understand$ or aware$ or compl$).ti.
38	or/31-37
39	and/6,30,38
40	limit 39 to english language

Database(s): CINAHL via EBSCOhost

#	Query	Limiters/Expanders
S47	S6 and S46	Limiters - English Language; Exclude MEDLINE records; Human Search modes - Boolean/Phrase
S46	S7 or S8 or S9 or S10 or S11 or S12 or S13 or S14 or S15 or S16 or S17 or S18 or S19 or S20 or S21 or S22 or S23 or S24 or S25 or S26 or S27 or S28 or S29 or S30 or S31 or S32 or S33 or S34 or S35 or S36 or S37 or S38 or S39 or S40 or S41 or S42 or S43 or S44 or S45	Search modes - Boolean/Phrase
S45	(MH "TELEMETRY")	Search modes - Boolean/Phrase
S44	TI (EFM) or AB (EFM)	Search modes - Boolean/Phrase
S43	TI (cardiotocograph*) or AB (cardiotograph*)	Search modes - Boolean/Phrase
S42	AB (sonicaid* or ultraso* or echo* or sono* or flowmet* or doppler*)	Search modes - Boolean/Phrase

#	Query	Limiters/Expanders
S41	TI (sonicaid* or ultraso* or echo* or sono* or flowmet* or doppler*)	Search modes - Boolean/Phrase
S40	MH ECHOCARDIOGRAPHY, DOPPLER	Search modes - Boolean/Phrase
S39	MH ULTRASONOGRAPHY, DOPPLER	Search modes - Boolean/Phrase
S38	TI (non stress test* or nonstress test* or NST) or AB (non stress test* or nonstress test* or NST)	Search modes - Boolean/Phrase
S37	MH NONSTRESS TESTING, FETAL	Search modes - Boolean/Phrase
S36	TI ("listening in") or AB ("listening in")	Search modes - Boolean/Phrase
S35	TI (auscultat* or IA or pin#ard* or fetoscop*) or AB (auscultat* or IA or pin#ard* or fetoscop*)	Search modes - Boolean/Phrase
S34	MH STETHOSCOPES	Search modes - Boolean/Phrase
S33	MH AUSCULTATION+	Search modes - Boolean/Phrase
S32	AB (umbilic* N3 gas*)	Search modes - Boolean/Phrase
S31	TI (umbilic* N3 gas*)	Search modes - Boolean/Phrase
S30	AB (cord N3 gas*)	Search modes - Boolean/Phrase
S29	TI (cord N3 gas*)	Search modes - Boolean/Phrase
S28	(MH "CORDOCENTESIS")	Search modes - Boolean/Phrase
S27	TI (CTG) or AB (CTG)	Search modes - Boolean/Phrase
S26	AB (ST?segment)	Search modes - Boolean/Phrase
S25	TI (ST?segment)	Search modes - Boolean/Phrase
S24	TI (QRS) or AB (QRS)	Search modes - Boolean/Phrase
S23	TI (electrocardiogr*) or AB (electrocardiogr*)	Search modes - Boolean/Phrase
S22	TI (ECG) or AB (ECG)	Search modes - Boolean/Phrase
S21	(MH "ELECTROCARDIOGRAPHY+") OR (MH "ELECTROCARDIOGRAPHY, AMBULATORY") OR (MH "QRS COMPLEX") OR (MH "ST SEGMENT") OR (MH "VECTORCARDIOGRAPHY+")	Search modes - Boolean/Phrase
S20	(MH "FETAL MONITORING, ELECTRONIC+")	Search modes - Boolean/Phrase
S19	(fetal N3 blood) or AB (fetus* N3 blood) or AB (foetal N3 blood) or AB (foetus* N3 blood)	Search modes - Boolean/Phrase
S18	TI (FBS) or AB (FBS)	Search modes - Boolean/Phrase
S17	(MH "ACID-BASE IMBALANCE+")	Search modes - Boolean/Phrase

#	Query	Limiters/Expanders
S16	(MH "FETAL HEART")	Search modes - Boolean/Phrase
S15	(MH "FETAL BLOOD")	Search modes - Boolean/Phrase
S14	TI (FHR) or AB (FHR)	Search modes - Boolean/Phrase
S13	AB (fetal N3 heart*) or AB (fetus* N3 heart*) or AB (foetal N3 heart*) or AB (foetus* N3 heart*)	Search modes - Boolean/Phrase
S12	TI (fetal N3 heart*) or TI (fetus* N3 heart*) or TI (foetal N3 heart*) or TI (foetus* N3 heart*)	Search modes - Boolean/Phrase
S11	MH HEART RATE, FETAL	Search modes - Boolean/Phrase
S10	AB (fetal N3 monitor*) or AB (fetus* N3 monitor*) or AB (foetal N3 monitor*) or AB (foetus* N3 monitor*)	Search modes - Boolean/Phrase
S9	TI (fetal N3 monitor*) or TI (fetus* N3 monitor*) or TI (foetal N3 monitor*) or TI (foetus* N3 monitor*)	Search modes - Boolean/Phrase
S8	MH UTERINE MONITORING	Search modes - Boolean/Phrase
S7	MH FETAL MONITORING+	Search modes - Boolean/Phrase
S6	S1 or S2 or S3 or S4 or S5	Search modes - Boolean/Phrase
S5	AB (partu* or birth* or childbirth* or intrapartu* or labo#r*)	Search modes - Boolean/Phrase
S4	TI (partu* or birth* or childbirth* or intrapartu* or labo#r*)	Search modes - Boolean/Phrase
S3	MH DELIVERY+	Search modes - Boolean/Phrase
S2	MH LABOR+	Search modes - Boolean/Phrase
S1	MH CHILDBIRTH+	Search modes - Boolean/Phrase

D.8 Cardiotocography with electrocardiogram analysis compared with cardiotocography alone

The search strategies below are reproduced from CG190 and were re-run from January 2014 as part of the 2016 evidence review.

A health economics search was also conducted for this review question.

Database(s): Ovid MEDLINE(R)

#	Searches
1	randomized controlled trial.pt.
2	controlled clinical trial.pt.
3	DOUBLE BLIND METHOD/
4	SINGLE BLIND METHOD/
5	RANDOM ALLOCATION/
6	exp RANDOMIZED CONTROLLED TRIALS/
7	or/1-6

#	Searches
8	((single or double or triple or treble) adj5 (blind$ or mask$)).tw,sh.
9	clinical trial.pt.
10	exp CLINICAL TRIAL/
11	exp CLINICAL TRIALS AS TOPIC/
12	(clinic$ adj5 trial$).tw,sh.
13	PLACEBOS/
14	placebo$.tw,sh.
15	random$.tw,sh.
16	or/8-15
17	or/7,16
18	META ANALYSIS/
19	META ANALYSIS AS TOPIC/
20	meta analysis.pt.
21	(metaanaly$ or meta-analy$ or (meta adj analy$)).tw,sh.
22	(systematic$ adj5 (review$ or overview$)).tw,sh.
23	(methodologic$ adj5 (review$ or overview$)).tw,sh.
24	or/18-23
25	review$.pt.
26	(medline or medlars or embase or cinahl or cochrane or psycinfo or psychinfo or psychlit or psyclit or "web of science" or "science citation" or scisearch).tw.
27	((hand or manual$) adj2 search$).tw.
28	(electronic database$ or bibliographic database$ or computeri?ed database$ or online database$).tw,sh.
29	(pooling or pooled or mantel haenszel).tw,sh.
30	(peto or dersimonian or der simonian or fixed effect).tw,sh.
31	or/26-30
32	and/25,31
33	or/24,32
34	letter.pt.
35	case report.tw.
36	comment.pt.
37	editorial.pt.
38	historical article.pt.
39	or/34-38
40	17 not 39
41	33 not 39
42	or/40-41
43	comparative study.pt.
44	or/42-43
45	exp PARTURITION/
46	exp LABOR, OBSTETRIC/
47	exp DELIVERY, OBSTETRIC/
48	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
49	or/45-48
50	ELECTROCARDIOGRAPHY/
51	electrocardiograph$.ti,ab.

#	Searches
52	(FECG or ECG or EKG).ti,ab.
53	(ST adj3 (analys#s or segment$ or wave$)).ti,ab.
54	STAN.ti,ab.
55	((PR or time) adj3 interval$).ti,ab.
56	"T-QRS".ti,ab.
57	or/50-56
58	FETAL MONITORING/
59	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).ti,ab.
60	HEART RATE, FETAL/
61	FETAL DISTRESS/
62	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).ti,ab.
63	FHR.ti,ab.
64	CARDIOTOCOGRAPHY/
65	(cardiotocogra$ or CTG or EFM).ti,ab.
66	(electronic adj (f?etal or f?etus$) adj monitor$).ti,ab.
67	or/58-66
68	and/49,57,67
69	LETTER/
70	EDITORIAL/
71	NEWS/
72	exp HISTORICAL ARTICLE/
73	ANECDOTES AS TOPIC/
74	COMMENT/
75	CASE REPORT/
76	(letter or comment* or abstracts).ti.
77	or/69-76
78	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
79	77 not 78
80	ANIMALS/ not HUMANS/
81	exp ANIMALS, LABORATORY/
82	exp ANIMAL EXPERIMENTATION/
83	exp MODELS, ANIMAL/
84	exp RODENTIA/
85	(rat or rats or mouse or mice).ti.
86	or/79-85
87	and/44,68
88	87 not 86
89	limit 88 to english language

Database(s): Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations

#	Searches
1	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
2	electrocardiograph$.ti,ab.
3	(FECG or ECG or EKG).ti,ab.
4	(ST adj3 (analys#s or segment$ or wave$)).ti,ab.

#	Searches
5	STAN.ti,ab.
6	((PR or time) adj3 interval$).ti,ab.
7	"T-QRS".ti,ab.
8	or/2-7
9	(cardiotocogra$ or CTG or EFM or FHR).ti,ab.
10	((f?etal or f?etus$) adj3 heart adj3 (rate$ or trace$)).ti,ab.
11	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).ti,ab.
12	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).ti,ab.
13	or/9-12
14	and/1,8,13

Database(s): EBM Reviews - Cochrane Central Register of Controlled Trials

#	Searches
1	exp PARTURITION/
2	exp LABOR, OBSTETRIC/
3	exp DELIVERY, OBSTETRIC/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
5	or/1-4
6	ELECTROCARDIOGRAPHY/
7	electrocardiograph$.ti,ab.
8	(FECG or ECG or EKG).ti,ab.
9	(ST adj3 (analys#s or segment$ or wave$)).ti,ab.
10	STAN.ti,ab.
11	((PR or time) adj3 interval$).ti,ab.
12	"T-QRS".ti,ab.
13	or/6-12
14	FETAL MONITORING/
15	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).ti,ab.
16	HEART RATE, FETAL/
17	FETAL DISTRESS/
18	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).ti,ab.
19	FHR.ti,ab.
20	CARDIOTOCOGRAPHY/
21	(cardiotocogra$ or CTG or EFM).ti,ab.
22	(electronic adj (f?etal or f?etus$) adj monitor$).ti,ab.
23	or/14-22
24	and/5,13,23

Database(s): EBM Reviews - Cochrane Database of Systematic Reviews, EBM Reviews - Database of Abstracts of Reviews of Effects

#	Searches
1	PARTURITION.kw.
2	LABOR, OBSTETRIC.kw.
3	DELIVERY, OBSTETRIC.kw.

#	Searches
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).tw,tx.
5	or/1-4
6	ELECTROCARDIOGRAPHY.kw.
7	electrocardiograph$.tw,tx.
8	(FECG or ECG or EKG).tw,tx.
9	(ST adj3 (analys#s or segment$ or wave$)).tw,tx.
10	STAN.tw,tx.
11	((PR or time) adj3 interval$).tw,tx.
12	"T-QRS".tw,tx.
13	or/6-12
14	FETAL MONITORING.kw.
15	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).tw,tx.
16	HEART RATE, FETAL.kw.
17	FETAL DISTRESS.kw.
18	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).tw,tx.
19	FHR.tw,tx.
20	CARDIOTOCOGRAPHY.kw.
21	(cardiotocogra$ or CTG or EFM).tw,tx.
22	(electronic adj (f?etal or f?etus$) adj monitor$).tw,tx.
23	or/14-22
24	and/5,13,23

Database(s): EBM Reviews - Health Technology Assessment

#	Searches
1	exp PARTURITION/
2	exp LABOR, OBSTETRIC/
3	exp DELIVERY, OBSTETRIC/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).tw.
5	or/1-4
6	ELECTROCARDIOGRAPHY/
7	electrocardiograph$.tw.
8	(FECG or ECG or EKG).tw.
9	(ST adj3 (analys#s or segment$ or wave$)).tw.
10	STAN.tw.
11	((PR or time) adj3 interval$).tw.
12	"T-QRS".tw.
13	or/6-12
14	FETAL MONITORING/
15	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).tw.
16	HEART RATE, FETAL/
17	FETAL DISTRESS/
18	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).tw.
19	FHR.tw.
20	CARDIOTOCOGRAPHY/
21	(cardiotocogra$ or CTG or EFM).tw.

#	Searches
22	(electronic adj (f?etal or f?etus$) adj monitor$).tw.
23	or/14-22
24	and/5,13,23

Database(s): Embase

#	Searches
1	CLINICAL TRIAL/ or "CLINICAL TRIAL (TOPIC)"/
2	(clinic$ adj5 trial$).tw,sh.
3	SINGLE BLIND PROCEDURE/
4	DOUBLE BLIND PROCEDURE/
5	RANDOM ALLOCATION/
6	CROSSOVER PROCEDURE/
7	PLACEBO/
8	placebo$.tw,sh.
9	random$.tw,sh.
10	RANDOMIZED CONTROLLED TRIAL/ or "RANDOMIZED CONTROLLED TRIAL (TOPIC)"/
11	((single or double or triple or treble) adj (blind$ or mask$)).tw,sh.
12	randomi?ed control$ trial$.tw.
13	or/1-12
14	META ANALYSIS/
15	((meta adj analy$) or metaanalys$ or meta-analy$).tw,sh.
16	(systematic$ adj5 (review$ or overview$)).tw,sh.
17	(methodologic$ adj5 (review$ or overview$)).tw,sh.
18	or/14-17
19	review.pt.
20	(medline or medlars or embase).ab.
21	(scisearch or science citation index).ab.
22	(psychlit or psyclit or psychinfo or psycinfo or cinahl or cochrane).ab.
23	((hand or manual$) adj2 search$).tw.
24	(electronic database$ or bibliographic database$ or computeri?ed database$ or online database$).tw.
25	(pooling or pooled or mantel haenszel).tw.
26	(peto or dersimonian or "der simonian" or fixed effect).tw.
27	or/20-26
28	and/19,27
29	COHORT ANALYSIS/
30	LONGITUDINAL STUDY/
31	FOLLOW UP/
32	PROSPECTIVE STUDY/
33	cohort$.tw.
34	or/29-33
35	or/13,18,28,34
36	(book or conference paper or editorial or letter or note or proceeding or short survey).pt.
37	35 not 36
38	COMPARATIVE STUDY/
39	or/37-38

#	Searches
40	BIRTH/
41	exp CHILDBIRTH/
42	exp DELIVERY/
43	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
44	or/40-43
45	FETUS ELECTROCARDIOGRAPHY/
46	electrocardiograph$.ti,ab.
47	(FECG or ECG or EKG).ti,ab.
48	ST SEGMENT/
49	(ST adj3 (analys#s or segment$ or wave$)).ti,ab.
50	STAN.ti,ab.
51	PR INTERVAL/
52	(T QRS adj ratio$).ti,ab.
53	((PR or time) adj3 interval$).ti,ab.
54	or/45-53
55	FETUS MONITORING/
56	exp FETAL MONITOR/
57	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).ti,ab.
58	FETUS HEART RATE/
59	FETUS DISTRESS/
60	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).ti,ab.
61	CARDIOTOCOGRAPHY/
62	CARDIOTOCOGRAPH/
63	(cardiotocogra$ or CTG or EFM).ti,ab.
64	(electronic adj3 (f?etal or f?etus$) adj3 monitor$).ti,ab.
65	or/55-64
66	and/44,54,65
67	and/39,66
68	conference abstract.pt.
69	letter.pt. or LETTER/
70	note.pt.
71	editorial.pt.
72	CASE REPORT/ or CASE STUDY/
73	(letter or comment* or abstracts).ti.
74	or/68-73
75	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
76	74 not 75
77	ANIMAL/ not HUMAN/
78	NONHUMAN/
79	exp ANIMAL EXPERIMENT/
80	exp EXPERIMENTAL ANIMAL/
81	ANIMAL MODEL/
82	exp RODENT/
83	(rat or rats or mouse or mice).ti.
84	or/76-83

#	Searches
85	67 not 84
86	limit 85 to english language

Database(s): CINAHL via EBSCOhost

#	Query	Limiters/Expanders
S47	S6 and S46	Limiters - English Language; Exclude MEDLINE records; Human Search modes - Boolean/Phrase
S46	S7 or S8 or S9 or S10 or S11 or S12 or S13 or S14 or S15 or S16 or S17 or S18 or S19 or S20 or S21 or S22 or S23 or S24 or S25 or S26 or S27 or S28 or S29 or S30 or S31 or S32 or S33 or S34 or S35 or S36 or S37 or S38 or S39 or S40 or S41 or S42 or S43 or S44 or S45	Search modes - Boolean/Phrase
S45	(MH "TELEMETRY")	Search modes - Boolean/Phrase
S44	TI (EFM) or AB (EFM)	Search modes - Boolean/Phrase
S43	TI (cardiotocograph*) or AB (cardiotograph*)	Search modes - Boolean/Phrase
S42	AB (sonicaid* or ultraso* or echo* or sono* or flowmet* or doppler*)	Search modes - Boolean/Phrase
S41	TI (sonicaid* or ultraso* or echo* or sono* or flowmet* or doppler*)	Search modes - Boolean/Phrase
S40	MH ECHOCARDIOGRAPHY, DOPPLER	Search modes - Boolean/Phrase
S39	MH ULTRASONOGRAPHY, DOPPLER	Search modes - Boolean/Phrase
S38	TI (non stress test* or nonstress test* or NST) or AB (non stress test* or nonstress test* or NST)	Search modes - Boolean/Phrase
S37	MH NONSTRESS TESTING, FETAL	Search modes - Boolean/Phrase
S36	TI ("listening in") or AB ("listening in")	Search modes - Boolean/Phrase
S35	TI (auscultat* or IA or pin#ard* or fetoscop*) or AB (auscultat* or IA or pin#ard* or fetoscop*)	Search modes - Boolean/Phrase
S34	MH STETHOSCOPES	Search modes - Boolean/Phrase
S33	MH AUSCULTATION+	Search modes - Boolean/Phrase
S32	AB (umbilic* N3 gas*)	Search modes - Boolean/Phrase
S31	TI (umbilic* N3 gas*)	Search modes - Boolean/Phrase
S30	AB (cord N3 gas*)	Search modes - Boolean/Phrase
S29	TI (cord N3 gas*)	Search modes - Boolean/Phrase
S28	(MH "CORDOCENTESIS")	Search modes - Boolean/Phrase

#	Query	Limiters/Expanders
S27	TI (CTG) or AB (CTG)	Search modes - Boolean/Phrase
S26	AB (ST?segment)	Search modes - Boolean/Phrase
S25	TI (ST?segment)	Search modes - Boolean/Phrase
S24	TI (QRS) or AB (QRS)	Search modes - Boolean/Phrase
S23	TI (electrocardiogr*) or AB (electrocardiogr*)	Search modes - Boolean/Phrase
S22	TI (ECG) or AB (ECG)	Search modes - Boolean/Phrase
S21	(MH "ELECTROCARDIOGRAPHY+") OR (MH "ELECTROCARDIOGRAPHY, AMBULATORY") OR (MH "QRS COMPLEX") OR (MH "ST SEGMENT") OR (MH "VECTORCARDIOGRAPHY+")	Search modes - Boolean/Phrase
S20	(MH "FETAL MONITORING, ELECTRONIC+")	Search modes - Boolean/Phrase
S19	(fetal N3 blood) or AB (fetus* N3 blood) or AB (foetal N3 blood) or AB (foetus* N3 blood)	Search modes - Boolean/Phrase
S18	TI (FBS) or AB (FBS)	Search modes - Boolean/Phrase
S17	(MH "ACID-BASE IMBALANCE+")	Search modes - Boolean/Phrase
S16	(MH "FETAL HEART")	Search modes - Boolean/Phrase
S15	(MH "FETAL BLOOD")	Search modes - Boolean/Phrase
S14	TI (FHR) or AB (FHR)	Search modes - Boolean/Phrase
S13	AB (fetal N3 heart*) or AB (fetus* N3 heart*) or AB (foetal N3 heart*) or AB (foetus* N3 heart*)	Search modes - Boolean/Phrase
S12	TI (fetal N3 heart*) or TI (fetus* N3 heart*) or TI (foetal N3 heart*) or TI (foetus* N3 heart*)	Search modes - Boolean/Phrase
S11	MH HEART RATE, FETAL	Search modes - Boolean/Phrase
S10	AB (fetal N3 monitor*) or AB (fetus* N3 monitor*) or AB (foetal N3 monitor*) or AB (foetus* N3 monitor*)	Search modes - Boolean/Phrase
S9	TI (fetal N3 monitor*) or TI (fetus* N3 monitor*) or TI (foetal N3 monitor*) or TI (foetus* N3 monitor*)	Search modes - Boolean/Phrase
S8	MH UTERINE MONITORING	Search modes - Boolean/Phrase
S7	MH FETAL MONITORING+	Search modes - Boolean/Phrase
S6	S1 or S2 or S3 or S4 or S5	Search modes - Boolean/Phrase
S5	AB (partu* or birth* or childbirth* or intrapartu* or labo#r*)	Search modes - Boolean/Phrase
S4	TI (partu* or birth* or childbirth* or intrapartu* or labo#r*)	Search modes - Boolean/Phrase
S3	MH DELIVERY+	Search modes - Boolean/Phrase

#	Query	Limiters/Expanders
S2	MH LABOR+	Search modes - Boolean/Phrase
S1	MH CHILDBIRTH+	Search modes - Boolean/Phrase

Health economics

Database(s): Ovid MEDLINE(R)

#	Searches
1	ECONOMICS/
2	VALUE OF LIFE/
3	exp "COSTS AND COST ANALYSIS"/
4	exp ECONOMICS, HOSPITAL/
5	exp ECONOMICS, MEDICAL/
6	exp RESOURCE ALLOCATION/
7	ECONOMICS, NURSING/
8	ECONOMICS, PHARMACEUTICAL/
9	exp "FEES AND CHARGES"/
10	exp BUDGETS/
11	budget*.ti,ab.
12	cost*.ti,ab.
13	(economic* or pharmaco?economic*).ti,ab.
14	(price* or pricing*).ti,ab.
15	(financ* or fee or fees or expenditure* or saving*).ti,ab.
16	(value adj2 (money or monetary)).ti,ab.
17	resourc* allocat*.ti,ab.
18	(fund or funds or funding* or funded).ti,ab.
19	(ration or rations or rationing* or rationed).ti,ab.
20	ec.fs.
21	or/1-20
22	exp PARTURITION/
23	exp LABOR, OBSTETRIC/
24	exp DELIVERY, OBSTETRIC/
25	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
26	or/22-25
27	ELECTROCARDIOGRAPHY/
28	electrocardiograph$.ti,ab.
29	(FECG or ECG or EKG).ti,ab.
30	(ST adj3 (analys#s or segment$ or wave$)).ti,ab.
31	STAN.ti,ab.
32	((PR or time) adj3 interval$).ti,ab.
33	"T-QRS".ti,ab.
34	or/27-33
35	CARDIOTOCOGRAPHY/
36	(cardiotocogra$ or CTG or EFM).ti,ab.
37	(electronic adj (f?etal or f?etus$) adj monitor$).ti,ab.

#	Searches
38	or/35-37
39	and/34,38
40	and/26,39
41	LETTER/
42	EDITORIAL/
43	NEWS/
44	exp HISTORICAL ARTICLE/
45	ANECDOTES AS TOPIC/
46	COMMENT/
47	CASE REPORT/
48	(letter or comment* or abstracts).ti.
49	or/41-48
50	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
51	49 not 50
52	ANIMALS/ not HUMANS/
53	exp ANIMALS, LABORATORY/
54	exp ANIMAL EXPERIMENTATION/
55	exp MODELS, ANIMAL/
56	exp RODENTIA/
57	(rat or rats or mouse or mice).ti.
58	or/51-57
59	and/40,58
60	40 not 59
61	and/21,60

Database(s): EBM Reviews - Cochrane Central Register of Controlled Trials

#	Searches
1	ECONOMICS/
2	VALUE OF LIFE/
3	exp "COSTS AND COST ANALYSIS"/
4	exp ECONOMICS, HOSPITAL/
5	exp ECONOMICS, MEDICAL/
6	exp RESOURCE ALLOCATION/
7	ECONOMICS, NURSING/
8	ECONOMICS, PHARMACEUTICAL/
9	exp "FEES AND CHARGES"/
10	exp BUDGETS/
11	budget*.ti,ab.
12	cost*.ti,ab.
13	(economic* or pharmaco?economic*).ti,ab.
14	(price* or pricing*).ti,ab.
15	(financ* or fee or fees or expenditure* or saving*).ti,ab.
16	(value adj2 (money or monetary)).ti,ab.
17	resourc* allocat*.ti,ab.
18	(fund or funds or funding* or funded).ti,ab.

#	Searches
19	(ration or rations or rationing* or rationed).ti,ab.
20	ec.fs.
21	or/1-20
22	exp PARTURITION/
23	exp LABOR, OBSTETRIC/
24	exp DELIVERY, OBSTETRIC/
25	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
26	or/22-25
27	ELECTROCARDIOGRAPHY/
28	electrocardiograph$.ti,ab.
29	(FECG or ECG or EKG).ti,ab.
30	(ST adj3 (analys#s or segment$ or wave$)).ti,ab.
31	STAN.ti,ab.
32	((PR or time) adj3 interval$).ti,ab.
33	"T-QRS".ti,ab.
34	or/27-33
35	CARDIOTOCOGRAPHY/
36	(cardiotocogra$ or CTG or EFM).ti,ab.
37	(electronic adj (f?etal or f?etus$) adj monitor$).ti,ab.
38	or/35-37
39	and/34,38
40	and/26,39
41	and/21,40

Database(s): EBM Reviews - Health Technology Assessment

#	Searches
1	exp PARTURITION/
2	exp LABOR, OBSTETRIC/
3	exp DELIVERY, OBSTETRIC/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).tw.
5	or/1-4
6	ELECTROCARDIOGRAPHY/
7	electrocardiograph$.tw.
8	(FECG or ECG or EKG).tw.
9	(ST adj3 (analys#s or segment$ or wave$)).tw.
10	STAN.tw.
11	((PR or time) adj3 interval$).tw.
12	"T-QRS".tw.
13	or/6-12
14	FETAL MONITORING/
15	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).tw.
16	HEART RATE, FETAL/
17	FETAL DISTRESS/
18	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).tw.
19	FHR.tw.

#	Searches
20	CARDIOTOCOGRAPHY/
21	(cardiotocogra$ or CTG or EFM).tw.
22	(electronic adj (f?etal or f?etus$) adj monitor$).tw.
23	or/14-22
24	and/5,13,23

Database(s): EBM Reviews - NHS Economic Evaluation Database

#	Searches
1	exp PARTURITION/
2	exp LABOR, OBSTETRIC/
3	exp DELIVERY, OBSTETRIC/
4	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).tw.
5	or/1-4
6	ELECTROCARDIOGRAPHY/
7	electrocardiograph$.tw.
8	(FECG or ECG or EKG).tw.
9	(ST adj3 (analys#s or segment$ or wave$)).tw.
10	STAN.tw.
11	((PR or time) adj3 interval$).tw.
12	"T-QRS".tw.
13	or/6-12
14	CARDIOTOCOGRAPHY/
15	(cardiotocogra$ or CTG or EFM).tw.
16	(electronic adj (f?etal or f?etus$) adj monitor$).tw.
17	or/14-16
18	and/13,17
19	and/5,18

Database(s): Embase

#	Searches
1	HEALTH ECONOMICS/
2	exp ECONOMIC EVALUATION/
3	exp HEALTH CARE COST/
4	exp FEE/
5	BUDGET/
6	FUNDING/
7	RESOURCE ALLOCATION/
8	budget*.ti,ab.
9	cost*.ti,ab.
10	(economic* or pharmaco?economic*).ti,ab.
11	(price* or pricing*).ti,ab.
12	(financ* or fee or fees or expenditure* or saving*).ti,ab.
13	(value adj2 (money or monetary)).ti,ab.
14	resourc* allocat*.ti,ab.
15	(fund or funds or funding* or funded).ti,ab.
16	(ration or rations or rationing* or rationed).ti,ab.

#	Searches
17	or/1-16
18	BIRTH/
19	exp CHILDBIRTH/
20	exp DELIVERY/
21	(partu$ or birth$ or childbirth$ or intra?partu$ or labo?r$).ti,ab.
22	or/18-21
23	FETUS ELECTROCARDIOGRAPHY/
24	electrocardiograph$.ti,ab.
25	(FECG or ECG or EKG).ti,ab.
26	ST SEGMENT/
27	(ST adj3 (analys#s or segment$ or wave$)).ti,ab.
28	STAN.ti,ab.
29	PR INTERVAL/
30	(T QRS adj ratio$).ti,ab.
31	((PR or time) adj3 interval$).ti,ab.
32	or/23-31
33	FETUS MONITORING/
34	exp FETAL MONITOR/
35	((f?etal or f?etus$ or uter$) adj5 (monitor$ or observ$ or assess$ or status$ or care)).ti,ab.
36	FETUS HEART RATE/
37	FETUS DISTRESS/
38	((f?etal or f?etus$) adj5 (heart$ or distress$ or reassur$ or non?reassur$ or compromis$)).ti,ab.
39	CARDIOTOCOGRAPHY/
40	CARDIOTOCOGRAPH/
41	(cardiotocogra$ or CTG or EFM).ti,ab.
42	(electronic adj3 (f?etal or f?etus$) adj3 monitor$).ti,ab.
43	or/33-42
44	and/22,32,43
45	conference abstract.pt.
46	letter.pt. or LETTER/
47	note.pt.
48	editorial.pt.
49	CASE REPORT/ or CASE STUDY/
50	(letter or comment* or abstracts).ti.
51	or/45-50
52	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
53	51 not 52
54	ANIMAL/ not HUMAN/
55	NONHUMAN/
56	exp ANIMAL EXPERIMENT/
57	exp EXPERIMENTAL ANIMAL/
58	ANIMAL MODEL/
59	exp RODENT/
60	(rat or rats or mouse or mice).ti.
61	or/53-60

#	Searches
62	44 not 61
63	and/17,62
64	limit 63 to english language

D.9 Automated interpretation of cardiotocograph traces

The search strategies below were developed specifically for the 2016 evidence review because no search strategies were published in CG190 for this question.

Database: Medline; Medline EPub Ahead of Print; and Medline In-Process & Other Non-Indexed Citations

#	Searches
1	FETAL MONITORING/
2	UTERINE MONITORING/
3	HEART RATE, FETAL/
4	exp FETAL HEART/
5	FETAL DISTRESS/
6	((f?etal or f?etus$ or uter$) adj3 (monitor$ or observ$ or assess$ or heart$ or distress$)).ti,ab.
7	FHR.ti,ab.
8	EFM.ti,ab.
9	CARDIOTOCOGRAPHY/
10	(cardiotocogra$ or CTG).ti,ab.
11	ELECTROCARDIOGRAPHY/ and (PERIPARTUM PERIOD/ or PARTURITION/ or exp LABOR, OBSTETRIC/ or exp DELIVERY, OBSTETRIC/ or FETUS/)
12	((electrocardiogra$ or ECG or EKG) adj5 (labo?r or birth or childbirth or partu$ or intra?part$ or peri?part$ or f?etal or f?etus$)).ti,ab.
13	or/1-12
14	exp COMPUTERS/
15	exp SOFTWARE/
16	exp SIGNAL PROCESSING, COMPUTER-ASSISTED/
17	AUTOMATIC DATA PROCESSING/
18	ARTIFICIAL INTELLIGENCE/
19	or/14-18
20	(estimat$ or assess$ or analy$ or interpret$ or (Decision? adj3 (make? or making or support$)) or alert$).ti.
21	(estimat$ or assess$ or analy$ or interpret$ or (Decision? adj3 (make? or making or support$)) or alert$).ab. /freq=2
22	or/20-21
23	19 and 22
24	((computer$ or software or hardware or (intelligen$ adj3 system$) or automat$) adj7 (estimat$ or assess$ or analy$ or interpret$ or (Decision? adj3 (make? or making or support$)) or alert$)).ti,ab.
25	DECISION SUPPORT SYSTEMS, CLINICAL/
26	DIAGNOSIS, COMPUTER-ASSISTED/
27	or/23-26
28	13 and 27
29	limit 28 to english language

#	Searches
30	limit 29 to yr="2006 -Current"
31	LETTER/
32	EDITORIAL/
33	NEWS/
34	exp HISTORICAL ARTICLE/
35	ANECDOTES AS TOPIC/
36	COMMENT/
37	CASE REPORT/
38	(letter or comment*).ti.
39	or/31-38
40	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
41	39 not 40
42	ANIMALS/ not HUMANS/
43	exp ANIMALS, LABORATORY/
44	exp ANIMAL EXPERIMENTATION/
45	exp MODELS, ANIMAL/
46	exp RODENTIA/
47	(rat or rats or mouse or mice).ti.
48	or/41-47
49	30 not 48

Database: Cochrane Central Register of Controlled Trials

#	Searches
1	FETAL MONITORING/
2	UTERINE MONITORING/
3	HEART RATE, FETAL/
4	exp FETAL HEART/
5	FETAL DISTRESS/
6	((f?etal or f?etus$ or uter$) adj3 (monitor$ or observ$ or assess$ or heart$ or distress$)).ti,ab.
7	FHR.ti,ab,kw.
8	EFM.ti,ab,kw.
9	CARDIOTOCOGRAPHY/
10	(cardiotocogra$ or CTG).ti,ab,kw.
11	ELECTROCARDIOGRAPHY/ and (PERIPARTUM PERIOD/ or PARTURITION/ or exp LABOR, OBSTETRIC/ or exp DELIVERY, OBSTETRIC/ or FETUS/)
12	((electrocardiogra$ or ECG or EKG) adj5 (labo?r or birth or childbirth or partu$ or intra?part$ or peri?part$ or f?etal or f?etus$)).ti,ab.
13	or/1-12
14	exp COMPUTERS/
15	exp SOFTWARE/
16	exp SIGNAL PROCESSING, COMPUTER-ASSISTED/
17	AUTOMATIC DATA PROCESSING/
18	ARTIFICIAL INTELLIGENCE/
19	or/14-18

#	Searches
20	(estimat$ or assess$ or analy$ or interpret$ or (Decision? adj3 (make? or making or support$)) or alert$).ti.
21	(estimat$ or assess$ or analy$ or interpret$ or (Decision? adj3 (make? or making or support$)) or alert$).ab. /freq=2
22	or/20-21
23	19 and 22
24	((computer$ or software or hardware or (intelligen$ adj3 system$) or automat$) adj7 (estimat$ or assess$ or analy$ or interpret$ or (Decision? adj3 (make? or making or support$)) or alert$)).ti,ab.
25	DECISION SUPPORT SYSTEMS, CLINICAL/
26	DIAGNOSIS, COMPUTER-ASSISTED/
27	or/23-26
28	13 and 27
29	limit 28 to yr="2006 -Current"

Database: Cochrane Database of Systematic Reviews

#	Searches
1	FETAL MONITORING.kw.
2	UTERINE MONITORING.kw.
3	HEART RATE, FETAL.kw.
4	FETAL HEART.kw.
5	FETAL DISTRESS.kw.
6	((f?etal or f?etus$ or uter$) adj3 (monitor$ or observ$ or assess$ or heart$ or distress$)).ti,ab.
7	FHR.ti,ab.
8	EFM.ti,ab.
9	CARDIOTOCOGRAPHY.kw.
10	(cardiotocogra$ or CTG).ti,ab.
11	(ELECTROCARDIOGRAPHY and (PERIPARTUM PERIOD or PARTURITION or LABOR, OBSTETRIC or DELIVERY, OBSTETRIC or FETUS)).kw.
12	((electrocardiogra$ or ECG or EKG) adj5 (labo?r or birth or childbirth or partu$ or intra?part$ or peri?part$ or f?etal or f?etus$)).ti,ab.
13	or/1-12
14	COMPUTERS.kw.
15	SOFTWARE.kw.
16	SIGNAL PROCESSING, COMPUTER-ASSISTED.kw.
17	AUTOMATIC DATA PROCESSING.kw.
18	ARTIFICIAL INTELLIGENCE.kw.
19	or/14-18
20	(estimat$ or assess$ or analy$ or interpret$ or (Decision? adj3 (make? or making or support$)) or alert$).ti.
21	(estimat$ or assess$ or analy$ or interpret$ or (Decision? adj3 (make? or making or support$)) or alert$).ab. /freq=2
22	or/20-21
23	19 and 22
24	((computer$ or software or hardware or (intelligen$ adj3 system$) or automat$) adj7 (estimat$ or assess$ or analy$ or interpret$ or (Decision? adj3 (make? or making or support$)) or alert$)).ti,ab.

#	Searches
25	DECISION SUPPORT SYSTEMS, CLINICAL.kw.
26	DIAGNOSIS, COMPUTER-ASSISTED.kw.
27	or/23-26
28	13 and 27

Database: Database of Abstracts of Reviews of Effects

#	Searches
1	FETAL MONITORING.kw.
2	UTERINE MONITORING.kw.
3	HEART RATE, FETAL.kw.
4	FETAL HEART.kw.
5	FETAL DISTRESS.kw.
6	((f?etal or f?etus$ or uter$) adj3 (monitor$ or observ$ or assess$ or heart$ or distress$)).tw,tx.
7	FHR.tw,tx.
8	EFM.tw,tx.
9	CARDIOTOCOGRAPHY.kw.
10	(cardiotocogra$ or CTG).tw,tx.
11	(ELECTROCARDIOGRAPHY and (PERIPARTUM PERIOD or PARTURITION or LABOR, OBSTETRIC or DELIVERY, OBSTETRIC or FETUS)).kw.
12	((electrocardiogra$ or ECG or EKG) adj5 (labo?r or birth or childbirth or partu$ or intra?part$ or peri?part$ or f?etal or f?etus$)).tw,tx.
13	or/1-12
14	COMPUTERS.kw.
15	SOFTWARE.kw.
16	SIGNAL PROCESSING, COMPUTER-ASSISTED.kw.
17	AUTOMATIC DATA PROCESSING.kw.
18	ARTIFICIAL INTELLIGENCE.kw.
19	or/14-18
20	(estimat$ or assess$ or analy$ or interpret$ or (Decision? adj3 (make? or making or support$)) or alert$).tw,tx.
21	19 and 20
22	((computer$ or software or hardware or (intelligen$ adj3 system$) or automat$) adj7 (estimat$ or assess$ or analy$ or interpret$ or (Decision? adj3 (make? or making or support$)) or alert$)).tw,tx.
23	DECISION SUPPORT SYSTEMS, CLINICAL.kw.
24	DIAGNOSIS, COMPUTER-ASSISTED.kw.
25	or/21-24
26	13 and 25

Database: Health Technology Assessment

#	Searches
1	FETAL MONITORING/
2	UTERINE MONITORING/
3	HEART RATE, FETAL/
4	exp FETAL HEART/
5	FETAL DISTRESS/

#	Searches
6	((f?etal or f?etus$ or uter$) adj3 (monitor$ or observ$ or assess$ or heart$ or distress$)).tw.
7	FHR.tw.
8	EFM.tw.
9	CARDIOTOCOGRAPHY/
10	(cardiotocogra$ or CTG).tw.
11	ELECTROCARDIOGRAPHY/ and (PERIPARTUM PERIOD/ or PARTURITION/ or exp LABOR, OBSTETRIC/ or exp DELIVERY, OBSTETRIC/ or FETUS/)
12	((electrocardiogra$ or ECG or EKG) adj5 (labo?r or birth or childbirth or partu$ or intra?part$ or peri?part$ or f?etal or f?etus$)).tw.
13	or/1-12
14	exp COMPUTERS/
15	exp SOFTWARE/
16	exp SIGNAL PROCESSING, COMPUTER-ASSISTED/
17	AUTOMATIC DATA PROCESSING/
18	ARTIFICIAL INTELLIGENCE/
19	or/14-18
20	(estimat$ or assess$ or analy$ or interpret$ or (Decision? adj3 (make? or making or support$)) or alert$).tw.
21	19 and 20
22	((computer$ or software or hardware or (intelligen$ adj3 system$) or automat$) adj7 (estimat$ or assess$ or analy$ or interpret$ or (Decision? adj3 (make? or making or support$)) or alert$)).tw.
23	DECISION SUPPORT SYSTEMS, CLINICAL/
24	DIAGNOSIS, COMPUTER-ASSISTED/
25	or/21-24
26	13 and 25

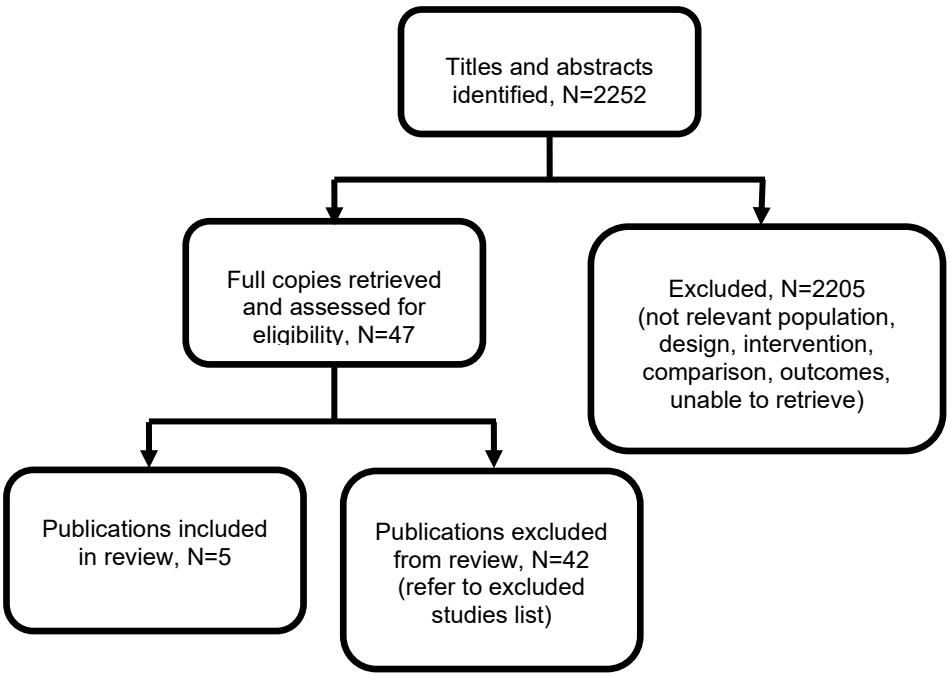
Database: Embase

#	Searches
1	*FETUS MONITORING/
2	*FETUS HEART RATE/
3	*FETUS HEART/
4	*FETUS DISTRESS/
5	((f?etal or f?etus$ or uter$) adj3 (monitor$ or observ$ or assess$ or heart$ or distress$)).ti,ab.
6	FHR.ti,ab.
7	EFM.ti,ab.
8	*CARDIOTOCOGRAPHY/
9	(cardiotocogra$ or CTG).ti,ab.
10	(*ELECTROCARDIOGRAPHY/ or *ELECTROCARDIOGRAPHY MONITORING/) and (*PERINATAL PERIOD/ or *BIRTH/ or exp *LABOR/ or exp *DELIVERY/ or *FETUS/)
11	((electrocardiogra$ or ECG or EKG) adj5 (labo?r or birth or childbirth or partu$ or intra?part$ or peri?part$ or f?etal or f?etus$)).ti,ab.
12	or/1-11
13	exp *COMPUTER/
14	exp *COMPUTER PROGRAM/
15	exp *SIGNAL PROCESSING/

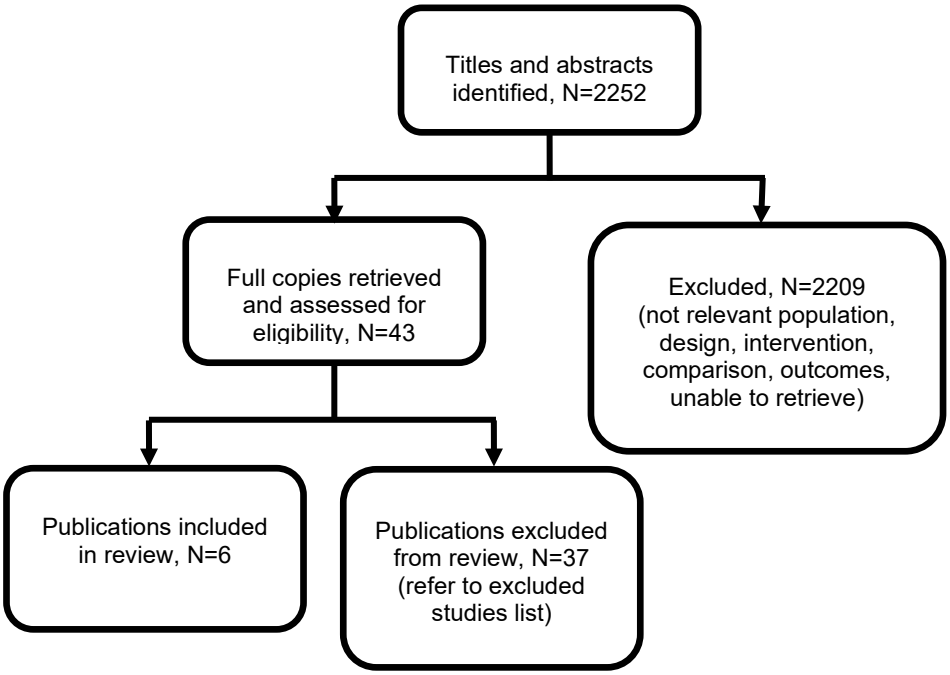
#	Searches
16	*INFORMATION PROCESSING/
17	*ARTIFICIAL INTELLIGENCE/
18	or/13-17
19	(estimat$ or assess$ or analy$ or interpret$ or (Decision? adj3 (make? or making or support$)) or alert$).ti.
20	(estimat$ or assess$ or analy$ or interpret$ or (Decision? adj3 (make? or making or support$)) or alert$).ab. /freq=2
21	or/19-20
22	18 and 21
23	((computer$ or software or hardware or (intelligen$ adj3 system$) or automat$) adj7 (estimat$ or assess$ or analy$ or interpret$ or (Decision? adj3 (make? or making or support$)) or alert$)).ti,ab.
24	*DECISION SUPPORT SYSTEM/
25	*COMPUTER ASSISTED DIAGNOSIS/
26	or/22-25
27	12 and 26
28	limit 27 to english language
29	limit 28 to yr="2006 -Current"
30	letter.pt. or LETTER/
31	note.pt.
32	editorial.pt.
33	CASE REPORT/ or CASE STUDY/
34	(letter or comment*).ti.
35	or/30-34
36	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
37	35 not 36
38	ANIMAL/ not HUMAN/
39	NONHUMAN/
40	exp ANIMAL EXPERIMENT/
41	exp EXPERIMENTAL ANIMAL/
42	ANIMAL MODEL/
43	exp RODENT/
44	(rat or rats or mouse or mice).ti.
45	or/37-44
46	29 not 45

Appendix E: Summary of identified studies

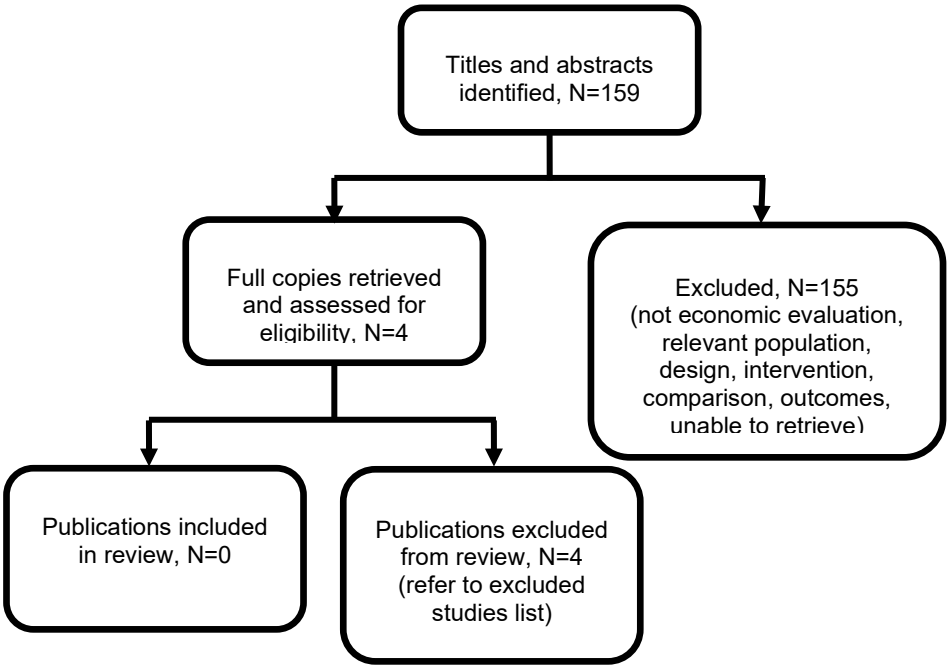
E.1 Intermittent auscultation compared with cardiotocography on admission



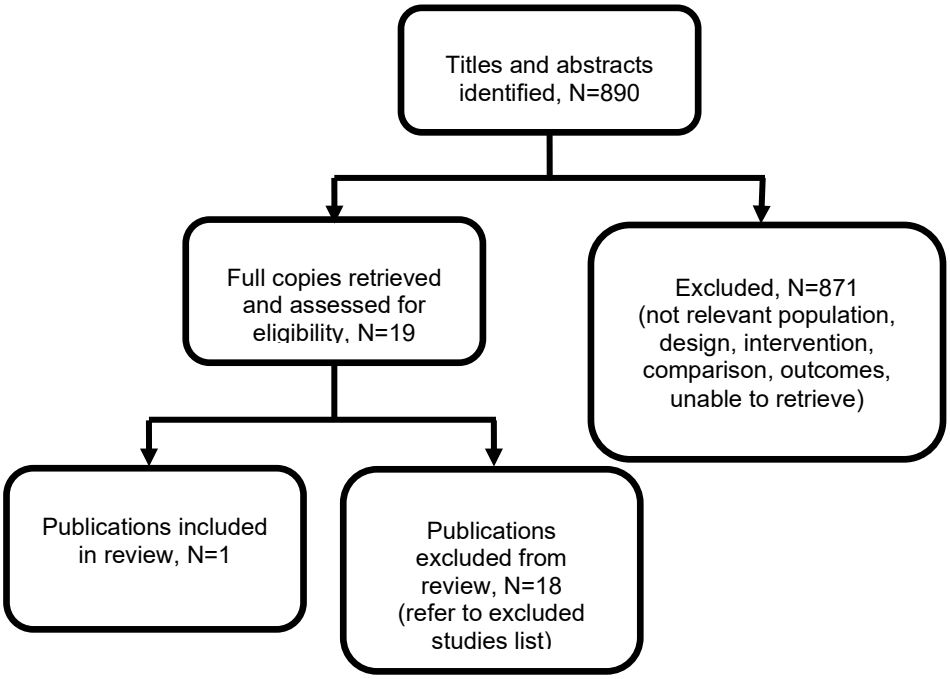
E.2 Intermittent auscultation compared with cardiotocography during labour



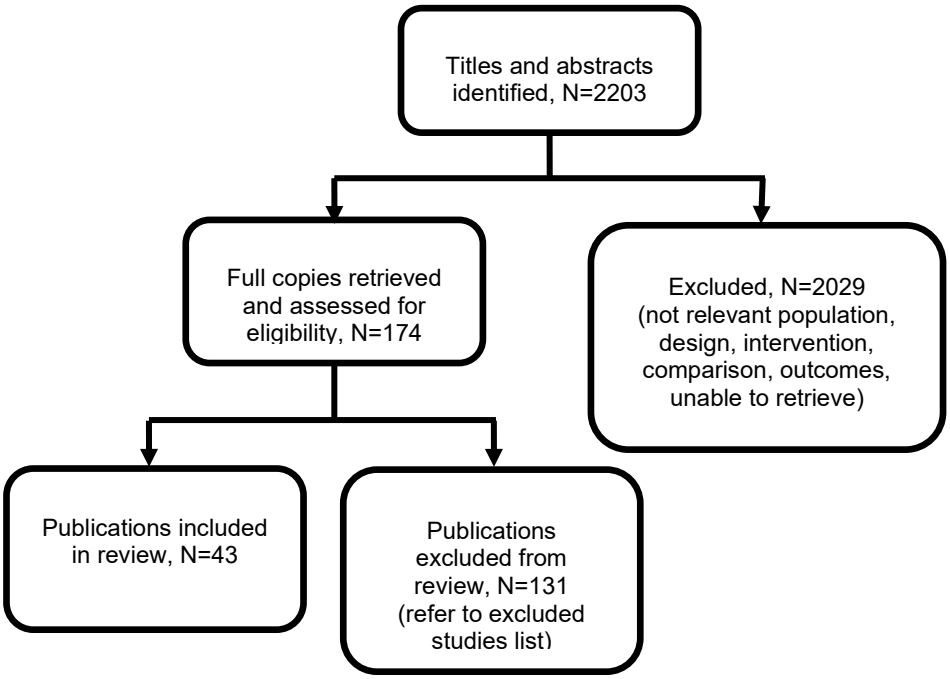
E.3 Intermittent auscultation compared with cardiotocography – health economics



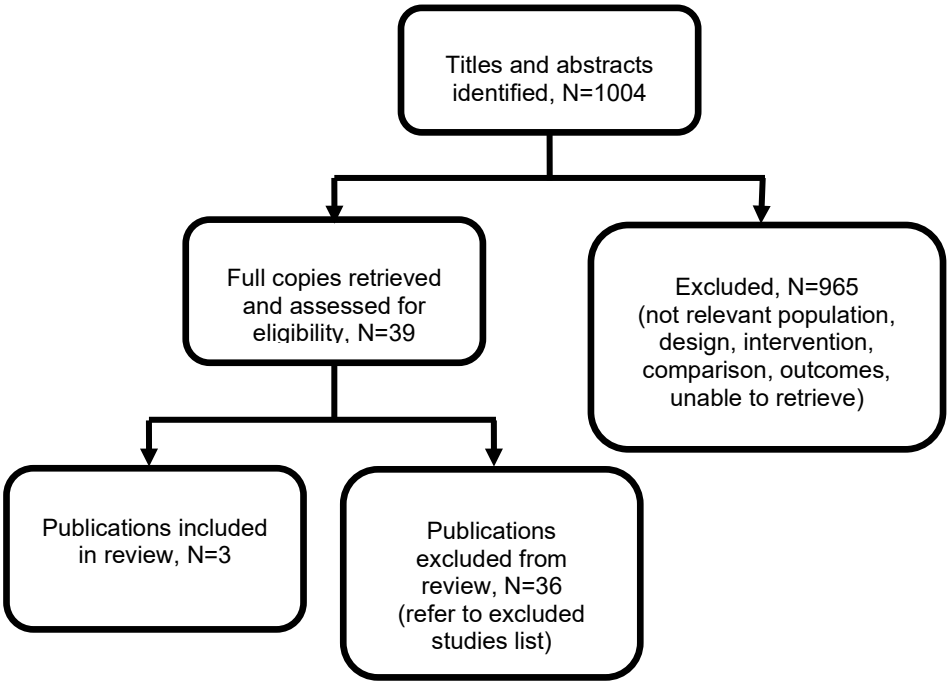
E.4 Intermittent auscultation compared with cardiotocography in the presence of meconium stained liquor



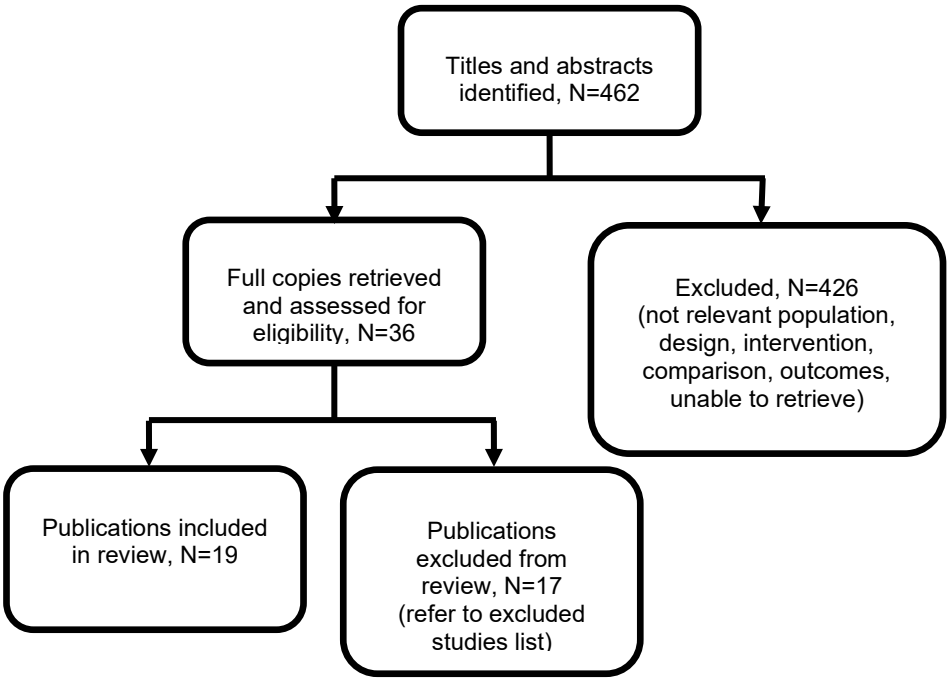
E.5 Interpretation of cardiotocograph traces



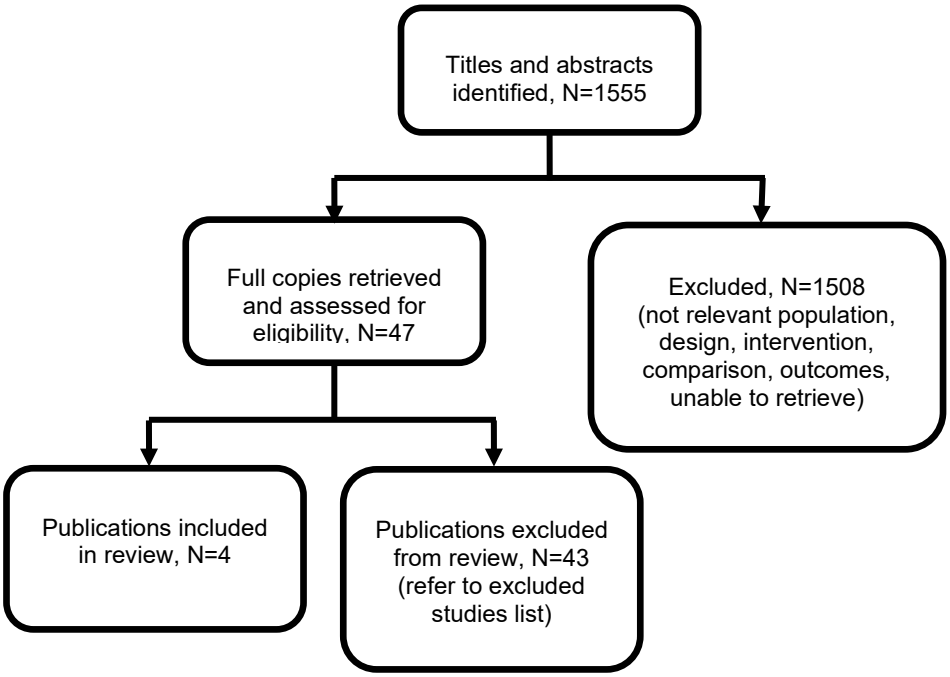
E.6 Care in labour as a result of cardiotocography



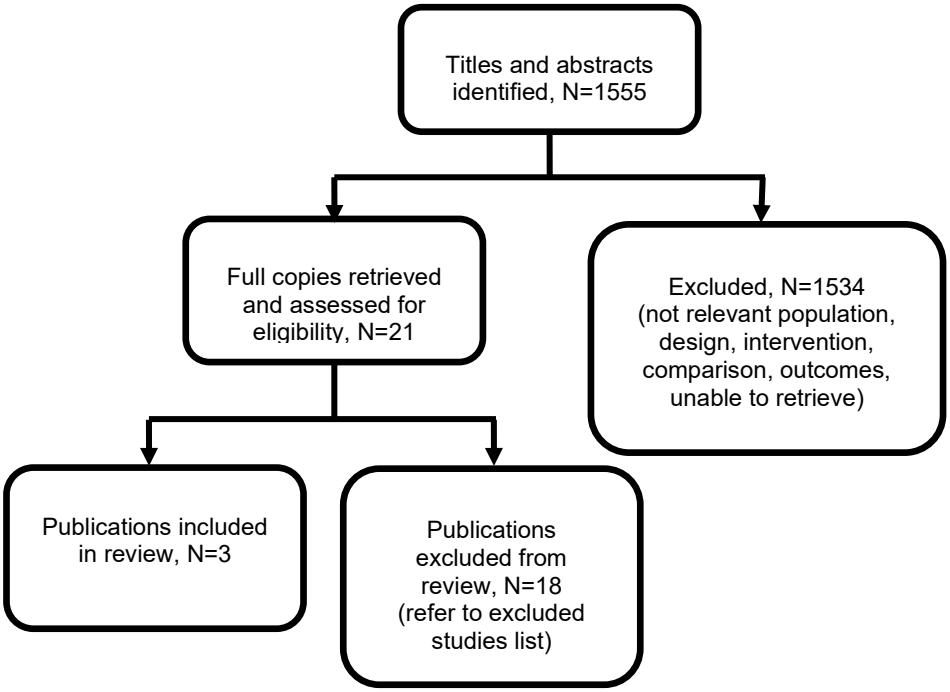
E.7 Fetal scalp stimulation



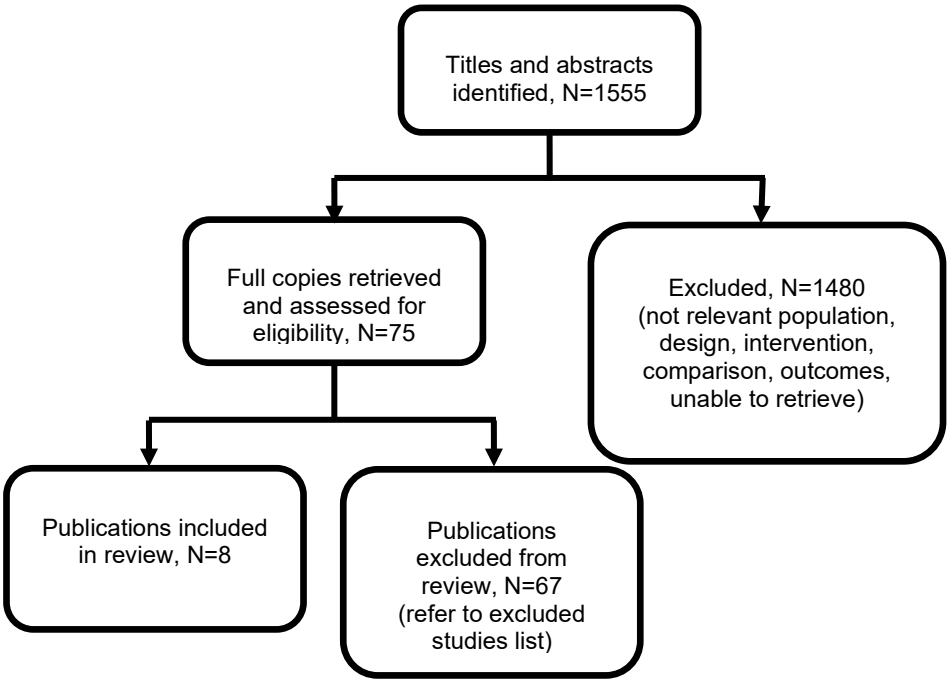
E.8 Fetal blood sampling as an adjunct to cardiotocography



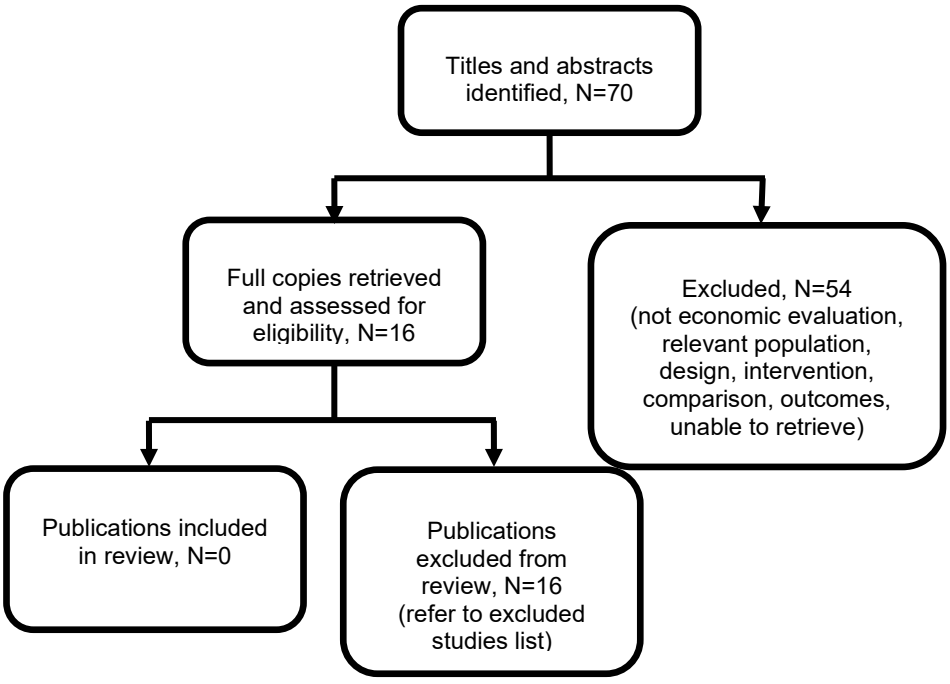
E.9 Fetal blood sampling – time to result



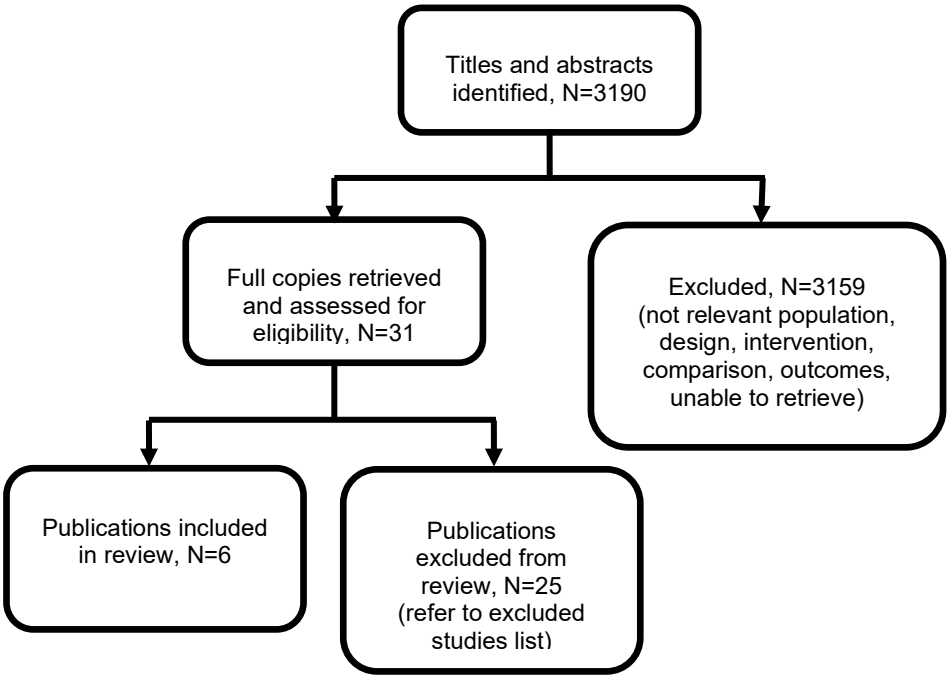
E.10 Predictive value of fetal blood sampling



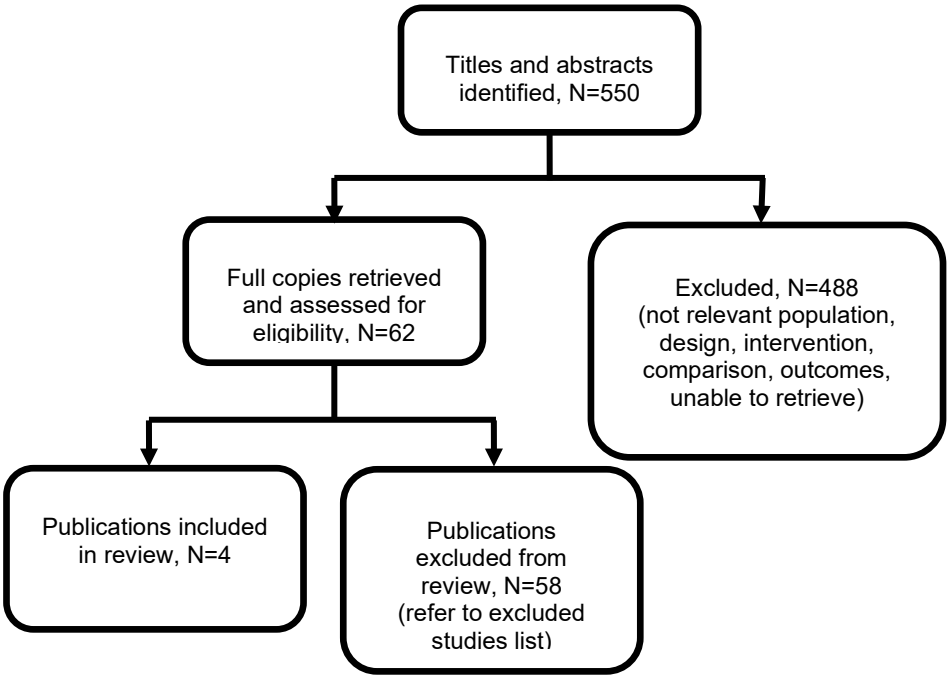
E.11 Fetal blood sampling – health economics



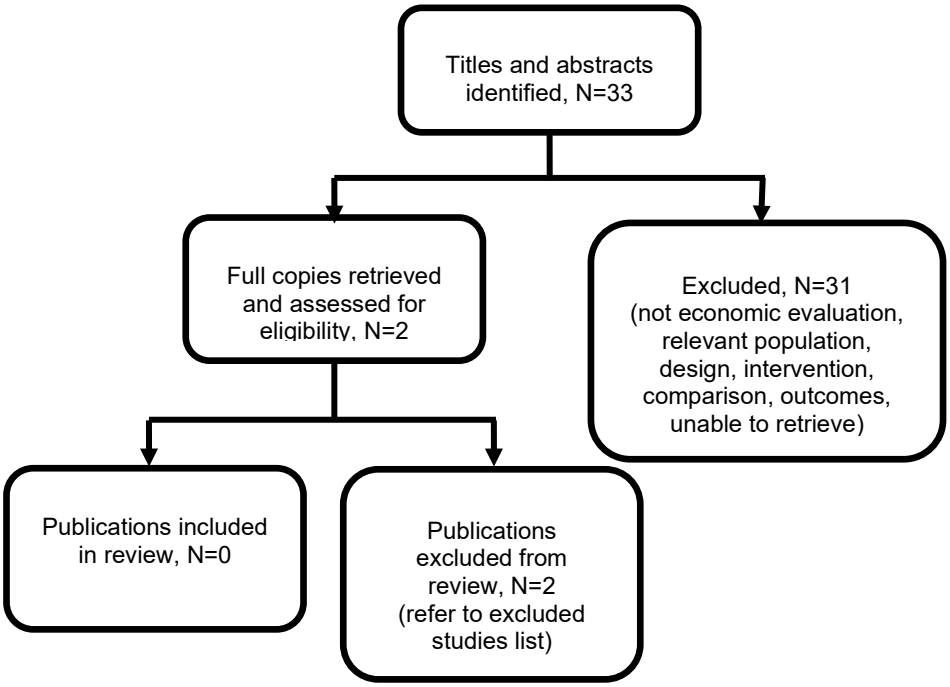
E.12 Women's experience of fetal monitoring



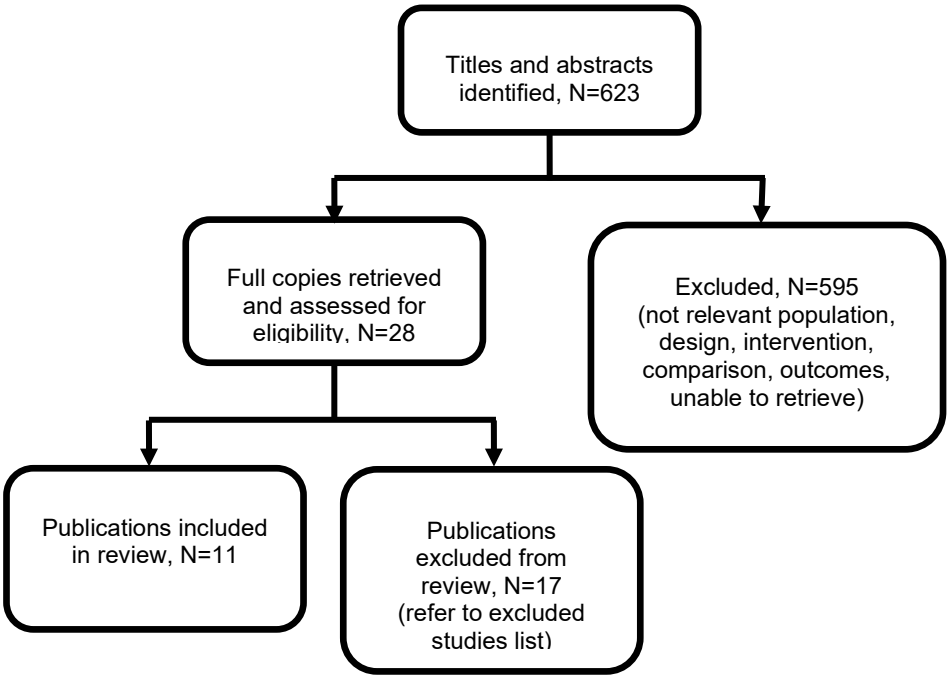
E.13 Cardiotocography with electrocardiogram analysis compared with cardiotocography alone



E.14 Cardiotocography with electrocardiogram analysis compared with cardiotocography alone – health economics



E.15 Automated interpretation of cardiotocograph traces



Appendix F:Excluded studies

F.1 Intermittent auscultation compared with cardiotocography on admission

Study	Reason for Exclusion
Intermittent Auscultation for Intrapartum Fetal Heart Rate Surveillance, Journal of Midwifery and Women's Health, 52, 314-319, 2007	Non-systematic review
Intermittent Auscultation for Intrapartum Fetal Heart Rate Surveillance (replaces ACNM Clinical Bulletin #9, March 2007), Journal of Midwifery and Women's Health, 55, 397-403, 2010	Non-systematic review
Alfirevic,Z., Devane,D., Gyte,G.M., Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour, The Cochrane database of systematic reviews, 5, CD006066-, 2013	Intervention outside of interest: CTG during labour
Alfirevic,Z., Devane,D., Gyte,G.M., Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour. [55 refs]Updated, Cochrane Database of Systematic Reviews, 5, CD006066-, 2013	This systematic review evaluates monitoring in labour, not the use of admission CTG compared with intermittent auscultation
Barstow,Craig, Gauer,Robert, Jamieson,Barbara, How does electronic fetal heart rate monitoring affect labor and delivery outcomes?, Evidence-Based Practice, 14, 1-2, 2011	Summary of a Cochrane review that reports use of EFM in labour, not on admission
Becker, J. H., Krikhaar, A., Schuit, E., Martendal, A., Marsal, K., Kwee, A., Visser, G. H., Amer-Wahlin, I., The added predictive value of biphasic events in ST analysis of the fetal electrocardiogram for intrapartum fetal monitoring, Acta Obstetricia et Gynecologica Scandinavica, 94, 175-82, 2015	Comparison outside of interest: the aim was to study the predictive value of biphasic ST events for interventions
Bernatavicius, G., Roberts, S., Garrod, A., Whitworth, M. K., Johnstone, E. D., Gillham, J. C., Lavender, T., Heazell, A. E. P., A feasibility study for a randomised controlled trial of management of reduced fetal movements after 36 weeks gestation, Archives of Disease in Childhood: Fetal and Neonatal Edition. Conference: 16th Annual Conference of the British Maternal and Fetal Medicine Society Dublin Ireland. Conference Start, 98, 2013	Intervention outside of interest: intervention on poor fetal movement
Blix,E., Reinar,L.M., Klovning,A., Oian,P., Prognostic value of the labour admission test and its effectiveness compared with auscultation only: A systematic review, BJOG: An International Journal of Obstetrics and Gynaecology, 112, 1595-1604, 2005	All three included RCTs are reported in a more recent systematic review (Devane 2012) that has been included in the guideline review
Brocklehurst, P., A study of an intelligent system to support decision making in the management of labour using the cardiotocograph - the	Protocol

Study	Reason for Exclusion
INFANT study protocol, BMC Pregnancy and Childbirth, 16 (1) (no pagination), 2016	
Bureev, A. S., Zhdanov, D. S., Zilberman, N. N., Kiseleva, E. Y., Yuriev, S. Y., Comparative assessment of 24-hour fetal monitoring methods based on cardiac rhythm, Biosciences Biotechnology Research Asia, 12, 1743-1750, 2015	Non-systematic review
Cahill, A. G., Spain, J., Intrapartum fetal monitoring, Clinical Obstetrics & Gynecology, 58, 263-8, 2015	Non-systematic review
Cahill, Alison G., Tuuli, Methodius G., Stout, Molly J., Deych, Elena, Shannon, William, Macones, George A., 456: Predicting normal pH with Intrapartum electronic fetal monitoring (EFM), American Journal of Obstetrics & Gynecology, 214, S250-S251 1p, 2016	Conference proceeding; to examine the association between EFM and normal pH
Cahill, Alison G., Tuuli, Methodius G., Stout, Molly J., Deych, Elena, Shannon, William, Macones, George A., 29: Predicting acidemia with intrapartum electronic fetal monitoring (EFM), American Journal of Obstetrics & Gynecology, 214, S20-S21 1p, 2016	Conference proceeding; to examine the association between EFM and acidaemia
Chen,H.Y., Chauhan,S., Abuhamad,A., Vintzileos,A., Ananth,C., Electronic fetal heart rate monitoring and infant mortality: A population-based study in the United States, American Journal of Obstetrics and Gynecology, 204, S43-S44, 2011	Wrong comparator and study design; this cohort study evaluates EFM compared with no EFM during labour, not compared with intermittent auscultation
Chen,H.Y., Chauhan,S.P., Ananth,C.V., Vintzileos,A.M., Abuhamad,A.Z., Electronic fetal heart rate monitoring and its relationship to neonatal and infant mortality in the United States, American Journal of Obstetrics and Gynecology, 204, 491-491, 2011	Wrong intervention; study is not evaluating use of admission tests
David, B., Saraswathi, K., Role of admission CTG as a screening test to predict fetal outcome and mode of delivery, Research Journal of Pharmaceutical, Biological and Chemical Sciences, 5, 295-299, 2014	Comparison outside of interest: to examine the association between CTG and fetal outcome
Goncalves, H., Pinto, P., Silva, M., Ayres-de-Campos, D., Bernardes, J., Toward the improvement in fetal monitoring during labor with the inclusion of maternal heart rate analysis, Medical & Biological Engineering & Computing, 54, 691-9, 2016	Comparison outside of interest: maternal heart rate versus fetal heart rate
Gourounti,K., Sandall,J., Admission cardiotocography versus intermittent auscultation of fetal heart rate: effects on neonatal Apgar score, on the rate of caesarean sections and on the rate of instrumental delivery--a systematic review. [18 refs], International Journal of Nursing Studies, 44, 1029-1035, 2007	All three included studies in this systematic review are incorporated in a more recent systematic review which has been included
Graham,E.M., Petersen,S.M., Christo,D.K., Fox,H.E., Intrapartum electronic fetal heart rate monitoring and the prevention of perinatal brain	Wrong comparison; this review is not evaluating monitoring at admission

Study	Reason for Exclusion
injury. [62 refs], Obstetrics and Gynecology, 108, 656-666, 2006	
Grivell, R. M., Alfirevic, Z., Gyte, G. M., Devane, D., Antenatal cardiotocography for fetal assessment, Cochrane Database of Systematic Reviews, 9, CD007863, 2015	Systematic review limited to antenatal care
Hastings, Chrissie, The role of fetal monitoring in intrapartum care, British Journal of Healthcare Management, 21, 166-170 5p, 2015	Review and opinion on clinical care
Heelan, L., Fetal monitoring: creating a culture of safety with informed choice, Journal of Perinatal Education, 22, 156-65, 2013	Non-systematic review
Jackson, Sherri, Gregory, Kimberly D., Management of the First Stage of Labor: Potential Strategies to Lower the Cesarean Delivery Rate, Clinical Obstetrics & Gynecology, 58, 217-226 10p, 2015	Non-systematic review
Kessler, J., Moster, D., Albrechtsen, S., Intrapartum monitoring with cardiotocography and ST-waveform analysis in breech presentation: an observational study, BJOG: An International Journal of Obstetrics & Gynaecology, 122, 528-35, 2015	Comparison outside of interest: STAN CTG monitoring for breech versus vertex presentation
Kwon, J. Y., Park, I. Y., Fetal heart rate monitoring: from Doppler to computerized analysis, Obstetrics & Gynecology Science, 59, 79-84, 2016	Non-systematic review
Lakhno, I., The Use of Fetal Noninvasive Electrocardiography, Scientifica, 2016, 5386595, 2016	Comparison outside of interest: to evaluate the efficacy of non-invasive ECG among normal women versus those with pre-eclampsia
Liston,R., Sawchuck,D., Young,D., Society of Obstetrics and Gynaecologists of Canada, British Columbia Perinatal Health Program., Fetal health surveillance: antepartum and intrapartum consensus guideline.[Erratum appears in J Obstet Gynaecol Can. 2007 Nov;29(11):909], Journal of Obstetrics and Gynaecology Canada: JOGC, 29, S3-56, 2007	This publication is a guideline, incorporating a systematic review; all relevant studies included in the systematic review were other systematic reviews, which have been appraised for inclusion individually
Lutomski, Jennifer E., Meaney, Sarah, Greene, Richard A., Ryan, Anthony C., Devane, Declan, Expert systems for fetal assessment in labour, Cochrane Database of Systematic Reviews, 2015	Comparison outside of interest
Maso, G., Piccoli, M., De Seta, F., Parolin, S., Banco, R., Camacho Mattos, L., Bogatti, P., Alberico, S., Intrapartum fetal heart rate monitoring interpretation in labour: a critical appraisal, Minerva Ginecologica, 67, 65-79, 2015	Non-systematic review
Mdoe, P., Mduma, E., Kidanto, H., Moshiro, R., Perlman, J., Ersdal, H., Randomized controlled study comparing hand held doppler and pinard fetoscope (PF) for fetal heart rate (FHR) monitoring in Tanzania, International Journal of Gynecology and Obstetrics, 131, E121-E122, 2015	Comparison outside of interest

Study	Reason for Exclusion
Michikata, K., Urabe, H., Tokunaga, S., Sameshima, H., Tsuyomu, I., Effect of fetal heart rate monitoring network system in Japan, Reproductive Sciences, 22, 2015	Comparison outside of interest: to examine the fetal heart rate (FHR) monitoring network
Neilson, J. P., Fetal electrocardiogram (ECG) for fetal monitoring during labour, Cochrane Database of Systematic Reviews, 12, CD000116, 2015	Comparison outside of interest
Nunes, I., Ayres-de-Campos, D., Costa-Santos, C., Bernardes, J., Differences between external and internal fetal heart rate monitoring during the second stage of labor: a prospective observational study, Journal of Perinatal Medicine, 42, 493-8, 2014	Intervention outside of interest: the study compared external and internal fetal monitoring methods simultaneously on a single fetus
Olofsson, P., Ayres-de-Campos, D., Kessler, J., Tendal, B., Yli, B. M., Devoe, L., A critical appraisal of the evidence for using cardiotocography plus ECG ST interval analysis for fetal surveillance in labor. Part II: the meta-analyses, Acta Obstetricia et Gynecologica Scandinavica, 93, 571-86; discussion 587-8, 2014	Comparsion outside of interest
Olofsson, P., Ayres-de-Campos, D., Kessler, J., Tendal, B., Yli, B. M., Devoe, L., A critical appraisal of the evidence for using cardiotocography plus ECG ST interval analysis for fetal surveillance in labor. Part I: the randomized controlled trials, Acta Obstetricia et Gynecologica Scandinavica, 93, 556-68; discussion 568-9, 2014	Comparison outside of interest
Pinas, A., Chandraharan, E., Continuous cardiotocography during labour: Analysis, classification and management, Best Practice & Research in Clinical Obstetrics & Gynaecology, 30, 33-47, 2016	Expert's review article
Riffle, Elizabeth M., Fetal Heart Rate Assessment Best Practice, International Journal of Childbirth Education, 29, 55-58 4p, 2014	Narrative review and opinion
Saccone, G., Schuit, E., Amer-Wahlin, I., Xodo, S., Berghella, V., Electrocardiogram st analysis during labor: A systematic review and meta-Analysis of randomized controlled trials, Obstetrics and Gynecology, 127, 127-135, 2016	Intervention outside of interest
Sharbaf,F.R., Amjadi,N., Alavi,A., Akbari,S., Forghani,F., Normal and indeterminate pattern of fetal cardiotocography in admission test and pregnancy outcome, Journal of Obstetrics and Gynaecology Research, 40, 694-699, 2014	The study did not compare intermittent auscultation and the aim was to evaluate the patterns of CTG in admission test and pregnancy outcome
Soncini, Emanuele, Paganelli, Simone, Vezzani, Cristina, Gargano, Giancarlo, Giovanni Battista, La Sala, Intrapartum fetal heart rate monitoring: evaluation of a standardized system of interpretation for prediction of metabolic acidosis at delivery and neonatal neurological morbidity, Journal of Maternal-Fetal & Neonatal Medicine, 27, 1465-1469 5p, 2014	The study aims to assess the effectiveness of an intrapartum FHR interpretation system

Study	Reason for Exclusion
Walsh,D., CTG use in intrapartum care: assessing the evidence, British Journal of Midwifery, 16, 367-369, 2008	Not a systematic review
Wretler, S., Holzmann, M., Graner, S., Lindqvist, P., Falck, S., Nordstrom, L., Fetal heart rate monitoring of short term variation (STV): a methodological observational study, BMC Pregnancy & Childbirth, 16, 55, 2016	The aim was to study how calculation from the monitors of signals for short-term variation should be derived; no intermittent auscultation comparison

F.2 Intermittent auscultation compared with cardiotocography during labour

Study	Reason for Exclusion
Intermittent Auscultation for Intrapartum Fetal Heart Rate Surveillance, Journal of Midwifery and Women's Health, 52, 314-319, 2007	Non-systematic review
Intermittent Auscultation for Intrapartum Fetal Heart Rate Surveillance (replaces ACNM Clinical Bulletin #9, March 2007), Journal of Midwifery and Women's Health, 55, 397-403, 2010	Non-systematic review
Intermittent Auscultation for Intrapartum Fetal Heart Rate Surveillance...September/October 2015 issue of the Journal of Midwifery & Womenâ□™s Health (60[5]:626-632), Journal of Midwifery & Women's Health, 61, 134-134 1p, 2016	A clinical bulletin - an educational aid for midwives
Alfirevic,Z., Devane,D., Gyte,G.M., Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour, The Cochrane database of systematic reviews, 5, CD006066-, 2013	All relevant studies have already been included in the previous review
Alfirevic,Z., Devane,D., Gyte,G.M., Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour. [55 refs]Updated, Cochrane Database of Systematic Reviews, 5, CD006066-, 2013	Insufficient detail about risk status was reported in the Cochrane review; therefore, all included studies were accessed in full text and appraised for inclusion individually
Alper,B.S., Evidence-based medicine. Continuous cardiotocography may reduce neonatal seizures, Clinical Advisor for Nurse Practitioners, 10, 161-161, 2007	This is a summary of a Cochrane review which was later updated
Amin, P., Re: Are we (mis)guided by current guidelines on intrapartum fetal heart rate monitoring? Case for a more physiological approach to interpretation...BJOG. 2014 Aug;121(9):1063-70, BJOG: An International Journal of Obstetrics & Gynaecology, 122, 588-588 1p, 2015	A comment
Barstow,Craig, Gauer,Robert, Jamieson,Barbara, How does electronic fetal heart rate monitoring affect labor and delivery outcomes?, Evidence-Based Practice, 14, 1-2, 2011	This is a summary of a Cochrane review, which has been updated and included in full text

Study	Reason for Exclusion
Cahill, A. G., Spain, J., Intrapartum fetal monitoring, Clinical Obstetrics & Gynecology, 58, 263-8, 2015	A narrative review, an opinion
Cahill, Alison G., Tuuli, Methodius G., Stout, Molly J., Deych, Elena, Shannon, William, Macones, George A., 456: Predicting normal pH with Intrapartum electronic fetal monitoring (EFM), American Journal of Obstetrics & Gynecology, 214, S250-S251 1p, 2016	An abstract
Chen,H.Y., Chauhan,S.P., Ananth,C.V., Vintzileos,A.M., Abuhamad,A.Z., Electronic fetal heart rate monitoring and its relationship to neonatal and infant mortality in the United States, American Journal of Obstetrics and Gynecology, 204, 491-491, 2011	Wrong comparator and study design - this cohort study evaluates EFM compared with no EFM, not compared with intermittent auscultation
Ellison,P.H., Foster,M., Sheridan-Pereira,M., MacDonald,D., Electronic fetal heart monitoring, auscultation, and neonatal outcome, American Journal of Obstetrics and Gynecology, 164, 1281-1289, 1991	The main publication from this trial (MacDonald 1985) and one follow-up study have already been included; this article does not report any further clinical outcomes of interest
Graham,E.M., Petersen,S.M., Christo,D.K., Fox,H.E., Intrapartum electronic fetal heart rate monitoring and the prevention of perinatal brain injury. [62 refs], Obstetrics and Gynecology, 108, 656-666, 2006	The systematic review evaluated in this review has been updated, and the updated version was assessed for inclusion separately
Hastings, Chrissie, The role of fetal monitoring in intrapartum care, British Journal of Healthcare Management, 21, 166-170 5p, 2015	A brief overview of fetal heart rate monitoring
Haverkamp,A.D., Orleans,M., Langendoerfer,S., McFee,J., Murphy,J., Thompson,H.E., A controlled trial of the differential effects of intrapartum fetal monitoring, American Journal of Obstetrics and Gynecology, 134, 399-412, 1979	Study population was all high-risk women
Haverkamp,A.D., Thompson,H.E., McFee,J.G., Cetrulo,C., The evaluation of continuous fetal heart rate monitoring in high-risk pregnancy, American Journal of Obstetrics and Gynecology, 125, 310-320, 1976	Study population was not low-risk - 41% of women had labour induced with pitocin, had pre-eclampsia or had babies that were small for gestational age; a further 30% of women had other risk factors which were not reported in detail
Herbst,A., Ingemarsson,I., Intermittent versus continuous electronic monitoring in labour: a randomised study, British Journal of Obstetrics and Gynaecology, 101, 663-668, 1994	Study does not have an arm that received intermittent auscultation
Jauniaux, E., Prefumo, F., Fetal heart monitoring in labour: from pinard to artificial intelligence, BJOG: An International Journal of Obstetrics & Gynaecology, 123, 870-870 1p, 2016	A descriptive article
Killien,M.G., Shy,K., A randomized trial of electronic fetal monitoring in preterm labor: mothers' views, Birth, 16, 7-12, 1989	Study population is not low-risk women; only women in labour at 26-32 weeks expected to deliver very low birthweight babies were included
Koszalka,M.F.,Jr., Haverkamp,A.D., Orleans,M., Murphy,J., The effects of internal electronic fetal heart rate monitoring on maternal and infant	Study population was all high-risk women

Study	Reason for Exclusion
infections in high-risk pregnancies, Journal of Reproductive Medicine, 27, 661-665, 1982	
Kwon, J. Y., Park, I. Y., Fetal heart rate monitoring: from Doppler to computerized analysis, Obstetrics & Gynecology Science, 59, 79-84, 2016	A narrative article
Langendoerfer,S., Haverkamp,A.D., Murphy,J., Nowick,K.D., Orleans,M., Pacosa,F., van,Doorninck W., Pediatric follow-up of a randomized controlled trial of intrapartum fetal monitoring techniques, Journal of Pediatrics, 97, 103-107, 1980	Study only included high-risk women
Larson,E.B., van,Belle G., Shy,K.K., Luthy,D.A., Strickland,D., Hughes,J.P., Fetal monitoring and predictions by clinicians: observations during a randomized clinical trial in very low birth weight infants, Obstetrics and Gynecology, 74, 584-589, 1989	Study population is not low-risk women; only women in labour at 26-32 weeks expected to deliver very low birthweight babies were included
Liston,R., Sawchuck,D., Young,D., Society of Obstetrics and Gynaecologists of Canada, British Columbia Perinatal Health Program., Fetal health surveillance: antepartum and intrapartum consensus guideline.[Erratum appears in J Obstet Gynaecol Can. 2007 Nov;29(11):909], Journal of Obstetrics and Gynaecology Canada: JOGC, 29, S3-56, 2007	This publication is a guideline incorporating a systematic review; all relevant studies included in the systematic review were other systematic reviews, which have been appraised for inclusion individually
Luthy,D.A., Shy,K.K., van,Belle G., Larson,E.B., Hughes,J.P., Benedetti,T.J., Brown,Z.A., Effer,S., King,J.F., Stenchever,M.A., A randomized trial of electronic fetal monitoring in preterm labor, Obstetrics and Gynecology, 69, 687-695, 1987	Study population is not low-risk women; only women in labour at 26-32 weeks expected to deliver very low birthweight babies were included
Lutomski, Jennifer E., Meaney, Sarah, Greene, Richard A., Ryan, Anthony C., Devane, Declan, Expert systems for fetal assessment in labour, Cochrane Database of Systematic Reviews, 2015	Not the comparison of interest
Mahomed,K., Nyoni,R., Mulambo,T., Kasule,J., Jacobus,E., Randomised controlled trial of intrapartum fetal heart rate monitoring, BMJ, 308, 497-500, 1994	Study population are not low-risk: 35% of women had post-term pregnancy, hypertension or a previous caesarean section; a further 20% of women had other, non-specified risk factors
Miller, L. A., Listen Carefully: Implementing Intermittent Auscultation Into Routine Practice, Journal of Perinatal & Neonatal Nursing, 29, 197-9, 2015	A column about the legal cosiderations regarding implementations of intermittent auscultation in clinical practice
Neldam,S., Osler,M., Hansen,P.K., Nim,J., Smith,S.F., Hertel,J., Intrapartum fetal heart rate monitoring in a combined low- and high-risk population: a controlled clinical trial, European Journal of Obstetrics, Gynecology, and Reproductive Biology, 23, 1-11, 1986	43% of women had a high-risk pregnancy (including obesity, pre-eclampsia, post-term, maternal disease)and outcomes were not reported separately for low-risk women
Pinas, A., Chandraharan, E., Continuous cardiotocography during labour: Analysis, classification and management, Best Practice & Research in Clinical Obstetrics & Gynaecology, 30, 33-47, 2016	Technical aspects of fetal heart rate and fetal physiopathology

Study	Reason for Exclusion
Renou,P., Chang,A., Anderson,I., Wood,C., Controlled trial of fetal intensive care, American Journal of Obstetrics and Gynecology, 126, 470-476, 1976	Study population was not low risk; 36% of women had hypertension, prolonged pregnancy, cardiac disease, diabetes, IUGR or antepartum haemorrhage
Riffle, Elizabeth M., Fetal Heart Rate Assessment Best Practice, International Journal of Childbirth Education, 29, 55-58 4p, 2014	A descriptive article, an opinion
Sholapurkar, S. L., Intermittent Auscultation in Labor: Could It Be Missing Many Pathological (Late) Fetal Heart Rate Decelerations? Analytical Review and Rationale for Improvement Supported by Clinical Cases, Journal of Clinical Medicine Research, 7, 919-25, 2015	Paper focuses on different intermittent auscultation regimen recommended by most national guidelines for low-risk labours
Shy,K.K., Luthy,D.A., Bennett,F.C., Whitfield,M., Larson,E.B., van,Belle G., Hughes,J.P., Wilson,J.A., Stenchever,M.A., Effects of electronic fetal-heart-rate monitoring, as compared with periodic auscultation, on the neurologic development of premature infants, New England Journal of Medicine,N Engl J Med, 322, 588-593, 1990	Study population is not low-risk women; only women in labour at 26-32 weeks expected to deliver very low birthweight babies were included
Thacker,Stephen B., Stroup,Donna, Chang,Manhuei, Continuous electronic heart rate monitoring for fetal assessment during labor, Cochrane Database of Systematic Reviews, -, 2006	This systematic review has been superseded by a more recent Cochrane review (Alfirevic 2013)
Walsh,D., CTG use in intrapartum care: assessing the evidence, British Journal of Midwifery, 16, 367-369, 2008	Not a systematic review
Wisner, K., Intermittent auscultation in low-risk labor, MCN, American Journal of Maternal Child Nursing, 40, 58, 2015	A descriptive article, an opinion

F.3 Intermittent auscultation compared with cardiotocography – health economics

Study	Reason for Exclusion
East,C.E., Gascoigne,M.B., Doran,C.M., Brennecke,S.P., King,J.F., Colditz,P.B., A cost-effectiveness analysis of the intrapartum fetal pulse oximetry multicentre randomised controlled trial (the FOREMOST trial), BJOG: An International Journal of Obstetrics and Gynaecology, 113, 1080-1087, 2006	Not the question in the guideline
Heintz,E., Brodtkorb,T.H., Nelson,N., Levin,L.A., The long-term cost-effectiveness of fetal monitoring during labour: a comparison of cardiotocography complemented with ST analysis versus cardiotocography alone, BJOG: An International Journal of Obstetrics and Gynaecology, 115, 1676-1687, 2008	For EFM and ECG versus EFM question
Tran,K., Cunningham,J., Fetal scalp lactate testing to reduce caesarean sections: a review of the clinical and cost-effectiveness (Structured	No cost-effectiveness studies were identified

Study	Reason for Exclusion
abstract), Health Technology Assessment Database, -, 2013	
Vijgen,S.M., Westerhuis,M.E., Opmeer,B.C., Visser,G.H., Moons,K.G., Porath,M.M., Oei,G.S., van Geijn,H.P., Bolte,A.C., Willekes,C., Nijhuis,J.G., van,Beek E., Graziosi,G.C., Schuitemaker,N.W., van Lith,J.M., van den Akker,E.S., Drogtrop,A.P., Van Dessel,H.J., Rijnders,R.J., Oosterbaan,H.P., Mol,B.W., Kwee,A., Cost-effectiveness of cardiotocography plus ST analysis of the fetal electrocardiogram compared with cardiotocography only, Acta Obstetricia et Gynecologica Scandinavica, 90, 772-778, 2011	Not for this question

F.4 Intermittent auscultation compared with cardiotocography in the presence of meconium stained liquor

Study	Reason for Exclusion
Becker,S., Solomayer,E., Dogan,C., Wallwiener,D., Fehm,T., Meconium-stained amniotic fluid--perinatal outcome and obstetrical management in a low-risk suburban population, European Journal of Obstetrics, Gynecology, and Reproductive Biology, 132, 46-50, 2007	Wrong population: control group consisted of women with no meconium stained liquor
Byaruhanga,R., Bassani,D.G., Jagau,A., Muwanguzi,P., Montgomery,A.L., Lawn,J.E., Use of wind-up fetal Doppler versus Pinard for fetal heart rate intermittent monitoring in labour: A randomised clinical trial, BMJ Open, 5, -, 2015	Population outside of scope: not clear what proportion of pregnancy with meconium-stained liquor
Centre for Reviews and Dissemination, Prognostic value of the labour admission test and its effectiveness compared with auscultation only: a systematic review (Structured abstract), Database of Abstracts of Reviews of Effects, 2015	Population outside of scope: any women with meconium-stained liquor
Devane,Declan, Lalor,Joan G., Daly,Sean, McGuire,William, Smith,Valerie, Cardiotocography versus intermittent auscultation of fetal heart on admission to labour ward for assessment of fetal wellbeing, Cochrane Database of Systematic Reviews, -, 2012	Wrong population: study population consisted of women with no meconium stained liquor
Eskandar, M., Suresh Babu, C., Al-Shahrani, M., Modified biophysical profile: It's importance in fetal surveillance at the time of labor, International Journal of Gynecology and Obstetrics, 131, E490, 2015	Intervention outside of scope: modified biophysical profile
Frey, H. A., Tuuli, M. G., Shanks, A. L., Macones, G. A., Cahill, A. G., Interpreting category II fetal heart rate tracings: does meconium matter?, American Journal of Obstetrics & Gynecology, 211, 644.e1-8, 2014	Comparison outside of scope: with or without meconium comparison
Haverkamp,A.D., Orleans,M., Langendoerfer,S., McFee,J., Murphy,J., Thompson,H.E., A controlled trial of the differential effects of	Less than 25% of the population were women with meconium stained liquor; no subgroup analysis performed for that group

Study	Reason for Exclusion
intrapartum fetal monitoring, American Journal of Obstetrics and Gynecology, 134, 399-412, 1979	
Haverkamp,A.D., Thompson,H.E., McFee,J.G., Cetrulo,C., The evaluation of continuous fetal heart rate monitoring in high-risk pregnancy, American Journal of Obstetrics and Gynecology, 125, 310-320, 1976	Less than 27% of the population were women with meconium stained liquor; no subgroup analysis performed for that group
Kelso,I.M., Parsons,R.J., Lawrence,G.F., Arora,S.S., Edmonds,D.K., Cooke,I.D., An assessment of continuous fetal heart rate monitoring in labor. A randomized trial, American Journal of Obstetrics and Gynecology, 131, 526-532, 1978	Percentage of women with meconium stained liquor not reported
Kiettisanpipop, P., Phupong, V., Intrapartum and neonatal outcome of screening non-stress test (NST) compared with no screening NST in healthy women at 40-40 (+6) weeks of gestation, Journal of Obstetrics and Gynaecology Research, 41, 50-54, 2015	Population outside of scope: small number of pregnant women with meconium-stained liquor
Killien,M.G., Shy,K., A randomized trial of electronic fetal monitoring in preterm labor: mothers' views, Birth, 16, 7-12, 1989	Preterm population
Martis,Ruth, Emilia,Ova, Nurdiati,Detty S., Intermittent auscultation (IA) of fetal heart rate in labour for fetal well-being, Cochrane Database of Systematic Reviews, -, 2010	A study protocol
Ouladsahebmadarek,E., Hoseinian,M.H., Hamdi,K., Ghojazadeh,M., Perinatal outcome in relation to mode of delivery in Meconium-Stained neonates, Pakistan Journal of Medical Sciences, 28, 13-16, 2012	No report of electronic fetal monitoring during labour
Renou,P., Chang,A., Anderson,I., Wood,C., Controlled trial of fetal intensive care, American Journal of Obstetrics and Gynecology, 126, 470-476, 1976	Included in the review as a part of a systematic review (Alfirevic 2013)
Saccone, G., Schuit, E., Amer-Wahlin, I., Xodo, S., Berghella, V., Electrocardiogram st analysis during labor: A systematic review and meta-Analysis of randomized controlled trials, Obstetrics and Gynecology, 127, 127-135, 2016	Few/unclear number of women with meconium-stained liquor
Sharp, Gemma C., Stock, Sarah J., Norman, Jane E., Fetal assessment methods for improving neonatal and maternal outcomes in preterm prelabour rupture of membranes, Cochrane Database of Systematic Reviews, 2014	Comparison outside of scope: no EFM
Vintzileos,A.M., Antsaklis,A., Varvarigos,I., Papas,C., Sofatzis,I., Montgomery,J.T., A randomized trial of intrapartum electronic fetal heart rate monitoring versus intermittent auscultation, Obstetrics and Gynecology, 81, 899-907, 1993	Less than 20% of the population were women with meconium stained liquor; no subgroup analysis performed for that group
Xu,H., Mas-Calvet,M., Wei,S.Q., Luo,Z.C., Fraser,W.D., Abnormal fetal heart rate tracing patterns in patients with thick meconium staining of the amniotic fluid: association with perinatal	Wrong intervention: electronic fetal monitoring is not compared with intermittent auscultation

Study	Reason for Exclusion
outcomes, American Journal of Obstetrics and Gynecology, 200, 283-287, 2009	

F.5 Interpretation of cardiotocograph traces

Study	Reason for Exclusion
ACOG Practice Bulletin #62: Intrapartum fetal heart rate monitoring, Obstetrics and Gynecology, 105, 1161-1169, 2005	Narrative review
Abbasalizadeh, F., Abbasalizadeh, S., Pouraliakbar, S., Bastani, P., Correlation between nonreassuring patterns in fetal cardiotocography and birth asphyxia, International Journal of Women's Health and Reproduction Sciences, 3, 151-154, 2015	No relevant data (odds ratios or measures of diagnostic accuracy are not reported and it is not possible to calculate them with the data provided)
Acien,P., Salvatierra,V., Navarrete,L., Fetal heart rate deceleration index. Its relation with fetal pH, apgar score and dips or decelerations, Journal of Perinatal Medicine, 7, 7-18, 1979	High-risk population
Aernout, E. M., Devos, P., Deruelle, P., Houfflin-Debarge, V., Subtil, D., Short-Term Variation of the Fetal Heart Rate for Predicting Neonatal Acidosis in Preeclampsia, Fetal Diagnosis and Therapy, 38, 179-185, 2015	Preterm babies mostly, median gestational age 30.9 weeks -2.8; not according to protocol(should be term babies)
Aina-Mumuney,A.J., Althaus,J.E., Henderson,J.L., Blakemore,M.C., Johnson,E.A., Graham,E.M., Intrapartum electronic fetal monitoring and the identification of systemic fetal inflammation, Journal of Reproductive Medicine, 52, 762-768, 2007	Population consisted of term and preterm birth, with no results reported for term birth
Alfirevic,Zarko, Devane,Declan, Gyte,Gillian ML, Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour, Cochrane Database of Systematic Reviews, -, 2008	Wrong intervention; CTG was compared with intermittent auscultation and intermittent CTG
Altaf,S., Oppenheimer,C., Shaw,R., Waugh,J., xon-Woods,M., Practices and views on fetal heart monitoring: a structured observation and interview study, BJOG: An International Journal of Obstetrics and Gynaecology, 113, 409-418, 2006	No outcome of interest; deviation from NICE guideline in relation to fetal monitoring assessed
Amaya, K. E., Matushewski, B., Durosier, L. D., Frasch, M. G., Richardson, B. S., Ross, M. G., Accelerated acidosis in response to variable fetal heart rate decelerations in chronically hypoxic ovine fetuses, American Journal of Obstetrics & Gynecology, 214, 270.e1-8, 2016	Study on ovine fetuses, not human
American College of Obstetricians and Gynecologists., ACOG Practice Bulletin No. 106: Intrapartum fetal heart rate monitoring: nomenclature, interpretation, and general management principles.[Update of Obstet Gynecol. 2005 Dec;106(6):1453-60; PMID: 16319279], Obstetrics and Gynecology, 114, 192-202, 2009	Narrative review

Study	Reason for Exclusion
Annunziata, M. L., Tagliaferri, S., Esposito, F. G., Giuliano, N., Mereghini, F., Di Lieto, A., Campanile, M., Computerized analysis of fetal heart rate variability signal during the stages of labor, Journal of Obstetrics and Gynaecology Research, 42, 258-265, 2016	This study compares the CTG features in different stages of labour and prelabour; it does not look at any outcomes of interest
Aye, C. Y., Redman, C. W., Georgieva, A., The effect of augmentation of labour with syntocinon on the fetal CTG using objective computerised analysis: a nested case-control study, European Journal of Obstetrics, Gynecology, & Reproductive Biology, 176, 112-8, 2014	No relevant data (odds ratios or measures of diagnostic accuracy are not reported and it is not possible to calculate them with the data provided)
Bailey,R.E., Intrapartum fetal monitoring, American Family Physician, 80, 1388-1396, 2009	Narrative review
Bannerman,C.G., Grobman,W.A., Antoniewicz,L., Hutchinson,M., Blackwell,S., Assessment of the concordance among 2-tier, 3-tier, and 5-tier fetal heart rate classification systems, American Journal of Obstetrics and Gynecology, 205, 288-4, 2011	Wrong comparators; comparing three different American interpretation systems
Barros,A.K., Extracting the fetal heart rate variability using a frequency tracking algorithm, Neurocomputing, 49, 279-288, 2002	Electrocardiogram analysis
Beard,R.W., Filshie,G.M., Knight,C.A., Roberts,G.M., The significance of the changes in the continuous fetal heart rate in the first stage of labour, Journal of Obstetrics and Gynaecology of the British Commonwealth, 78, 865-881, 1971	Pregnancies > 28 weeks' gestation are included; no outcomes of interest for this review
Becker, J. H., Krikhaar, A., Schuit, E., Martendal, A., Marsal, K., Kwee, A., Visser, G. H., Amer-Wahlin, I., The added predictive value of biphasic events in ST analysis of the fetal electrocardiogram for intrapartum fetal monitoring, Acta Obstetricia et Gynecologica Scandinavica, 94, 175-82, 2015	This study examines the relationship of 'abnormal' STAN CTG trace with different outcomes, not only CTG
Beinder,E., Grancay,T., Menendez,T., Singer,H., Hofbeck,M., Fetal sinus bradycardia and the long QT syndrome, American Journal of Obstetrics and Gynecology, 185, 743-747, 2001	No outcomes of interest for this review
Buscicchio,G., Gentilucci,L., Martorana,R., Martino,C., Tranquilli,A.L., How to read fetal heart rate tracings in labor: a comparison between ACOG and NICE guidelines, Journal of Maternal-Fetal and Neonatal Medicine, 25, 2797-2798, 2012	Wrong intervention; assessing reproducibility and clinical relevance of current guidelines on fetal heart rate
Cao,H., Lake,D.E., Ferguson,J.E., Chisholm,C.A., Griffin,M.P., Moorman,J.R., Toward quantitative fetal heart rate monitoring, IEEE Transactions on Biomedical Engineering, 53, 111-118, 2006	No outcomes of interest; observer errors
Chandraharan,E., Arulkumaran,S., Prevention of birth asphyxia: responding appropriately to cardiotocograph (CTG) traces, Best Practice and Research in Clinical Obstetrics and Gynaecology, 21, 609-624, 2007	Narrative review

Study	Reason for Exclusion
Chauhan,S.P., Klauser,C.K., Woodring,T.C., Sanderson,M., Magann,E.F., Morrison,J.C., Intrapartum nonreassuring fetal heart rate tracing and prediction of adverse outcomes: interobserver variability, American Journal of Obstetrics and Gynecology, 199, 623-625, 2008	No outcomes of interest; inter-observer variability
Chen,H.Y., Chauhan,S.P., Ananth,C.V., Vintzileos,A.M., Abuhamad,A.Z., Electronic fetal heart rate monitoring and its relationship to neonatal and infant mortality in the United States, American Journal of Obstetrics and Gynecology, 204, 491-491, 2011	No outcomes of interest, fetal heart rate features not evaluated
Chez,B.F., Baird,S.M., Electronic fetal heart rate monitoring: where are we now?, Journal of Perinatal and Neonatal Nursing, 25, 180-192, 2011	Narrative review
Chuang,J., Chou,C.T., Cheng,W.C., Huang,L.W., Hwang,J.L., Tsai,Y.L., Spontaneous fetal heart rate deceleration: an ominous sign for fetal outcome, Archives of Gynecology and Obstetrics, 269, 254-258, 2004	Small case series, reported Apgar (no outcome of interest)and neonatal complication; no definition for neonatal complication provided
Chudacek,V., Spilka,J., Janku,P., Koucky,M., Lhotska,L., Huptych,M., Automatic evaluation of intrapartum fetal heart rate recordings: a comprehensive analysis of useful features, Physiological Measurement, 32, 1347-1360, 2011	Inter- and intra-observer variability
Clark,S.L., Nageotte,M.P., Garite,T.J., Freeman,R.K., Miller,D.A., Simpson,K.R., Belfort,M.A., Dildy,G.A., Parer,J.T., Berkowitz,R.L., D'Alton,M., Rouse,D.J., Gilstrap,L.C., Vintzileos,A.M., van Dorsten,J.P., Boehm,F.H., Miller,L.A., Hankins,G.D., Intrapartum management of category II fetal heart rate tracings: towards standardization of care, American Journal of Obstetrics and Gynecology, 209, 89-97, 2013	Narrative review
Clark,S.L., Nageotte,M.P., Garite,T.J., Freeman,R.K., Miller,D.A., Simpson,K.R., Belfort,M.A., Dildy,G.A., Parer,J.T., Berkowitz,R.L., D'Alton,M., Rouse,D.J., Gilstrap,L.C., Vintzileos,A.M., Van,DorstenJ, Boehm,F.H., Miller,L.A., Hankins,G.D.V., Intrapartum management of category II fetal heart rate tracings: Towards standardization of care, American Journal of Obstetrics and Gynecology, 209, 89-97, 2013	Clinical opinion papar
Cohen,W.R., Ommani,S., Hassan,S., Mirza,F.G., Solomon,M., Brown,R., Schifrin,B.S., Himsworth,J.M., Hayes-Gill,B.R., Accuracy and reliability of fetal heart rate monitoring using maternal abdominal surface electrodes, Acta Obstetricia et Gynecologica Scandinavica, 91, 1306-1313, 2012	Wrong intervention; STAN analysis
Coletta,J., Murphy,E., Rubeo,Z., Gyamfi-Bannerman,C., The 5-tier system of assessing fetal heart rate tracings is superior to the 3-tier	Wrong comparators; comparing two different American interpretation systems

Study	Reason for Exclusion
system in identifying fetal acidemia, American Journal of Obstetrics and Gynecology, 206, 226-5, 2012	
Dash, S., Quirk, J. G., Djuric, P. M., Fetal heart rate classification using generative models, IEEE Transactions on Biomedical Engineering, 61, 2796-805, 2014	Compares different classification systems, no relevant data
Dawes,N.W., Dawes,G.S., Moulden,M., Redman,C.W., Fetal heart rate patterns in term labor vary with sex, gestational age, epidural analgesia, and fetal weight, American Journal of Obstetrics and Gynecology, 180, 181-187, 1999	The effect of fetal sex on the fetal heart was assessed
Dawes,N.W., Dawes,G.S., Moulden,M., Redman,C.W., Fetal heart rate patterns in term labor vary with sex, gestational age, epidural analgesia, and fetal weight, American Journal of Obstetrics and Gynecology, 180, 181-187, 1999	No outcomes of interest
Doret, M., Spilka, J., Chudacek, V., Goncalves, P., Abry, P., Fractal analysis and Hurst parameter for intrapartum fetal heart rate variability analysis: A versatile alternative to frequency bands and LF/HF ratio, PLoS ONE, 10 (8) (no pagination), 2015	Internvention is ECG not CTG
Downs,T., Zlomke,E., Fetal heart rate pattern notification guidelines and suggested management algorithm for intrapartum electronic fetal heart rate monitoring, Permanente Journal, 11, 22-28, 2007	No outcomes of interest
East, Christine E., Begg, Lisa, Colditz, Paul B., Lau, Rosalind, Fetal pulse oximetry for fetal assessment in labour, Cochrane Database of Systematic Reviews, 2014	Compared fetal pulse oximetry with other monitoring methods, not relevant
Egley,C.C., Bowes,W.A.,Jr., Wagner,D., Sinusoidal fetal heart rate pattern during labor, American Journal of Perinatology, 8, 197-202, 1991	No outcomes of interest for this review
Elimian,A., Lawlor,P., Figueroa,R., Wiencek,V., Garry,D., Quirk,J.G., Intrapartum assessment of fetal well-being: any role for a fetal admission test?, Journal of Maternal-Fetal and Neonatal Medicine, 13, 408-413, 2003	No outcomes of interest for this review
Elliott,C., Warrick,P.A., Graham,E., Hamilton,E.F., Graded classification of fetal heart rate tracings: association with neonatal metabolic acidosis and neurologic morbidity, American Journal of Obstetrics and Gynecology, 202, 258-258, 2010	The fetal heart rate traces were analysed using computer software
Figueras,F., Albela,S., Bonino,S., Palacio,M., Barrau,E., Hernandez,S., Casellas,C., Coll,O., Cararach,V., Visual analysis of antepartum fetal heart rate tracings: inter- and intra-observer agreement and impact of knowledge of neonatal outcome, Journal of Perinatal Medicine, 33, 241-245, 2005	No outcomes of interest; inter- and intra-observer agreement
Frasch, M. G., Xu, Y., Stampalija, T., Durosier, L. D., Herry, C., Wang, X., Casati, D., Seely, A. J., Alfirevic, Z., Gao, X., Ferrazzi, E., Correlating	Wrong intervention: fetal ECG CTG

Study	Reason for Exclusion
multidimensional fetal heart rate variability analysis with acid-base balance at birth, Physiological measurement, 35, L1-L12, 2014	
Frey, H. A., Tuuli, M. G., Shanks, A. L., Macones, G. A., Cahill, A. G., Interpreting category II fetal heart rate tracings: does meconium matter?, American Journal of Obstetrics & Gynecology, 211, 644.e1-8, 2014	Only pregnancies with category II fetal heart rate are included in the study; moreover, within this group, the presence of each trace feature is compared to the absence of said feature, however concurrent features in the comparison and intervention groups are not clearly defined; therefore, this study does not allow an accurate assessment of the predictive value of trace features
Fulcher,B.D., Georgieva,A.E., Redman,C.W., Jones,N.S., Highly comparative fetal heart rate analysis, Conference Proceedings: .., Annual International Conference of the IEEE Engineering in Medicine and Biology Society. 2012, 3135-3138, 2012	No outcomes of interest
Gaziano,E.P., A study of variable decelerations in association with other heart rate patterns during monitored labor, American Journal of Obstetrics and Gynecology, 135, 360-363, 1979	No outcomes of interest for this review: only Apgar score reported
Georgieva, A., Papageorghiou, A. T., Payne, S. J., Moulden, M., Redman, C. W., Phase-rectified signal averaging for intrapartum electronic fetal heart rate monitoring is related to acidaemia at birth, BJOG: An International Journal of Obstetrics & Gynaecology, 121, 889-94, 2014	No relevant data (odds ratios or measures of diagnostic accuracy are not reported and it is not possible to calculate them with the data provided)
Georgieva,A., Payne,S.J., Moulden,M., Redman,C.W., Computerized fetal heart rate analysis in labor: detection of intervals with un-assignable baseline, Physiological Measurement, 32, 1549-1560, 2011	Computerised analysis
Georgoulas,G., Gavrilis,D., Tsoulos,I.G., Stylios,C., Bernardes,J., Groumpos,P.P., Novel approach for fetal heart rate classification introducing grammatical evolution, Biomedical Signal Processing and Control, 2, 69-79, 2007	Wrong intervention
Hamilton,E., Warrick,P., O'Keeffe,D., Variable decelerations: do size and shape matter?, Journal of Maternal-Fetal and Neonatal Medicine, 25, 648-653, 2012	No relevant data (odds ratios or measures of diagnostic accuracy are not reported and it is not possible to calculate them with the data provided)
Hankins,G.D., Miller,D.A., A review of the 2008 NICHD Research Planning Workshop: recommendations for fetal heart rate terminology and interpretation, Clinical Obstetrics and Gynecology, 54, 3-7, 2011	Narrative review
Hasegawa,J., Matsuoka,R., Ichizuka,K., Kotani,M., Nakamura,M., Mikoshiba,T., Sekizawa,A., Okai,T., Atypical variable deceleration in the first stage of labor is a characteristic fetal heart-rate pattern for velamentous cord insertion and hypercoiled cord, Journal of Obstetrics and Gynaecology Research, 35, 35-39, 2009	No outcomes of interest for this review
Hayashi,M., Nakai,A., Sekiguchi,A., Takeshita,T., Fetal heart rate classification	No outcomes of iterest; inter- and intra-observer reproducibility

Study	Reason for Exclusion
proposed by the perinatology committee of the Japan Society of Obstetrics and Gynecology: reproducibility and clinical usefulness, Journal of Nippon Medical School = Nihon Ika Daigaku Zasshi, 79, 60-68, 2012	
Hayashi,M., Nakai,A., Sekiguchi,A., Takeshita,T., Fetal heart rate classification proposed by the perinatology committee of the Japan society of obstetrics and gynecology: reproducibility and clinical usefulness, Journal of Nippon Medical School = Nihon Ika Daigahu Zasshi, 79, 60-68, 2012	No outcomes of interest; reproducibility of interobsever and intraobserver assessed
Hecher,K., Bilardo,C.M., Stigter,R.H., Ville,Y., Hackeloer,B.J., Kok,H.J., Senat,M.V., Visser,G.H., Monitoring of fetuses with intrauterine growth restriction: a longitudinal study, Ultrasound in Obstetrics and Gynecology, 18, 564-570, 2001	No outcomes of interest for this review
Helgason,H., Abry,P., Goncalves,P., Gharib,C., Gaucherand,P., Doret,M., Adaptive multiscale complexity analysis of fetal heart rate, IEEE Transactions on Biomedical Engineering, 58, 2186-2193, 2011	Computer analysis of fetal heart rate(RR interval)
Hendrix,N.W., Chauhan,S.P., Cesarean delivery for nonreassuring fetal heart rate tracing, Obstetrics and Gynecology Clinics of North America, 32, 273-286, 2005	Narrative review
Hopkins,P., Outram,N., Lofgren,N., Ifeachor,E.C., Rosen,K.G., A comparative study of fetal heart rate variability analysis techniques, Conference Proceedings: .., Annual International Conference of the IEEE Engineering in Medicine and Biology Society. 1, 1784-1787, 2006	Wrong intervention; STAN analysis
Ibarra-Polo,A.A., Guiloff,E., Gomez-Rogers,C., Fetal heart rate throughout pregnancy, American Journal of Obstetrics and Gynecology, 113, 814-818, 1972	Fetal heart rate assessed in the antenatal period
Ikeda,S., Okazaki,A., Miyazaki,K., Kihira,K., Furuhashi,M., Fetal heart rate pattern interpretation in the second stage of labor using the five-tier classification: Impact of the degree and duration on severe fetal acidosis, Journal of Obstetrics and Gynaecology Research, 40, 1274-1280, 2014	No relevant data (odds ratios or measures of diagnostic accuracy are not reported and it is not possible to calculate them with the data provided)
International Federation of Gynaecology and Obstetrics, Guidelines for the use of fetal monitoring, International Journal of Gynaecology and Obstetrics, 25, 159-167, 1987	Narrative review
Jezewski,J., Wrobel,J., Horoba,K., Comparison of doppler ultrasound and direct electrocardiography acquisition techniques for quantification of fetal heart rate variability, IEEE Transactions on Biomedical Engineering, 53, 855-864, 2006	Computer analysis
Jonsson, M., Agren, J., Norden-Lindeberg, S., Ohlin, A., Hanson, U., Neonatal encephalopathy and the association to asphyxia in labor,	Population consists of neonates with encephalopathy, no controls

Study	Reason for Exclusion
American Journal of Obstetrics & Gynecology, 211, 667.e1-8, 2014	
Kaneko,M., Sameshima,H., Ikeda,T., Ikenoue,T., Minematsu,T., Intrapartum fetal heart rate monitoring in cases of cytomegalovirus infection, American Journal of Obstetrics and Gynecology, 191, 1257-1262, 2004	Wrong intervention: fetal heart traces not used as the diagnostic measure of the cases with cytomegalovirus infection
Katsuragi, S., Parer, J. T., Noda, S., Onishi, J., Kikuchi, H., Ikeda, T., Mechanism of reduction of newborn metabolic acidemia following application of a rule-based 5-category color-coded fetal heart rate management framework, Journal of Maternal-Fetal and Neonatal Medicine, 28, 1608-1613, 2015	No relevant data (odds ratios or measures of diagnostic accuracy are not reported and it is not possible to calculate them with the data provided)
Katsuragi,S., Ikeda,T., Noda,S., Onishi,J., Ikenoue,T., Parer,J.T., Immediate newborn outcome and mode of delivery: use of standardized fetal heart rate pattern management, Journal of Maternal-Fetal and Neonatal Medicine, 26, 71-74, 2013	Wrong intervention; fetal heart rate pattern management
Kleanthi,G., Action points for successful implementation of electronic fetal monitoring guidelines, Review of Clinical Pharmacology and Pharmacokinetics, International Edition, 22, 461-464, 2008	Narrative review
Krebs,H.B., Petres,R.E., Dunn,L.J., Jordaan,H.V., Segreti,A., II. Multifactorial analysis of intrapartum fetal heart rate tracings, American Journal of Obstetrics and Gynecology, 133, 773-780, 1979	No outcomes of interest for this review
Krebs,H.B., Petres,R.E., Dunn,L.J., Jordaan,H.V., Segreti,A., II. Multifactorial analysis of intrapartum fetal heart rate tracings, American Journal of Obstetrics and Gynecology, 133, 773-780, 1979	No outcomes of interest
Krebs,H.B., Petres,R.E., Dunn,L.J., Jordaan,H.V., Segreti,A., Intrapartum fetal heart rate monitoring. I. Classification and prognosis of fetal heart rate patterns, American Journal of Obstetrics and Gynecology, 133, 762-772, 1979	No outcomes of interest (only Apgar score is reported)
Krupa,N., Ali,M., Zahedi,E., Ahmed,S., Hassan,F.M., Antepartum fetal heart rate feature extraction and classification using empirical mode decomposition and support vector machine, Biomedical Engineering Online, 10, 6-, 2011	Computer analysis
Lange,S., Van,Leeuwen P., Geue,D., Hatzmann,W., Gronemeyer,D., Influence of gestational age, heart rate, gender and time of day on fetal heart rate variability, Medical and Biological Engineering and Computing, 43, 481-486, 2005	Population consisted of women from 16 to 42 weeks' gestation
Leslie,K., Arulkumaran,S., Intrapartum fetal surveillance, Obstetrics, Gynaecology and Reproductive Medicine, 21, 59-67, 2011	Narrative review

Study	Reason for Exclusion
Leung,T.Y., Chung,P.W., Rogers,M.S., Sahota,D.S., Lao,T.T.-H., Chung,T.K.H., Urgent cesarean delivery for fetal bradycardia, Obstetrics and Gynecology, 114, 1023-1028, 2009	Wrong intervention for this review: decision to delivery intervals
Li, X., Xu, Y., Herry, C., Durosier, L. D., Casati, D., Stampalija, T., Maisonneuve, E., Seely, A. J., Audibert, F., Alfirevic, Z., Ferrazzi, E., Wang, X., Frasch, M. G., Sampling frequency of fetal heart rate impacts the ability to predict pH and BE at birth: a retrospective multi-cohort study, Physiological measurement, 36, L1-L12, 2015	No relevant data (odds ratios or measures of diagnostic accuracy are not reported and it is not possible to calculate them with the data provided)
Li,X., Zheng,D., Zhou,S., Tang,D., Wang,C., Wu,G., Approximate entropy of fetal heart rate variability as a predictor of fetal distress in women at term pregnancy, Acta Obstetricia et Gynecologica Scandinavica, 84, 837-843, 2005	Computer analysis
Lin, S., Esplin, I., Esplin, S., Use of risk stratification and fetal heart rate (FHR) interpretation algorithms for earlier intervention (EI) in cases of fetal acidemia, Reproductive Sciences, 1), 275A, 2016	Conference abstract
Lin, S., Holmgren, C., Heuser, C., Jackson, M., Rose, N. C., Barbour, K., Herrera, C., Eller, A., Richards, D., Esplin, I., Porter, T. F., Esplin, S., Application of fetal heart rate (FHR) algorithms to predict acidemia at birth, American Journal of Obstetrics and Gynecology, 1), S121, 2016	Conference abstract
MacDonald,D., Grant,A., Sheridan-Pereira,M., Boylan,P., Chalmers,I., The Dublin randomized controlled trial of intrapartum fetal heart rate monitoring, American Journal of Obstetrics and Gynecology, 152, 524-539, 1985	Wrong intervention; EFM was compared with intermittent auscultation
Macones,G.A., Hankins,G.D., Spong,C.Y., Hauth,J., Moore,T., The 2008 National Institute of Child Health and Human Development workshop report on electronic fetal monitoring: update on definitions, interpretation, and research guidelines, Obstetrics and Gynecology, 112, 661-666, 2008	Narrative review; data on NICHD fetal heart rate classification reported in the review
Macones,G.A., Hankins,G.D., Spong,C.Y., Hauth,J., Moore,T., The 2008 National Institute of Child Health and Human Development workshop report on electronic fetal monitoring: update on definitions, interpretation, and research guidelines. [7 refs], JOGNN - Journal of Obstetric, Gynecologic, and Neonatal Nursing, 37, 510-515, 2008	Narrative review
Maso, G., Piccoli, M., De Seta, F., Parolin, S., Banco, R., Camacho Mattos, L., Bogatti, P., Alberico, S., Intrapartum fetal heart rate monitoring interpretation in labour: a critical appraisal, Minerva Ginecologica, 67, 65-79, 2015	Narrative review
Michikata, K., Urabe, H., Tokunaga, S., Sameshima, H., Tsuyomu, I., Effect of fetal heart	Conference abstract

Study	Reason for Exclusion
rate monitoring network system in Japan, Reproductive Sciences, 22, 2015	
Miller,D.A., Miller,L.A., Electronic fetal heart rate monitoring: applying principles of patient safety, American Journal of Obstetrics and Gynecology, 206, 278-283, 2012	Narrative review
Muro,M., Shono,H., Shono,M., Uchiyama,A., Iwasaka,T., Changes in diurnal variations in the fetal heart rate baseline with advancing gestational age, Sleep and Biological Rhythms, 2, 83-85, 2004	Single case study
National Institute for Clinical Excellence., The use of electronic fetal monitoring. The use and interpretation of cardiotocography in intrapartum fetal surveillance - guideline (Structured abstract), Health Technology Assessment Database, -, 2012	A URL link to previous NICE IPC guideline
Nisenblat,V., Alon,E., Barak,S., Gonen,R., Bader,D., Ohel,G., Fetal heart rate patterns and neurodevelopmental outcome in very low birth weight infants, Acta Obstetricia et Gynecologica Scandinavica, 85, 792-796, 2006	Preterm population
Okai,T., Ikeda,T., Kawarabayashi,T., Kozuma,S., Sugawara,J., Chisaka,H., Yoneda,S., Matsuoka,R., Nakano,H., Okamura,K., Saito,S., Perinatology Committee of the Japan Society of Obstetrics and Gynecology., Intrapartum management guidelines based on fetal heart rate pattern classification, Journal of Obstetrics and Gynaecology Research, 36, 925-928, 2010	Narrative review
Painter,M.J., Depp,R., O'Donoghue,P.D., Fetal heart rate patterns and development in the first year of life, American Journal of Obstetrics and Gynecology, 132, 271-277, 1978	Small case series study (n =36) with Apgar as main fetal wellbeing assessment
Parer,J.T., Ikeda,T., A framework for standardized management of intrapartum fetal heart rate patterns, American Journal of Obstetrics and Gynecology, 197, 26-26, 2007	Narrative review
Parer,J.T., Ikeda,T., King,T.L., The 2008 National Institute of Child Health and Human Development report on fetal heart rate monitoring, Obstetrics and Gynecology, 114, 136-138, 2009	Narrative review
Paul,R.H., Suidan,A.K., Yeh,S., Schifrin,B.S., Hon,E.H., Clinical fetal monitoring. VII. The evaluation and significance of intrapartum baseline FHR variability, American Journal of Obstetrics and Gynecology, 123, 206-210, 1975	Fetal heart rate assessed with fetal electrocardiogram
Paul,R.H., Suidan,A.K., Yeh,S., Schifrin,B.S., Hon,E.H., Clinical fetal monitoring. VII. The evaluation and significance of intrapartum baseline FHR variability, American Journal of Obstetrics and Gynecology, 123, 206-210, 1975	No outcomes of interest
Reinhard,J., Hayes-Gill,B.R., Yi,Q., Hatzmann,H., Schiermeier,S., Comparison of non-invasive fetal electrocardiogram to Doppler	Wrong intervention; fetal ECG compared with CTG

Study	Reason for Exclusion
cardiotocogram during the 1st stage of labor, Journal of Perinatal Medicine, 38, 179-185, 2010	
Ridgeway,J.J., Weyrich,D.L., Benedetti,T.J., Fetal heart rate changes associated with uterine rupture, Obstetrics and Gynecology, 103, 506-512, 2004	Wrong intervention: fetal heart rate traces were not used as a diagnostic measure of the cases with uterine ruptures
Rodney,J.R., Huntley,B.J., Rodney,W.M., Electronic fetal monitoring: family medicine obstetrics, Primary Care; Clinics in Office Practice, 39, 115-133, 2012	Narrative review
Roemer, V. M., Walden, R., The factor time in fetal heart rate monitoring and the detection of acidosis using the WAS score, Zeitschrift fur Geburtshilfe und Neonatologie, 218, 80-6, 2014	No relevant data (odds ratios or measures of diagnostic accuracy are not reported and it is not possible to calculate them with the data provided)
Roemer,V.M., Walden,R., Sensitivity, specificity, receiver-operating characteristic (ROC) curves and likelihood ratios for electronic foetal heart rate monitoring using new evaluation techniques, Zeitschrift fur Geburtshilfe und Neonatologie, 214, 108-118, 2010	Computer analysis
Romano,M., Bifulco,P., Cesarelli,M., Sansone,M., Bracale,M., Foetal heart rate power spectrum response to uterine contraction, Medical and Biological Engineering and Computing, 44, 188-201, 2006	No outcomes of interest
Ross,M.G., Labor and fetal heart rate decelerations: relation to fetal metabolic acidosis, Clinical Obstetrics and Gynecology, 54, 74-82, 2011	Narrative review
Rzepka,R., Torbe,A., Kwiatkowski,S., Blogowski,W., Czajka,R., Clinical outcomes of high-risk labours monitored using fetal electrocardiography, Annals of the Academy of Medicine, Singapore, 39, 27-32, 2010	STAN analysis
Sadaka,A., Furuhashi,M., Minami,H., Miyazaki,K., Yoshida,K., Ishikawa,K., Observation on validity of the five-tier system for fetal heart rate pattern interpretation proposed by Japan Society of Obstetricians and Gynecologists, Journal of Maternal-Fetal and Neonatal Medicine, 24, 1465-1469, 2011	No outcomes of interest; inter-observer variability
Sahhaf,F., Abbas',Alizadeh F., Kokcheli,H., Ghojazadeh,M., Effect of uterine contraction and amniotomy on fetal cardiotocograph, Pakistan Journal of Biological Sciences, 13, 34-39, 2010	An observational study with the outcomes not linked to maternal and neonatal wellbeing
Sameshima,H., Ikenoue,T., Ikeda,T., Kamitomo,M., Ibara,S., Association of nonreassuring fetal heart rate patterns and subsequent cerebral palsy in pregnancies with intrauterine bacterial infection, American Journal of Perinatology, 22, 181-187, 2005	Wrong population; pregnant women with intrauterine bacterial infection
Schiermeier,S., Pildner,VonSteinburgS, Thieme,A., Reinhard,J., Daumer,M., Scholz,M., Hatzmann,W., Schneider,K.T.M., Sensitivity and specificity of intrapartum computerised FIGO criteria for cardiotocography and fetal scalp pH during labour: Multicentre, observational study,	Computer analysis

Study	Reason for Exclusion
BJOG: An International Journal of Obstetrics and Gynaecology, 115, 1557-1563, 2008	
Schifrin,B.S., Artenos,J., Lyseight,N., Late-onset fetal cardiac decelerations associated with fetal breathing movements, Journal of Maternal-Fetal and Neonatal Medicine, 12, 253-259, 2002	No outcomes of interest
Shaw, C. J., Lees, C. C., Giussani, D. A., Variations on fetal heart rate variability, Journal of Physiology, 594, 1279-80, 2016	Not an original study
Sheen, T. C., Lu, M. H., Lee, M. Y., Chen, S. R., Nonreassuring fetal heart rate decreases heart rate variability in newborn infants, Annals of Noninvasive Electrocardiology, 19, 273-8, 2014	Intervention was ECG, not relevant
Shoham,I., richa-Tamir,B., Weintraub,A.Y., Mazor,M., Wiznitzer,A., Holcberg,G., Sheiner,E., Fetal heart rate tracing patterns associated with congenital hypothyroidism, American Journal of Obstetrics and Gynecology, 201, 48-4, 2009	Wrong intervention: fetal heart traces not used as the diagnostic measure of the congenital hypothyroidism condition
Shy,K.K., Luthy,D.A., Bennett,F.C., Whitfield,M., Larson,E.B., van,Belle G., Hughes,J.P., Wilson,J.A., Stenchever,M.A., Effects of electronic fetal-heart-rate monitoring, as compared with periodic auscultation, on the neurologic development of premature infants, New England Journal of Medicine,N Engl J Med, 322, 588-593, 1990	Premature population
Siira,S., Ojala,T., Ekholm,E., Vahlberg,T., Blad,S., Rosen,K.G., Change in heart rate variability in relation to a significant ST-event associates with newborn metabolic acidosis, BJOG: An International Journal of Obstetrics and Gynaecology, 114, 819-823, 2007	STAN analysis
Siira,S.M., Ojala,T.H., Vahlberg,T.J., Jalonen,J.O., Valimaki,I.A., Rosen,K.G., Ekholm,E.M., Marked fetal acidosis and specific changes in power spectrum analysis of fetal heart rate variability recorded during the last hour of labour, BJOG: An International Journal of Obstetrics and Gynaecology, 112, 418-423, 2005	STAN analysis
Sisco,K.M., Cahill,A.G., Stamilio,D.M., Macones,G.A., Is continuous monitoring the answer to incidentally observed fetal heart rate decelerations?, Journal of Maternal-Fetal and Neonatal Medicine, 22, 405-409, 2009	No outcomes of interest
Smith,Jr, Onstad,J.H., Assessment of the fetus: Intermittent auscultation, electronic fetal heart rate tracing, and fetal pulse oximetry, Obstetrics and Gynecology Clinics of North America, 32, 245-254, 2005	Narrative review
Stefos,T., Sotiriadis,A., Tsirkas,P., Korkontzelos,I., Papadimitriou,D., Lolis,D., Evaluation of fetal heart monitoring in the first stage of labor, Journal of Maternal-Fetal Medicine, 10, 48-51, 2001	Wrong intervention; continuous fetal heart rate monitoring in early cervical dilatation (<4 cm) versus continuous monitoring later (cervical dilation >4 cm) was assessed
Tagliaferri, S., Fanelli, A., Esposito, G., Esposito, F. G., Magenes, G., Signorini, M. G.,	CTG taken antepartum, not during labour

Study	Reason for Exclusion
Campanile, M., Martinelli, P., Evaluation of the acceleration and deceleration phase-rectified slope to detect and improve IUGR clinical management, Computational and Mathematical Methods in Medicine, 2015 (no pagination), 2015	
Tongsong,T., Iamthongin,A., Wanapirak,C., Piyamongkol,W., Sirichotiyakul,S., Boonyanurak,P., Tatiyapornkul,T., Neelasri,C., Accuracy of fetal heart-rate variability interpretation by obstetricians using the criteria of the National Institute of Child Health and Human Development compared with computer-aided interpretation, Journal of Obstetrics and Gynaecology Research, 31, 68-71, 2005	Computer aided analysis used as a gold standard
Tortosa,M.N., Acien,P., Evaluation of variable decelerations of fetal heart rate with the deceleration index: influence of associated abnormal parameters and their relation to the state and evolution of the newborn, European Journal of Obstetrics, Gynecology, and Reproductive Biology, 34, 235-245, 1990	Fetal heart rate was recorded via electrocardiogram (ECG)
Tranquilli,A.L., Fetal heart rate in the second stage of labor: recording, reading, interpreting and acting, Journal of Maternal-Fetal and Neonatal Medicine, 25, 2551-2554, 2012	Narrative review
Tranquilli,A.L., Biagini,A., Greco,P., Di,Tommaso M., Giannubilo,S.R., The correlation between fetal bradycardia area in the second stage of labor and acidemia at birth, Journal of Maternal-Fetal and Neonatal Medicine, 26, 1425-1429, 2013	Computer-based analysis and interpretation
Trochez,R.D., Sibanda,T., Sharma,R., Draycott,T., Fetal monitoring in labor: are accelerations good enough?, Journal of Maternal-Fetal and Neonatal Medicine, 18, 349-352, 2005	No outcomes of interest; evaluating fetal heart rate in response to scalp stimulation
Uccella,S., Cromi,A., Colombo,G., Agosti,M., Bogani,G., Casarin,J., Ghezzi,F., Prediction of fetal base excess values at birth using an algorithm to interpret fetal heart rate tracings: a retrospective validation, BJOG: An International Journal of Obstetrics and Gynaecology, 119, 1657-1664, 2012	No oucomes of iterest; inter- and intra-observer reproducibility
Ueda,K., Ikeda,T., Iwanaga,N., Katsuragi,S., Yamanaka,K., Neki,R., Yoshimatsu,J., Shiraishi,I., Intrapartum fetal heart rate monitoring in cases of congenital heart disease, American Journal of Obstetrics and Gynecology, 201, 64-66, 2009	Fetal heart rate traces were not used as a diagnostic measure of cases with congenital heart disease
Ungureanu,G.M., Taralunga,D.D., Gussi,I., Wolf,W., Piper,D., Strungaru,R., Monitoring the fetal heart rate variations by means of time-variant multivariate analysis, Conference Proceedings: .., Annual International Conference of the IEEE Engineering in Medicine and Biology Society. 2013, 4370-4373, 2013	No outcome of interest

Study	Reason for Exclusion
van der Hout-van der Jagt MB, Jongen,G.J., Bovendeerd,P.H., Oei,S.G., Insight into variable fetal heart rate decelerations from a mathematical model, Early Human Development, 89, 361-369, 2013	No outcome of interest: umbilical cord compression-induced variable decelerations
van Laar,J.O., Peters,C.H., Houterman,S., Wijn,P.F., Kwee,A., Oei,S.G., Normalized spectral power of fetal heart rate variability is associated with fetal scalp blood pH, Early Human Development, 87, 259-263, 2011	Wrong intervention; STAN review
van Laar,J.O., Peters,C.H., Vullings,R., Houterman,S., Oei,S.G., Power spectrum analysis of fetal heart rate variability at near term and post term gestation during active sleep and quiet sleep, Early Human Development, 85, 795-798, 2009	STAN analysis
Van,Leeuwen P., Lange,S., Geue,D., Gronemeyer,D., Heart rate variability in the fetus: a comparison of measures, Biomedizinische Technik, 52, 61-65, 2007	Wrong intervention; magnetocardiography used
Visser,G.H., Dawes,G.S., Redman,C.W., Numerical analysis of the normal human antenatal fetal heart rate, British Journal of Obstetrics and Gynaecology, 88, 792-802, 1981	Antenatal intervention
von,SteinburgS, Boulesteix,A.L., Lederer,C., Grunow,S., Schiermeier,S., Hatzmann,W., Schneider,K.T.M., Daumer,M., What is the "normal" fetal heart rate?, PeerJ, 2013, -, 2013	Computerised analysis performed
Warmerdam, G. J., Vullings, R., Van Laar, J. O., Van der Hout-Van der Jagt, M. B., Bergmans, J. W., Schmitt, L., Oei, S. G., Using uterine activity to improve fetal heart rate variability analysis for detection of asphyxia during labor, Physiological Measurement, 37, 387-400, 2016	Intervention not relevant (ECG instead of CTG)
Westgate,J.A., Wibbens,B., Bennet,L., Wassink,G., Parer,J.T., Gunn,A.J., The intrapartum deceleration in center stage: a physiologic approach to the interpretation of fetal heart rate changes in labor, American Journal of Obstetrics and Gynecology, 197, 236-11, 2007	Narrative review
Wheeler,T., Murrills,A., Patterns of fetal heart rate during normal pregnancy, British Journal of Obstetrics and Gynaecology, 85, 18-27, 1978	Fetal heart rate was assessed in antenatal period
Whitworth,M.K., Bricker,L., Cardiotocograph interpretation. [6 refs], British Journal of Hospital Medicine, 67, M190-M192, 2006	Narrative review

F.6 Care in labour as a result of cardiotocography

Study	Reason for Exclusion
Abdel-Aleem,H., Amin,A.F., Shokry,M., Radwan,R.A., Therapeutic amnioinfusion for intrapartum fetal distress using a pediatric feeding tube, International Journal of Gynaecology and Obstetrics, , 94-98, 2005	Intervention not relevant

Study	Reason for Exclusion
Ahmed,B., Ghaffari,Z., Abukhalil,M.Z., The relationship between intrapartum amniotic fluid index, fetal distress and fetal acidemia, Saudi Medical Journal, 25, 1297-1299, 2004	Intervention and outcome not relevant; diagnostic study
Ahn,M.O., Korst,L.M., Phelan,J.P., Normal fetal heart rate pattern in the brain-damaged infant: A failure of intrapartum fetal monitoring?, Journal of Maternal-Fetal Investigation, 8, 58-60, 1998	No relevant intervention or comparison
Alatas, C., Aksoy, E., Akarsu, C., Yakin, K., Bahceci, M., Prediction of perinatal outcome by middle cerebral artery Doppler velocimetry, Archives of Gynecology & Obstetrics, 258, 141-6, 1996	No relevant comparison; normal risk group is was compared to a high-risk group; no comparison of a CTG-guided intervention protocol
Albers, L. L., Savitz, D. A., Hospital setting for birth and use of medical procedures in low-risk women, Journal of Nurse-Midwifery, 36, 327-33, 1991	No relevant comparison; frequencies of electronic fetal monitoring use and of other childbirth procedures were compared between different hospital settings; no description of CTG-guided intervention protocols
Alfirevic, Z., Luckas, M., Walkinshaw, S. A., McFarlane, M., Curran, R., A randomised comparison between amniotic fluid index and maximum pool depth in the monitoring of post-term pregnancy, British Journal of Obstetrics and Gynaecology, 104, 207-11, 1997	No relevant comparison; fetal monitoring by CTG and amniotic fluid index was compared to fetal monitoring by CTG and maximum pool depth; no comparison of a CTG-guided intervention protocol
Alfirevic, Z., Stampalija, T., Gyte, G. M., Fetal and umbilical Doppler ultrasound in high-risk pregnancies, Cochrane Database of Systematic Reviews, 11, CD007529, 2013	No relevant intervention and outcome; comparison of ST pattern between ECG and cardiotocography
American College of, Obstetricians, Gynecologists,, ACOG Practice Bulletin No. 106: Intrapartum fetal heart rate monitoring: nomenclature, interpretation, and general management principles.[Update of Obstet Gynecol. 2005 Dec;106(6):1453-60; PMID: 16319279], Obstetrics & Gynecology, 114, 192-202, 2009	Guideline and narrative review
Amer-Wahlin, I., Ingemarsson, I., Marsal, K., Herbst, A., Fetal heart rate patterns and ECG ST segment changes preceding metabolic acidaemia at birth, BJOG: An International Journal of Obstetrics & Gynaecology, 112, 160-5, 2005	Intervention and outcome not relevant; comparison of ST segment pattern from ECG and cardiotocography and intervention decision
Amer-Wahlin,I., Marsal,K., ST analysis of fetal electrocardiography in labor, Seminars in Fetal and Neonatal Medicine, 16, 29-35, 2011	Narrative review of ST analysis of fetal electrocardiography
Anteby, E. Y., Tadmor, O., Revel, A., Yagel, S., Post-term pregnancies with normal cardiotocographs and amniotic fluid columns: the role of Doppler evaluation in predicting perinatal outcome, European Journal of Obstetrics, Gynecology, & Reproductive Biology, 54, 93-8, 1994	Not the intervention of interest
Arikan,G.M., Haeusler,M.C., Deutsch,M.T., Greimel,E.R., Dorfer,M., Maternal perceptions of labor with fetal monitoring by pulse oximetry in a research setting, Birth, 25, 182-189, 1998	No relevant comparison; CTG with fetal pulse oximetry was compared to CTG alone; no comparison of a CTG-guided intervention protocol

Study	Reason for Exclusion
Bond, D. M., Gordon, A., Hyett, J., de Vries, B., Carberry, A. E., Morris, J., Planned early delivery versus expectant management of the term suspected compromised baby for improving outcomes, Cochrane Database of Systematic Reviews, 11, CD009433, 2015	Wrong population; the studies included in this review included women with IUGR or oligohydramnios, not abnormal/non-re-assuring CTG tracings
Briozzo,L., Martinez,A., Nozar,M., Fiol,V., Pons,J., Alonso,J., Tocolysis and delayed delivery versus emergency delivery in cases of non-reassuring fetal status during labor, Journal of Obstetrics and Gynaecology Research, 33, 266-273, 2007	Mixed population includes preterm before 37 weeks
Burge, D. M., Ade-Ajayi, N., Adverse outcome after prenatal diagnosis of gastroschisis: the role of fetal monitoring, Journal of Pediatric Surgery, 32, 441-4, 1997	No description of a CGT-guided intervention protocol
Carseldine, W. J., Phipps, H., Zawada, S. F., Campbell, N. T., Ludlow, J. P., Krishnan, S. Y., De Vries, B. S., Does occiput posterior position in the second stage of labour increase the operative delivery rate?, Australian & New Zealand Journal of Obstetrics & Gynaecology, 53, 265-70, 2013	Not the intervention of interest
Chang,T.C., Tan,K.T., Neow,P., Yeo,G.S., Computerised analysis of foetal heart rate variation: prediction of adverse perinatal outcome in patients undergoing prostaglandin induction of labour at term, Annals of the Academy of Medicine, Singapore, 26, 772-775, 1997	No relevant comparison; no comparison of a CTG-guided intervention protocol
Cheyne,H., Dunlop,A., Shields,N., Mathers,A.M., A randomised controlled trial of admission electronic fetal monitoring in normal labour, Midwifery, 19, 221-229, 2003	Not the intervention of interest
Chiossi,G., Costantine,M.M., Pfannstiel,J.M., Hankins,G.D., Saade,G.R., Wu,Z.H., Intervention for fetal distress among obstetricians, registered nurses, and residents: similarities, differences, and determining factors, Obstetrics and Gynecology, 118, 809-817, 2011	No relevant comparison; frequency of different indications to expedite birth based on CTG findings were compared between registered nurses, physicians and residents
Clark, S., Hamilton, E., Garite, T., Timmons, A., Collins, K., Warrick, P., Smith, S., Use of a standardized protocol for the management of category II fetal heart rate tracings leads to earlier intervention in infants born with metabolic acidosis, American Journal of Obstetrics and Gynecology, 1), S194, 2016	Conference abstract
Crump,W.J., Oxytocin and the induction of labor: use in a network of community hospitals, Family Medicine, 21, 110-113, 1989	Irrelevant intervention and outcome; sample included post-date pregnancy
Daly,N., Brennan,D., Foley,M., O'Herlihy,C., Cardiotocography as a predictor of fetal outcome in women presenting with reduced fetal movement, European Journal of Obstetrics, Gynecology, and Reproductive Biology, 159, 57-61, 2011	Mixed population group

Study	Reason for Exclusion
Doret,M., Massoud,M., Constans,A., Gaucherand,P., Use of peripartum ST analysis of fetal electrocardiogram without blood sampling: a large prospective cohort study, European Journal of Obstetrics, Gynecology, and Reproductive Biology, 156, 35-40, 2011	Not the intervention of interest
Doria,V., Papageorghiou,A.T., Gustafsson,A., Ugwumadu,A., Farrer,K., Arulkumaran,S., Review of the first 1502 cases of ECG-ST waveform analysis during labour in a teaching hospital, BJOG: An International Journal of Obstetrics and Gynaecology, 114, 1202-1207, 2007	Intervention not relevant
East, C. E., Leader, L. R., Sheehan, P., Henshall, N. E., Colditz, P. B., Lau, R., Intrapartum fetal scalp lactate sampling for fetal assessment in the presence of a non-reassuring fetal heart rate trace, Cochrane Database of Systematic Reviews, 5, CD006174, 2015	No relevant intervention and comparison; fetal scalp sampling covered by another review question
Elliott,C., Warrick,P.A., Graham,E., Hamilton,E.F., Graded classification of fetal heart rate tracings: association with neonatal metabolic acidosis and neurologic morbidity, American Journal of Obstetrics and Gynecology, 202, 258-258, 2010	Not the intervention of interest
Farrell,T., Mires,G.J., Owen,P., Patel,N.B., The influence of interpretation on the value of routine labour admission cardiotocography in a 'low risk' obstetric population, Journal of Obstetrics and Gynaecology, 15, 161-164, 1995	No relevant comparison; outcomes of abnormal and normal CTGs were compared; no comparison of a CTG-guided intervention protocol
Garite,T.J., Dildy,G.A., McNamara,H., Nageotte,M.P., Boehm,F.H., Dellinger,E.H., Knuppel,R.A., Porreco,R.P., Miller,H.S., Sunderji,S., Varner,M.W., Swedlow,D.B., A multicenter controlled trial of fetal pulse oximetry in the intrapartum management of nonreassuring fetal heart rate patterns, American Journal of Obstetrics and Gynecology, 183, 1049-1058, 2000	Not the intervention of interest
Hendrix,N.W., Chauhan,S.P., Scardo,J.A., Ellings,J.M., Devoe,L.D., Managing nonreassuring fetal heart rate patterns before cesarean delivery. Compliance with ACOG recommendations, Journal of Reproductive Medicine, 45, 995-999, 2000	Irrelevant intervention and outcome; study measured the rate of compliance with existing guidelines
Jonsson, M., Norden Lindeberg, S., Ostlund, I., Hanson, U., Acidemia at birth in the vigorous infant as a trigger incident to assess intrapartum care with regard to CTG patterns, Journal of Maternal-Fetal & Neonatal Medicine, 26, 1094-8, 2013	Population includes preterm labour (gestational age >=34 weeks)
Katsuragi,S., Ikeda,T., Noda,S., Onishi,J., Ikenoue,T., Parer,J.T., Immediate newborn outcome and mode of delivery: use of standardized fetal heart rate pattern management, Journal of Maternal-Fetal and Neonatal Medicine, 26, 71-74, 2013	Same study population as Katsuragi 2015 which was included in the review; no additional outcomes of interest were reported

Study	Reason for Exclusion
Kidd, L. C., Smith, R., Non-stress antenatal cardiotocography, a prospective randomized clinical trial, British Journal of Obstetrics and Gynaecology, 92, 1156-1159, 1985	Antenatal care
Lin, S., Esplin, I., Esplin, S., Use of risk stratification and fetal heart rate (FHR) interpretation algorithms for earlier intervention (EI) in cases of fetal acidemia, Reproductive Sciences, 1), 275A, 2016	Conference abstract
Lin, S., Holmgren, C., Heuser, C., Jackson, M., Rose, N. C., Barbour, K., Herrera, C., Eller, A., Richards, D., Esplin, I., Porter, T. F., Esplin, S., Application of fetal heart rate (FHR) algorithms to predict acidemia at birth, American Journal of Obstetrics and Gynecology, 1), S121, 2016	Conference abstract; wrong intervention and comparison
Salamalekis,E., Siristatidis,C., Vasios,G., Saloum,J., Giannaris,D., Chrelias,C., Prentza,A., Koutsouris,D., Fetal pulse oximetry and wavelet analysis of the fetal heart rate in the evaluation of abnormal cardiotocography tracings, Journal of Obstetrics and Gynaecology Research, 32, 135-139, 2006	Not the intervention of interest
Vayssiere,C., Haberstich,R., Sebahoun,V., David,E., Roth,E., Langer,B., Fetal electrocardiogram ST-segment analysis and prediction of neonatal acidosis, International Journal of Gynaecology and Obstetrics, 97, 110-114, 2007	Not the intervention of interest

F.7 Fetal scalp stimulation

Study	Reason for Exclusion
Bolnick, J. M., Garcia, G., Fletcher, B. G., Rayburn, W. F., Cross-over trial of fetal heart rate response to halogen light and vibroacoustic stimulation, Journal of Maternal-Fetal & Neonatal Medicine, 19, 215-9, 2006	Antenatal stimulation
Chittacharoen,A., Chaitum,A., Suthutvoravut,S., Herabutya,Y., Fetal acoustic stimulation for early intrapartum assessment of fetal well-being, International Journal of Gynaecology and Obstetrics, 69, 275-277, 2000	All included women had high-risk pregnancies
Col,SoodA, Col,SinghS, Vibroacoustic stimulation and modified fetal biophysical profile for early intrapartum fetal assessment, Journal of Obstetrics and Gynecology of India, 61, 291-295, 2011	Women were not having electronic fetal monitoring - ultrasound observation of fetal heart rate response to stimulation; 59% were high-risk pregnancies
Divon,M.Y., Braverman,J.J., Guidetti,D.A., Langer,O., Merkatz,I.R., Intrapartum vibratory acoustic stimulation of the human fetus during episodes of decreased heart rate variability, American Journal of Obstetrics and Gynecology, 157, 1355-1358, 1987	No 'gold standard' reference test
East, C. E., Leader, L. R., Sheehan, P., Henshall, N. E., Colditz, P. B., Lau, R., Intrapartum fetal scalp lactate sampling for fetal assessment in the presence of a non-reassuring	Wrong intervention; not scalp stimulation

Study	Reason for Exclusion
fetal heart rate trace, Cochrane Database of Systematic Reviews, 5, CD006174, 2015	
East, Christine E., Smyth, M. D. Rebecca, Leader, Leo R., Henshall, Naomi E., Colditz, Paul B., Lau, Rosalind, Tan, Kelvin H., Vibroacoustic stimulation for fetal assessment in labour in the presence of a nonreassuring fetal heart rate trace, Cochrane Database of Systematic Reviews, 2013	Relevant systematic review: no studies included
East,Christine E., Leader,Leo R., Sheehan,Penelope, Henshall,Naomi E., Colditz,Paul B., Intrapartum fetal scalp lactate sampling for fetal assessment in the presence of a non-reassuring fetal heart rate trace, Cochrane Database of Systematic Reviews, -, 2012	Wrong intervention; not scalp stimulation
East,Christine E., Smyth,Rebecca MD, Leader,Leo R., Henshall,Naomi E., Colditz,Paul B., Tan,Kelvin H., Vibroacoustic stimulation for fetal assessment in labour in the presence of a nonreassuring fetal heart rate trace, Cochrane Database of Systematic Reviews, -, 2009	Systematic review with no included studies
Grivell, Rosalie M., Alfirevic, Zarko, Gyte, M. L. Gillian, Devane, Declan, Antenatal cardiotocography for fetal assessment, Cochrane Database of Systematic Reviews, 2015	Systematic review: studies did not describe any fetal stimulation method
Holzmann, M., Wretler, S., Cnattingius, S., Nordstrom, L., Cardiotocography patterns and risk of intrapartum fetal acidemia, Journal of Perinatal Medicine, 43, 473-479, 2015	No comparison of interest: fetal blood sampling not for scalp stimulation
Ingemarsson,I., Arulkumaran,S., Paul,R.H., Ingemarsson,E., Tambyraja,R.L., Ratnam,S.S., Fetal acoustic stimulation in early labor in patients screened with the admission test, American Journal of Obstetrics and Gynecology, 158, 70-74, 1988	No 'gold standard' reference test
Issel,E.P., Fetal response to external mechanical stimuli, Journal of Perinatal Medicine, 11, 232-242, 1983	No 'gold standard' reference test
Ohel,G., Simon,A., Beyth,Y., Sadovsky,E., Intrapartum vibroacoustic stimulation in cases of normal and abnormal fetal heart rate patterns, Gynecologic and Obstetric Investigation, 21, 1-5, 1986	No 'gold standard' reference test
Panayotopoulos,N., Salamalekis,E., Kassanos,D., Vitoratos,N., Loghis,C., Batalias,L., Intrapartum vibratory acoustic stimulation after maternal meperidine administration, Clinical and Experimental Obstetrics and Gynecology, 25, 139-140, 1998	No 'gold standard' reference test
Papadopoulos,V.G., Decavalas,G.O., Kondakis,X.G., Beratis,N.G., Vibroacoustic stimulation in abnormal biophysical profile: Verification of facilitation of fetal well-being, Early Human Development, 83, 191-197, 2007	In the majority of cases gestational age at birth was 35 weeks

Study	Reason for Exclusion
Poehlmann,S., Pinette,M., Stubblefield,P., Effect of labor analgesia with nalbuphine hydrochloride on fetal response to vibroacoustic stimulation, Journal of Reproductive Medicine, 40, 707-710, 1995	No 'gold standard' reference test
Porter,T.F., Clark,S.L., Vibroacoustic and scalp stimulation, Obstetrics and Gynecology Clinics of North America, 26, 657-669, 1999	Narrative review
Salamalekis,E., Batalias,L., Kassanos,D., Loghis,C., Pyrgiotis,E., Zourlas,P.A., The acoustic stimulation test and antenatal cardiotocography as diagnostic tools in high risk pregnancies, Journal of Obstetrics and Gynaecology, 15, 292-294, 1995	Antenatal stimulation
Salamalekis,E., Vitoratos,N., Loghis,C., Kassanos,D., Salloum,I., Batalias,L., Creatsas,G., Evaluation of non-reassuring fetal heart rate patterns with fetal pulse oximetry combined with vibratory acoustic stimulation, Journal of Maternal-Fetal and Neonatal Medicine, 13, 110-114, 2003	Cannot calculate 2x2 table
Serafini,P., Lindsay,M.B., Nagey,D.A., Pupkin,M.J., Tseng,P., Crenshaw,C.,Jr., Antepartum fetal heart rate response to sound stimulation: the acoustic stimulation test, American Journal of Obstetrics and Gynecology, 148, 41-45, 1984	Antepartum stimulation
Shaw,K.J., Paul,R.H., Fetal responses to external stimuli, Obstetrics and Gynecology Clinics of North America, 17, 235-248, 1990	Narrative review
Skupski,D.W., Rosenberg,C.R., Eglinton,G.S., Intrapartum fetal stimulation tests: a meta-analysis, Obstetrics and Gynecology, 99, 129-134, 2002	Systematic review - individual studies included within the current review
Smith, C. V., Phelan, J. P., Platt, L. D., Broussard, P., Paul, R. H., Fetal acoustic stimulation testing. II. A randomized clinical comparison with the nonstress test, American Journal of Obstetrics & Gynecology, 155, 131-4, 1986	Antepartum care
Sood, A. K., Vibroacoustic stimulation and modified fetal biophysical profile in high risk pregnancy, Journal of obstetrics and gynaecology of India, 57, 37-41, 2007	Antenatal stimulation
Tan, K. H., Smyth, R. M., Wei, X., Fetal vibroacoustic stimulation for facilitation of tests of fetal wellbeing, Cochrane Database of Systematic Reviews, 12, CD002963, 2013	Individual studies assessed for inclusion
Zimmer,E.Z., Vadasz,A., Influence of the fetal scalp electrode stimulation test on fetal heart rate and body movements in quiet and active behavioral states during labor, American Journal of Perinatology, 6, 24-29, 1989	No 'gold standard' reference test

F.8 Fetal blood sampling as an adjunct to cardiotocography

Study	Reason for Exclusion
Arulkumaran,S., Ingemarsson,I., Ratnam,S.S., Fetal heart rate response to scalp stimulation as a test of fetal well-being in labour, Asia-Oceania Journal of Obstetrics and Gynaecology, 13, 131-135, 1987	The aim of the study was to compare outcomes in response to fetal scalp stimulation between a suspicious or ominous fetal heart rate (FHR)
Ayromlooi,J., Garfinkel,R., Impact of fetal scalp blood pH on the incidence of cesarean section performed for fetal distress, International Journal of Gynecology and Obstetrics, 17, 391-392, 1980	Retrospective before and after study
Bachok,N., Nor,N.M., Hamzah,T.N.T., Ibrahim,W.N., Daud,A., A five-year review of perinatal deaths at Pasir Mas district, International Medical Journal, 15, 193-198, 2008	Study does not report any details of fetal blood sampling
Barber,Vicki, Linsell,Louise, Locock,Louise, Powell,Lesley, Shakeshaft,Clare, Lean,Katie, Colman,Jacqueline, Juszczak,Ed, Brocklehurst,Peter, Electronic fetal monitoring during labour and anxiety levels in women taking part in a RCT, British Journal of Midwifery, 21, 394-403, 2013	Intervention outside of interest: decision support software for EFM
Borruto,F., Comparetto,C., Treisser,A., Prevention of cerebral palsy during labour: role of foetal lactate, Archives of Gynecology and Obstetrics, 278, 17-22, 2008	Study does not report clinical outcomes for the comparison of fetal blood sampling with EFM or EFM plus ECG
Cantu, J., Szychowski, J. M., Li, X., Biggio, J., Edwards, R. K., Andrews, W., Tita, A. T., Predicting fetal acidemia using umbilical venous cord gas parameters, Obstetrics and gynecology, 124, 926-932, 2014	Intervention outside of interest: value of fetal cord venous blood pH and base deficit as a predictor of fetal acidaemia at birth in comparison with fetal cord arterial blood as a reference standard
Carbonne, B., Pons, K., Maisonneuve, E., Foetal scalp blood sampling during labour for pH and lactate measurements, Best Practice and Research: Clinical Obstetrics and Gynaecology, 30, 62-67, 2016	Non-systematic review
Chandraharan, E., Fetal scalp blood sampling during labour: is it a useful diagnostic test or a historical test that no longer has a place in modern clinical obstetrics?, BJOG: An International Journal of Obstetrics & Gynaecology, 121, 1056-60; discussion 1060-2, 2014	Non-systematic review
Doret, M., Spilka, J., Chudacek, V., Goncalves, P., Abry, P., Fractal analysis and Hurst parameter for intrapartum fetal heart rate variability analysis: A versatile alternative to frequency bands and LF/HF ratio, PLoS ONE, 10 (8) (no pagination), 2015	The aim was to determine the predictive value of a FHR cut-off for fetal acidosis
Doret,M., Helgason,H., Abry,P., Goncalves,P., Gharib,C., Gaucherand,P., Multifractal analysis of fetal heart rate variability in fetuses with and without severe acidosis during labor, American Journal of Perinatology, 28, 259-266, 2011	Wrong intervention; reports use of umbilical arterial pH measurement, not fetal blood sampling
Durosier, L. D., Green, G., Batkin, I., Seely, A. J., Ross, M. G., Richardson, B. S., Frasch, M.	Intervention outside of interest: did not include fetal blood sampling (FBS) as intervention

Study	Reason for Exclusion
G., Sampling rate of heart rate variability impacts the ability to detect acidemia in ovine fetuses near-term, Frontiers in Pediatrics, 2, 38, 2014	
East, C. E., Begg, L., Colditz, P. B., Lau, R., Fetal pulse oximetry for fetal assessment in labour, Cochrane Database of Systematic Reviews, 10, CD004075, 2014	Intervention outside of interest: did not include FBS as intervention
East, C. E., Kane, S. C., Davey, M. A., Kamlin, C. O., Brennecke, S. P., Davis, P. G., A. Sheehan P, Cullinane, F., Smith, L., Ryan, J., duPlessis, J., Veljanovski, S., Saal, J., Grainger, T., White, A., Protocol for a randomised controlled trial of fetal scalp blood lactate measurement to reduce caesarean sections during labour: The Flamingo trial [ACTRN12611000172909], BMC Pregnancy and Childbirth, 15 (1) (no pagination), 2015	Protocol only: no relevant data to be extracted
East, C. E., Leader, L. R., Sheehan, P., Henshall, N. E., Colditz, P. B., Lau, R., Intrapartum fetal scalp lactate sampling for fetal assessment in the presence of a non-reassuring fetal heart rate trace, Cochrane Database of Systematic Reviews, 5, CD006174, 2015	Wrong comparison; included studies evaluating lactate and pH measurements
East,C.E., Leader,L.R., Sheehan,P., Henshall,N.E., Colditz,P.B., Intrapartum fetal scalp lactate sampling for fetal assessment in the presence of a non-reassuring fetal heart rate trace, Cochrane Database of Systematic Reviews, -, 2010	Wrong comparison; included studies evaluating lactate and pH measurements
East,Christine E., Leader,Leo R., Sheehan,Penelope, Henshall,Naomi E., Colditz,Paul B., Intrapartum fetal scalp lactate sampling for fetal assessment in the presence of a non-reassuring fetal heart rate trace, Cochrane Database of Systematic Reviews, -, 2012	Relevant studies included in this review are already included in the guideline review
Giannubilo,S.R., Buscicchio,G., Gentilucci,L., Palla,G.P., Tranquilli,A.L., Deceleration area of fetal heart rate trace and fetal acidemia at delivery: A case-control study, Journal of Maternal-Fetal and Neonatal Medicine, 20, 141-144, 2007	Wrong intervention; reports use of umbilical blood gas analysis, not fetal blood sampling
Haverkamp,A.D., Orleans,M., Langendoerfer,S., McFee,J., Murphy,J., Thompson,H.E., A controlled trial of the differential effects of intrapartum fetal monitoring, American Journal of Obstetrics and Gynecology, 134, 399-412, 1979	One component study included in Alfirevic 2013
Holzmann, M., Wretler, S., Cnattingius, S., Nordstrom, L., Cardiotocography patterns and risk of intrapartum fetal acidemia, Journal of Perinatal Medicine, 43, 473-479, 2015	The aim was to examine the association between CTG patterns and intrapartum acidaemia
Holzmann, M., Wretler, S., Cnattingius, S., Nordstrom, L., Neonatal outcome and delivery mode in labors with repetitive fetal scalp blood sampling, European Journal of Obstetrics,	Intervention outside of interest; number of fetal blood samples to be performed

Study	Reason for Exclusion
Gynecology, & Reproductive Biology, 184, 97-102, 2015	
Irvine, L. M., Shaw, R. W., Fetal blood sampling and caesarean section for fetal distress: results of a pilot study, Journal of obstetrics and gynaecology, 10, 32-34, 1989	Retrospective before and after study
Jorgensen, J. S., Weber, T., Fetal scalp blood sampling in labor - A review, Acta Obstetricia et Gynecologica Scandinavica, 93, 548-555, 2014	Systematic review; individual studies have been checked for relevance
Kanayama, N., Niwayama, M., Examiner's finger-mounted fetal tissue oximetry, Journal of Biomedical Optics, 19, 067008, 2014	Intervention outside of scope: fetal oxygen saturation
Kessler,J., Moster,D., Albrechtsen,S., Intrapartum monitoring of high-risk deliveries with ST analysis of the fetal electrocardiogram: an observational study of 6010 deliveries, Acta Obstetricia et Gynecologica Scandinavica, 92, 75-84, 2013	High-risk population
Kiettisanpipop, Patcharin, Phupong, Vorapong, Intrapartum and neonatal outcome of screening non-stress test (NST) compared with no screening NST in healthy women at 40-40 (+6) weeks of gestation, Journal of Obstetrics & Gynaecology Research, 41, 50-54 5p, 2015	Intervention outside of interest: did not include fetal blood sampling as intervention
Labrecque, L., Provencal, M., Caqueret, A., Wo, B. L., Bujold, E., Lariviere, F., Bedard, M. J., Correlation of cord blood pH, base excess, and lactate concentration measured with a portable device for identifying fetal acidosis, Journal of obstetrics and gynaecology Canada : JOGC = Journal d'obstetrique et gynecologie du Canada : JOGC, 36, 598-604, 2014	The aim was to measure the efficacy of a portable device for identifying fetal acidosis
Li, X., Xu, Y., Herry, C., Durosier, L. D., Casati, D., Stampalija, T., Maisonneuve, E., Seely, A. J., Audibert, F., Alfirevic, Z., Ferrazzi, E., Wang, X., Frasch, M. G., Sampling frequency of fetal heart rate impacts the ability to predict pH and BE at birth: a retrospective multi-cohort study, Physiological measurement, 36, L1-L12, 2015	Intervention outside of interest: did not include fetal blood sampling as intervention
Liljestrom,L., Wikstrom,A.K., Skalkidou,A., Akerud,H., Jonsson,M., Experience of fetal scalp blood sampling during labor, Acta Obstetricia et Gynecologica Scandinavica, 93, 113-117, 2014	Intervention outside of interest
Mansano,R.Z., Beall,M.H., Ross,M.G., Fetal ST segment heart rate analysis in labor: improvement of intervention criteria using interpolated base deficit, Journal of Maternal-Fetal and Neonatal Medicine, 20, 47-52, 2007	Wrong intervention; fetal blood sampling was never performed, the authors interpolated back from umbilical artery values
O'Brien,Y.M.; Murphy,D.J., The reliability of fetal blood sampling as a test of fetal acidosis in labour, European Journal of Obstetrics, Gynaecology and Reproductive Biology, , 142-145, 2013	Two fetal blood samples taken during a single procedure were checked at different times for reliability of the test value
Perkins,R.P., Perinatal observations in a high-risk population managed without intrapartum	Descriptive study: neonatal outcomes of EFM at one hospital over a 3-year period

Study	Reason for Exclusion
fetal pH studies, American Journal of Obstetrics and Gynecology, 149, 327-336, 1984	
Reif, P., Lakovschek, I., Tappauf, C., Haas, J., Lang, U., Scholl, W., Validation of a point-of-care (POC) lactate testing device for fetal scalp blood sampling during labor: Clinical considerations, practicalities and realities, Clinical Chemistry and Laboratory Medicine, 52, 825-833, 2014	The aim was to measure the efficacy of a point-of-care lactate testing device
Rorbye, C., Perslev, A., Nickelsen, C., Lactate versus pH levels in fetal scalp blood during labor - using the Lactate Scout System, Journal of Maternal-Fetal & Neonatal Medicine, 29, 1200-4, 2016	The aim was to measure the efficacy of the 'Lactate Scout System'
Saling,E., Fetal blood analysis during labor, American Journal of Obstetrics and Gynecology, 194, 896-899, 2006	Non-systematic review
Salmelin,A., Wiklund,I., Bottinga,R., Brorsson,B., Ekman-Ordeberg,G., Grimfors,E.E., Hanson,U., Blom,M., Persson,E., Fetal monitoring with computerized ST analysis during labor: a systematic review and meta-analysis, Acta Obstetricia et Gynecologica Scandinavica, 92, 28-39, 2013	Systematic review; individual studies have been checked for relevance
Schaap,T.P., Moormann,K.A., Becker,J.H., Westerhuis,M.E., Evers,A., Brouwers,H.A., Schuitemaker,N.W., Visser,G.H., Kwee,A., Cerebrospinal fluid leakage, an uncommon complication of fetal blood sampling: a case report and review of the literature, Obstetrical and Gynecological Survey, 66, 42-46, 2011	Descriptive study
Smith, L., Brennecke, S. P., East, C. E., Compliance with a clinical practice guideline for fetal scalp blood lactate measurement, Journal of Paediatrics and Child Health, 51, 61, 2015	Conference proceeding
Soncini, E., Paganelli, S., Vezzani, C., Gargano, G., Giovanni Battista, L. S., Intrapartum fetal heart rate monitoring: evaluation of a standardized system of interpretation for prediction of metabolic acidosis at delivery and neonatal neurological morbidity, Journal of Maternal-Fetal & Neonatal Medicine, 27, 1465-9, 2014	CTG alone and analysis using different criteria
Talaulikar,V.S., Lowe,V., Arulkumaran,S., Intrapartum fetal surveillance, Obstetrics, Gynaecology and Reproductive Medicine, 24, 45-55, 2014	Case reports (n=3)
Tomialowicz,M., Zimmer,M., Pomorski,M., Fuchs,T., Biophysical and biochemical assessment of fetal perinatal hypoxia, Advances in Clinical and Experimental Medicine, 16, 249-255, 2007	Wrong intervention; does not report the use of fetal blood sampling
Van,de,V, Pexsters,A., Hanssens,M., Fetal assessment: do newer technologies offer better assessment and outcomes?, Current Opinion in Anaesthesiology, 16, 253-256, 2003	Non-systematic review

Study	Reason for Exclusion
Westerhuis,M.E.M.H., Visser,G.H.A., Moons,K.G.M., Van,BeekE, Benders,M.J., Bijvoet,S.M., Van,DesselH, Drogtrop,A.P., Van,GeijnH, Graziosi,G.C., Groenendaal,F., Van,LithJ, Nijhuis,J.G., Oei,S.G., Oosterbaan,H.P., Porath,M.M., Rijnders,R.J.P., Schuitemaker,N.W.E., Sopacua,L.M., Van,DerTweeII, Wijnberger,L.D.E., Willekes,C., Zuithoff,N.P.A., Mol,B.W.J., Kwee,A., Cardiotocography plus ST analysis of fetal electrocardiogram compared with cardiotocography only for intrapartum monitoring: A randomized controlled trial, Obstetrics and Gynecology, 115, 1173-1180, 2010	Outcomes are not reported separately for women who did and did not receive fetal blood sampling
Zalar,R.W.,Jr., Quilligan,E.J., The influence of scalp sampling on the cesarean section rate for fetal distress, American Journal of Obstetrics and Gynecology, 135, 239-246, 1979	Unclear number of women undergoing electronic fetal monitoring in comparison group

F.9 Fetal blood sampling – time to result

Study	Reason for Exclusion
Bakr,A.F., Al-Abd,M., Karkour,T., Fetal pulse oximetry and neonatal outcome: a study in a developing country, Journal of Perinatology, 25, 759-762, 2005	No reported outcomes of interest - does not report time from decision to result
Becker,J.H., Westerhuis,M.E., Sterrenburg,K., van den Akker,E.S., van,Beek E., Bolte,A.C., van Dessel,T.J., Drogtrop,A.P., van Geijn,H.P., Graziosi,G.C., van Lith,J.M., Mol,B.W., Moons,K.G., Nijhuis,J.G., Oei,S.G., Oosterbaan,H.P., Porath,M.M., Rijnders,R.J., Schuitemaker,N.W., Wijnberger,L.D., Willekes,C., Visser,G.H., Kwee,A., Fetal blood sampling in addition to intrapartum ST-analysis of the fetal electrocardiogram: evaluation of the recommendations in the Dutch STAN[REGISTERED] trial, BJOG: An International Journal of Obstetrics and Gynaecology, 118, 1239-1246, 2011	No reported outcomes of interest - does not report time from decision to result
Borruto,F., Comparetto,C., Treisser,A., Prevention of cerebral palsy during labour: role of foetal lactate, Archives of Gynecology and Obstetrics, 278, 17-22, 2008	No reported outcomes of interest - does not report time from decision to result
Chandraharan, E., Fetal scalp blood sampling during labour: is it a useful diagnostic test or a historical test that no longer has a place in modern clinical obstetrics?, BJOG: An International Journal of Obstetrics & Gynaecology, 121, 1056-60; discussion 1060-2, 2014	A descriptive article
East,Christine E., Leader,Leo R., Sheehan,Penelope, Henshall,Naomi E., Colditz,Paul B., Intrapartum fetal scalp lactate sampling for fetal assessment in the presence of a non-reassuring fetal heart rate trace,	No reported outcomes of interest - does not report time from decision to result

Study	Reason for Exclusion
Cochrane Database of Systematic Reviews, -, 2011	
Heazell,A.E.P., Riches,J., Hopkins,L., Myers,J.E., Fetal blood sampling in early labour: Is there an increased risk of operative delivery and fetal morbidity?, BJOG: An International Journal of Obstetrics and Gynaecology, 118, 849-855, 2011	No reported outcomes of interest - does not report time from decision to result
Heinis,A.M., Spaanderman,M.E., Gunnewiek,J.M., Lotgering,F.K., Scalp blood lactate for intra-partum assessment of fetal metabolic acidosis, Acta Obstetricia et Gynecologica Scandinavica, 90, 1107-1114, 2011	No reported outcomes of interest - does not report time from decision to result
Holzmann,M., Cnattingius,S., Nordstrom,L., Outcome of severe intrapartum acidemia diagnosed with fetal scalp blood sampling, Journal of Perinatal Medicine, 39, 545-548, 2011	No reported outcomes of interest - does not report time from decision to result
Liljestrom,L., Wikstrom,A.K., Hanson,U., Akerud,H., Jonsson,M., Evaluation of the discrepancy between pH and lactate in combined fetal scalp blood sampling, Acta Obstetricia et Gynecologica Scandinavica, 90, 1088-1093, 2011	No reported outcomes of interest - does not report time from decision to result
Nordstrom,L., Fetal scalp blood measurements during labour-lactate or pH?, Clinical Biochemistry, 44, 456-457, 2011	No reported outcomes of interest - does not report time from decision to result
Noren,H., Luttkus,A.K., Stupin,J.H., Blad,S., Arulkumaran,S., Erkkola,R., Luzietti,R., Visser,G.H., Yli,B., Rosen,K.G., Fetal scalp pH and ST analysis of the fetal ECG as an adjunct to cardiotocography to predict fetal acidosis in labor--a multi-center, case controlled study, Journal of Perinatal Medicine, 35, 408-414, 2007	No reported outcomes of interest - does not report time from decision to result
Ramanah,R., Martin,A., Clement,M.C., Maillet,R., Riethmuller,D., Fetal scalp lactate microsampling for non-reassuring fetal status during labor: a prospective observational study, Fetal Diagnosis and Therapy, 27, 14-19, 2010	No reported outcomes of interest - does not report time from decision to result
Saling,E., Fetal blood analysis during labor, American Journal of Obstetrics and Gynecology, 194, 896-899, 2006	Non-systematic review
Schiermeier,S., Reinhard,J., Hatzmann,H., Zimmermann,R.C., Westhof,G., Fetal short time variation during labor: a non-invasive alternative to fetal scalp pH measurements?, Journal of Perinatal Medicine, 37, 529-533, 2009	No reported outcomes of interest - does not report time from decision to result
Stein,W., Hellmeyer,L., Misselwitz,B., Schmidt,S., Impact of fetal blood sampling on vaginal delivery and neonatal outcome in deliveries complicated by pathologic fetal heart rate: a population based cohort study, Journal of Perinatal Medicine, 34, 479-483, 2006	No reported outcomes of interest - does not report time from decision to result
van,LaarJ, Peters,C.H.L., Houterman,S., Wijn,P.F.F., Kwee,A., Oei,S.G., Normalized spectral power of fetal heart rate variability is	No reported outcomes of interest - does not report time from decision to result

Study	Reason for Exclusion
associated with fetal scalp blood pH, Early Human Development, 87, 259-263, 2011	
Wiberg-Itzel,E., Lipponer,C., Norman,M., Herbst,A., Prebensen,D., Hansson,A., Bryngelsson,A.L., Christoffersson,M., Sennstrom,M., Wennerhholm,U.B., Nordstrom,L., Determination of pH or Lactate in fetal scalp blood in management of intrapartum fetal distress: Randomized controlled multicenter trial, Obstetrical and Gynecological Survey, 63, 687-689, 2008	This is a summary of a randomised controlled trial that has been appraised in full text
Wiberg-Itzel,E., Lipponer,C., Norman,M., Herbst,A., Prebensen,D., Hansson,A., Bryngelsson,A.L., Christoffersson,M., Sennstrom,M., Wennerholm,U.B., Nordstrom,L., Determination of pH or lactate in fetal scalp blood in management of intrapartum fetal distress: randomised controlled multicentre trial, BMJ, 336, 1284-1287, 2008	No reported outcomes of interest - does not report time from decision to result

F.10 Predictive value of fetal blood sampling

Study	Reason for Exclusion
Prediction of Neonatal Metabolic Acidosis in Women with a Singleton Term Pregnancy in Cephalic Presentation, American Journal of Perinatology, 28, 1-7, 2011	Wrong intervention; does not evaluate predictive value of fetal blood sampling
Annappa,R., Campbell,D.J., Simpson,N.A., Fetal blood sampling in labour and the decision to delivery interval, European Journal of Obstetrics, Gynecology, and Reproductive Biology, 141, 10-12, 2008	Time interval between sample and birth is not reported for the whole study population; it is only reported for 19/72 (26%) women
Arto-Medrano,F., Verges,Torres A., Rius Avila,F.J., Relationship between blood pH, heart rate and meconium in the fetus, during the second stage of labor, Gynaecologia, 168, 135-143, 1969	No reported outcomes of interest (included in original NICE intrapartum care guideline)
Arulkumaran,S., Ingemarsson,I., Ratnam,S.S., Fetal heart rate response to scalp stimulation as a test of fetal well-being in labour, Asia-Oceania Journal of Obstetrics and Gynaecology, 13, 131-135, 1987	The aim of the study was to compare outcomes in response to fetal scalp stimulation between a suspicious or ominous fetal heart rate (FHR)
Ayromlooi,J., Tobias,M., Berg,P., Correlation of ominous fetal heart rate pattern and scalp blood pH with one-minute Apgar score, International Journal of Gynaecology and Obstetrics,Int.J.Gynaecol.Obstet., 17, 185-189, 1979	No details about interval between sample and birth are reported (study included in original NICE intrapartum care guideline)
Bachok,N., Nor,N.M., Hamzah,T.N.T., Ibrahim,W.N., Daud,A., A five-year review of perinatal deaths at Pasir Mas district, International Medical Journal, 15, 193-198, 2008	Study does not report any details of fetal blood sampling
Beard,R.W., Morris,E.D., Clayton,S.G., pH of foetal capillary blood as an indicator of the condition of the foetus, Journal of Obstetrics and Gynaecology of the British Commonwealth,J.Obstet.Gynaecol.Br.Commonw., 74, 812-822, 1967	No reported outcomes of interest (included in original NICE intrapartum care guideline)
Becker,J.H., Westerhuis,M.E., Sterrenburg,K., van den Akker,E.S., van,Beek E., Bolte,A.C., van Dessel,T.J., Drogtrop,A.P., van Geijn,H.P., Graziosi,G.C., van Lith,J.M., Mol,B.W., Moons,K.G., Nijhuis,J.G., Oei,S.G., Oosterbaan,H.P., Porath,M.M., Rijnders,R.J.,	Time interval between sample and birth is only reported for selected individual cases, not the whole study population

Study	Reason for Exclusion
Schuitemaker,N.W., Wijnberger,L.D., Willekes,C., Visser,G.H., Kwee,A., Fetal blood sampling in addition to intrapartum ST-analysis of the fetal electrocardiogram: evaluation of the recommendations in the Dutch STAN[REGISTERED] trial, BJOG: An International Journal of Obstetrics and Gynaecology, 118, 1239-1246, 2011	
Borruto,F., Comparetto,C., Treisser,A., Prevention of cerebral palsy during labour: role of foetal lactate, Archives of Gynecology and Obstetrics, 278, 17-22, 2008	No details about interval between sample and birth are reported
Bowen,L.W., Kochenour,N.K., Rehm,N.E., Woolley,F.R., Maternal-fetal pH difference and fetal scalp pH as predictors of neonatal outcome, Obstetrics and Gynecology,Obstet.Gynecol., 67, 487-495, 1986	Time interval between sample and birth is not reported for the whole study population; data are reported only for true positives and false negatives, which are 6% of the study population and had a mean interval of 30 minutes and 120 minutes, respectively (study included in original NICE intrapartum care guideline)
Brandt-Niebelschutz,S., Saling,E., Indications for operative termination of labor on cardiotocography and fetal blood analysis: the reliability of these methods, Journal of Perinatal Medicine, 22, 19-27, 1994	No relevant diagnostic accuracy data reported
Cantu, J., Szychowski, J. M., Li, X., Biggio, J., Edwards, R. K., Andrews, W., Tita, A. T., Predicting fetal acidemia using umbilical venous cord gas parameters, Obstetrics and gynecology, 124, 926-932, 2014	Intervention outside of interest: value of fetal cord venous blood pH and base deficit as a predictor of fetal acidaemia at birth in comparison with fetal cord arterial blood as a reference standard
Carbonne, B., Pons, K., Maisonneuve, E., Foetal scalp blood sampling during labour for pH and lactate measurements, Best Practice and Research: Clinical Obstetrics and Gynaecology, 30, 62-67, 2016	Non-systematic review
Chandraharan, E., Fetal scalp blood sampling during labour: is it a useful diagnostic test or a historical test that no longer has a place in modern clinical obstetrics?, BJOG: An International Journal of Obstetrics & Gynaecology, 121, 1056-60; discussion 1060-2, 2014	Non-systematic review
Coltart,T.M., Trickey,N.R., Beard,R.W., Foetal blood sampling. Practical approach to management of foetal distress, British Medical Journal,BMJ, 1, 342-346, 1969	Time interval between sample and birth is not reported for the whole study population; the only details provided are immediate birth of acidaemic babies (study included in original NICE intrapartum care guideline)
De La Rama FE Jr, Merkatz,I.R., Evaluation of fetal scalp pH with a proposed new clinical assessment of the neonate, American Journal of Obstetrics and Gynecology,Am.J.Obstet.Gynecol., 107, 93-99, 1970	No details about the time interval between sample and birth are reported (study included in original NICE intrapartum care guideline)
Doret, M., Spilka, J., Chudacek, V., Goncalves, P., Abry, P., Fractal analysis and Hurst parameter for intrapartum fetal heart rate variability analysis: A versatile alternative to frequency bands and LF/HF ratio, PLoS ONE, 10 (8) (no pagination), 2015	The aim was to determine the predictive value of a FHR cut-off for fetal acidosis
Doret,M., Helgason,H., Abry,P., Goncalves,P., Gharib,C., Gaucherand,P., Multifractal analysis of fetal heart rate variability in fetuses with and without severe acidosis during labor, American Journal of Perinatology, 28, 259-266, 2011	Wrong intervention; reports use of umbilical arterial pH measurement, not fetal blood sampling

Study	Reason for Exclusion
Dudenhausen,J.W., Milz,T., Consequences of intrauterine acidosis for early morbidity of term newborn infants, Zeitschrift fur Geburtshilfe und Neonatologie, 211, 153-156, 2007	Wrong intervention; reports use of umbilical blood analysis not fetal blood sampling
Durosier, L. D., Green, G., Batkin, I., Seely, A. J., Ross, M. G., Richardson, B. S., Frasch, M. G., Sampling rate of heart rate variability impacts the ability to detect acidemia in ovine fetuses near-term, Frontiers in Pediatrics, 2, 38, 2014	Intervention outside of interest: did not include FBS as intervention
East, C. E., Begg, L., Colditz, P. B., Lau, R., Fetal pulse oximetry for fetal assessment in labour, Cochrane Database of Systematic Reviews, 10, CD004075, 2014	Intervention outside of interest: did not include FBS as intervention
East, C. E., Kane, S. C., Davey, M. A., Kamlin, C. O., Brennecke, S. P., Davis, P. G., A. Sheehan P, Cullinane, F., Smith, L., Ryan, J., duPlessis, J., Veljanovski, S., Saal, J., Grainger, T., White, A., Protocol for a randomised controlled trial of fetal scalp blood lactate measurement to reduce caesarean sections during labour: The Flamingo trial [ACTRN12611000172909], BMC Pregnancy and Childbirth, 15 (1) (no pagination), 2015	Protocol only: no relevant data to be extracted
East, C. E., Leader, L. R., Sheehan, P., Henshall, N. E., Colditz, P. B., Lau, R., Intrapartum fetal scalp lactate sampling for fetal assessment in the presence of a non-reassuring fetal heart rate trace, Cochrane Database of Systematic Reviews, 5, CD006174, 2015	This review was already included as East 2011 and there were no additional data to be added
Fleischer,A., Schulman,H., Jagani,N., Mitchell,J., Randolph,G., The development of fetal acidosis in the presence of an abnormal fetal heart rate tracing. I. The average for gestational age fetus, American Journal of Obstetrics and Gynecology, 144, 55-60, 1982	Study does not report any data that allows calculation of predictive accuracy of fetal blood sampling; in addition, babies with pH <= 7.25 were excluded from the study
Frasch, M. G., Xu, Y., Stampalija, T., Durosier, L. D., Herry, C., Wang, X., Casati, D., Seely, A. J., Alfirevic, Z., Gao, X., Ferrazzi, E., Correlating multidimensional fetal heart rate variability analysis with acid-base balance at birth, Physiological measurement, 35, L1-L12, 2014	This study looked at the relationship between fetal heart rate variability and fetal blood pH, not the predictive value of fetal blood pH
Galloway,R.K., Clinical experience with fetal blood pH measurement in fetal distress, Journal of Obstetrics and Gynaecology of the British Commonwealth,J.Obstet.Gynaecol.Br.Commonw., 77, 587-590, 1970	Data are not reported for the samples taken within 1 hour of birth (study included in original NICE intrapartum care guideline)
Giannubilo,S.R., Buscicchio,G., Gentilucci,L., Palla,G.P., Tranquilli,A.L., Deceleration area of fetal heart rate trace and fetal acidemia at delivery: A case-control study, Journal of Maternal-Fetal and Neonatal Medicine, 20, 141-144, 2007	Wrong intervention; reports use of umbilical blood gas analysis, not fetal blood sampling
Grimwade,J.C., The management of fetal distress with the use of fetal blood pH. A clinical review, American Journal of Obstetrics and Gynecology, 106, 266-271, 1970	Data are not reported separately for samples taken within 1 hour of birth (study included in original NICE intrapartum care guideline)
Heazell,A.E.P., Riches,J., Hopkins,L., Myers,J.E., Fetal blood sampling in early labour: Is there an increased risk of operative delivery and fetal morbidity?, BJOG: An International Journal of Obstetrics and Gynaecology, 118, 849-855, 2011	No details about time interval between sample and birth are reported

Study	Reason for Exclusion
Heinis,A.M., Spaanderman,M.E., Gunnewiek,J.M., Lotgering,F.K., Scalp blood lactate for intra-partum assessment of fetal metabolic acidosis, Acta Obstetricia et Gynecologica Scandinavica, 90, 1107-1114, 2011	Median time interval between sample and birth was 54 minutes (range 33 to 105) and sampling performed within 1 hour of birth cannot be separated because individual details are only reported for 17 cases (3.5%)
Holzmann, M., Wretler, S., Cnattingius, S., Nordstrom, L., Cardiotocography patterns and risk of intrapartum fetal acidemia, Journal of Perinatal Medicine, 43, 473-479, 2015	The aim was to examine the association between CTG patterns and intrapartum acidaemia
Holzmann, M., Wretler, S., Cnattingius, S., Nordstrom, L., Neonatal outcome and delivery mode in labors with repetitive fetal scalp blood sampling, European Journal of Obstetrics, Gynecology, & Reproductive Biology, 184, 97-102, 2015	Intervention outside of interest; number of fetal blood samples to perform
Holzmann,M., Cnattingius,S., Nordstrom,L., Outcome of severe intrapartum acidemia diagnosed with fetal scalp blood sampling, Journal of Perinatal Medicine, 39, 545-548, 2011	Time interval between sample and birth is not reported for the whole study population; only the median values and the proportion born within 15 minutes of FBS (32%) are reported; data from the same trial have been reported more comprehensively in other included studies (East 2011; Wiberg-Itzel 2008)
Holzmann,M., Cnattingius,S., Nordstrom,L., Outcome in cases with severe intrapartum acidemia diagnosed with fetal scalp blood sampling, American Journal of Obstetrics and Gynecology, 201, S189-S190, 2009	Abstract of a randomised controlled trial that has been appraised in full text
Kanayama, N., Niwayama, M., Examiner's finger-mounted fetal tissue oximetry, Journal of Biomedical Optics, 19, 067008, 2014	Intervention outside of interest: measures fetal oxygen saturation
Khazin,A.F., Hon,E.H., Biochemical studies of the fetus. IV. Fetal-maternal pH and base deficit difference versus Apgar scores, Biology of the Neonate, 18, 225-242, 1971	Study evaluates fetal-maternal pH and base-deficit difference, which are not tests of interest for this review (study included in original NICE intrapartum care guideline)
Kiettisanpipop, Patcharin, Phupong, Vorapong, Intrapartum and neonatal outcome of screening non-stress test (NST) compared with no screening NST in healthy women at 40-40 (+6) weeks of gestation, Journal of Obstetrics & Gynaecology Research, 41, 50-54 5p, 2015	Intervention outside of interest: did not include fetal blood sampling as intervention
Labrecque, L., Provencal, M., Caqueret, A., Wo, B. L., Bujold, E., Lariviere, F., Bedard, M. J., Correlation of cord blood pH, base excess, and lactate concentration measured with a portable device for identifying fetal acidosis, Journal of obstetrics and gynaecology Canada : JOGC = Journal d'obstetrique et gynecologie du Canada : JOGC, 36, 598-604, 2014	The aim was to measure the efficacy of a portable device for identifying fetal acidosis
Li, X., Xu, Y., Herry, C., Durosier, L. D., Casati, D., Stampalija, T., Maisonneuve, E., Seely, A. J., Audibert, F., Alfirevic, Z., Ferrazzi, E., Wang, X., Frasch, M. G., Sampling frequency of fetal heart rate impacts the ability to predict pH and BE at birth: a retrospective multi-cohort study, Physiological measurement, 36, L1-L12, 2015	Intervention outside of interest: did not include fetal blood sampling as intervention
Liljestrom,L., Wikstrom,A.K., Hanson,U., Akerud,H., Jonsson,M., Evaluation of the discrepancy between pH and lactate in combined fetal scalp blood sampling, Acta	Data are not reported separately for samples taken within 1 hour of birth

Study	Reason for Exclusion
Obstetricia et Gynecologica Scandinavica, 90, 1088-1093, 2011	
Mansano,R.Z., Beall,M.H., Ross,M.G., Fetal ST segment heart rate analysis in labor: improvement of intervention criteria using interpolated base deficit, Journal of Maternal-Fetal and Neonatal Medicine, 20, 47-52, 2007	Wrong intervention; fetal blood sampling was never performed, the authors interpolated back from umbilical artery values
McDonald,J.S., Evaluation of fetal blood pH as a reflection of fetal well-being, American Journal of Obstetrics and Gynecology,Am.J.Obstet.Gynecol., 97, 912-918, 1967	Details about time interval between sample and birth are reported only for 10 illustrative cases (study included in original NICE intrapartum care guideline)
Murphy,K.W., MacDonald,D., Fetal blood sampling in Dublin. A year's review, Journal of Obstetrics and Gynaecology,J.Obstet.Gynaecol., 10, 194-198, 1990	Data are not reported separately for samples taken within 1 hour of birth (included in original NICE intrapartum care guideline)
Nordstrom,L., Fetal scalp blood measurements during labour-lactate or pH?, Clinical Biochemistry, 44, 456-457, 2011	This trial has been reported in more detail in other included papers (East 2010; Wiberg-Itzel 2008)
Noren,H., Luttkus,A.K., Stupin,J.H., Blad,S., Arulkumaran,S., Erkkola,R., Luzietti,R., Visser,G.H., Yli,B., Rosen,K.G., Fetal scalp pH and ST analysis of the fetal ECG as an adjunct to cardiotocography to predict fetal acidosis in labor--a multi-center, case controlled study, Journal of Perinatal Medicine, 35, 408-414, 2007	Data are not reported separately for samples taken within 1 hour of birth
Perkins,R.P., Perinatal observations in a high-risk population managed without intrapartum fetal pH studies, American Journal of Obstetrics and Gynecology, 149, 327-336, 1984	Descriptive study: neonatal outcomes of EFM at one hospital over a 3-year period
Ramanah,R., Martin,A., Clement,M.C., Maillet,R., Riethmuller,D., Fetal scalp lactate microsampling for non-reassuring fetal status during labor: a prospective observational study, Fetal Diagnosis and Therapy, 27, 14-19, 2010	Data are not reported separately for samples taken within 1 hour of birth
Reif, P., Lakovschek, I., Tappauf, C., Haas, J., Lang, U., Scholl, W., Validation of a point-of-care (POC) lactate testing device for fetal scalp blood sampling during labor: Clinical considerations, practicalities and realities, Clinical Chemistry and Laboratory Medicine, 52, 825-833, 2014	The aim was to measure the efficacy of a point-of-care lactate testing device
Rorbye, C., Perslev, A., Nickelsen, C., Lactate versus pH levels in fetal scalp blood during labor - using the Lactate Scout System, Journal of Maternal-Fetal & Neonatal Medicine, 29, 1200-4, 2016	The aim was to measure the efficacy of the 'Lactate Scout System'
Saling,E., Fetal blood analysis during labor, American Journal of Obstetrics and Gynecology, 194, 896-899, 2006	Non-systematic review
Schaap,T.P., Moormann,K.A., Becker,J.H., Westerhuis,M.E., Evers,A., Brouwers,H.A., Schuitemaker,N.W., Visser,G.H., Kwee,A., Cerebrospinal fluid leakage, an uncommon complication of fetal blood sampling: a case report and review of the literature, Obstetrical and Gynecological Survey, 66, 42-46, 2011	No reported outcomes of interest; study does not evaluate predictive value of fetal blood sampling
Schiermeier,S., Pildner,VonSteinburgS, Thieme,A., Reinhard,J., Daumer,M., Scholz,M., Hatzmann,W., Schneider,K.T.M., Sensitivity and specificity of intrapartum computerised FIGO criteria for cardiotocography and fetal scalp pH during labour:	Study does not report clinical outcomes stratified by result of FBS

Study	Reason for Exclusion
Multicentre, observational study, BJOG: An International Journal of Obstetrics and Gynaecology, 115, 1557-1563, 2008	
Schiermeier,S., Reinhard,J., Hatzmann,H., Zimmermann,R.C., Westhof,G., Fetal short time variation during labor: a non-invasive alternative to fetal scalp pH measurements?, Journal of Perinatal Medicine, 37, 529-533, 2009	No details about time interval between sample and birth are reported
Soncini, E., Paganelli, S., Vezzani, C., Gargano, G., Giovanni Battista, L. S., Intrapartum fetal heart rate monitoring: evaluation of a standardized system of interpretation for prediction of metabolic acidosis at delivery and neonatal neurological morbidity, Journal of Maternal-Fetal & Neonatal Medicine, 27, 1465-9, 2014	CTG analysis alone using different criteria
Suidan,J.S., Young,B.K., Outcome of fetuses with lactic acidemia, American Journal of Obstetrics and Gynecology, 150, 33-37, 1984	Wrong test; reports umbilical artery measurements not fetal blood sampling (included in original NICE intrapartum care guideline)
Talaulikar,V.S., Lowe,V., Arulkumaran,S., Intrapartum fetal surveillance, Obstetrics, Gynaecology and Reproductive Medicine, 24, 45-55, 2014	Case reports (n=3)
Tejani,N., Mann,L.I., Bhakthavathsalan,A., Correlation of fetal heart rate patterns and fetal pH with neonatal outcome, Obstetrics and Gynecology,Obstet.Gynecol., 48, 460-463, 1976	Data for samples taken within 1 hour are not reported separately (included in original NICE intrapartum care guideline)
Tomialowicz,M., Zimmer,M., Pomorski,M., Fuchs,T., Biophysical and biochemical assessment of fetal perinatal hypoxia, Advances in Clinical and Experimental Medicine, 16, 249-255, 2007	Wrong intervention; does not report the use of fetal blood sampling
Trochez,R.D., Sibanda,T., Sharma,R., Draycott,T., Fetal monitoring in labor: are accelerations good enough?, Journal of Maternal-Fetal and Neonatal Medicine, 18, 349-352, 2005	Time interval between sample and birth is only reported for acidotic babies, not the whole study population
Van,de,V, Pexsters,A., Hanssens,M., Fetal assessment: do newer technologies offer better assessment and outcomes?, Current Opinion in Anaesthesiology, 16, 253-256, 2003	Non-systematic review
van,LaarJ, Peters,C.H.L., Houterman,S., Wijn,P.F.F., Kwee,A., Oei,S.G., Normalized spectral power of fetal heart rate variability is associated with fetal scalp blood pH, Early Human Development, 87, 259-263, 2011	No clinical outcomes are reported
Weber,T., Continuous fetal pH monitoring and neonatal Apgar score, Journal of Perinatal Medicine,J.Perinat.Med., 8, 158-163, 1980	No reported outcomes of interest (included in original NICE intrapartum care guideline)
Weber,T., The validity of discontinuous pH-measurements on fetal blood and of cardiotocography in predicting neonatal Apgar score, Danish Medical Bulletin, 26, 186-191, 1979	Non-systematic review (included in original NICE intrapartum care guideline; therefore any relevant included studies have been appraised individually)
Westgren,M., Kruger,K., Ek,S., Grunevald,C., Kublickas,M., Naka,K., Wolff,K., Persson,B., Lactate compared with pH analysis at fetal scalp blood sampling: a prospective randomised study, British Journal of Obstetrics and Gynaecology, 105, 29-33, 1998	No details of time interval between sample and birth are reported (included in original NICE intrapartum care guideline)

Study	Reason for Exclusion
Wiberg-Itzel,E., Akerud,H., Fetal blood sampling in normal and dysfunctional labor, American Journal of Obstetrics and Gynecology, 204, S257-, 2011	Abstract of a randomised controlled trial that has been appraised in full text
Wiberg-Itzel,E., Lipponer,C., Norman,M., Herbst,A., Prebensen,D., Hansson,A., Bryngelsson,A.L., Christoffersson,M., Sennstrom,M., Wennerhholm,U.B., Nordstrom,L., Determination of pH or Lactate in fetal scalp blood in management of intrapartum fetal distress: Randomized controlled multicenter trial, Obstetrical and Gynecological Survey, 63, 687-689, 2008	This is a summary of a randomised controlled trial that has been appraised in full text
Wood,C., Diagnostic and therapeutic implications of intrapartum fetal pH measurement, Acta Obstetricia et Gynecologica Scandinavica,Acta Obstet.Gynecol.Scand., 57, 13-18, 1978	Not primary research (included in original NICE intrapartum care guideline)

F.11 Women's experience of fetal monitoring

Study	Reason for Exclusion
Alfirevic,Zarko, Devane,Declan, Gyte,Gillian ML, Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour, Cochrane Database of Systematic Reviews, -, 2008	No outcomes of interest, clinical outcomes reported
Barber,Vicki, Linsell,Louise, Locock,Louise, Powell,Lesley, Shakeshaft,Clare, Lean,Katie, Colman,Jacqueline, Juszczak,Ed, Brocklehurst,Peter, Electronic fetal monitoring during labour and anxiety levels in women taking part in a RCT, British Journal of Midwifery, 21, 394-403, 2013	The comparator group received the same intervention as the experimental group; the only difference was the support of decision making software which is not listed as an intervention in the protocol
Binfa, L., Pantoja, L., Ortiz, J., Gurovich, M., Cavada, G., Foster, J., Assessment of the implementation of the model of integrated and humanised midwifery health services in Chile, Midwifery, 35, 53-61, 2016	No relevant data
Centre for Reviews and Dissemination, Ultrasound screening in pregnancy: a systematic review of the clinical effectiveness, cost-effectiveness and women's views (Structured abstract), Database of Abstracts of Reviews of Effects, 2015	Antenatal intervention
Evans, M. K., Watts, N., Gratton, R., Women's Satisfaction With Obstetric Triage Services, JOGNN - Journal of Obstetric, Gynecologic, & Neonatal Nursing, 44, 693-700, 2015	No relevant data
Flenady, V., Gardener, G., Middleton, P., Crowther, C., Ellwood, D., Coory, M., Wojcieszek, A., Mahomed, K., Kent, A., Callander, E., Norman, J., Froen, F., 'Moving with the times': Raising awareness of decreased fetal movements (DFM) in australia and New Zealand through a stepped-wedge cluster RCT, Journal of Paediatrics and Child Health, 50, 47, 2014	Conference abstract
Hennegan, J., Kruske, S., Redshaw, M., Remote access and care: A comparison of Queensland women's maternity care experience according to	No relevant data

Study	Reason for Exclusion
area of residence, Women & Birth: Journal of the Australian College of Midwives, 27, 281-91, 2014	
Hennegan, J., Redshaw, M., Miller, Y., Born in another country: women's experience of labour and birth in Queensland, Australia, Women & Birth: Journal of the Australian College of Midwives, 27, 91-7, 2014	No relevant data
Ladfors,L., Eriksson,M., Mattsson,L.A., Kyleback,K., Magnusson,L., Milsom,I., A population based study of Swedish women's opinions about antenatal, delivery and postpartum care, Acta Obstetricia et Gynecologica Scandinavica, 80, 130-136, 2001	Small study with no detailed results for intrapartum women reported
Li, Y. P., Lin, S. Y., Yeh, C. H., Hsu, H. C., Yang, Y. L., Lee, C. N., Kuo, S. C., A proposed mother-friendly childbirth model for Taiwanese women and obstetricians' attitudes toward it, Taiwanese Journal of Obstetrics & Gynecology, 54, 666-70, 2015	Focus group that established a mother-friendly childbirth model; only included one women's rights representative; the other members of the focus group were health or social care professionals
Li, Y. P., Yeh, C. H., Lin, S. Y., Chen, T. C., Yang, Y. L., Lee, C. N., Kuo, S. C., A proposed mother-friendly childbirth model for Taiwanese women, the implementation and satisfaction survey, Taiwanese Journal of Obstetrics & Gynecology, 54, 731-6, 2015	No relevant data
Macfarlane, A. J., Rocca-Ihenacho, L., Turner, L. R., Survey of women's experiences of care in a new freestanding midwifery unit in an inner city area of London, England: 2. Specific aspects of care, Midwifery, 30, 1009-20, 2014	No relevant data
MacRae,D.J., Bekhit,S.M., Kundu,G., Experience with new types of electrodes in monitoring the condition of the fetus during labour, Journal of Obstetrics and Gynaecology of the British Commonwealth, 76, 419-423, 1969	No outcomes of interest, clinical outcomes reported
Malm, M. C., Radestad, I., Rubertsson, C., Hildingsson, I., Lindgren, H., Women's experiences of two different self-assessment methods for monitoring fetal movements in full-term pregnancy - a crossover trial, BMC Pregnancy and Childbirth, 14 (1) (no pagination), 2014	Antenatal intervention
Mancuso,A., De,Vivo A., Fanara,G., Denaro,A., Lagana,D., Accardo,F.M., Effects of antepartum electronic fetal monitoring on maternal emotional state, Acta Obstetricia et Gynecologica Scandinavica, 87, 184-189, 2008	Women were not in labour, CTG used as an antenatal screening tool
Mangesi, Lindeka, Hofmeyr, Justus G., Smith, Valerie, Smyth, M. D. Rebecca, Fetal movement counting for assessment of fetal wellbeing, Cochrane Database of Systematic Reviews, 2015	Included studies were assessed for inclusion, however they focus on antenatal interventions
Manley,J.W., Newman,R.L., Fetal monitoring experiences in a private hospital, Missouri Medicine, 70, 310-312, 1973	No outcomes of interest, clinical outcomes reported

Study	Reason for Exclusion
Nilsson, C., The delivery room: is it a safe place? A hermeneutic analysis of women's negative birth experiences, Sexual & reproductive healthcare : official journal of the Swedish Association of Midwives, 5, 199-204, 2014	The comments were on interventions that were either not sufficiently specific or not relevant
Porath,M., Luttkus,A.K., Dudenhausen,J.W., Experience with a new monitoring method during labour and delivery. The fetal EKG >>STAN<<, Gynakologische Praxis, 26, 39-43, 2002	Clinical outcomes reported
Sabanayagam, A., Zaidi, A., A pregnancy survey: Current attitude of women with congenital heart disease regarding pregnancy in North America, Journal of the American College of Cardiology, 1), A551, 2015	Conference abstract
Shenker,L., Clinical experiences with fetal heart rate monitoring of one thousand patients in labor, American Journal of Obstetrics and Gynecology, 115, 1111-1116, 1973	No outcomes of interest, clinical outcomes reported
Snelgrove-Clarke, E., Davies, B., Flowerdew, G., Young, D., Implementing a Fetal Health Surveillance Guideline in Clinical Practice: A Pragmatic Randomized Controlled Trial of Action Learning, Worldviews on Evidence-Based Nursing, 12, 281-8, 2015	No relevant data(the labour experience questionnaire results relating to fetal monitoring are not disaggregated by fetal monitoring method)
Soliday, E., Strahm, A., Mammenga, S., Fetal health locus of control: Scale properties and applications in preconception health programs, Evaluation & Program Planning, 55, 85-90, 2016	Participants are not women in labour
Thomsen, S. G., Legarth, J., Weber, T., Kristensen, J., Monitoring of normal pregnancies by daily fetal movement registration or hormone assessment. A random allocation study, Journal of obstetrics and gynaecology, 10, 189-93, 1990	Antenatal intervention
Tingstrom, J., Hjelmstedt, A., Welin Henriksson, E., Sonesson, S. E., Wahren-Herlenius, M., Ro/SSA autoantibody-positive pregnancy: reactions to serial fetal Doppler echocardiographic surveillance, Lupus, 24, 1540-5, 2015	Antenatal intervention

F.12 Cardiotocography with electrocardiogram analysis compared with cardiotocography alone

Study	Reason for Exclusion
Amer-Wahlin,I., Kallen,K., Herbst,A., Rydhstroem,H., Sundstrom,A.K., Marsal,K., Implementation of new medical techniques: experience from the Swedish randomized controlled trial on fetal ECG during labor, Journal of Maternal-Fetal and Neonatal Medicine, 18, 93-100, 2005	One component study in a systematic review that has been included (Neilson 2015)
Amer-Wahlin, I., Kwee, A., Combined cardiotocographic and ST event analysis: A	Not a systematic review; included studies have been checked for relevance

Study	Reason for Exclusion
review, Best Practice & Research in Clinical Obstetrics & Gynaecology, 30, 48-61, 2016	
Amer-Wahlin,I., Kjellmer,I., Marsal,K., Olofsson,P., Rosen,K.G., Swedish randomized controlled trial of cardiotocography only versus cardiotocography plus ST analysis of fetal electrocardiogram revisited: analysis of data according to standard versus modified intention-to-treat principle, Acta Obstetricia et Gynecologica Scandinavica, 90, 990-996, 2011	One component study in a systematic review that has been included (Neilson 2015)
Amer-Wahlin,I., Ingemarsson,I., Marsal,K., Herbst,A., Fetal heart rate patterns and ECG ST segment changes preceding metabolic acidaemia at birth, BJOG: An International Journal of Obstetrics and Gynaecology, 112, 160-165, 2005	No outcome of interest
Ayres-de-Campos,D., Ugwumadu,A., Banfield,P., Lynch,P., Amin,P., Horwell,D., Costa,A., Santos,C., Bernardes,J., Rosen,K., A randomised clinical trial of intrapartum fetal monitoring with computer analysis and alerts versus previously available monitoring, BMC Pregnancy and Childbirth, Vol.10, pp.71, 2010., -, -32676	Trial protocol
Becker, J. H., Krikhaar, A., Schuit, E., Martendal, A., Marsal, K., Kwee, A., Visser, G. H., Amer-Wahlin, I., The added predictive value of biphasic events in ST analysis of the fetal electrocardiogram for intrapartum fetal monitoring, Acta Obstetricia et Gynecologica Scandinavica, 94, 175-82, 2015	Prospective cohort study
Becker,J.H., Bax,L., mer-Wahlin,I., Ojala,K., Vayssiere,C., Westerhuis,M.E., Mol,B.W., Visser,G.H., Marsal,K., Kwee,A., Moons,K.G., ST analysis of the fetal electrocardiogram in intrapartum fetal monitoring: a meta-analysis, Obstetrics and Gynecology, 119, 145-154, 2012	Studies all included in Neilson 2015 Cochrane review
Becker,J.H., Westerhuis,M.E., Sterrenburg,K., van den Akker,E.S., van,Beek E., Bolte,A.C., van Dessel,T.J., Drogtrop,A.P., van Geijn,H.P., Graziosi,G.C., van Lith,J.M., Mol,B.W., Moons,K.G., Nijhuis,J.G., Oei,S.G., Oosterbaan,H.P., Porath,M.M., Rijnders,R.J., Schuitemaker,N.W., Wijnberger,L.D., Willekes,C., Visser,G.H., Kwee,A., Fetal blood sampling in addition to intrapartum ST-analysis of the fetal electrocardiogram: evaluation of the recommendations in the Dutch STAN[REGISTERED] trial, BJOG: An International Journal of Obstetrics and Gynaecology, 118, 1239-1246, 2011	Not an RCT; evaluates use of feta blood sampling in conjunction with STAN
Berghella,V., Potti,S., Cardiotocography plus st waveform analysis (STAN) vs cardiotocography alone for intrapartum fetal monitoring: A meta-analysis of randomized trials, American Journal of Obstetrics and Gynecology, #2011 31st Annual Meeting of the Society for Maternal-Fetal Medicine, S262-Fetal, 2011	Conference proceeding

Study	Reason for Exclusion
Blix, E., Brurberg, K. G., Reierth, E., Reinar, L. M., Oian, P., ST waveform analysis versus cardiotocography alone for intrapartum fetal monitoring: A systematic review and meta-analysis of randomized trials, Acta Obstetricia et Gynecologica Scandinavica, 95, 16-27, 2016	Studies and outcomes included in Neilson 2015 Cochrane review
Bureev, A. S., Zhdanov, D. S., Zilberman, N. N., Kiseleva, E. Y., Yuriev, S. Y., Comparative assessment of 24-hour fetal monitoring methods based on cardiac rhythm, Biosciences Biotechnology Research Asia, 12, 1743-1750, 2015	Narrative review
Casati, D., Stampalija, T., Rizas, K., Ferrazzi, E., Mastroianni, C., Rosti, E., Quadrifoglio, M., Bauer, A., Assessment of coupling between trans-abdominally acquired fetal ECG and uterine activity by bivariate phase-rectified signal averaging analysis, PLoS ONE, 9 (4) (no pagination), 2014	No relevant data to be extracted
Centre for Reviews and Dissemination, ST waveform analysis versus cardiotocography alone for intrapartum fetal monitoring: a meta-analysis of randomized trials (Provisional abstract), Database of Abstracts of Reviews of Effects, 2015	Same as Blix 2016; studies and outcomes all included in Neilson 2015 Cochrane review
Centre for Reviews and Dissemination, Effectiveness of electronic fetal monitoring with additional ST analysis in vertex singleton pregnancies at >36 weeks of gestation: an individual participant data metaanalysis (Provisional abstract), Database of Abstracts of Reviews of Effects, 2015	Individual patient data analysis; studies and outcomes already included in Neilson 2015 Cochrane review
Centre for Reviews and Dissemination, Fetal monitoring with computerized ST analysis during labor: a systematic review and meta-analysis (Provisional abstract), Database of Abstracts of Reviews of Effects, 2015	Systematic review; RCT studies and data already included in Neilson 2015 Cochrane review
Centre for Reviews and Dissemination, ST analysis of the fetal electrocardiogram in intrapartum fetal monitoring: a meta-analysis (Provisional abstract), Database of Abstracts of Reviews of Effects, 2015	Systematic review; studies and data already included in Neilson 2015 Cochrane review
Devoe, L. D., Future perspectives in intrapartum fetal surveillance, Best Practice & Research in Clinical Obstetrics & Gynaecology, 30, 98-106, 2016	Non-systematic review
Devoe,L.D., Fetal ECG analysis for intrapartum electronic fetal monitoring: a review, Clinical Obstetrics and Gynecology, 54, 56-65, 2011	Narrative review
East, C. E., Begg, L., Colditz, P. B., Lau, R., Fetal pulse oximetry for fetal assessment in labour, Cochrane Database of Systematic Reviews, 10, CD004075, 2014	Systematic review; no relevant studies
Eremina, O., Baev, O., Shmakov, R., Gus, A., Combination of direct ECG and CTG (STAN) versus traditional CTG in labor: What's better in suspicious CTG patterns in labour?,	Conference proceeding

Study	Reason for Exclusion
International Journal of Gynecology and Obstetrics, 131, E122, 2015	
Frasch, M. G., Xu, Y., Stampalija, T., Durosier, L. D., Herry, C., Wang, X., Casati, D., Seely, A. J., Alfirevic, Z., Gao, X., Ferrazzi, E., Correlating multidimensional fetal heart rate variability analysis with acid-base balance at birth, Physiological measurement, 35, L1-L12, 2014	Comparsion outside of scope
Gongora, R. J., Naveiro, S. M., Ruiz, D. S., Puertas, P. A., Barranco, A. M., Carrillo, B. M. P., A comparison of intrapartum fetal electrocardiography versus conventional cardiotocography in prolonged gestations: Preliminary results, Journal of maternal fetal & neonatal medicine, 27, 2014	Conference proceeding
Graatsma,E.M., Jacod,B.C., van Egmond,L.A., Mulder,E.J., Visser,G.H., Fetal electrocardiography: feasibility of long-term fetal heart rate recordings, BJOG: An International Journal of Obstetrics and Gynaecology, 116, 334-337, 2009	Wrong intervention; antenatal record of ECG
Kazmi,T., Radfer,F., Khan,S., ST Analysis of the Fetal ECG, as an Adjunct to Fetal Heart Rate Monitoring in Labour: A Review, Oman Medical Journal, 26, 459-460, 2011	Opinion paper
Kessler, J., Moster, D., Albrechtsen, S., Intrapartum monitoring with cardiotocography and ST-waveform analysis in breech presentation: an observational study, BJOG: An International Journal of Obstetrics & Gynaecology, 122, 528-35, 2015	Prospective observational study
Kessler,J., Moster,D., Albrechtsen,S., Intrapartum monitoring of high-risk deliveries with ST analysis of the fetal electrocardiogram: an observational study of 6010 deliveries, Acta Obstetricia et Gynecologica Scandinavica, 92, 75-84, 2013	Study population consists of women with high-risk pregnancies; not a randomised controlled trial
Kiettisanpipop, Patcharin, Phupong, Vorapong, Intrapartum and neonatal outcome of screening non-stress test (NST) compared with no screening NST in healthy women at 40-40 (+6) weeks of gestation, Journal of Obstetrics & Gynaecology Research, 41, 50-54 5p, 2015	Intervention outside of scope: CTG versus EFM comparison
Kwee,A., Cardiotocography plus ST-analysis of the fetal electrocardiogram versus cardiotocography only for intrapartum monitoring: a Dutch randomized trial, Journal of Perinatal Medicine, 37, 66, 2009-, 2009	Conference abstract
Leipala,J., Update: Fetal intrapartum surveillance - Does STAN improve safety after all? (Project record), Health Technology Assessment Database, -, 2013	A project report with no data added
Li, X., Xu, Y., Herry, C., Durosier, L. D., Casati, D., Stampalija, T., Maisonneuve, E., Seely, A. J., Audibert, F., Alfirevic, Z., Ferrazzi, E., Wang, X., Frasch, M. G., Sampling frequency of fetal heart rate impacts the ability to predict pH and BE at	Comparison outside of scope

Study	Reason for Exclusion
birth: a retrospective multi-cohort study, Physiological measurement, 36, L1-L12, 2015	
Lutomski, Jennifer E., Meaney, Sarah, Greene, Richard A., Ryan, Anthony C., Devane, Declan, Expert systems for fetal assessment in labour, Cochrane Database of Systematic Reviews, 2015	Systematic review: no relevant included studies
Neilson,James P., Fetal electrocardiogram (ECG) for fetal monitoring during labour, Cochrane Database of Systematic Reviews, -, 2013	Replaced by updated 2015 version (Neilson 2015)
Noren,H., Blad,S., Carlsson,A., Flisberg,A., Gustavsson,A., Lilja,H., Wennergren,M., Hagberg,H., STAN in clinical practice--the outcome of 2 years of regular use in the city of Gothenburg, American Journal of Obstetrics and Gynecology, 195, 7-15, 2006	The study is not a randomised controlled trial
Ojala,K., Vaarasmaki,M., Makikallio,K., Valkama,M., Tekay,A., A comparison of intrapartum automated fetal electrocardiography and conventional cardiotocography--a randomised controlled study, BJOG: An International Journal of Obstetrics and Gynaecology, 113, 419-423, 2006	One component study in a systematic review that has been included (Neilson 2015)
Olofsson, P., Ayres-de-Campos, D., Kessler, J., Tendal, B., Yli, B. M., Devoe, L., A critical appraisal of the evidence for using cardiotocography plus ECG ST interval analysis for fetal surveillance in labor. Part II: the meta-analyses, Acta Obstetricia et Gynecologica Scandinavica, 93, 571-86; discussion 587-8, 2014	Data and outcomes already included in Neilson 2015 Cochrane review
Potti,S., Berghella,V., ST waveform analysis versus cardiotocography alone for intrapartum fetal monitoring: a meta-analysis of randomized trials, American Journal of Perinatology, 29, 657-664, 2012	Studies and data already included in Neilson 2015 Cochrane review
Ragupathy,K., Ismail,F., Nicoll,A.E., The use of STAN monitoring in the labour ward, Journal of Obstetrics and Gynaecology, 30, 465-469, 2010	This study is not a randomised controlled trial
Reinhard,J., Hayes-Gill,B.R., Yi,Q., Hatzmann,H., Schiermeier,S., Comparison of non-invasive fetal electrocardiogram to Doppler cardiotocogram during the 1st stage of labor, Journal of Perinatal Medicine, 38, 179-185, 2010	Not an RCT; no outcomes of interest reported
Rosen,K.G., Fetal electrocardiogram waveform analysis in labour. [12 refs], Current Opinion in Obstetrics and Gynecology, 17, 147-150, 2005	Narrative review
Saade, G., Fetal ECG analysis of the ST segment as an adjunct to intrapartum fetal heart rate monitoring: A randomized clinical trial, American Journal of Obstetrics and Gynecology, 1), S2, 2015	Conference proceeding
Saccone, G., Schuit, E., Amer-Wahlin, I., Xodo, S., Berghella, V., Electrocardiogram st analysis during labor: A systematic review and meta-	Systematic review; individual studies contributing to the review have been checked for relevance and included where appropriate

Study	Reason for Exclusion
Analysis of randomized controlled trials, Obstetrics and Gynecology, 127, 127-135, 2016	
Schuit,E., mer-Wahlin,I., Ojala,K., Vayssiere,C., Westerhuis,M.E., Marsal,K., Tekay,A., Saade,G.R., Visser,G.H., Groenwold,R.H., Moons,K.G., Mol,B.W., Kwee,A., Effectiveness of electronic fetal monitoring with additional ST analysis in vertex singleton pregnancies at >36 weeks of gestation: an individual participant data metaanalysis, American Journal of Obstetrics and Gynecology, 208, 187-187, 2013	Component studies have all been included in Neilson 2015 Cochrane review
Schuit,E., mer-Wahlin,I., Ojala,K., Vayssiere,C., Westerhuis,M.E.M.H., Marsal,K., Tekay,A., Saade,G.R., Visser,G.H.A., Groenwold,R.H.H., Moons,K.G.M., Mol,B.W.J., Kwee,A., Effectiveness of electronic fetal monitoring with additional ST analysis in vertex singleton pregnancies at >36 weeks of gestation: An individual participant data metaanalysis, American Journal of Obstetrics and Gynecology, 208, 187e1-187e13, 2013	Studies and data already included in Neilson 2015 Cochrane review
Steer, P. J., Hvidman, L. E., Scientific and clinical evidence for the use of fetal ECG ST segment analysis (STAN), Acta Obstetricia et Gynecologica Scandinavica, 93, 533-8, 2014	Narrative review
Su,L.L., Chong,Y.S., Biswas,A., Use of fetal electrocardiogram for intrapartum monitoring. [33 refs], Annals of the Academy of Medicine, Singapore, 36, 416-420, 2007	Narrative review
Swedish Council on Technology Assessment in Health Care., STAN - ST waveform analysis combined with cardiotocography for fetal monitoring during childbirth - early assessment briefs (Alert) (Structured abstract), Health Technology Assessment Database, -, 2013	A structured abstract
Vayssiere,C., David,E., Haberstich,R., Sebahoun,V., Roth,E., Meyer,N., Favre,R., Nisand,I., Langer,B., A French randomized controlled trial on ST analysis in a population with abnormal FHR in labor [abstract], American Journal of Obstetrics and Gynecology, 195, S222, 2006-, 2006	An abstract (study included in a systematic review that has been included; Neilson 2015)
Vayssiere,C., David,E., Meyer,N., Haberstich,R., Sebahoun,V., Roth,E., Favre,R., Nisand,I., Langer,B., A French randomized controlled trial of ST-segment analysis in a population with abnormal cardiotocograms during labor, American Journal of Obstetrics and Gynecology, #197, 299-299e6, 2007	One component study in a systematic review that has been included (Neilson 2015)
Vijgen,S.M., Westerhuis,M.E., Opmeer,B.C., Visser,G.H., Moons,K.G., Porath,M.M., Oei,G.S., van Geijn,H.P., Bolte,A.C., Willekes,C., Nijhuis,J.G., van,Beek E., Graziosi,G.C., Schuitemaker,N.W., van Lith,J.M., van den Akker,E.S., Drogtrop,A.P., Van Dessel,H.J., Rijnders,R.J., Oosterbaan,H.P., Mol,B.W., Kwee,A., Cost-effectiveness of cardiotocography plus ST	Heath economic analysis of a trial

Study	Reason for Exclusion
analysis of the fetal electrocardiogram compared with cardiotocography only, Acta Obstetricia et Gynecologica Scandinavica, 90, 772-778, 2011	
Vijgen,S.M.C., Westerhuis,M.E.M.H., Opmeer,B.C., Visser,G.H.A., Moons,K.G.M., Porath,M.M., Oei,G.S., Van,H.P., Bolte,A.C., Willekes,C., Nijhuis,J.G., Van,E., Graziosi,G.C.M., Schuitemaker,N.W.E., Van,J.M.M., Van,ESA Akker, Drogtrop,A.P., Van,H.J.H.M., Rijnders,R.J.P., Oosterbaan,H.P., Mol,B.W.J., Kwee,A., Cost-effectiveness of cardiotocography plus ST analysis of the fetal electrocardiogram compared with cardiotocography only, Acta Obstetricia et Gynecologica Scandinavica, 90, 772-778, 2011	Health economic review
Vijgen,S.M.C., Westerhuis,M.E.M.H., Opmeer,B.C., Visser,G.H.A., Moons,K.G.M., Porath,M.M., Oei,G.S., Van,GeijnH, Bolte,A.C., Willekes,C., Nijhuis,J.G., Van,BeekE, Graziosi,G.C.M., Schuitemaker,N.W.E., Van,LithJ, Van,DenAkkerE, Drogtrop,A.P., Van,DesselH, Rijnders,R.J.P., Oosterbaan,H.P., Mol,B.W.J., Kwee,A., Cost-effectiveness of cardiotocography plus ST-analysis of the fetal electrocardiogram compared to cardiotocography only in the prevention of cerebral palsy, American Journal of Obstetrics and Gynecology, 201, S192-, 2009	Conference proceeding
Visser, G. H., Kessler, J., It is time to introduce ST analysis for fetal monitoring in the labor ward?, Acta Obstetricia et Gynecologica Scandinavica, 93, 539-43, 2014	Non-systematic review
Westerhuis,M., Porath,M., Mol,B.W., Kwee,A., A comparison of intrapartum automated fetal electrocardiography and conventional cardiotocography - A randomised controlled study, BJOG: An International Journal of Obstetrics and Gynaecology, 113, 1103-, 2006	Letter
Westerhuis,M.E., Moons,K.G., van,Beek E., Bijvoet,S.M., Drogtrop,A.P., van Geijn,H.P., van Lith,J.M., Mol,B.W., Nijhuis,J.G., Oei,S.G., Porath,M.M., Rijnders,R.J., Schuitemaker,N.W., van,der Tweel,I, Visser,G.H., Willekes,C., Kwee,A., A randomised clinical trial on cardiotocography plus fetal blood sampling versus cardiotocography plus ST-analysis of the fetal electrocardiogram (STAN) for intrapartum monitoring, BMC Pregnancy and Childbirth, Vol.7, pp.13, 2007., -, -32676	Trial protocol
Westerhuis,M.E., Visser,G.H., Moons,K.G., van,Beek E., Benders,M.J., Bijvoet,S.M., van Dessel,H.J., Drogtrop,A.P., van Geijn,H.P., Graziosi,G.C., Groenendaal,F., van Lith,J.M., Nijhuis,J.G., Oei,S.G., Oosterbaan,H.P., Porath,M.M., Rijnders,R.J., Schuitemaker,N.W., Sopacua,L.M., van,der Tweel,I, Wijnberger,L.D., Willekes,C., Zuithoff,N.P., Mol,B.W., Kwee,A., Cardiotocography plus ST analysis of fetal	An erratum

Study	Reason for Exclusion
electrocardiogram compared with cardiotocography only for intrapartum monitoring: a randomized controlled trial.[Erratum appears in Obstet Gynecol. 2011 Feb;117(2 Pt 1):412], Obstetrics and Gynecology, 115, 1173-1180, 2010	
Westerhuis,M.E.M.H., Intra partum fetal monitoring with and without ST-analysis of the fetal electrocardiogram: An analysis of missed clinical cases (preliminary results), American Journal of Obstetrics and Gynecology, 201, S42-, 2009	Conference proceeding
Westerhuis,M.E.M.H., Porath,M.M., Becker,J.H., Van,DenAkkerE, Van,BeekE, Van,DesselH, Drogtrop,A.P., Van,GeijnH, Graziosi,G.C.M., Groenendaal,F., Van,LithJ, Mol,B.W.J., Moons,K.G.M., Nijhuis,J.G., Oei,S.G., Oosterbaan,H.P., Rijnders,R.J.P., Schuitemaker,N.W.E., Wijnberger,L.D.E., Willekes,C., Wouters,M.G.A.J., Visser,G.H.A., Kwee,A., Identification of cases with adverse neonatal outcome monitored by cardiotocography versus ST analysis: Secondary analysis of a randomized trial, Acta Obstetricia et Gynecologica Scandinavica, 91, 830-837, 2012	One component study in a systematic review that has been included (Neilson 2015)
Yeh, H. M., Chang, Y. C., Lin, C., Yeh, C. H., Lee, C. N., Shyu, M. K., Hung, M. H., Hsiao, P. N., Wang, Y. H., Tseng, Y. H., Tsao, J., Lai, L. P., Lin, L. Y., Lo, M. T., A new method to derive fetal heart rate from maternal abdominal electrocardiogram: monitoring fetal heart rate during cesarean section, PLoS ONE [Electronic Resource], 10, e0117509, 2015	The aim of the study was to derive fetal heart rate from maternal abdominal ECG

F.13 Cardiotocography with electrocardiogram analysis compared with cardiotocography alone – health economics

Study	Reason for Exclusion
Heintz,E., Brodtkorb,T.H., Nelson,N., Levin,L.A., The long-term cost-effectiveness of fetal monitoring during labour: a comparison of cardiotocography complemented with ST analysis versus cardiotocography alone, BJOG: An International Journal of Obstetrics and Gynaecology, 115, 1676-1687, 2008	Not a UK study
Vijgen,S.M., Westerhuis,M.E., Opmeer,B.C., Visser,G.H., Moons,K.G., Porath,M.M., Oei,G.S., van Geijn,H.P., Bolte,A.C., Willekes,C., Nijhuis,J.G., van,Beek E., Graziosi,G.C., Schuitemaker,N.W., van Lith,J.M., van den Akker,E.S., Drogtrop,A.P., Van Dessel,H.J., Rijnders,R.J., Oosterbaan,H.P., Mol,B.W., Kwee,A., Cost-effectiveness of cardiotocography plus ST analysis of the fetal electrocardiogram compared with cardiotocography only, Acta Obstetricia et Gynecologica Scandinavica, 90, 772-778, 2011	Not a UK study

F.14 Automated interpretation of cardiotocograph traces

Study	Reason for Exclusion
Amer-Wahlin, I., Miller, L. A., ST analysis as an adjunct to electronic fetal monitoring: an overview, Journal of Perinatal & Neonatal Nursing, 24, 231-7, 2010	A descriptive paper
Ayres-de-Campos, D., Rei, M., Nunes, I., Sousa, P., Bernardes, J., SisPorto 4.0 - computer analysis following the 2015 FIGO Guidelines for intrapartum fetal monitoring, Journal of Maternal-Fetal & Neonatal Medicine, 1-15, 2016	The article provides a description of the analysis performed by the computer analysis system Sisporto 4.0 system
Buscicchio,G., Gentilucci,L., Martorana,R., Martino,C., Tranquilli,A.L., How to read fetal heart rate tracings in labor: a comparison between ACOG and NICE guidelines, Journal of Maternal-Fetal and Neonatal Medicine, 25, 2797-2798, 2012	Not the comparison of interest
Chen,C.Y., Chen,J.C., Yu,C., Lin,C.W., A comparative study of a new cardiotocography analysis program, Annual International IEEE Engineering in Medicine and Biology Society, 2009, 2567-2570, 2009	Not the outcome of interest (reports proportion of agreement)
Georgieva, A., Papageorghiou, A. T., Payne, S. J., Moulden, M., Redman, C. W., Phase-rectified signal averaging for intrapartum electronic fetal heart rate monitoring is related to acidaemia at birth, BJOG: An International Journal of Obstetrics & Gynaecology, 121, 889-94, 2014	Not the comparison of interest
Georgieva,A., Payne,S.J., Moulden,M., Redman,C.W., Computerized fetal heart rate analysis in labor: detection of intervals with un-assignable baseline, Physiological Measurement, 32, 1549-1560, 2011	Not the outcomes of interest
Georgoulas,G., Stylios,C.D., Groumpos,P.P., Predicting the risk of metabolic acidosis for newborns based on fetal heart rate signal classification using support vector machines, IEEE Transactions on Biomedical Engineering, 53, 875-884, 2006	Analysis of fetal heart rate using an algorithm; not entirely clear if women were in labour
Hruban, L., Janku, P., Spilka, J., Chudacek, V., Bursa, M., Huptych, M., Hudec, A., Kacerovsky, M., Koucky, M., Lhotska, L., Prochazka, M., Korecko, V., Seget'a, J., S. imetka O, Unzeitig, V., Analysis of CTG interpretation of expertobstetricians-is it time for change?, Journal of Maternal-Fetal and Neonatal Medicine, 27, 192, 2014	An abstract
Karvelis, P., Spilka, J., Georgoulas, G., Chudacek, V., Stylios, C. D., Lhotska, L., Combining latent class analysis labeling with multiclass approach for fetal heart rate categorization, Physiological Measurement, 36, 1001-24, 2015	Not the comparison of interest
Nunes, I., Ayres-de-Campos, D., Computer analysis of foetal monitoring signals, Best Practice & Research in Clinical Obstetrics & Gynaecology, 30, 68-78, 2016	An overview of existing systems for computer analysis of fetal monitoring signals

Study	Reason for Exclusion
Ocak,H., A medical decision support system based on support vector machines and the genetic algorithm for the evaluation of fetal well-being, Journal of Medical Systems, 37, 9913-, 2013	Genetic algorithm and development of support vector machines classifier
Ojala,K., Makikallio,K., Haapsamo,M., Ijas,H., Tekay,A., Interobserver agreement in the assessment of intrapartum automated fetal electrocardiography in singleton pregnancies, Acta Obstetricia et Gynecologica Scandinavica, 87, 536-540, 2008	Not the comparison of interest
Romano, M., Bifulco, P., Ruffo, M., Improta, G., Clemente, F., Cesarelli, M., Software for computerised analysis of cardiotocographic traces, Computer Methods & Programs in Biomedicine, 124, 121-37, 2016	Mixed population: women in antepartum and intrapartum period
Salmelin,A., Wiklund,I., Bottinga,R., Brorsson,B., Ekman-Ordeberg,G., Grimfors,E.E., Hanson,U., Blom,M., Persson,E., Fetal monitoring with computerized ST analysis during labor: a systematic review and meta-analysis, Acta Obstetricia et Gynecologica Scandinavica, 92, 28-39, 2013	Not the comparison of interest
Schiermeier, S., Pildner von Steinburg, S., Thieme, A., Reinhard, J., Daumer, M., Scholz, M., Hatzmann, W., Schneider, K. T., Sensitivity and specificity of intrapartum computerised FIGO criteria for cardiotocography and fetal scalp pH during labour: multicentre, observational study, BJOG: An International Journal of Obstetrics & Gynaecology, 115, 1557-63, 2008	No relevant results presented for the comparison of interest
Schiermeier,S., Westhof,G., Leven,A., Hatzmann,H., Reinhard,J., Intra- and interobserver variability of intrapartum cardiotocography: a multicenter study comparing the FIGO classification with computer analysis software, Gynecologic and Obstetric Investigation, 72, 169-173, 2011	No direct comparison between the computer and the 'experts'
Spilka, J., Chudacek, V., Janku, P., Hruban, L., Bursa, M., Huptych, M., Zach, L., Lhotska, L., Analysis of obstetricians' decision making on CTG recordings, Journal of Biomedical Informatics, 51, 72-9, 2014	Tests a scheme of voting - latent class analysis

Appendix G: Evidence tables

The evidence tables are presented in a separate file.

G.1 Intermittent auscultation compared with cardiotocography on admission

G.2 Intermittent auscultation compared with cardiotocography during labour

G.3 Intermittent auscultation compared with cardiotocography in the presence of meconium stained liquor

G.4 Interpretation of cardiotocograph traces

G.5 Care in labour as a result of cardiotocography

G.6 Fetal scalp stimulation

G.7 Fetal blood sampling as an adjunct to cardiotocography

G.8 Fetal blood sampling – time to result

G.9 Predictive value of fetal blood sampling

G.10 Women's experience of fetal monitoring

G.11 Cardiotocography with electrocardiogram analysis compared with cardiotocography alone

G.12 Automated interpretation of cardiotocograph traces

Appendix H: Forest plots

H.1 Intermittent auscultation compared with cardiotocography on admission

Figure 1: Caesarean section

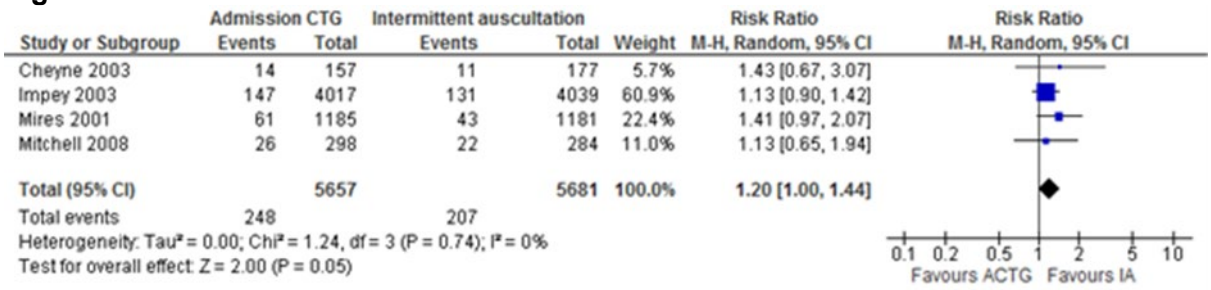


Figure 2: Instrumental vaginal birth

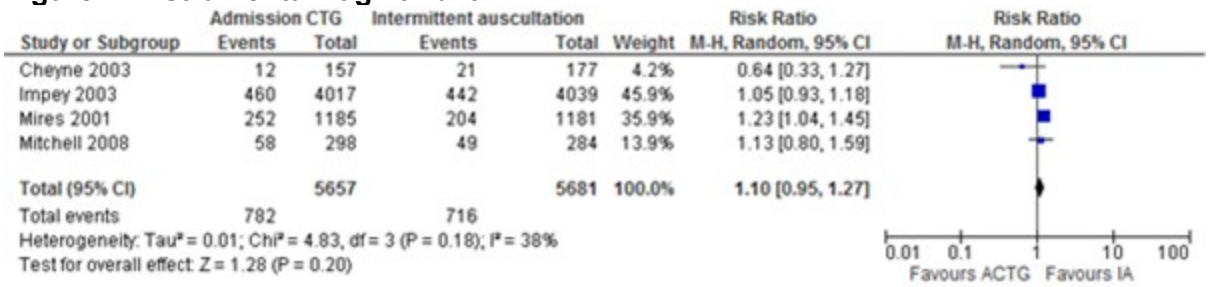


Figure 3: Fetal and neonatal deaths

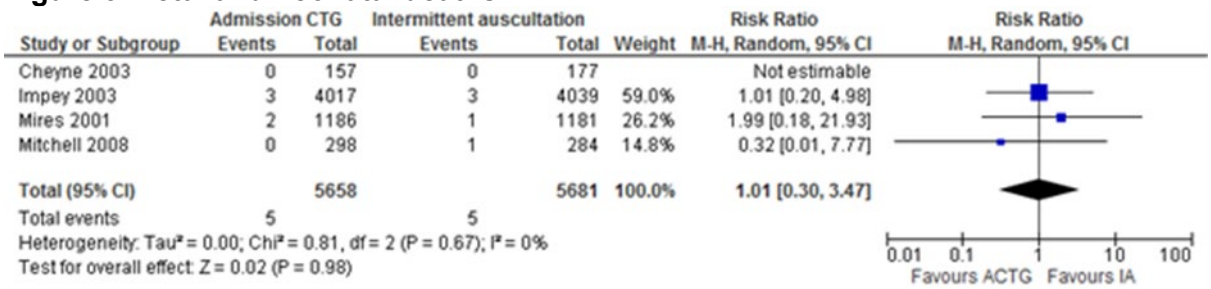
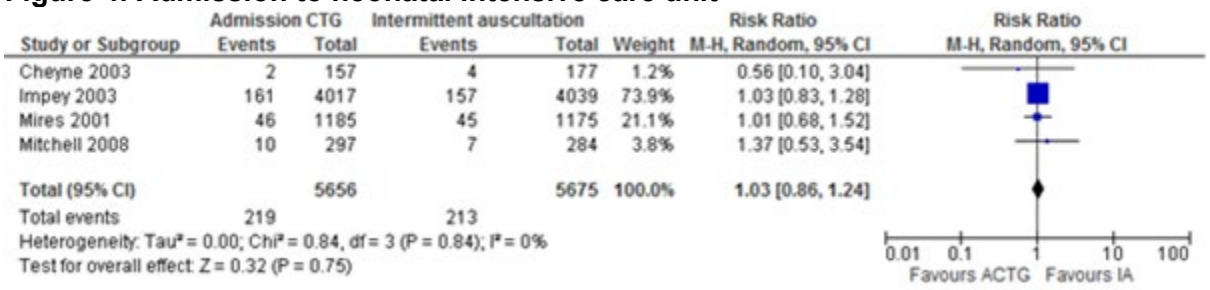


Figure 4: Admission to neonatal intensive care unit



H.2 Intermittent auscultation compared with cardiotocography during labour

Figure 5: Spontaneous vaginal birth

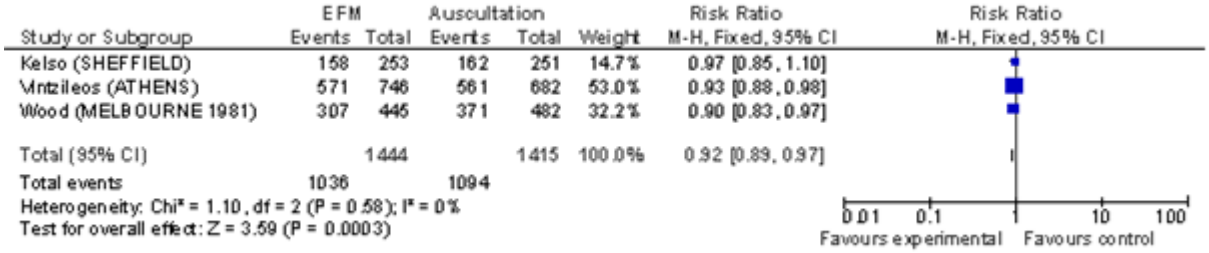


Figure 6: Instrumental birth (any indication)

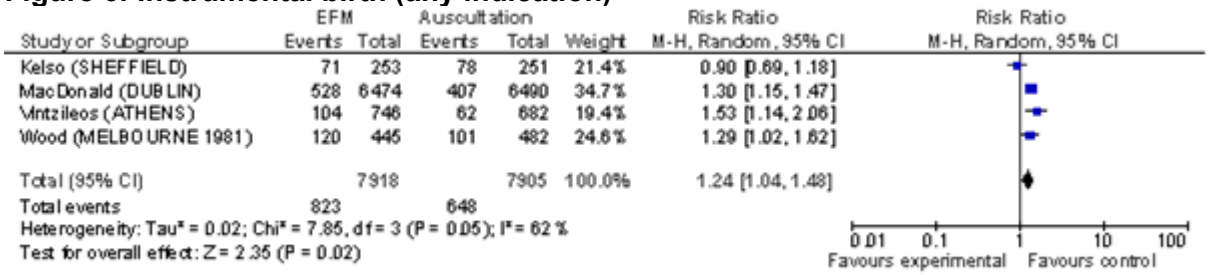


Figure 7: Caesarean section (any indication)

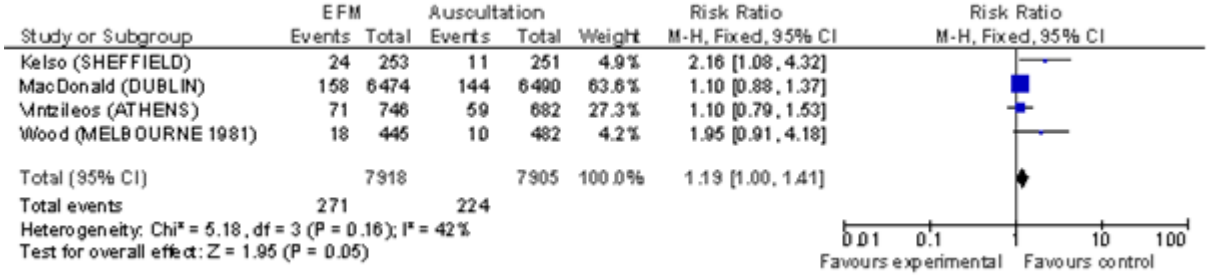


Figure 8: Caesarean section for fetal distress

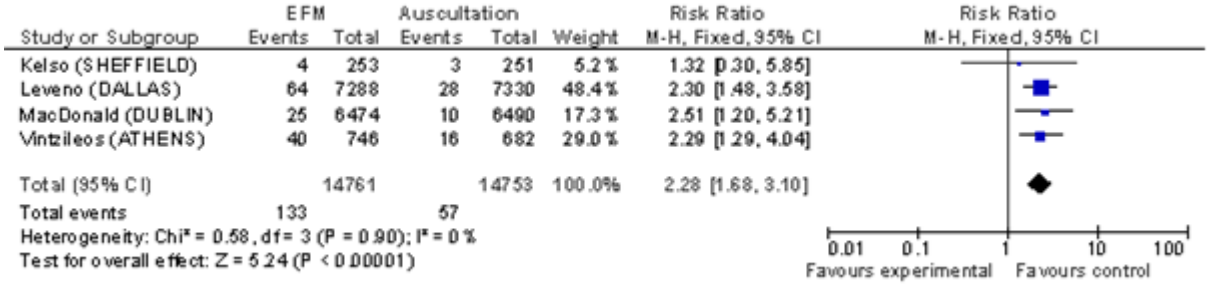


Figure 9: Intrapartum fetal death

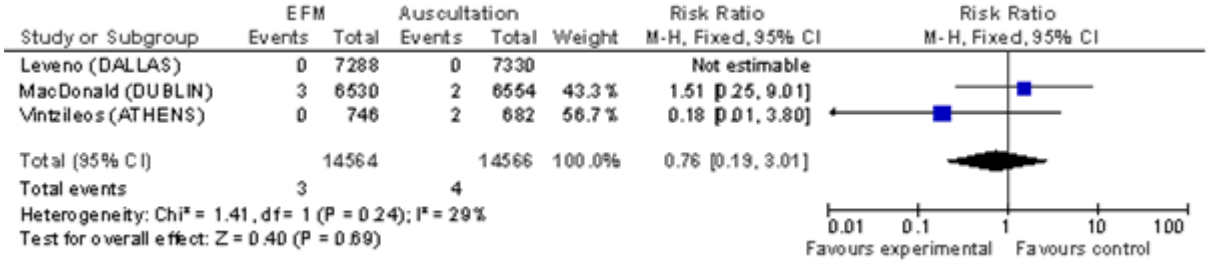


Figure 10: Neonatal death

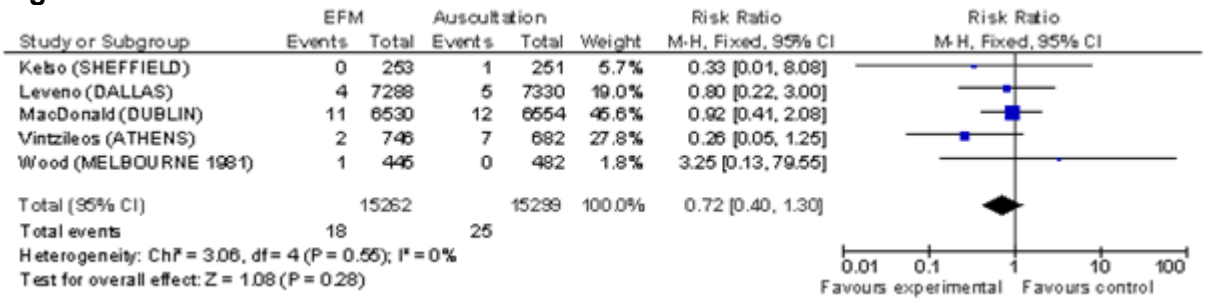
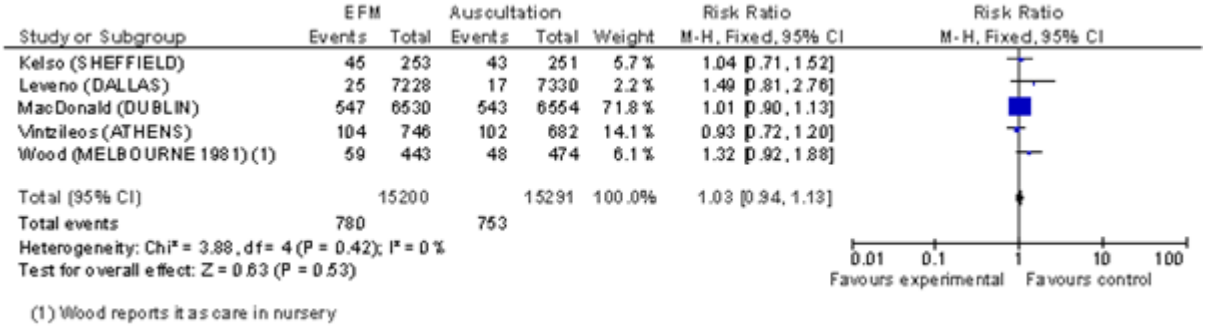
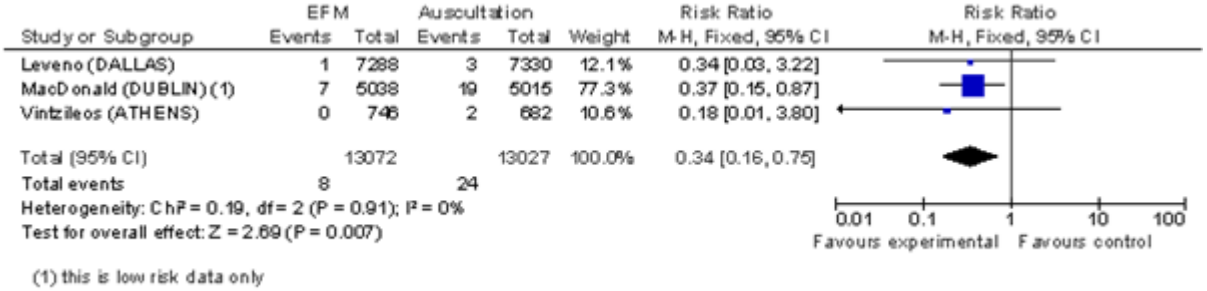


Figure 11: Admission to neonatal intensive care unit



(1) Wood reports it as care in nursery

Figure 12: Neonatal seizures



(1) this is low risk data only

Figure 13: Abnormal neurologic signs

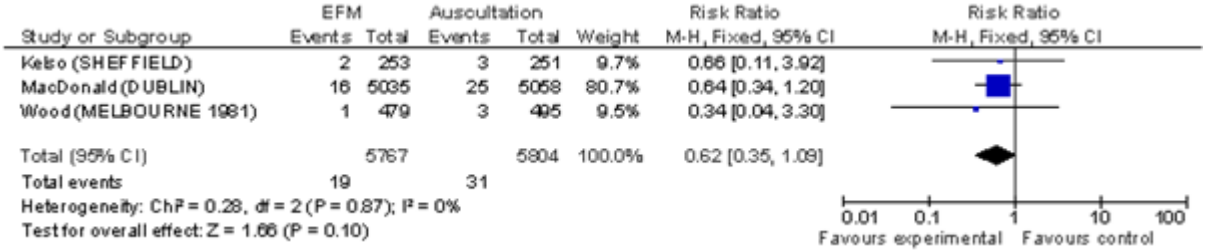
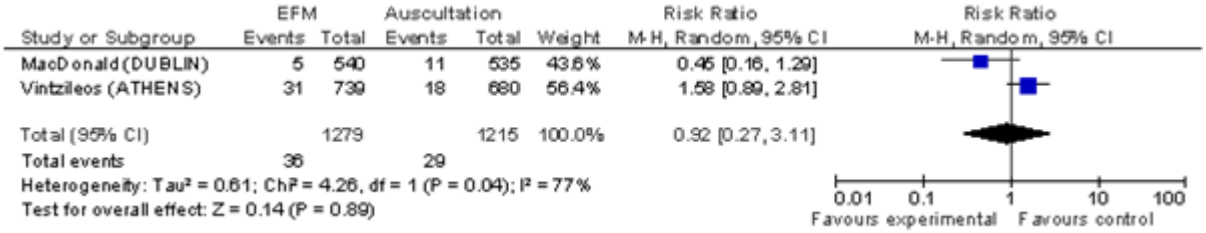


Figure 14: Low cord blood gas (< 7.10)



Subgroup analysis

Figure 15: Spontaneous vaginal birth

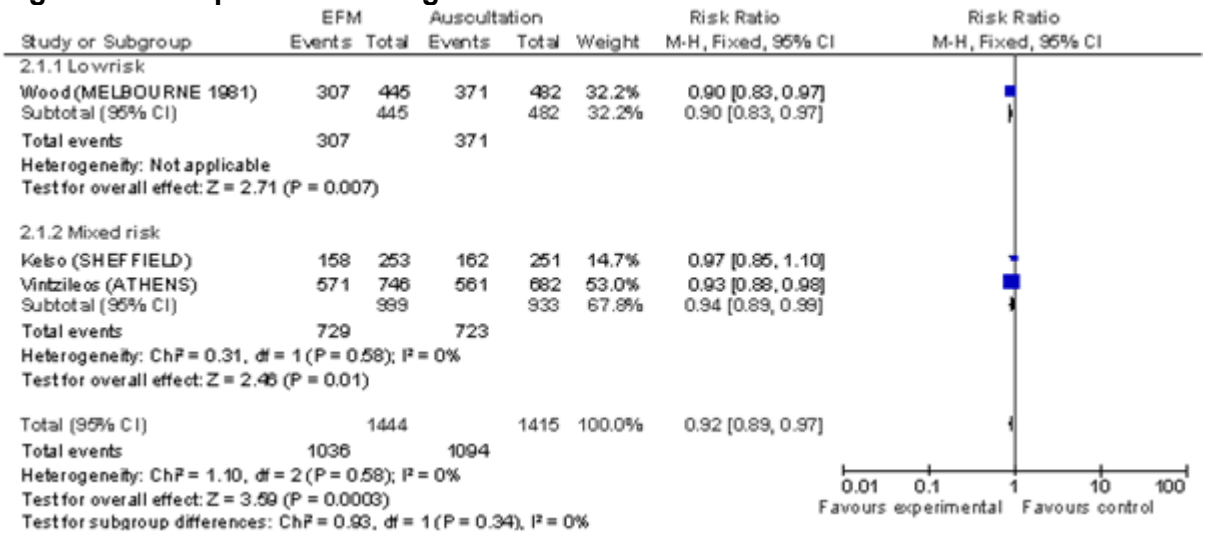


Figure 16: Instrumental birth (any indication)

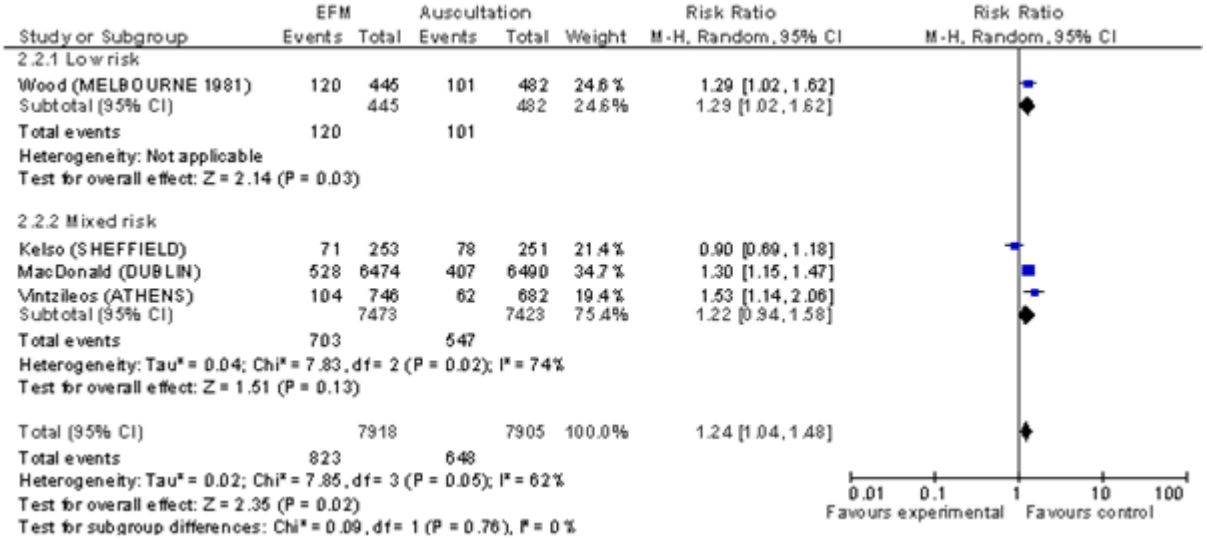


Figure 17: Caesarean section any indication

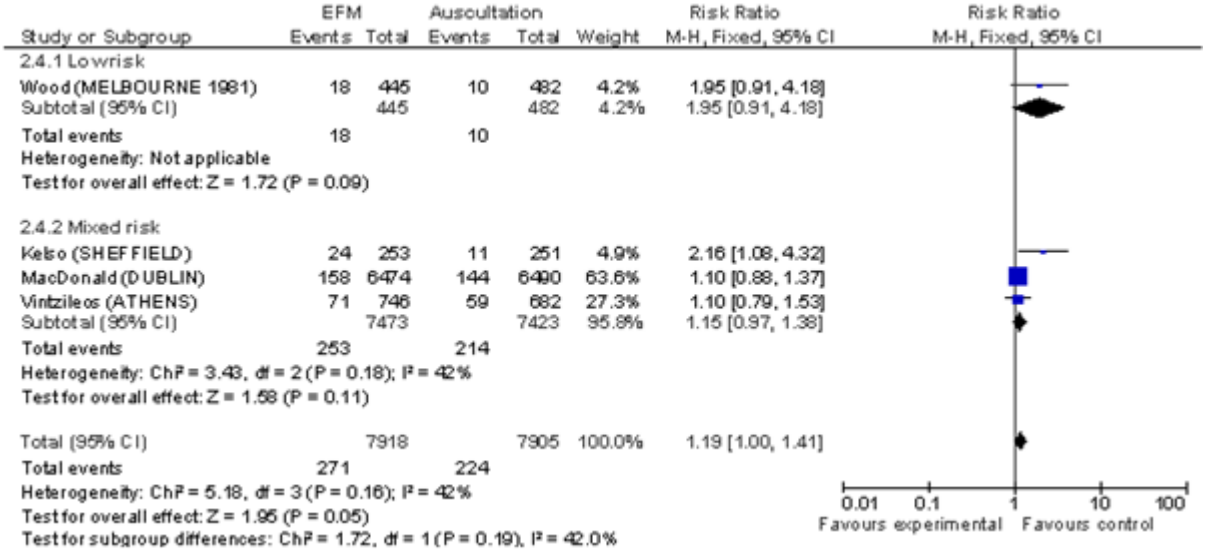


Figure 18: Caesarean section for fetal distress

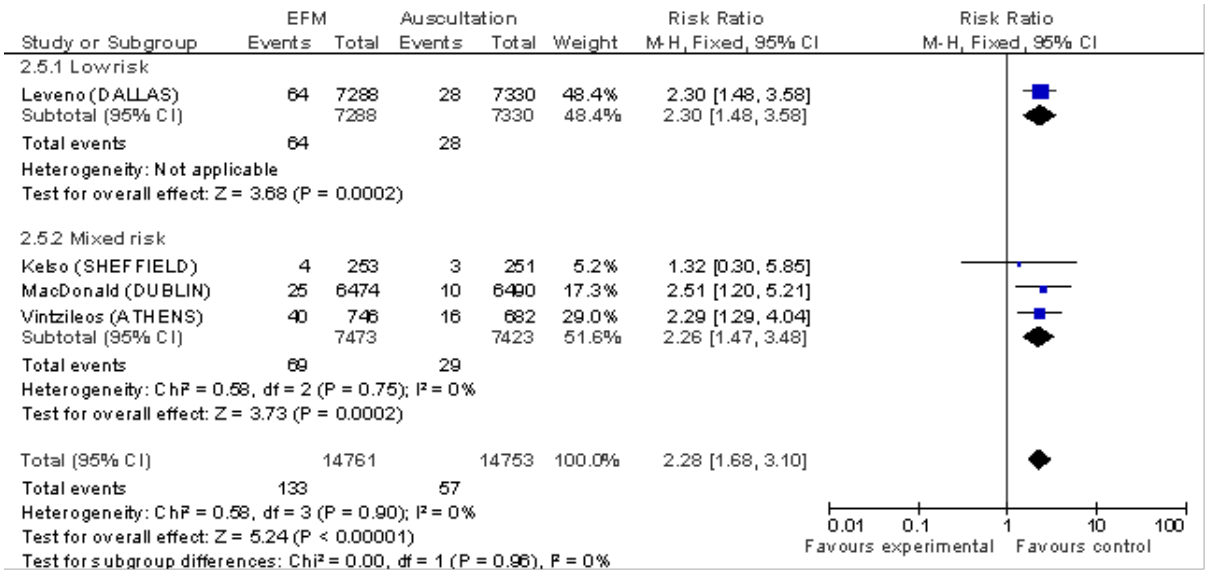


Figure 19: Intrapartum fetal death

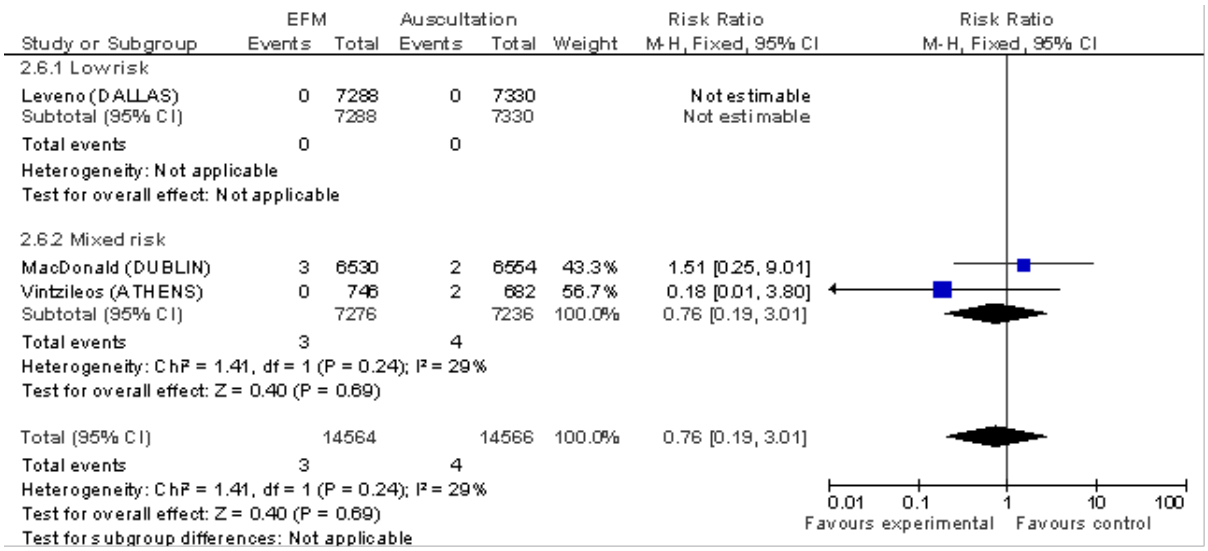


Figure 20: Neonatal death

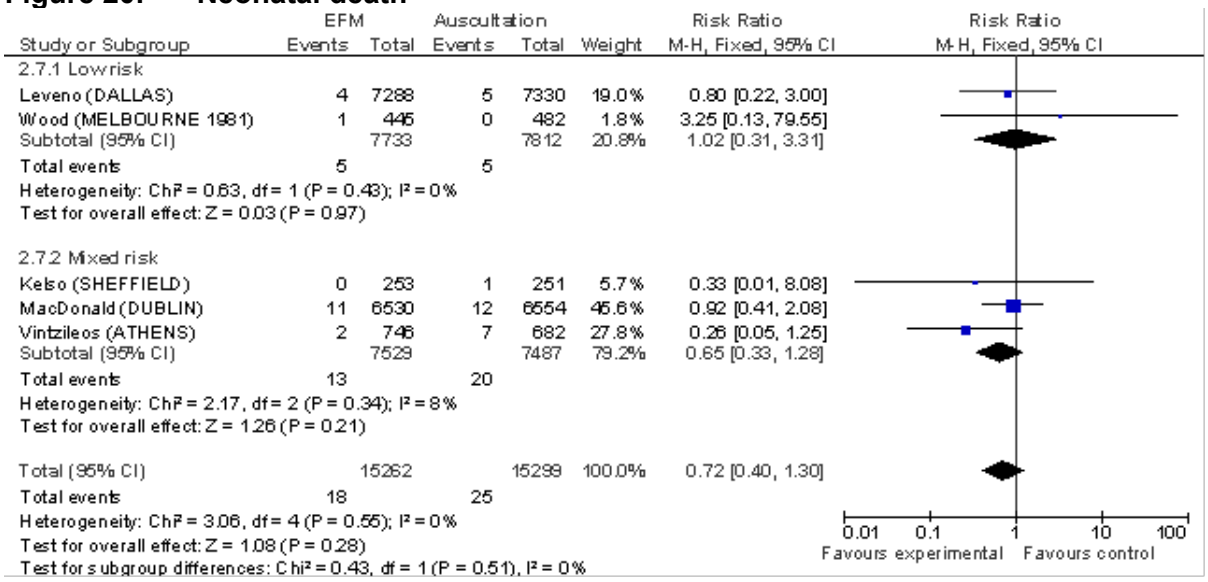


Figure 21: Admission to neonatal intensive care unit

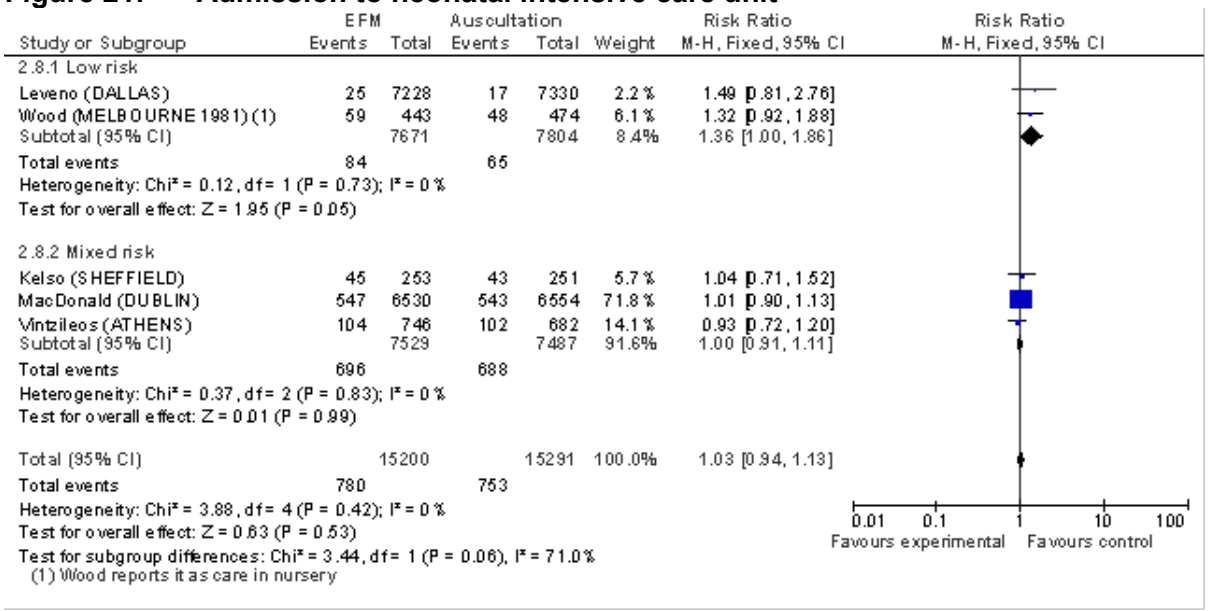


Figure 22: Neonatal seizures

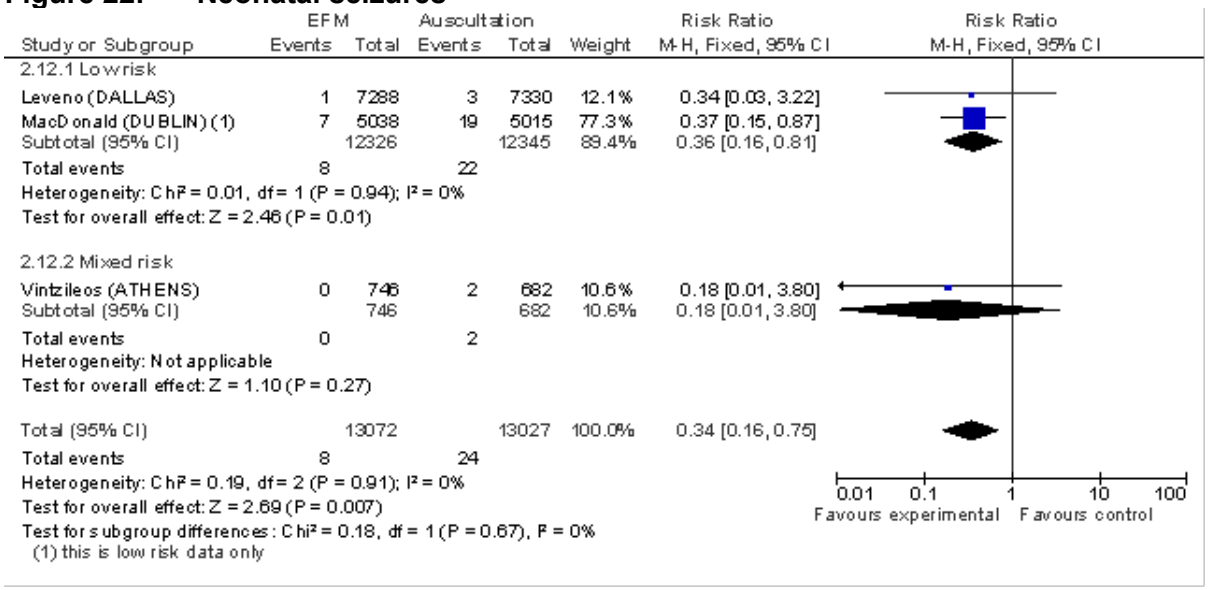
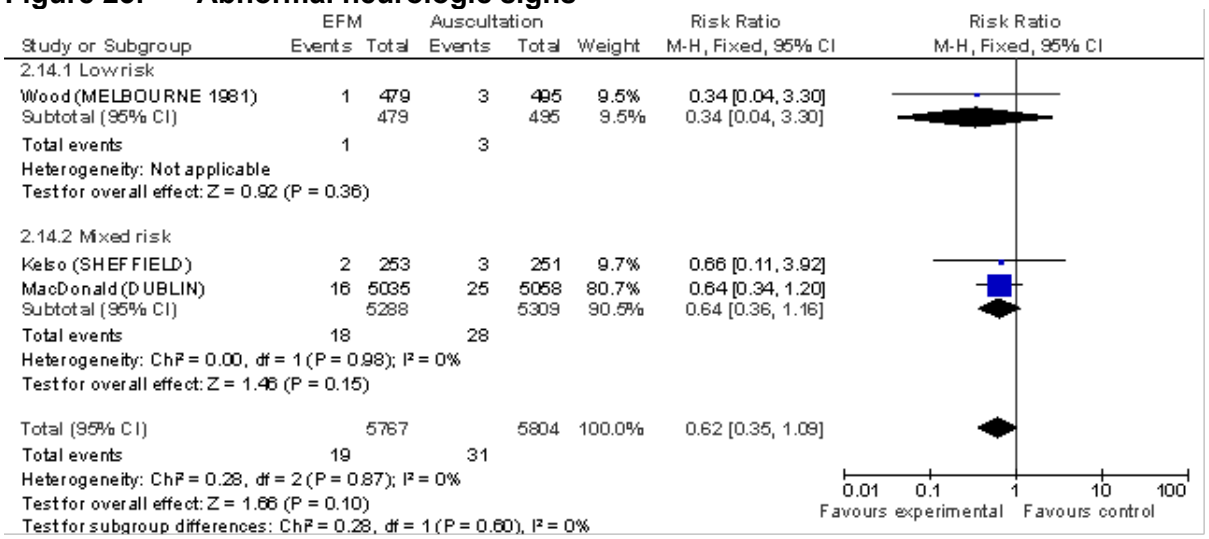


Figure 23: Abnormal neurologic signs



H.3 Intermittent auscultation compared with cardiotocography in the presence of meconium stained liquor

Figure 24: Caesarean section

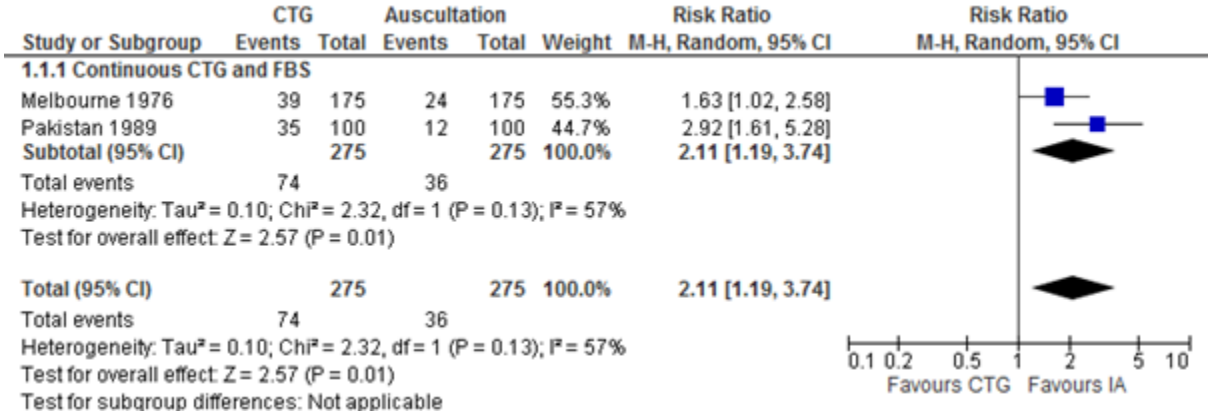


Figure 25: Caesarean section for abnormal fetal heart rate pattern or acidosis

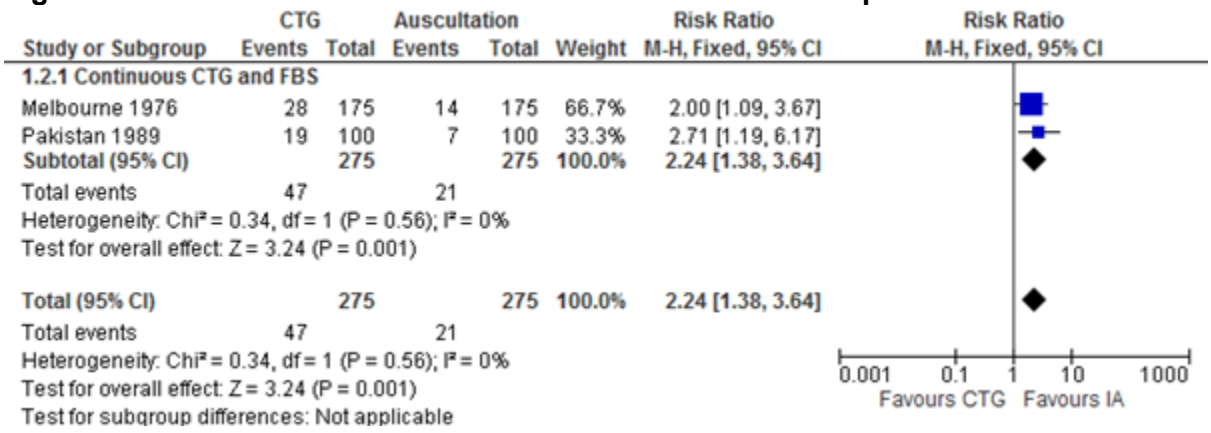


Figure 26: Caesarean section for other reason

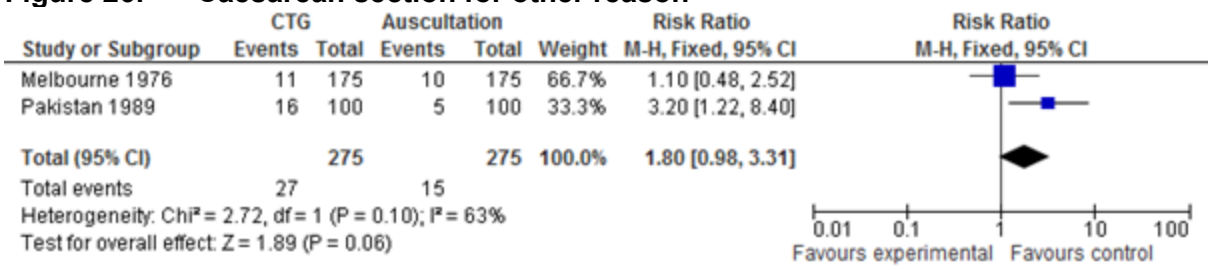


Figure 27: Instrumental vaginal birth

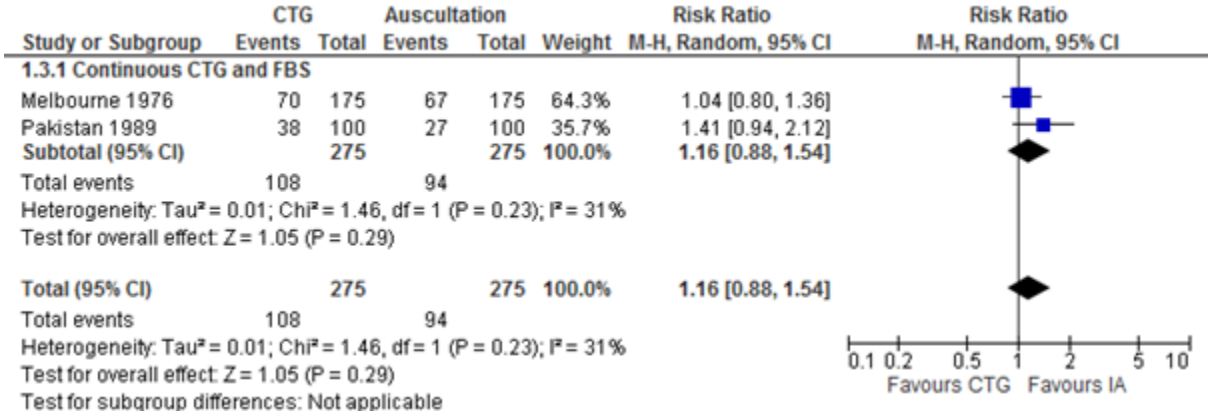


Figure 28: Spontaneous vaginal birth not achieved

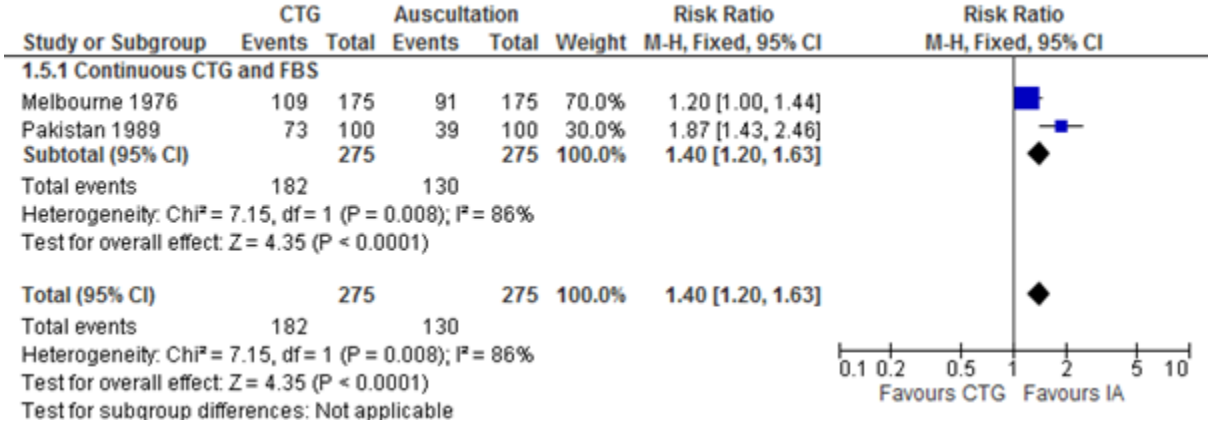
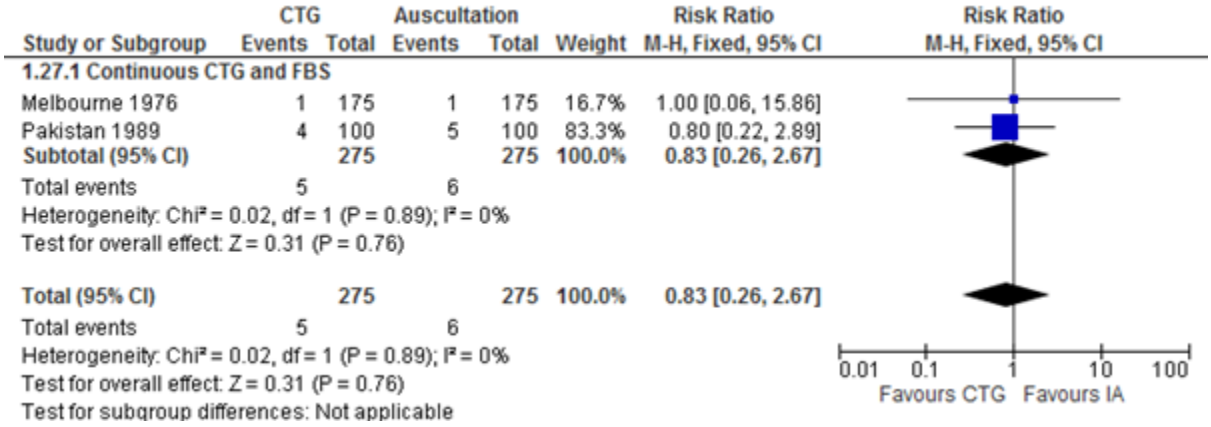


Figure 29: Perinatal death



H.4 Interpretation of cardiotocograph traces

There are no forest plots for this review question.

H.5 Care in labour as a result of cardiotocography

There are no forest plots for this review question.

H.6 Fetal scalp stimulation

There are no forest plots for this review question.

H.7 Fetal blood sampling as an adjunct to cardiotocography

Figure 30: Caesarean section

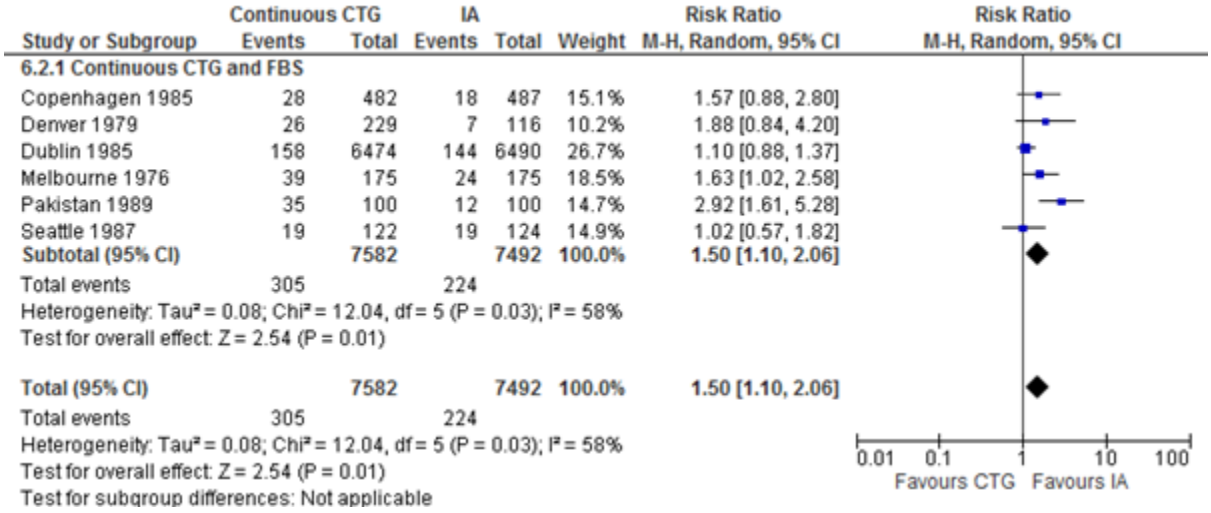


Figure 31: Instrumental vaginal birth

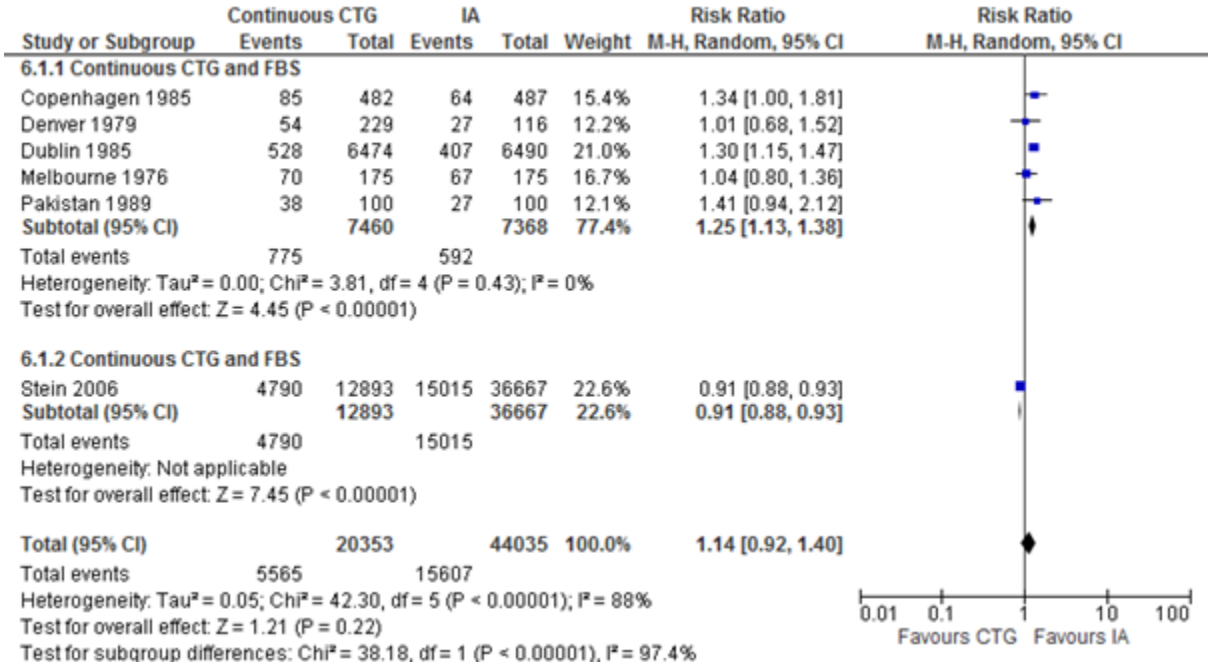


Figure 32: Cord blood acidosis (pH < 7.0)

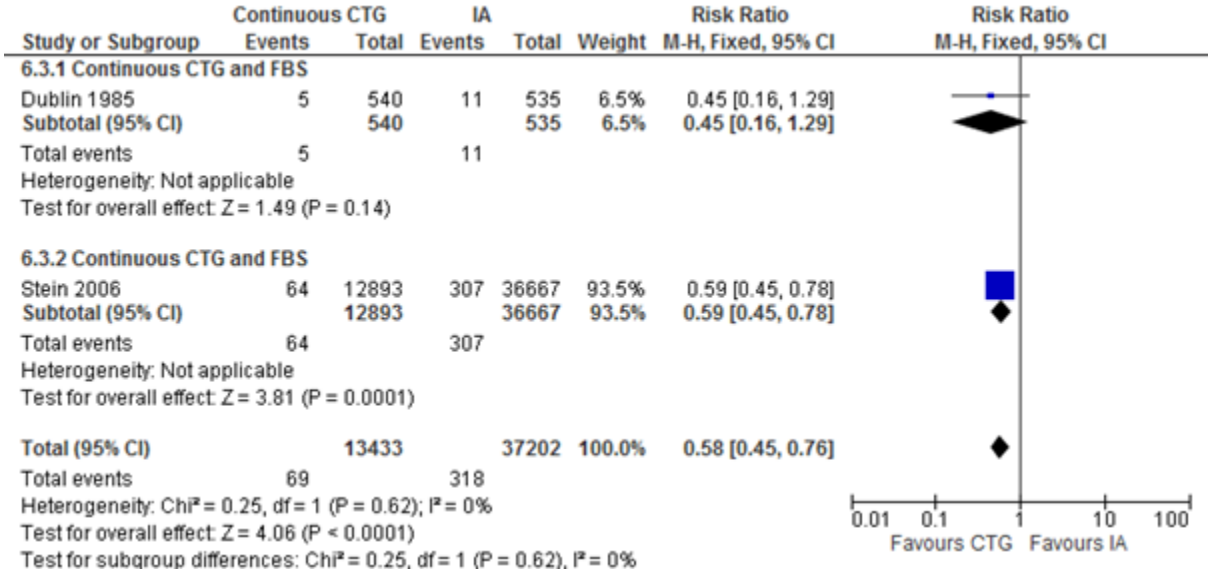


Figure 33: Cerebral palsy

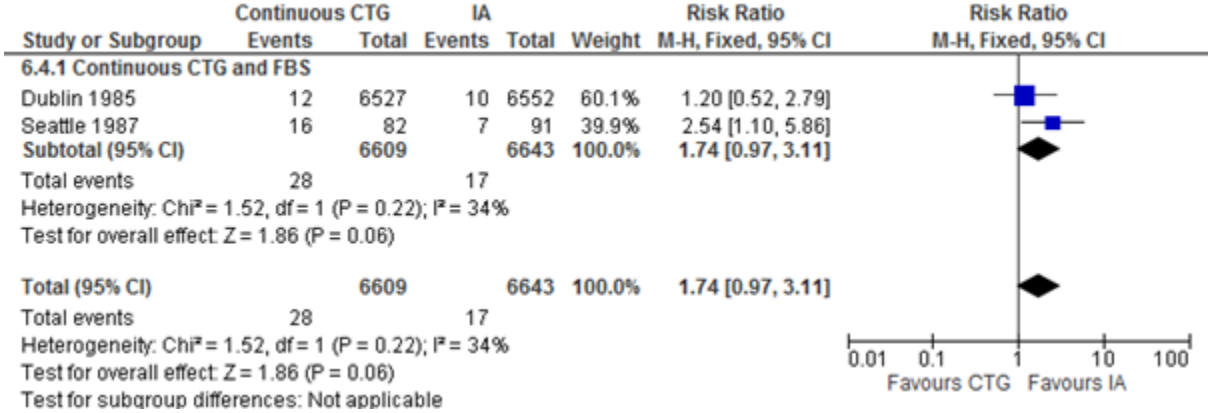
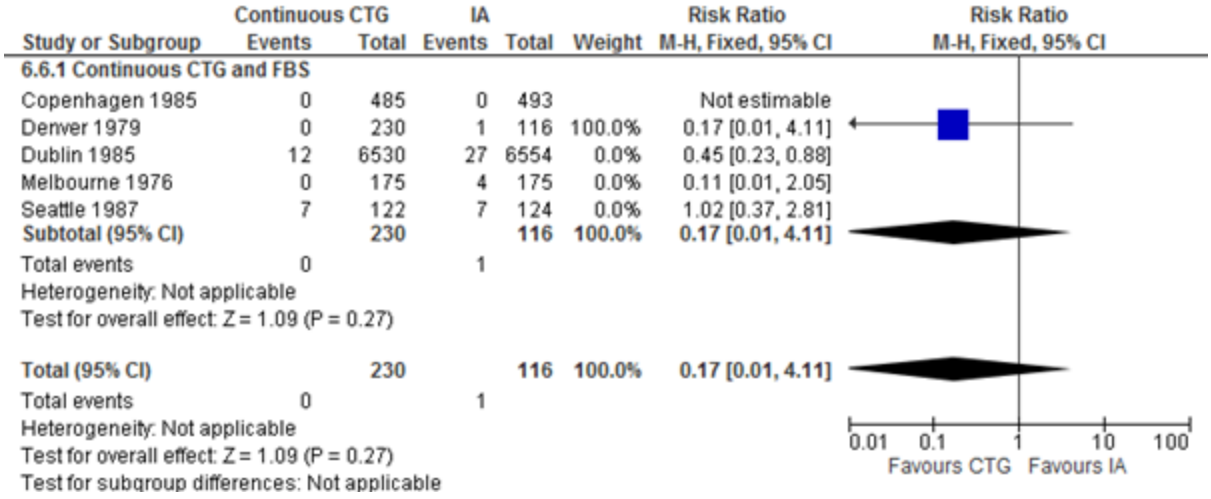


Figure 34: Neonatal seizures



H.8 Fetal blood sampling – time to result

There are no forest plots for this review question.

H.9 Predictive value of fetal blood sampling

Figure 35: Mode of birth – spontaneous vaginal birth

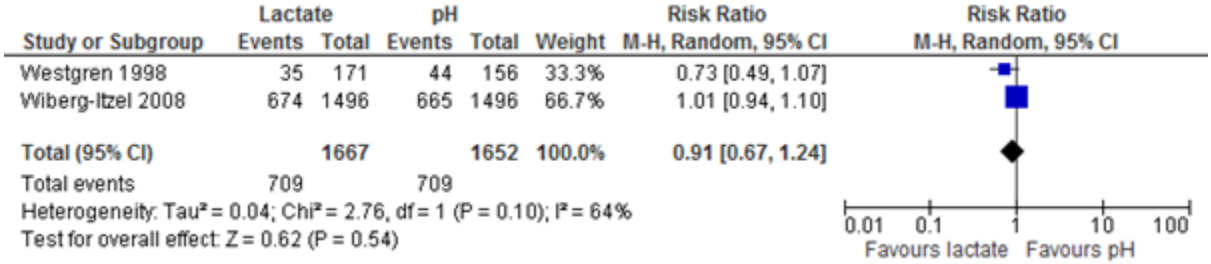


Figure 36: Mode of birth – assisted vaginal birth

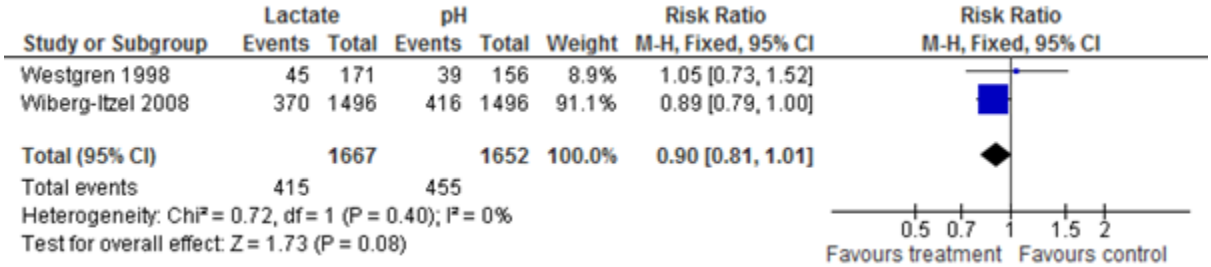


Figure 37: Mode of birth – caesarean section

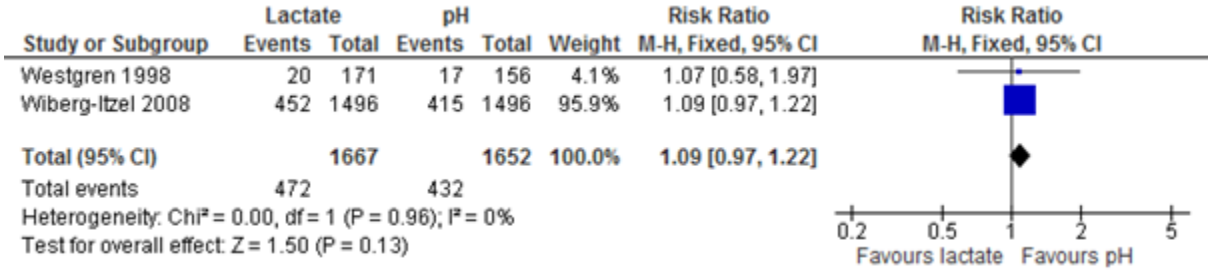
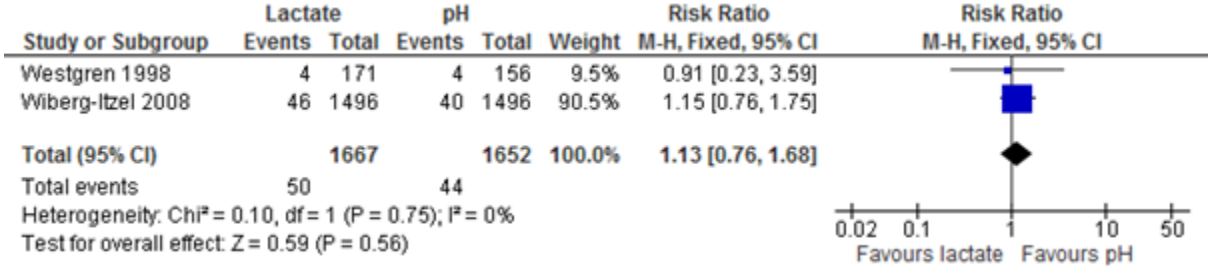


Figure 38: Apgar score < 7 at 5 minutes



H.10 Women's experience of fetal monitoring

There are no forest plots for this review question.

H.11 Cardiotocography with electrocardiogram analysis compared with cardiotocography alone

PR interval analysis

Figure 39: Assisted birth (caesarean section or instrumental vaginal birth)

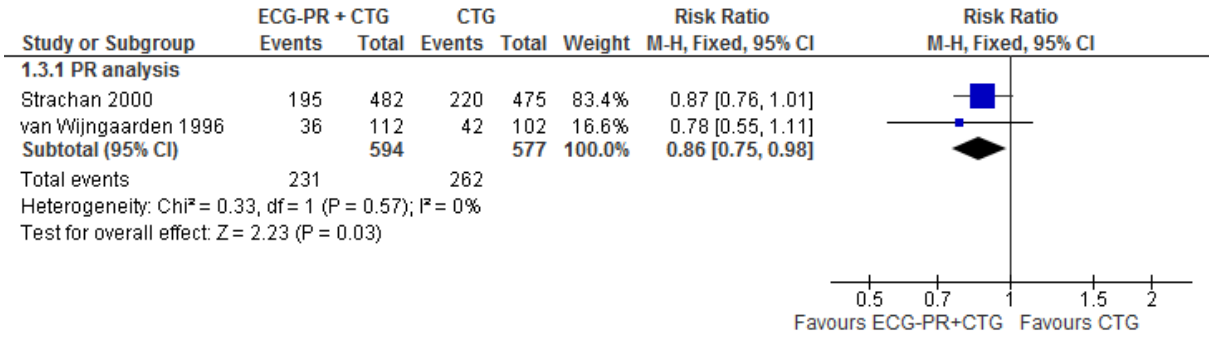
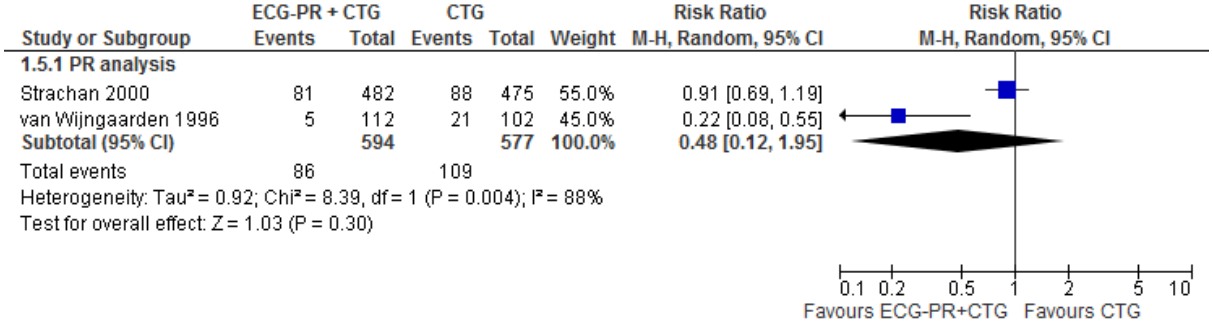


Figure 40: Fetal blood sampling



ST waveform analysis

Figure 41: Spontaneous vaginal birth

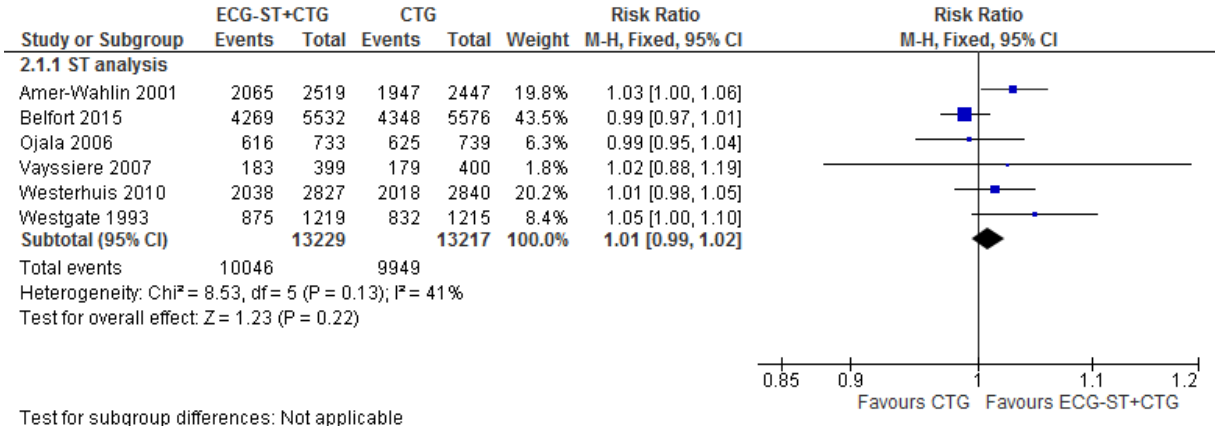


Figure 42: Caesarean section

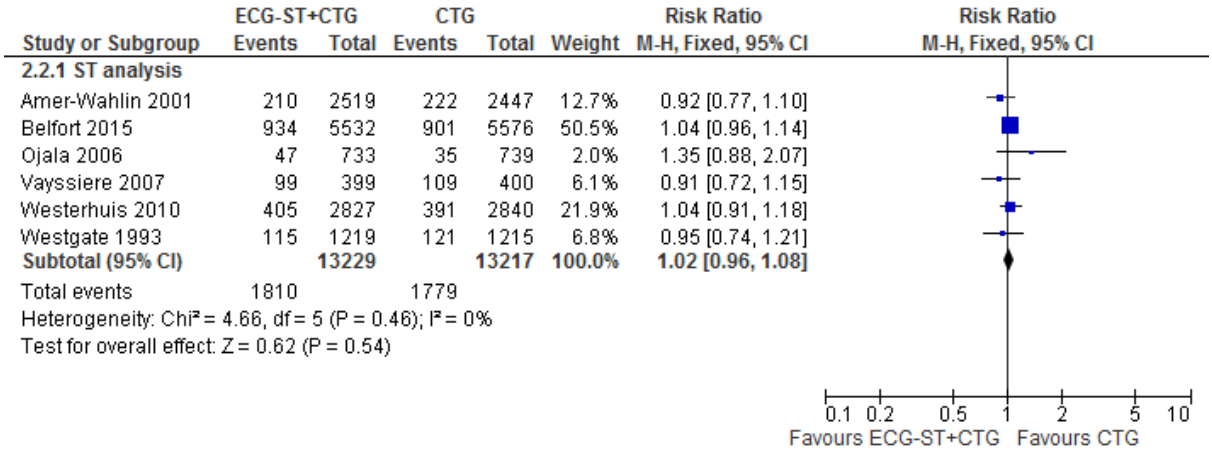


Figure 43: Instrumental vaginal birth

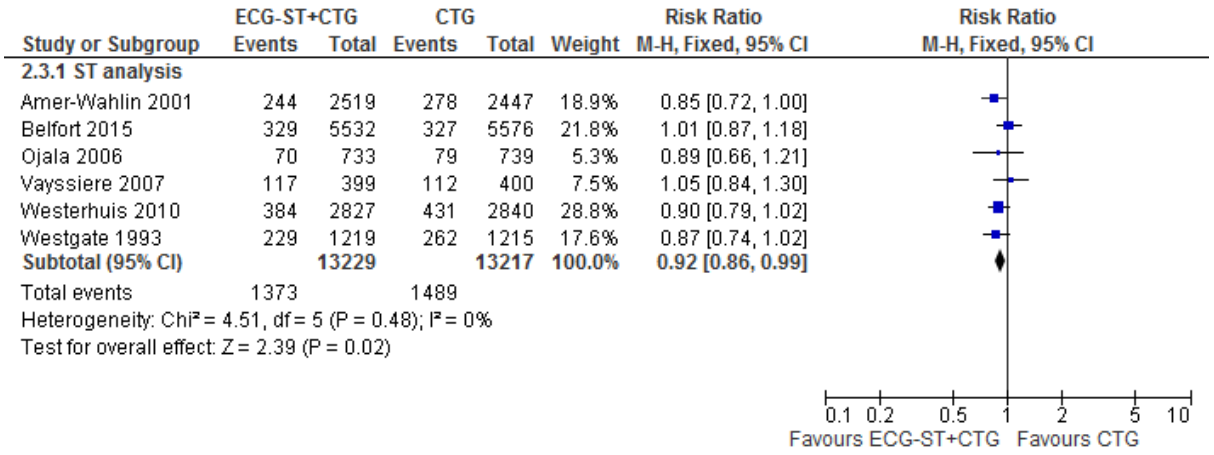


Figure 44: Fetal blood sampling

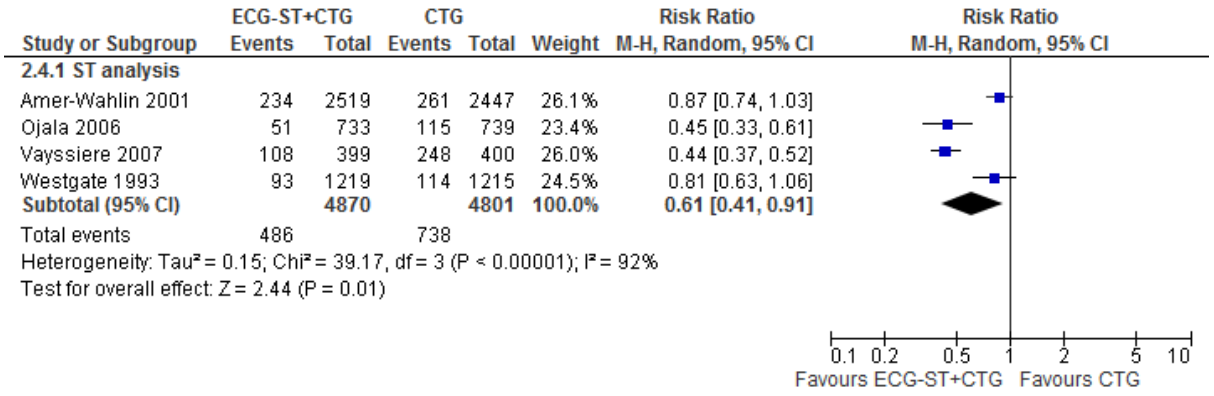


Figure 45: Fetal and neonatal death

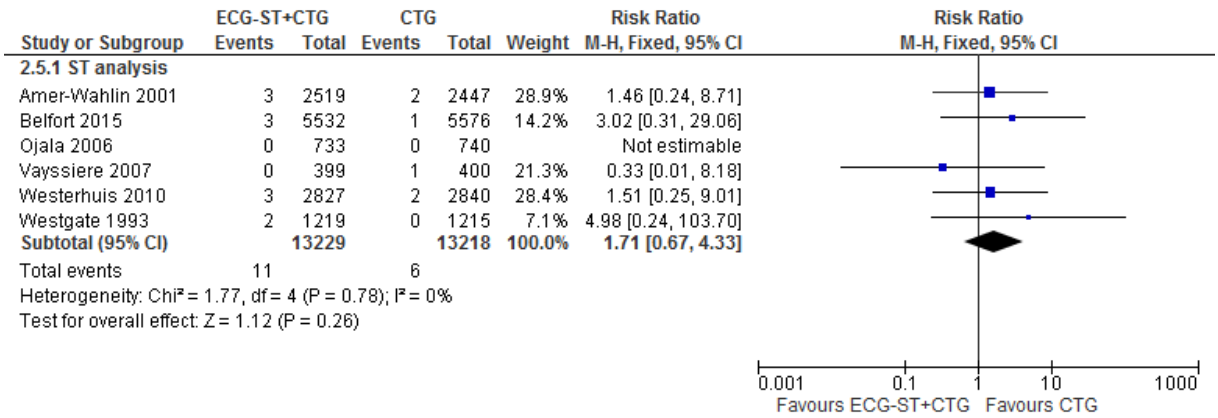


Figure 46: Cord pH < 7.05 and base deficit > 12 mmol/l

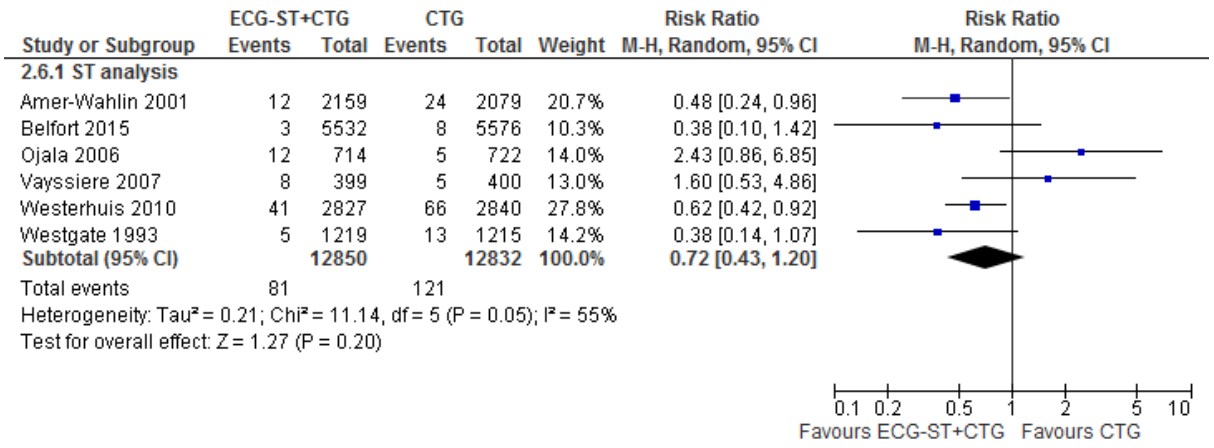


Figure 47: Neonatal encephalopathy

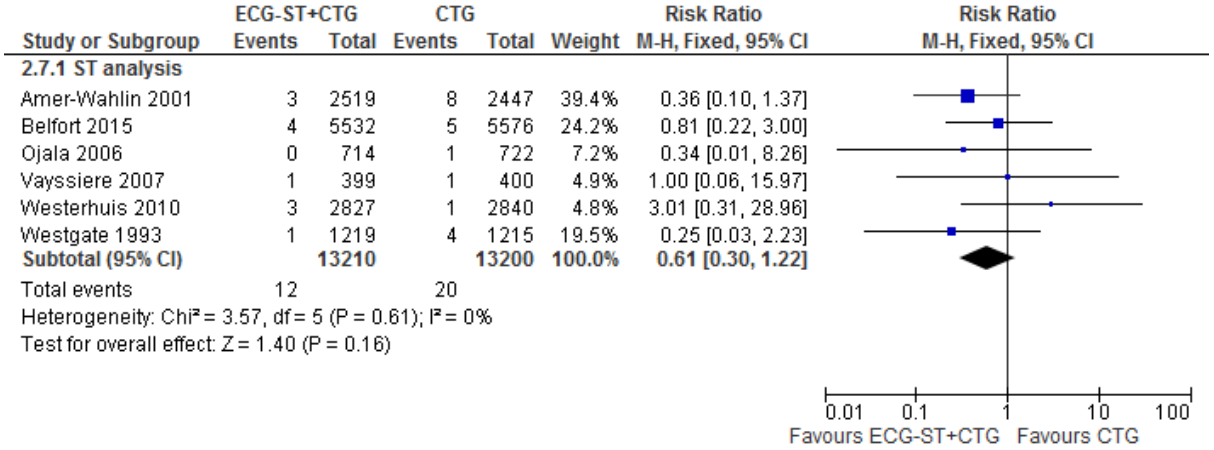


Figure 48: Admission to neonatal intensive care unit

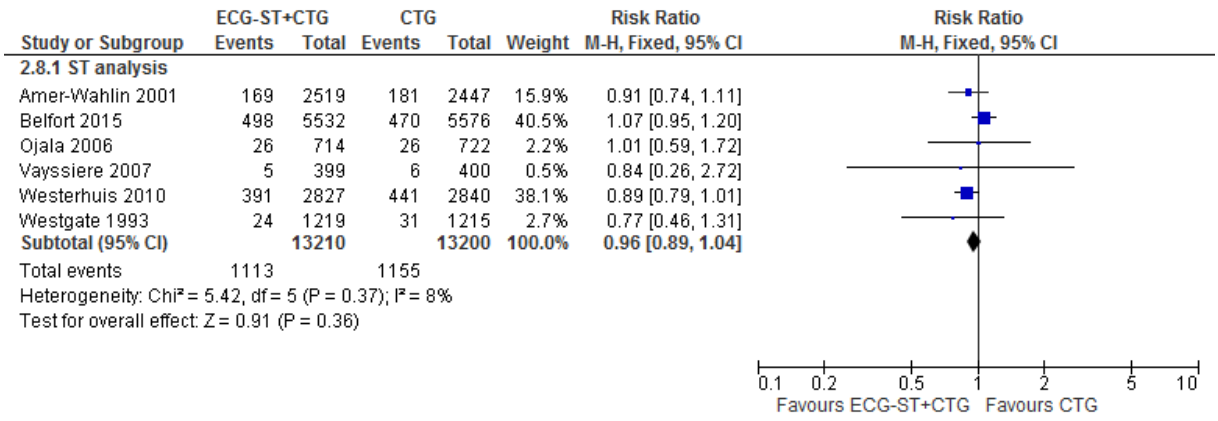


Figure 49: Apgar score < 7 at 5 minutes

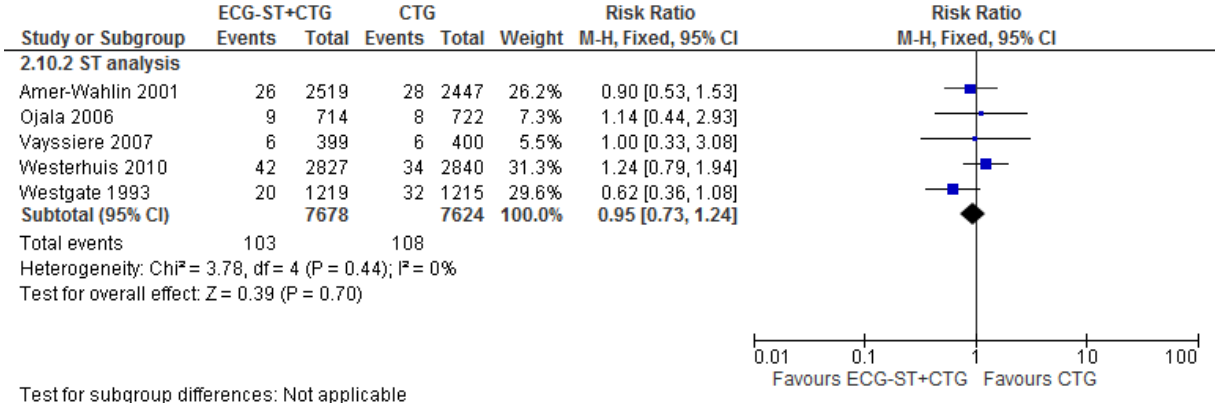
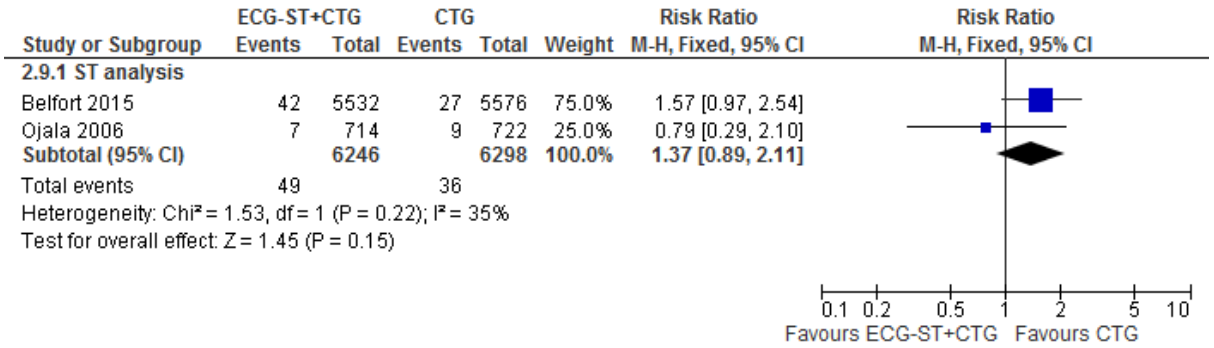


Figure 50: Neonatal intubation



H.12 Automated interpretation of cardiotocograph traces

There are no forest plots for this review question.

Appendix I: GRADE tables

The GRADE tables in this section provide further detail about the quality assessment for the studies included in the guideline reviews.

I.1 Intermittent auscultation compared with cardiotocography on admission

Table 3: GRADE findings for comparison of continuous cardiotocography compared with intermittent auscultation on admission

Quality assessment							Number of women or babies		Effect		
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Electronic fetal monitoring	Intermittent auscultation	Relative (95% CI)	Absolute (95% CI) and p-value (if reported)	Quality
Mode of birth: caesarean section											
1 meta-analysis of 4 studies (Devane 2012)	Randomised trials	Serious[1]	No serious inconsistency	Serious[2]	No serious imprecision	None	248/5657 (4.4%)	207/5681 (3.6%)	RR 1.2 (1 to 1.44)	7 more per 1000 (from 0 fewer to 16 more)	Low
Mode of birth: instrumental vaginal birth											
1 meta-analysis of 4 studies (Devane 2012)	Randomised trials	Serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	None	782/5657 (13.8%)	716/5681 (12.6%)	RR 1.1 (0.95 to 1.27)	13 more per 1000 (from 6 fewer to 34 more)	Moderate
Fetal and neonatal deaths											
1 meta-analysis of 4 studies	Randomised trials	Serious[1]	No serious inconsistency	Serious[3]	No serious imprecision	None	5/5658 (0.09%)	5/5681 (0.09%)	RR 1.01 (0.3 to 3.47)	0 more per 1000	Low

Quality assessment							Number of women or babies		Effect		
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Electronic fetal monitoring	Intermittent auscultation	Relative (95% CI)	Absolute (95% CI) and p-value (if reported)	Quality
(Devane 2012)										(from 1 fewer to 2 more)	
Neonatal morbidity: hypoxic ischaemic encephalopathy											
1 study (Devane 2012)	Randomised trial	Very serious[4,5]	No serious inconsistency	No serious indirectness	No serious imprecision	None	6/1186 (0.51%)	5/1181 (0.42%)	RR 1.19 (0.37 to 3.9)	1 more per 1000 (from 3 fewer to 12 more)	Low
Neonatal morbidity: seizures											
1 study (Devane 2012)	Randomised trial	No serious risk of bias	No serious inconsistency	Serious[6]	No serious imprecision	None	10/4017 (0.25%)	14/4039 (0.35%)	RR 0.72 (0.32 to 1.61)	1 fewer per 1000 (from 2 fewer to 2 more)	Moderate
Admission to neonatal intensive care unit (NICU)											
1 meta-analysis of 4 studies (Devane 2012)	Randomised trials	Serious[1]	No serious inconsistency	Serious[7]	No serious imprecision	None	219/5656 (3.9%)	213/5675 (3.8%)	RR 1.03 (0.86 to 1.24)	1 more per 1000 (from 5 fewer to 9 more)	Low
Cord blood gas values at birth: metabolic acidosis (pH < 7.20 with a base deficit of > 8.0)											
1 study (Mires 2001)	Randomised trial	Very serious[4,5,8]	No serious inconsistency	No serious indirectness	No serious imprecision	None	159/876 (18.2%)	154/860 (17.9%)	RR 1.01 (0.83 to 1.24)	2 more per 1000 (from 30 fewer to 43 more)	Low

CI confidence interval, RR relative risk, NICU neonatal intensive care unit

1 In one trial randomisation was performed in the third trimester and 37% of recruited women subsequently developed complications prior to admission. It is unclear whether this resulted in an imbalance in baseline characteristics influencing outcomes
2 In one trial (contributing 61% of the weight of the meta-analysis) 18% of the study population of the trial had their labour induced.
3 In one trial (contributing 59% of the weight of the meta-analysis), 18% of the study population of the trial had their labour induced.
4 The proportion of women considered to have an abnormal fetal heart pattern at the start of labour was significantly higher in the CTG arm compared to the auscultation arm (21.5% compared to 3.6%)
5 Trial protocol for monitoring women in labour is not reported
6 18% of the study population had their labour induced.
7 In one trial (contributing 74% of the weight of the meta-analysis) 18% of the study population of the trial had their labour induced.
8 27% of the study population had missing data for this outcome

I.2 Intermittent auscultation compared with cardiotocography during labour

Table 4: GRADE findings for comparison of electronic fetal monitoring compared with intermittent auscultation during established labour

Quality assessment							Number of women or babies		Effect		
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Electronic fetal monitoring	Intermittent auscultation	Relative (95% CI)	Absolute (95% CI) and p-value (if reported)	Quality
Mode of birth: spontaneous vaginal birth											
1 meta-analysis of 3 studies (Kelso 1978; Vintzileos 1993; Wood 1981)	Randomised trials	Serious[1]	No serious inconsistency	Serious[2]	No serious imprecision	None	1036/1444 (71.7%)	1094/1415 (77.3%)	RR 0.92 (0.89 to 0.97)	62 fewer per 1000 (from 23 fewer to 85 fewer)	Low
Mode of birth: instrumental vaginal birth for any indication											
1 meta-analysis of 4 studies	Randomised trials	No serious	Serious[3]	Serious[4]	No serious	None	823/7918 (10.4%)	648/7905 (8.2%)	RR 1.24 (1.04 to 1.48)	20 more per 1000	Low

Quality assessment							Number of women or babies		Effect		
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Electronic fetal monitoring	Intermittent auscultation	Relative (95% CI)	Absolute (95% CI) and p-value (if reported)	Quality
(Kelso 1978; MacDonald 1985; Vintzileos 1993; Wood 1981)		risk of bias			imprecision					(from 3 more to 39 more)	
Mode of birth: instrumental vaginal birth for fetal distress											
1 study (MacDonald 1985)	Randomised trial	No serious risk of bias	No serious inconsistency	Serious[5]	No serious imprecision	None	190/6474 (2.9%)	75/6490 (1.2%)	RR 2.54 (1.95 to 3.31)	18 more per 1000 (from 11 more to 27 more)	Moderate
Mode of birth: caesarean section for any indication											
1 meta-analysis of 4 studies (Kelso 1978; MacDonald 1985; Vintzileos 1993; Wood 1981)	Randomised trials	No serious risk of bias	No serious inconsistency	Serious[6]	No serious imprecision	None	271/7918 (3.4%)	224/7905 (2.8%)	RR 1.19 (1 to 1.41)	5 more per 1000 (from 0 fewer to 12 more)	Moderate
Mode of birth: caesarean section for fetal distress											
1 meta-analysis of 4 studies (Kelso 1978; Leveno 1986;	Randomised trials	Serious[7]	No serious inconsistency	Serious[6]	No serious imprecision	None	133/14761 (0.9%)	57/14753 (0.39%)	RR 2.28 (1.68 to 3.1)	5 more per 1000 (from 3 more to 8 more)	Low

Quality assessment							Number of women or babies		Effect		
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Electronic fetal monitoring	Intermittent auscultation	Relative (95% CI)	Absolute (95% CI) and p-value (if reported)	Quality
MacDonald 1985; Vintzileos 1993)											
Intrapartum fetal death											
1 meta-analysis of 3 studies (Leveno 1986; MacDonald 1985; Vintzileos 1993)	Randomised trials	No serious risk of bias	No serious inconsistency	Serious[8]	No serious imprecision	None	3/14564 (0.02%)	4/14566 (0.03%)	RR 0.76 (0.19 to 3.01)	0 fewer per 1000 (from 0 fewer to 1 more)	Moderate
Neonatal death											
1 meta-analysis of 5 studies (Kelso 1978; Leveno 1986; MacDonald 1985; Vintzileos 1993; Wood 1981)	Randomised trials	No serious risk of bias	No serious inconsistency	Serious[9]	No serious imprecision	None	18/15262 (0.12%)	25/15299 (0.16%)	RR 0.72 (0.4 to 1.3)	0 fewer per 1000 (from 1 fewer to 0 more)	Moderate
Neonatal morbidity: cerebral palsy											
1 study (Grant 1989)	Randomised trial	Serious[10]	No serious	Serious[11]	No serious	None	12/6527 (0.18%)	10/6552 (0.15%)	RR 1.2	0 more per 1000	Low

Quality assessment							Number of women or babies		Effect		
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Electronic fetal monitoring	Intermittent auscultation	Relative (95% CI)	Absolute (95% CI) and p-value (if reported)	Quality
			inconsistency		imprecision				(0.52 to 2.79)	(from 1 fewer to 3 more)	
Neonatal morbidity: hypoxic ischaemic encephalopathy											
1 study (Vintzileos 1993)	Randomised trial	Serious[12]	No serious inconsistency	Serious[13]	No serious imprecision	None	1/746 (0.13%)	2/682 (0.29%)	RR 0.46 (0.04 to 5.03)	2 fewer per 1000 (from 3 fewer to 12 more)	Low
Neonatal morbidity: seizures											
1 meta-analysis of 3 studies (Leveno 1986; MacDonald 1985; Vintzileos 1993)	Randomised trials	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	None	8/13072 (0.06%)	24/13027 (0.18%)	RR 0.34 (0.16 to 0.75)	1 fewer per 1000 (from 0 fewer to 2 fewer)[a]	High
Neonatal morbidity: intraventricular haemorrhage											
1 study (Vintzileos 1993)	Randomised trial	Serious[12]	No serious inconsistency	Serious[13]	No serious imprecision	None	0/746 (0%)	1/682 (0.15%)	RR 0.3 (0.01 to 7.47)	1 fewer per 1000 (from 1 fewer to 9 more)	Low
Neonatal morbidity: respiratory distress											

Quality assessment							Number of women or babies		Effect		
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Electronic fetal monitoring	Intermittent auscultation	Relative (95% CI)	Absolute (95% CI) and p-value (if reported)	Quality
1 study (Vintzileos 1993)	Randomised trial	Serious[12]	No serious inconsistency	Serious[13]	Very serious[14]	None	55/746 (7.4%)	40/682 (5.9%)	RR 1.26 (0.85 to 1.86)	15 more per 1000 (from 9 fewer to 50 more)	Very low
Neonatal morbidity: abnormal neurologic symptoms or signs											
1 meta-analysis of 3 studies (Kelso 1978; MacDonald 1985; Wood 1981)	Randomised trials	Serious[15]	No serious inconsistency	Serious[16]	No serious imprecision	None	19/5767 (0.33%)	31/5804 (0.53%)	RR 0.62 (0.35 to 1.09)	2 fewer per 1000 (from 3 fewer to 0 more)	Low
Admission to neonatal intensive care unit (NICU) or nursery											
1 meta-analysis of 5 studies (Kelso 1978; Leveno 1986; MacDonald 1985; Vintzileos 1993; Wood 1981)	Randomised trials	No serious risk of bias	No serious inconsistency	Serious[17]	No serious imprecision	None	780/15200 (5.1%)	753/15291 (4.9%)	RR 1.03 (0.94 to 1.13)	1 more per 1000 (from 3 fewer to 6 more)	Moderate
Cord blood gas values at birth: arterial or venous pH < 7.10											
1 meta-analysis of 2 studies	Randomised trials	Serious[18]	Serious[3]	Serious[19]	No serious	None	36/1279 (2.8%)	29/1215 (2.4%)	RR 0.92 (0.27 to 3.11)	2 fewer per 1000	Very low

Quality assessment							Number of women or babies		Effect		
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Electronic fetal monitoring	Intermittent auscultation	Relative (95% CI)	Absolute (95% CI) and p-value (if reported)	Quality
(MacDonald 1985; Vintzileos 1993)					imprecision					(from 17 fewer to 50 more)	

CI confidence interval, RR relative risk

a When expressed per 10,000 babies, the absolute effect is 12 fewer (from 5 fewer to 15 fewer)
1 In Vintzileos 1993 (53% of weight of meta-analysis), significantly more women in the EFM arm were induced or augmented with oxytocin when compared to the auscultation arm. In Wood 1981 (32% of the weight of the meta-analysis), treatment allocation was not concealed. A significant difference in the proportion of nulliparous women in the two arms had to be corrected by the removal of women at random. In Kelso 1978 (15% of weight of meta-analysis), method of randomisation was not reported. In addition, monitoring was done internally therefore EFM arm may have received an extra intervention in the form of an amniotomy, that the auscultation arm did not.
2 In Vintzileos 1993 (53% of the weight of the meta-analysis), 12.8% of women had antepartum risk factors, 7.4% were preterm and 12% were induced. In Kelso 1978 (15% of the weight of the meta-analysis), 26% of the women had induction of labour.
3 High heterogeneity ($I^2 > 60\%$)
4 In MacDonald 1985 (35% of the weight of the meta-analysis) 22.5% of women were classified as high risk. In two further trials, Kelso 1978 and Vintzileos 1993 (totalling 40% of the weight of the meta-analysis), approximately a quarter of the women had induction of labour or antepartum risk factors
5 22.5% of women were classified as high risk
6 Three out of the four trials (over 50% of the weight of the meta-analysis) included a proportion of women who were not completely low risk
7 Leveno 1986 (48% of the meta-analysis) allocated women in alternating months; therefore, it was not truly randomised and treatment allocation was not concealed. The comparison being evaluated by the trial was selective versus universal use of EFM; therefore, the comparison of interest for this review is poorly reported and comparability of the two arms cannot be assessed.
8 Two out of the three trials (100% of the weight of the meta-analysis) had a proportion of women who would not be considered completely low risk
9 3 out of the 5 trials (79% of the weight of the meta-analysis) had a proportion of women who would not be considered completely low risk
10 Due to the method of data collection, any infants or children who did not attend clinics in Ireland (i.e. those who may have moved or died) or have symptoms at birth would not have been identified
11 22.5% of the original trial population were classified as high risk
12 There were significant differences between the two arms: more women were induced or augmented with oxytocin in the EFM arm when compared to the auscultation arm. The trial was also stopped early due to mortality rates.
13 12.8% of women had antepartum risk factors, 7.4% were preterm and 12% were induced.
14 Very wide confidence interval
15 In MacDonald 1985 (81% of the weight of the meta-analysis), data on this outcome was not collected for 23% of the study population because the trial protocol was simplified during the study period. In Wood 1981 (10% of the weight of the meta-analysis) no details of the type of neurological signs and symptoms are reported and there is no explanation of how the data was collected.

16 In MacDonald 1985 (81% of the weight of the meta-analysis), 22.5% of the original trial population were classified as high risk. In Kelso 1978 (10% of the weight of the meta-analysis), 26% of women had induction of labour
17 In MacDonald 1985 (72% of the weight of the meta-analysis), 22.5% of the original trial population were classified as high risk. In two other trials (a further 20% of the weight of the meta-analysis), there were a proportion of women who would not be considered low risk.
18 In Vintzileos 1993 (56% of the weight of the meta-analysis), there were significant differences between the two arms: more women were induced or augmented with oxytocin in the EFM arm when compared to the auscultation arm. The trial was also stopped early due to mortality rates.
19 Both trials included some women who were not low risk. In Vintzileos 1993 (56% of the weight of the meta-analysis), 12.8% of women had antepartum risk factors, 7.4% were preterm and 12% were induced. In MacDonald 1985 (44% of the weight of the meta-analysis), 22.5% of women were high risk.

I.3 Intermittent auscultation compared with cardiotocography in the presence of meconium stained liquor

Table 5: GRADE findings for comparison of continuous cardiotocography with intermittent auscultation

Quality assessment							Number of women		Effect		
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Continuous CTG	Intermittent auscultation (IA)	Relative (95% CI)	Absolute (95% CI)	Quality
Caesarean section											
1 meta-analysis of 2 studies (Alfirevic 2013)	Randomised trials	Serious[1]	Serious[2]	Serious[3]	Serious[4]	None	74/275 (26.9%)	36/275 (13.1%)	RR 2.11 (1.19 to 3.74)	145 more per 1000 (from 25 more to 359 more)	Very low
Caesarean section for abnormal FHR pattern and/or acidosis											
1 meta-analysis of 2 studies (Alfirevic 2013)	Randomised trials	Serious[1]	No serious inconsistency	Serious[3]	No serious imprecision	None	47/275 (17.1%)	21/275 (7.6%)	RR 2.24 (1.38 to 3.64)	95 more per 1000 (from 29 more to 202 more)	Low
Caesarean section for other reason											
1 meta-analysis of 2 studies	Randomised trials	Serious[1]	Serious[2]	Serious[3]	Very serious[5]	None	27/275 (9.8%)	15/275 (5.5%)	RR 1.80 (0.98 to 3.31)	43 more per 1000	Very low

Quality assessment							Number of women		Effect		
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Continuous CTG	Intermittent auscultation (IA)	Relative (95% CI)	Absolute (95% CI)	Quality
(Alfirevic 2013)										(from 1 fewer to 125 more)	
Instrumental vaginal birth											
1 meta-analysis of 2 studies (Alfirevic 2013)	Randomised trials	Serious[1]	No serious inconsistency	Serious[3]	Very serious[5]	None	108/275 (39.3%)	94/275 (34.2%)	RR 1.16 (0.88 to 1.54)	55 more per 1000 (from 41 fewer to 185 more)	Very low
Spontaneous vaginal birth not achieved											
1 meta-analysis of 2 studies (Alfirevic 2013)	Randomised trials	Serious[1]	Serious[6]	Serious[3]	No serious imprecision	None	182/275 (66.2%)	130/275 (47.3%)	RR 1.4 (1.2 to 1.63)	189 more per 1000 (from 95 more to 298 more)	Very low
Perinatal death											
1 meta-analysis of 2 studies (Alfirevic 2013)	Randomised trials	Serious[1]	No serious inconsistency	Serious[3]	Serious[4]	None	5/275 (1.8%)[a]	6/275 (2.2%)[a]	RR 0.83 (0.26 to 2.67)	4 fewer per 1000 (from 16 fewer to 36 more)	Very low
NICU admissions											
1 study (Alfirevic 2013)	Randomised trial	No serious risk of bias	No serious inconsistency	Serious[3]	No serious imprecision	None	11/175 (6.3%)	30/175 (17.1%)	RR 0.37 (0.19 to 0.71)	108 fewer per 1000 (from 50 fewer to 139 fewer)	Moderate
Neonatal seizures											
1 study	Randomised trial	No serious	No serious	Serious[3]	Serious[4]	None	0/175	4/175	RR 0.11	20 fewer per 1000	Low

Quality assessment							Number of women		Effect		
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Continuous CTG	Intermittent auscultation (IA)	Relative (95% CI)	Absolute (95% CI)	Quality
(Alfirevic 2013)		risk of bias	inconsistency				(0%)	(2.3%)	(0.01 to 2.05)	(from 23 fewer to 24 more)	
Damage/infection from scalp electrode or scalp sampling											
1 study (Alfirevic 2013)	Randomised trial	Serious[1]	No serious inconsistency	No serious indirectness	Serious[4]	None	1/100 (1%)	0/100 (0%)	RR 3 (0.12 to 72.77)	NC	Low

CI confidence interval, CTG cardiotocography, IA intermittent auscultation, NICU neonatal intensive care unit, RR relative risk

a The rate of mortality was 4.5% (4/100 in CTG group and 5/100 in IA group) in one study (Pakistan 1989) and 0.6% (1/175 in CTG group and 1/175 in IA group) in the other study (Melbourne 1976). 89% of the weight of the meta-analysis is from one study (Pakistan 1989) .The reasons for the perinatal deaths are not reported
1 No allocation concealment in one study (Pakistan 1989). Data from this study extracted from unpublished trial lodged with Cochrane centre. No detailed description of the study is reported
2 I^2 = 57%
3 Population in one study (Melbourne 1976) consisted of high-risk women with 40% of women with meconium-stained liquor
4 Wide CI
5 Very wide CI
6 I^2: 86%
7 I^2: 64%

I.4 Interpretation of cardiotocograph traces

I.4.1 Low risk and mixed populations

I.4.1.1 Baseline fetal heart rate (tachycardia and bradycardia)

Table 6: GRADE findings for predictive value of tachycardia and bradycardia for adverse neonatal outcomes

Quality assessment								Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Definition of outcome	Stage of labour		Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Tachycardia (> 150 bpm)(FIGO classification 1987)													
1 study (Holzmann 2015)	Prospective cohort	Very serious[1]	No serious inconsistency	No serious indirectness	Serious imprecision[2]	Fetal lactacidaemia (lactate > 4.8 mmol/l)	NR; 60 minutes prior to first fetal blood sampling	1070	62.50 % (35.87 to 83.72)[a]	67.43 % (62.21 to 72.26)[a]	1.92 (1.28 to 2.89)[a]	0.56 (0.29 to 1.05)[a]	Very low
1 study (Holzmann 2015)	Prospective cohort	Very serious[1]	No serious inconsistency	No serious indirectness	Serious imprecision[2]	Fetal lactacidaemia (lactate > 4.8 mmol/l)	NR; 60 minutes prior to last fetal blood sampling	888	64.0% (42.6 to 81.3)[a]	66.4% (60.4 to 72.0)[a]	1.91 (1.36 to 2.67)[a]	0.54 (0.32 to 0.92)[a]	Very low
Tachycardia (> 160 bpm) (duration not reported)													
1 study (Nelson 1996)	Case control	Serious[3]	No serious inconsistency	No serious indirectness	No serious imprecision	Cerebral palsy	NR	378	28.2% (19.4 to 39)[b]	71.7% (66.3 to 76.5)[b]	0.99 (0.66 to 1.48)[b]	1.0 (0.85 to 1.17)[b]	Low

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
1 study (Gilstrap 1984)	Cohort	Serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH < 7.20	NR	583	47.2% (30.9 to 63.5)[b]	80.4% (76.9 to 83.87)[b]	2.41 (1.63 to 3.55)[b]	0.65 (0.48 to 0.89)[b]	Moderate
Tachycardia (> 180 bpm) (duration not reported)													
1 study (Nelson 1996)	Case control	Serious[3]	No serious inconsistency	No serious indirectness	No serious imprecision	Cerebral palsy	NR	378	6.4% (2.8 to 14.1)[b]	94.7% (91.5 to 96.7)[b]	1.20 (0.45 to 3.17)[b]	0.98 (0.92 to 1.05)[b]	Low
Bradycardia (< 110 bpm) (NICHD classification) (duration not reported)													
1 study (Williams 2004)	Case series	Serious[5]	No serious inconsistency	No serious indirectness	No serious imprecision	Seizure	1 hour before birth	50	46.7% (30.2 to 63.9)[b]	19.2% (8.5 to 37.9)[b]	0.57 (0.37 to 0.88)[b]	2.77 (1.17 to 6.52)[b]	Low
FHR baseline (< 110 bpm) (NICHD classification) (duration not reported)													
1 study (Larma 2007)	Case control	Serious[6]	No serious inconsistency	Serious[7]	No serious imprecision	Moderate HIE	Last hour of tracing	214	15.4 %	98.9%	7.50	0.86	Very low
Bradycardia ("terminal deceleration")[c]													
1 study (Cahill 2013)	Case control	No serious risk of bias	No serious inconsistency	No serious inconsistency	No serious imprecision	Umbilical cord arterial pH < 7.10	30 minutes before birth	5388	21.0%	82.3%	1.20 (0.72 to	0.96 (0.84 to	Low

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
									(11.3 to 33.9)[b]	(81.3 to 93.4)[b]	1.98)[b]	1.10)[b]	
Bradycardia ("terminal deceleration")[c]													
1 study (Cahill 2013)	Case control	No serious risk of bias	No serious inconsistency	No serious inconsistency	No serious imprecision	Umbilical cord arterial pH < 7.10 and base excess < -8.0	30 minutes before birth	5388	22.0% (11.5 to 36.0)[b]	82.3% (81.3 to 83.4)[b]	1.25 (0.47 to 2.11)[b]	0.95 (0.82 to 1.10)[b]	Low
Bradycardia ("terminal deceleration")[c]													
1 study (Cahill 2013)	Case control	No serious risk of bias	No serious inconsistency	No serious inconsistency	No serious imprecision	NICU admission	30 minutes before birth	5388	06.67 % (1.11 to 32.0)[b]	82.3% (81.2 to 83.3)[b]	0.38 (0.06 to 2.51)[b]	1.13 (0.99 to 1.30)	Low
Prolonged bradycardia (< 110 bpm) (≥ 10 min)[d]													
1 study (Cahill 2013)	Case control	No serious risk of bias	No serious inconsistency	No serious inconsistency	No serious imprecision	Umbilical cord arterial pH < 7.10	30 minutes before birth	951	33.3% (10.13 to 65.5)[b]	97.12 % (95.84 to 98.1)[b]	11.6 (4.80 to 28.0)[b]	0.69 (0.46 to 1.02)[b]	Low
Bradycardia (< 100 bpm) (duration not reported)													
1 study (Nelson 1996)	Case control	Serious[3]	No serious inconsistency	No serious indirectness	No serious imprecision	Cerebral palsy	NR	378	34.6% (25 to 45.7)[b]	75% (69.8 to 79.6)[b]	1.38 (0.96 to 1.99)[b]	0.87 (0.73 to 1.03)[b]	Low

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Mild bradycardia (90 – 119 bpm) (duration not reported)													
1 study (Gilstrap 1984)	Cohort	Serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH < 7.20	10 minutes before birth	595	61.2% (47.5 to 74.87)[b]	75.2% (71.6 to 78.8)[b]	2.47 (1.89 to 3.23)[b]	0.51 (0.36 to 0.73)[b]	Very low
Bradycardia (< 80 bpm) (duration not reported)													
1 study (Nelson 1996)	Case control	Serious[3]	No serious inconsistency	No serious indirectness	No serious imprecision	Cerebral palsy	NR	378	16.7% (10 to 26.5)[b]	88.3% (84.2 to 91.5)[b]	1.42 (0.79 to 2.56)[b]	0.94 (0.84 to 1.05)[b]	Low
Moderate/marked bradycardia (60 – 89 bpm) (duration not reported)													
1 study (Gilstrap 1984)	Cohort	Serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH < 7.20	NR	551	63.4% (50.3 to 76.5)[b]	82.3% (79 to 85.7)[b]	3.59 (2.71 to 4.76)[b]	0.44 (0.30 to 0.63)[b]	Moderate
Bradycardic episode (<110 bpm as in FIGO classification 1987)													
1 study (Holzmann 2015)	Prospective cohort	Very serious[1]	No serious inconsistency	No serious indirectness	Serious imprecision[8]	Fetal lactacidaemia (lactate > 4.8 mmol/l)	NR; 60 minutes prior to first fetal blood sampling	1070	62.50 % (35.87 to 83.72)[a]	86.76 % (82.02 to 90.44)[a]	4.72 (2.90 to 7.68)[a]	0.43 (0.23 to 0.81)[a]	Very low

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
1 study (Holzmann 2015)	Prospective cohort	Very serious[1]	No serious inconsistency	No serious indirectness	Serious imprecision[8]	Fetal lactacidaemia (lactate > 4.8 mmol/l)	NR; 60 minutes prior to last fetal blood sampling	888	57.1% (34.4 to 77.4)[a]	88.1% (82.6 to 92.1)[a]	4.81 (2.84 to 8.15)[a]	0.49 (0.30 to 0.80)[a]	Very low

BPM beats per minute; CI confidence interval; FIGO International Federation of Gynecology and Obstetrics; HIE hypoxic ischaemic encephalopathy; NICHD National Institute of Child Health and Human Development; NICU Neonatal Intensive Care Unit; NR not reported

a Calculated by the 2017 NGA technical team
b Calculated by the 2014 NCC-WCH technical team
c The term 'terminal deceleration' used in the paper for this bradycardia defined as a prolonged deceleration (15 bpm or more below baseline for 2 minutes - 10 minutes)
d Bradycardia < 10 minutes compared with prolonged bradycardia > 10 minutes
1 All women in the study had received fetal blood sampling (FBS) therefore may not be representative of the whole population. CTGs were classified by a single observer
2. Confidence interval for the negative likelihood ratio crosses 0.5
3 Unclear if assessor was blinded to group allocation. No monitoring traces were available; data were collected from medical notes recorded by physicians who attended the birth
4 Unclear analysis
5 Unclear if babies identified as cases were born to women with a low risk pregnancy
6 Exclusion criteria not specified, high risk of selection bias
7 Unclear if women with pre-existing medical condition were excluded
8 Confidence interval for the positive likelihood ratio crosses 5; confidence interval for the negative likelihood ratio crosses 0.5

Table 7: GRADE findings for umbilical arterial pH and base excess in babies with intrapartum tachycardia or bradycardia

Quality assessment							Fetal heart rate tracing				
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Stage of labour	Normal	Tachycardia[a]	Mild bradycardia[a]	Moderate or severe bradycardia[a]	Quality
Umbilical cord artery pH (mean ± standard deviation)											
1 study (Honjo 2001)	Cohort	Serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	2nd stage	pH 7.31 ± 0.05 n = 236	pH 7.22 ± 0.11 p < 0.001[b] n = 57	pH 7.25 ± 0.06 p < 0.01[b] n = 11	pH 7.18 ± 0.06 p < 0.001[b] n = 61	Moderate
Base excess											
1 study (Honjo 2001)	Cohort	Serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	2nd stage	BE -5.2 ± 2.8 n = 236	BE -9.2 ± 4.5 p < 0.001[b] n = 57	BE -8.7 ± 4.4 p < 0.05[b] n = 11	BE -10.2 ± 3.5 p < 0.001[b] n = 61	Moderate

BE base excess

a Baseline tachycardia and bradycardia were defined as:

- *Mild bradycardia: baseline FHR between 90 - 109 bpm for ≥10 minutes*
- *Moderate to severe bradycardia: baseline FHR < 90 bpm for ≥10 minutes*
- *Tachycardia: baseline FHR of 160 bpm for ≥10 minutes*

b p value when compared with normal FHR tracing
1 Unclear how and by whom data were analysed

Table 8: GRADE findings for association between FHR (bradycardia and tachycardia) and umbilical artery blood gas values or adverse neonatal outcomes

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
"Mild" bradycardia (90- 119 bpm) (compared with normal FHR tracing)[a] (duration not reported)										
1 study (Berkus 1999)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Immediate adverse neonatal outcome[b]	1st stage	24	No statistically significant association (numerical data not reported)	Very low
1 study (Berkus 1999)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Immediate adverse neonatal outcome[b]	2nd stage	24	No statistically significant association (numerical data not reported)	Very low
"Mild" bradycardia (90 - 119 bpm) (duration not reported)										
1 study (Gilstrap 1987)	Cohort	Serious [4,5]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH mean (± SD)	2nd stage before head expulsion	53	7.23 ± 0.07 P < 0.05	Very low
Prolonged bradycardia (< 110 bpm) (≥ 10 min)										
1 study (Cahill 2013)	Cohort	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	Cord pH < 7.10	30 minutes before birth	31	OR[c] 18.6 (95% CI 5.0 to 68.9) P = 0.01	Low
1 study (Cahill 2013)	Cohort	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	Cord pH < 7.05	30 minutes before birth	31	OR[c] 46.0 (95% CI 5.7 to 373) P = 0.01	Low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**					
1 study (Cahill 2013)	Cohort	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	Cord pH < 7.10 and base excess < -8.0	30 minutes before birth	31	OR[c] 3.8 (95% CI 1.4 to 10.7) P = 0.01	Low
1 study (Cahill 2013)	Cohort	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	NICU admission	30 minutes before birth	31	OR[c] 14.2 (95% CI 3.4 to 59.6) P = 0.01	Low
"Prolonged" bradycardia (FHR < 90 bpm for more than 2.5 minutes) (compared with normal FHR tracing)[a]										
1 study (Berkus 1999)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Immediate adverse neonatal outcome[b]	1st stage	129	OR 1.9 (95% CI 1.3 to 3.7)	Very low
1 study (Berkus 1999)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Immediate adverse neonatal outcome[b]	2nd stage	129	No statistically significant association (numerical data not reported)	Very low
"Persistent" bradycardia (not defined) (duration not reported)										
1 study (Roy 2008)	Cohort	Serious [1,5,6]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord pH < 7.10	NR	106	n = 4 (3.7%)	Low
1 study (Roy 2008)	Cohort	Serious [1,5,6]	No serious inconsistency	No serious indirectness	No serious imprecision	Immediate NICU admission	NR	106	n = 16 (15%)	Low
"Moderate to severe" bradycardia (FHR < 90 bpm) (mean ± standard deviation)										
1 study (Gilstrap 1987)	Cohort	No serious	No serious inconsistency	Serious[3]	No serious imprecision	Umbilical cord arterial pH	1st stage	63	7.22 ± 0.07 P < 0.05	Moderate

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
		risk of bias				mean (± SD)				
Moderate bradycardia (100 - 109 bpm) (time period of 5 minutes)										
1 study (Maso 2012)	Case series	Serious [7]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.2	2 hours before birth	17	n = 6 (35.3%)	Low
1 study (Maso 2012)	Case series	Serious [7]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.1	2 hours before birth	17	n = 0 (0%)	Low
1 study (Maso 2012)	Case series	Serious [7]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.0	2 hours before birth	17	n = 0 (0%)	Low
1 study (Maso 2012)	Case series	Serious [7]	No serious inconsistency	No serious indirectness	No serious imprecision	BD ≥ 12 mmol/l	2 hours before birth	17	n = 5 (29.4%)	Low
1 study (Maso 2012)	Case series	Serious [7]	No serious inconsistency	No serious indirectness	No serious imprecision	Adverse composite neonatal outcome[d]	2 hours before birth	17	n = 0 (0%)	Low
Severe bradycardia (< 100 bpm) (time period of 10 min)										
1 study (Maso 2012)	Case series	Serious [7]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.2	2 hours before birth	15	n = 7 (46.7%)	Low
1 study (Maso 2012)	Case series	Serious [7]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.1	2 hours before birth	15	n = 4 (16.7%)	Low
1 study (Maso 2012)	Case series	Serious [7]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.0	2 hours before birth	15	n = 1 (6.7%)	Low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Maso 2012)	Case series	Serious [7]	No serious inconsistency	No serious indirectness	No serious imprecision	BD ≥ 12 mmol/l	2 hours before birth	15	n = 2 (13.3%)	Low
1 study (Maso 2012)	Case series	Serious [7]	No serious inconsistency	No serious indirectness	No serious imprecision	Adverse composite neonatal outcome[d]	2 hours before birth	15	n = 4 (26.7%)	Low
Bradycardia (< 70 bpm) (compared with normal FHR tracing - NICHD classification) (duration not reported)										
1 study (Sheiner 2001)	Case series	Serious [5,8]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.2 and base deficit (BD) ≥ 12 mmol/l	2nd stage	28	OR 3.4 (95% CI 1.2 to 8.6) P = 0.04	Low
1 study (Sheiner 2001)	Case series	Serious [5,8]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.2	1st stage	57	OR 26.6 (95% CI 5.2 to 150.3) P < 0.001	Low
1 study (Sheiner 2001)	Case series	Serious [5,8]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.2	2nd stage	57	OR 2.3 (95% CI 0.3 to 17.1) P = 0.390	Low
1 study (Sheiner 2001)	Case series	Serious [5,8]	No serious inconsistency	No serious indirectness	No serious imprecision	BD ≥ 12 mmol/l	1st stage	28	OR 5.2 (95% CI 0.8 to 31.9) P = 0.007	Low
1 study (Sheiner 2001)	Case series	Serious [5,8]	No serious inconsistency	No serious indirectness	No serious imprecision	BD ≥ 12 mmol/l	2nd stage	28	OR 3.8 (95% CI 0.3 to 44.2) P = 0.282	Low
Bradycardia ("terminal deceleration")[e]										

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Cahill 2013)	Cohort	No serious risk of bias	No serious inconsistency	No serious indirectness	Very serious[9]	cord pH < 7.10	30 minutes before birth	951	OR[c] 1.2 (95% CI 0.6 to 2.3) P = 0.49	Low
1 study (Cahill 2013)	Cohort	No serious risk of bias	No serious inconsistency	No serious indirectness	Very serious[9]	cord pH < 7.05	30 minutes before birth	951	OR[c] 1.4 (95% CI 0.5 to 4.4) P = 0.52	Low
1 study (Cahill 2013)	Cohort	No serious risk of bias	No serious inconsistency	No serious indirectness	Very serious[9]	Cord pH < 7.10 and base excess < -8.0	30 minutes before birth	951	OR[c] 1.3 (95% CI 0.6 to 2.5) P = 0.49	Low
1 study (Cahill 2013)	Cohort	No serious risk of bias	No serious inconsistency	No serious indirectness	Very serious[9]	NICU admission	30 minutes before birth	951	OR[c] 0.3 (95% CI 0.1 to 2.5) P = 0.49	Low
Bradycardia <110 bpm (duration not reported)										
1 study (Liu 2015)	Prospective cohort	Serious[10]	No serious inconsistency	No serious indirectness	Very serious[9]	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical	Last 30 minutes before birth	NR (total N=4736)	OR[f] 0.5 (95% CI 0.1 to 3.4)	Very low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
						ventilation in the first 24 hours)				
FHR <120 bpm (duration not reported)										
1 study (Liu 2015)	Prospective cohort	Serious [10]	No serious inconsistency	No serious indirectness	Very serious[9]	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical ventilation in the first 24 hours)	Last 30 minutes before birth	NR (total N=4736)	OR[f] 0.7 (95% CI 0.4 to 1.3)	Very low
Tachycardia (> 160 bpm) (duration not reported)										
1 study (Berkus 1999)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Immediate adverse neonatal outcome[b]	1st stage	126	No statistically significant association (numerical data not reported)	Very low
1 study (Berkus 1999)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Immediate adverse neonatal outcome[b]	2nd stage	126	OR 1.9 (95% CI 1.2 to 2.8)	Very low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Gilstrap 1987)	Cohort	Serious [1,2]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH < 7.2 Mean (± SD)	2nd stage before head expulsion	32	7.25 ± 0.05	Very low
1 study (Liu 2015)	Prospective cohort	Serious [10]	No serious inconsistency	No serious indirectness	No serious imprecision	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical ventilation in the first 24 hours)	Last 30 minutes before birth	NR (total N=4736)	OR[f] 2.9 (95% CI 1.9 to 4.4)	Very low
1 study (Liu 2015)	Prospective cohort	Serious [10]	No serious inconsistency	No serious indirectness	No serious imprecision	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any	Last 30 minutes before birth	NR (total N=3994, caesarean births excluded)	OR[f] 3.0 (95% CI 1.8 to 5.1)	Very low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
						mechanical ventilation in the first 24 hours)				
1 study (Liu 2015)	Prospective cohort	Serious [10]	No serious inconsistency	No serious indirectness	No serious imprecision	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical ventilation in the first 24 hours)	Last 30 minutes before birth	NR (total N=4647, participants with maternal fever excluded)	OR [f] 2.9 (95% CI 1.9 to 4.6)	Very low
1 study (Liu 2015)	Prospective cohort	Serious [10]	No serious inconsistency	No serious indirectness	No serious imprecision	Neonatal mechanical ventilation	Last 30 minutes before birth	NR (total N=4605)	OR [f] 3.1 (95% CI 1.4 to 6.7)	Very low

BD base deficit; BPM beats per minute; CI confidence interval; FHR fetal heart rate; NICHD National Institute of Child Health and Human Development; NICU neonatal intensive care unit; NR not reported; OR odds ratio; SD standard deviation

a A normal tracing defined as having a baseline rate of 120 – 160 bpm; variability ≥ 5 bpm from the baseline during the best 1 minute of a 30-minute tracing; presence of accelerations > 15 bpm for at least 15 seconds; no variable or late decelerations.
b Neonates were considered to have immediate adverse outcomes if they were admitted to level III neonatal intensive care unit for > 24 hours and required oxygen support (intubation > 6 hours, or > 24 hours of > 40% oxygen supplementation)
c Adjusted for nulliparity

d Composite neonatal outcomes: umbilical artery pH < 7 and/or APGAR score < 7 at 5 minutes and/or neonatal resuscitation in birth room and admission to neonatal intensive care unit for distress at birth
e The term 'terminal deceleration' used in the paper for this bradycardia defined as a prolonged deceleration (15 bpm or more below baseline for 2 minutes - 10 minutes)
f Adjusted for maternal fever, parity, pregestational diabetes, previous ceaesarean birth, pre-eclampsia
1 Unclear if the assessors were blinded to outcomes
2 No separate data for pH reported
3 Unclear if women with pre-existing medical conditions were excluded
4 No definition for fetal rate patterns reported
5 Women's demographic characteristics not reported
6 Population consisted of women who underwent caesarean section
7 Incomplete data reported
8 Unclear if assessors were blinded
9 CI crosses 0.75 and 1.25
10 Unclear if EFM tracing interpretation was performed by more than one person

Table 9: GRADE findings for fetal heart rate in babies born with umbilical cord blood acidaemia compared with those born without acidaemia

Quality assessment							Outcome		Effect		
Number of studies	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Stage of labour**	**Acidaemia[a]**	**Control (no acidaemia)**	**Relative (95% CI) compared to normal**	**Absolute (95% CI)**	**Quality**
Baseline FHR (bpm)											
1 study (Giannubilo 2007)	Case control	Serious[1, 2]	No serious inconsistency	Serious[2]	No serious imprecision	2nd stage	131.25 ± 9.19 n = 26	136.25 ± 10.14 n = 30	NC	MD 5 lower (10.06 lower to 0.06 higher)	Very low

CI confidence interval; FHR fetal heart rate; BPM beats per minute; NC not calculable; MD mean difference

a pH < 7.2, base deficit ≥ 12 mmol/l
1 High risk of selection bias (non-consecutive cases)
2 Unclear if the trace assessors were blinded to outcomes

Table 10: GRADE findings for correlation of marked tachycardia to neonatal convulsions

Quality assessment						Stage of labour	Number of women & baby pairs[a]	Correlation coefficient (p-value)	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				
"Marked" tachycardia[a] (not defined)									
1 study (Ellison 1991)	Cohort	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	1st stage	n = 135	r = -0.02 (P = NS)	Low

NS not significant

a Original cohort from Dublin RCT (MacDonald 1985), no definition of "marked" tachycardia reported
1 Women with pre-existing medical and obstetric conditions were included

I.4.1.2 Baseline variability

Table 11: GRADE findings for predictive value of fetal heart rate baseline variability for neonatal adverse outcomes

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
FHR reduced variability (FIGO classification)													
1 study (Spencer 1997)	Case control	Serious[1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Encephalopathy	First 30 minutes of tracing	73	10.53 % (0.77 to 20.28)[a]	94.29 % (86.60 to 100)[a]	1.84 (0.35 to 9.44)[a]	0.94 (0.82 to 1.08)[a]	Very low
1 study (Spencer 1997)	Case control	Serious[1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Encephalopathy	Last 30 minutes of tracing	73	38.89 % (22.96 to 54.81)[a]	87.10 % (75.30 to 98.90)[a]	3.01 (1.10 to 8.20)[a]	0.70 (0.52 to 0.94)[a]	Very low

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Reduced variability (FIGO classification 1987)													
1 study (Holzmann 2015)	Prospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision	Fetal lactacidaemia (lactate > 4.8 mmol/l)	NR; 60 minutes prior to first fetal blood sampling	1070	40.00 % (13.69 to 72.63)[b]	61.14 % (56.06 to 66.00)[b]	1.03 (0.48 to 2.22)[b]	0.98 (0.59 to 1.63)[b]	Low
1 study (Holzmann 2015)	Prospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision	Fetal lactacidaemia (lactate > 4.8 mmol/l)	NR; 60 minutes prior to last fetal blood sampling[5]	888	35.7% (14.1 to 63.9)[b]	62.2% (61.2 to 63.6)[b]	0.95 (0.36 to 1.76)[b]	1.03 (0.57 to 1.40)[b]	Low
Decreased variability (absent or minimal variability according to NICHD classification 2008)													
1 study (Graham. 2014)	Case control	Very serious[6]	No serious inconsistency	No serious indirectness	No serious imprecision	Whole-body hypothermia treatment for suspected moderate to severe encephalopathy	Last 1 hour tracing before birth	117	33.3% (19.6 to 50.3)[b]	80.8% (70.0 to 88.5)[b]	1.73 (0.92 to 3.27)[b]	0.83 (0.66 to 1.04)[b]	Very low
Baseline variability < 5 bpm (NICHD classification)													
1 study (Larma 2007)	Case control	Serious[4]	No serious inconsistency	Serious[3]	No serious imprecision	Moderate HIE	Last hour of tracing	214	53.8%	79.8%	2.50	0.50	Very low
Baseline variability < 5 bpm (NICHD classification)													

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
1 study (Nelson 1996)	Case control	Serious[2]	No serious inconsistency	Serious[3, 7]	No serious imprecision	Cerebral palsy in low and high risk population[c]	NR	378	26.9% (18.3 to 37.7)[a]	90.7% (86.8 to 93.5)[a]	2.88 (1.73 to 4.79)[a]	0.80 (0.70 to 0.92)[a]	Very low
"Minimal absent" variability (NICHD classification)													
1 study (Williams 2004)	Case series	Serious[2]	No serious inconsistency	No serious indirectness	No serious imprecision	Seizure	1 hour before birth	50	53% (36.2 to 69.5)[a]	64% (44.4 to 79.8)[a]	1.48 (0.79 to 2.75)[a]	0.72 (0.45 to 1.18)[a]	Moderate
Absent variability (FIGO classification 1987)													
1 study (Holzmann 2015)	Prospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	Serious imprecision[8]	Fetal lactacidaemia (lactate >4.8 mmol/l)	NR; 60 minutes prior to first fetal blood sampling	1070	40.00% (13.69 to 72.63)[b]	89.39% (84.88 to 92.72)[b]	3.77 (1.63 to 8.70)[b]	0.67 (0.40 to 1.11)[b]	Very low
1 study (Holzmann 2015)	Prospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	Serious imprecision[8]	Fetal lactacidaemia (lactate >4.8 mmol/l)	NR; 60 minutes prior to last fetal blood sampling[5]	888	43.8% (20.8 to 69.4)[b]	87.7% (82.2 to 91.7)[b]	3.55 (1.83 to 6.91)[b]	0.64 (0.42 to 0.99)[b]	Very low
Non-reactive trace (NICHD classification)													

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
1 study (Larma 2007)	Case control	Serious[7]	No serious inconsistency	Serious[3]	No serious imprecision	Moderate HIE	Last hour of tracing	214	92.3%	61.7%	2.30	0.13	Very low
FHR variability amplitude < 3 bpm[d]													
1 study (Samueloff 1994)	Cohort	Serious[9, 10]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord artery pH < 7.2	2nd stage	1814	10.99 %	93.80 %	1.40	0.96	Very low
FHR variability amplitude < 5 bpm[d]													
1 study (Samueloff 1994)	Cohort	Serious[9, 10]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord artery pH < 7.2	2nd stage	1814	26.24 %	78.93 %	1.18	0.94	Very low
FHR variability oscillation < 3 bpm[d]													
1 study (Samueloff 1994)	Cohort	Serious[9, 10]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord artery pH < 7.2	2nd stage	1810	6.78%	95.18 %	1.36	0.98	Very low
FHR variability oscillation < 5 bpm[d]													
1 study (Samueloff 1994)	Cohort	Serious[9, 10]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord artery pH < 7.2	2nd stage	1810	25.23 %	80.52 %	1.25	0.93	Very low
FHR variability ([amplitude[e] + oscillation[f]] ÷ 2) < 3 bpm[d]													

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
1 study (Samueloff 1994)	Cohort	Serious[9, 10]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord artery pH < 7.2	2nd stage	1913	7.44%	96.30 %	1.75	0.96	Very low
1 study (Samueloff 1994)	Cohort	Serious[9, 10]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord artery pH < 7.2	1st stage (following admission)	1913	2.1%	98.6%	1.50	0.99	Very low
FHR variability oscillation[f] < 3 bpm[d]													
1 study (Samueloff 1994)	Cohort	Serious[9, 10]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord artery pH < 7.2	1st stage (following admission)	1810	3.16%	98.2%	1.72	0.98	Very low
FHR variability amplitude[e] < 3bpm[d]													
1 study (Samueloff 1994)	Cohort	Serious[9, 10]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord artery pH < 7.2	1st stage (following admission)	1814	3.86%	97.13 %	1.31	0.99	Very low
Increased variability (FIGO classification 1987)													
1 study (Holzmann 2015)	Prospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	Very serious[11]	Fetal lactacidaemia (lactate > 4.8 mmol/l)	NR; 60 minutes prior to first fetal blood sampling	1070	25.00 % (4.45 to 64.42)[b]	96.72 % (93.40 to 98.47)[b]	7.63 (1.92 to 30.31)[b]	0.78 (0.52 to 1.16)[b]	Very low

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
1 study (Holzmann 2015)	Prospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	Very serious[11]	Fetal lactacidaemia (lactate > 4.8 mmol/l)	NR; 60 minutes prior to last fetal blood sampling[5]	888	18.2% (3.2%-52.2%)	97.3% (93.4-99.0%)	6.65 (1.45 - 30.51)	0.84 (0.64 - 1.11)	Very low
Mild pseudo-sinusoidal pattern[g]													
1 study (Murphy 1991)	Cohort	Serious[1, 2, 13]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical artery pH < 7.12	1st stage & 2nd stage	319	80.0% (64.3 to 95.6)[a]	32.3% (26.9 to 37.6)[a]	1.18 (0.95 to 1.46)[a]	0.61 (0.27 to 1.37)[a]	Low
1 study (Murphy 1991)	Cohort	Serious[8, 9]	No serious inconsistency	No serious indirectness	No serious imprecision	Admission to NICU	1st stage & 2nd stage	319	82.6% (67.1 to 98.1)[a]	32.4% (27.1 to 37.7)[a]	1.22 (0.99 to 1.49)[a]	0.53 (0.21 to 1.32)[a]	Low

BPM beats per minute; CI confidence interval; FHR fetal heart rate; FIGO International Federation of Obstetrics and Gynaecology; HIE hypoxic ischaemic encephalopathy; NICHD National Institute of Child Health and Human Development; NR not reported

a Calculated by the 2014 NCC-WCH technical team
b Calculated by the 2017 NGA technical team
c High risk of cerebral palsy was defined as incidence of bleeding during pregnancy, breech presentation, gestational age of less than 37 weeks at birth, maternal infection, and the presence of meconium in the amniotic fluid. Low risk was defined as the absence of the five risk factors and high risk as the presence of one or more of them. Positive predictive values were obtained by projection onto the entire population of children born during the three-year study period in four counties.
d Scored using 5 variables:

- *FHR amplitude ≥ 3 bpm - high variability, < 3 bpm - low variability*
- *FHR amplitude ≥ 5 bpm - high variability, < 5 bpm - low variability*
- *FHR frequency of oscillations ≥ 3/minute - high variability, < 3/minute - low variability*
- *FHR frequency of oscillations ≥ 5/minute - high variability, < 5/minute - low variability*

- *Combination of (amplitude + frequency) ÷ 2. Value < 3 low variability, ≥ 3 high variability*

eThe amplitude was measured as the highest elevation of FHR from the baseline
f Frequency of oscillations was counted from the number of intersections of oscillations from FHR baseline
g Pseudo-sinusoidal pattern classification based on amplitude of oscillations and frequency of cycles: Minor when the amplitude of the oscillations was 5 –15 bpm & 2-5 cycles/minute; intermediate when amplitude was 16 – 24 bpm & 2-5 cycles/minute; major when the amplitude was ≥ 25 bpm& 1-2 cycles/minute
1 Unclear who evaluated the traces
2 Small study with low statistical power
3 Unclear if women with pre-existing medical conditions were excludeds
4 All women in the study underwent FBS, therefore may not be representative of the whole population. A single observer interpreted the CTG traces
5 For the last sample in a particular woman, an exclusion criterion was active pushing prior to sampling
6 High risk of bias due to participant selection and timing
7 Exclusion criteria not specified, high risk of selection bias
8 CI for positive likelihood ratio crosses 5 and negative likelihood ratio crosses 0.5
9 Unclear if the assessors were blinded to outcomes
10 Number of participants in normal and abnormal categories were not matched
11 CI for positive likelihood ratio crosses 5 and 10
12 Unclear how and by whom the data were analysed
13 Unclear if the assessors were blinded to outcomes

Table 12: GRADE findings for predictive value of fetal heart rate baseline variability for mode of birth

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Mild pseudo-sinusoidal pattern[a]													
1 study (Murphy 1991)	Cohort	Serious[1, 2]	No serious inconsistency	No serious indirectness	No serious imprecision	Caesarean section	1st stage & 2nd stage	319	64.7% (48.6 to 80.7)[b]	30.8% (25.1 to 36.2)[b]	0.93 (0.72 to 1.21)[b]	1.14 (0.70 to 1.86)[b]	Low
1 study	Cohort	Serious[1, 2]	No serious	No serious	No serious	Instrumental vaginal birth	1st stage &	319	71.43 %	32.4%	1.05	0.88	Low

Quality assessment									Measure of diagnostic accuracy (95% CI)				
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Definition of outcome	Stage of labour	Total number of women & baby pairs	Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	Quality
(Murphy 1991)			inconsistency	indirectness	imprecision		2nd stage		(62.1 to 80.7)[b]	(26.3 to 38.5)[b]	(0.90 to 1.23)[b]	(0.60 to 1.28)[b]	

CI confidence interval

a Pseudo-sinusoidal pattern classification: minor when the amplitude of the oscillations was 5 –15 bpm; intermediate at 16 – 24 bpm; major when the amplitude was ≥ 25 bpm
b Calculated by the 2014 NCC-WCH technical team
1 Unclear who evaluated the traces
2 Unclear if the assessors were blinded to outcomes

Table 13: GRADE findings for association between fetal heart rate variability and neonatal adverse outcomes or umbilical artery blood gas values

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
Normal variability (> 5 bpm)										
1 study (Maso 2012)	Case series	Serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.2	2 hours before birth	51	n = 3 (5.9%)	Low
1 study (Maso 2012)	Case series	Serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.1	2 hours before birth	51	0 = 0 (0%)	Low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Maso 2012)	Case series	Serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.0	2 hours before birth	51	0 = 0 (0%)	Low
1 study (Maso 2012)	Case series	Serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	BD ≥ 12 mmol/l	2 hours before birth	51	0 = 0 (0%)	Low
1 study (Maso 2012)	Case series	Serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	Averse composite neonatal outcome[a]	2 hours before birth	51	0 = 0 (0%)	Low
Decreased variability (< 5 bpm)										
1 study (Berkus 1999)	Cohort	Serious [2,3]	No serious inconsistency	Serious[4]	No serious imprecision	Immediate adverse neonatal outcome[b]	1st stage	77	No statistically significant association (numerical data not reported)	Very low
1 study (Berkus 1999)	Cohort	Serious [2,3]	No serious inconsistency	Serious[4]	No serious imprecision	Immediate adverse neonatal outcome[b]	2nd stage	77	No statistically significant association (numerical data not reported)	Very low
Decreased variability (not defined)										
1 study (Roy 2008)	Cohort	Serious [5,6]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord pH < 7.10	NR	17	0%	Low
1 study (Roy 2008)	Cohort	Serious [5,6]	No serious inconsistency	No serious indirectness	No serious imprecision	Immediate NICU admission	NR	17	0%	Low
Reduced variability (compared with normal tracing - NICHD classification)										

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Sheiner 2001)	Cohort	Serious [2,6]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.2	2nd stage	57	OR 2.2 (95% CI 0.3 to 17.1) P = 0.728	Low
1 study (Sheiner 2001)	Cohort	Serious [2,6]	No serious inconsistency	No serious indirectness	No serious imprecision	BD ≥ 12 mmol/l	2nd stage	28	OR 5.1 (95% CI 0.6 to 46.1) P = 0.098	Low
Ever[c] absent or minimal variability (amplitude range undetectable or ≤ 5 bpm, NICHD classification)										
1 study (Liu 2015)	Prospective cohort	Serious [7]	No serious inconsistency	No serious indirectness	Serious[8]	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical ventilation in the first 24 hours)	Last 30 minutes before birth	NR (total N=4736)	OR[d] 1.3 (95% CI 0.9 to 1.8)	Very low
Mostly[e] absent or minimal variability (amplitude range undetectable or ≤ 5 bpm, NICHD classification)										
1 study (Liu 2015)	Prospective cohort	Serious [7]	No serious inconsistency	No serious indirectness	Serious[8]	Neonatal respiratory morbidity (either any oxygen requireme	Last 30 minutes before birth	NR (total N=4736)	OR[d] 1.1 (95% CI 0.8 to 1.6)	Very low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
						nt at or after 6 hours of life or any mechanical ventilation in the first 24 hours)				
Always[f] absent or minimal variability (amplitude range undetectable or ≤ 5 bpm, NICHD classification)										
1 study (Liu 2015)	Prospective cohort	Serious [7]	No serious inconsistency	No serious indirectness	Serious[8]	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical ventilation in the first 24 hours)	Last 30 minutes before birth	NR (total N=4736)	OR[d] 1.2 (95% CI 0.8 to 1.7)	Very low
Mostly[e] moderate variability (amplitude range 6-25 bpm, NICHD classification)										
1 study (Liu 2015)	Prospective cohort	Serious [7]	No serious inconsistency	No serious indirectness	Serious[9]	Neonatal respiratory morbidity (either any oxygen	Last 30 minutes before birth	NR (total N=4736)	OR[d] 0.7 (95% CI 0.5 to 1.0)	Very low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**					
						requirement at or after 6 hours of life or any mechanical ventilation in the first 24 hours)				
Always[f] moderate variability (amplitude range 6-25 bpm, NICHD classification)										
1 study (Liu 2015)	Prospective cohort	Serious [7]	No serious inconsistency	No serious indirectness	Serious[9]	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical ventilation in the first 24 hours)	Last 30 minutes before birth	NR (total N=4736)	OR[d] 0.7 (95% CI 0.5 to 0.9)	Very low
1 study (Liu 2015)	Prospective cohort	Serious [7]	No serious inconsistency	No serious indirectness	Serious[9]	Neonatal respiratory morbidity (either any oxygen	Last 30 minutes before birth	NR (total N=3997, caesarean births excluded)	OR[d] 0.7 (95% CI 0.5 to 1.1)	Very low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**					
						requirement at or after 6 hours of life or any mechanical ventilation in the first 24 hours)				
1 study (Liu 2015)	Prospective cohort	Serious [7]	No serious inconsistency	No serious indirectness	Serious[9]	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical ventilation in the first 24 hours)	Last 30 minutes before birth	NR (total N=4647, participants with maternal fever excluded)	OR[d] 0.7 (95% CI 0.5 to 1.0)	Very low
1 study (Liu 2015)	Prospective cohort	Serious [7]	No serious inconsistency	No serious indirectness	Very serious[10]	Neonatal mechanical ventilation	Last 30 minutes before birth	NR (total N=4605)	OR[d] 0.8 (95% CI 0.4 to 1.40)	Very low
Ever[c] marked variability (amplitude range > 25 bpm, NICHD classification)										

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Liu 2015)	Prospective cohort	Serious [7]	No serious inconsistency	No serious indirectness	No serious imprecision	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical ventilation in the first 24 hours)	Last 30 minutes before birth	NR (total N=4736)	OR[d] 2.7 (95% CI 1.5 to 5.0)	Very low
1 study (Liu 2015)	Prospective cohort	Serious [7]	No serious inconsistency	No serious indirectness	No serious imprecision	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical ventilation in the first 24 hours)	Last 30 minutes before birth	NR (total N=3994, caesarean births excluded)	OR[d] 2.7 (95% CI 1.3 to 5.7)	Very low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Liu 2015)	Prospective cohort	Serious [7]	No serious inconsistency	No serious indirectness	No serious imprecision	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical ventilation in the first 24 hours)	Last 30 minutes before birth	NR (total N=4647, participants with maternal fever excluded)	OR[d] 3.1 (95% CI 1.7 to 5.7)	Very low
1 study (Liu 2015)	Prospective cohort	Serious [7]	No serious inconsistency	No serious indirectness	No serious imprecision	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical ventilation in the first 24 hours)	Last 30 minutes before birth	NR (total N=4647, participants with maternal fever excluded)	OR[d] 3.1 (95% CI 1.7 to 5.7)	Very low

BD base deficit; BPM beats per minute; CI confidence interval; FHR fetal heart rate;NICHD National Institute of Child Health and Human Development; NICU neonatal intensive care unit; NR not reported; OR odds ratio

a Composite neonatal outcomes: umbilical artery pH < 7 and/or APGAR score < 7 at 5 minutes and/or neonatal resuscitation in birth room and admission to neonatal intensive care unit for distress at birth
b Neonates were considered to have immediate adverse outcomes if they were admitted to level III neonatal intensive care unit for > 24 hours and required oxygen support (intubation > 6 hours, or > 24 hours of > 40% oxygen supplementation)
c Ever' refers to the presence of the EFM feature during any 10-minute segment in the 30-minute period before birth
d Adjusted for maternal fever, parity, pregestational diabetes, previous caesarean birth, pre-eclampsia
e 'Mostly' refers to the presence of EFM feature for any ≥ 15-minute segment in the 30-minute period before birth
f 'Always' refers to the presence of the EFM feature during the entire 30-minute period before birth
1 Incomplete data
2 Unclear if the assessors were blinded to outcomes
3 No separate data for pH reported
4 Unclear if women with pre-existing medical condition were excluded
5 No definition for fetal rate patterns reported
6 Women's demographic characteristics not reported
7 Unclear if EFM tracing interpretation was performed by more than one observer
8. 95% CI crosses 1.25
9 95% CI crosses 0.75d
10 95% CI crosses 0.75 and 1.25

Table 14: GRADE findings for association between variability (with or without accelerations or decelerations) and umbilical artery blood gas values

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
Normal variability (NICHD classification)										
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.0	At least 2 hours of tracing[a]	42	n = 0 (0%)	Very low
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.1	At least 2 hours of tracing[a]	42	n = 4 (9.5%)	Very low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	BD > 12 mmol/l	At least 2 hours of tracing[a]	42	n = 1 (2.4%)	Very low
Normal variability with late decelerations (NICHD classification)										
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.0	At least 2 hours of tracing[a]	173	n = 3 (1.7%)	Very low
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.1	At least 2 hours of tracing[a]	173	n = 23 (13.3%)	Very low
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	BD > 12 mmol/l	At least 2 hours of tracing[a]	173	n = 8 (4.6%)	Very low
Normal variability with variable decelerations (NICHD classification)										
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.0	At least 2 hours of tracing[a]	219	n. = 50 (23%)	Very low
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.1	At least 2 hours of tracing[a]	219	n = 20 (9.1%)	Very low
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	BD > 12 mmol/l	At least 2 hours of tracing[a]	219	n = 12 (5.5%)	Very low
Decreased variability (NICHD classification)										

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.0	At least 2 hours of tracing[a]	13	n = 4 (31%)	Very low
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.1	At least 2 hours of tracing[a]	13	n = 5 (38.5%)	Very low
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	BD > 12 mmol/l	At least 2 hours of tracing[a]	13	n = 5 (38.5%)	Very low
Decreased variability with late decelerations (NICHD classification)										
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.0	At least 2 hours of tracing[a]	25	n = 6 (24%)	Very low
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.1	At least 2 hours of tracing[a]	25	n = 11 (44%)	Very low
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	BD > 12 mmol/l	At least 2 hours of tracing[a]	25	n = 8 (32%)	Very low
Decreased variability with variable decelerations (NICHD classification)										
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.0	At least 2 hours of tracing[a]	16	n = 2 (12.5%)	Very low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.1	At least 2 hours of tracing[a]	16	n = 3 (18.5%)	Very low
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	BD > 12 mmol/l	At least 2 hours of tracing[a]	16	n = 2 (12.5%)	Very low
Decreased variability with no accelerations (NICHD classification)										
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.0	At least 2 hours of tracing[a]	8	n = 5 (62.5%)	Very low
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.1	At least 2 hours of tracing[a]	8	n = 5 (62.5%)	Very low
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	BD > 12 mmol/l	At least 2 hours of tracing[a]	8	n = 5 (62.5%)	Very low
Decreased variability with late decelerations + no accelerations (NICHD classification)										
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.0	At least 2 hours of tracing[a]	19	n = 6 (31.5%)	Very low
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.1	At least 2 hours of tracing[a]	19	n = 10 (52.6%)	Very low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	BD > 12 mmol/l	At least 2 hours of tracing[a]	19	n = 8 (42.1%)	Very low
Decreased variability with variable decelerations + no accelerations (NICHD classification)										
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.0	At least 2 hours of tracing[a]	8	n = 2 (25%)	Very low
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.1	At least 2 hours of tracing[a]	8	n = 3 (37.5%)	Very low
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	BD > 12 mmol/l	At least 2 hours of tracing[a]	8	n = 2 (25%)	Very low
Normal variability and recovery from bradycardia (NICHD classification)										
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.0	At least 2 hours of tracing[a]	128	n = 2 (2%)	Very low
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.1	At least 2 hours of tracing[a]	128	n = 28 (22%)	Very low
1 study (Williams 2003)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	BD > 12 mmol/l	At least 2 hours of tracing[a]	128	n = 6 (5%)	Very low
Normal variability and no recovery from bradycardia (NICHD classification)										

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Williams 2002)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.0	At least 2 hours of tracing[a]	40	n = 7 (18%)	Very low
1 study (Williams 2002)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.1	At least 2 hours of tracing[a]	40	n = 13 (33%)	Very low
1 study (Williams 2002)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	BD > 12 mmol/l	At least 2 hours of tracing[a]	40	n = 5 (13%)	Very low
Decreased variability and recovery from bradycardia (NICHD classification)										
1 study (Williams 2002)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.0	At least 2 hours of tracing[a]	9	n = 4 (44%)	Very low
1 study (Williams 2002)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.1	At least 2 hours of tracing[a]	9	n = 5 (56%)	Very low
1 study (Williams 2002)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	BD > 12 mmol/l	At least 2 hours of tracing[a]	9	n = 2 (22%)	Very low
Decreased variability and no recovery from bradycardia (NICHD classification)										
1 study (Williams 2002)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.0	At least 2 hours of tracing[a]	9	n = 7 (78%)	Very low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Williams 2002)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	pH < 7.1	At least 2 hours of tracing[a]	9	n = 8 (89%)	Very low
1 study (Williams 2002)	Cohort	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	BD > 12 mmol/l	At least 2 hours of tracing[a]	9	n = 8 (89%)	Very low

BD base deficit; FHR fetal heart rate; NICHD National Institute of Child Health and Human Development

a Does not include the last 30 minutes before birth
1 No exclusion criteria specified hence high risk of selection bias
2 Women's demographic characteristics not reported
3 Unclear if women with pre-existing medical condition were excluded

I.4.1.3 Accelerations

Table 15: GRADE findings for predictive value of lack of fetal heart rate accelerations for adverse neonatal outcomes

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Lack of accelerations (Krebs classification)													
1 study (Spencer 1997)	Case control	Serious[1]	No serious inconsistency	Serious[2]	No serious imprecision	Encephalopathy	First 30 minutes of tracing	73	42.11 % (26.41 to 57.80)	77.14 % (63.23 to 91)	1.84 (0.9 to 3.76) [a]	0.75 (0.54 to 1.03) [a]	Very low

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
1 study (Spencer 1997)	Case control	Serious[1]	No serious inconsistency	Serious[2]	No serious imprecision	Encephalopathy	Last 30 minutes of tracing	67	72.2% (57.5 to 86.85)[a]	51.61 % (34.02 to 69.21)[a]	1.49 (0.98 to 2.26)[a]	0.58 (0.28 to 1.00)[a]	Very low
Lack of accelerations (NICHD classification)													
1 study (Williams 2004)	Case series	Serious[3]	No serious inconsistency	Serious[2]	No serious imprecision	Seizure	Last hour before birth	50	24% (11.5 to 43.4)[a]	52% (33.5 to 70)[a]	0.5 (0.22 to 1.12)[a]	1.46 (0.94 to 2.26)[a]	Very low
Lack of accelerations[b]													
1 study (Powell 1979)	Case series	Serious[4, 5]	No serious inconsistency	Serious[2]	No serious imprecision	Mortality	NR	50	83.3% (68.4 to 98.2)[a]	57.4% (55 to 59.7)[a]	1.95 (1.6 to 2.36)[a]	0.29 (0.11 to 0.71)[a]	Very low

CI confidence interval; NICHD National Institute of Child Health and Human Development; NR not reported

a Calculated by the 2014 NCC-WCH technical team
b An acceleration was defined as an increase of FHR of 15 bpm above the normal baseline occurring with a contraction. Three accelerations in 15 minutes were needed for inclusion in the acceleration category
1 Unclear who evaluated the traces
2 Unclear if women with pre-existing medical conditions were excluded
3 No exclusion criteria specified hence high risk of selection bias
4 Women's demographic characteristics not reported
5 Unclear how and by whom data were analysed

Table 16: GRADE findings for association of sporadic accelerationsa and perinatal mortality

Quality assessment							Number of babies with defined FHR patterns	Number (percentage) of babies who died	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Stage of labour			
Sporadic accelerations[a] (3 or more accelerations per 30-minute tracing) (women with no identified risk factors for adverse outcome)									
1 study (Krebs 1982)	Cohort	Serious [1,2,3]	No serious inconsistency	Serious[4]	No serious imprecision	First 30 minutes of tracing	811	n = 2 (0.2%)	Low
Sporadic accelerations[a] (fewer than 3 accelerations per 30-minute tracing) (women with identified risk factors for adverse outcome)									
1 study (Krebs 1982)	Cohort	Serious [1,2,3]	No serious inconsistency	Serious[4]	No serious imprecision	First 30 minutes of tracing	122	n = 12 (9.8%)	Very low
Sporadic accelerations[a] (3 or more accelerations per 30-minute tracing) (women with identified risk factors for adverse outcome)									
1 study (Krebs 1982)	Cohort	Serious [1,2,3]	No serious inconsistency	Serious[4]	No serious imprecision	First 30 minutes of tracing	955	n = 4 (0.4%)	Very low
Sporadic accelerations[a] (fewer than 3 accelerations per 30-minute tracing) (women with no identified risk factors for adverse outcome)									
1 study (Krebs 1982)	Cohort	Serious [1,2,3]	No serious inconsistency	Serious[4]	No serious imprecision	First 30 minutes of tracing	108	n = 3 (2.8%)	Very low

FHR fetal heart rate

a Sporadic accelerations occur independently from uterine contractions
1 No exclusion criteria specified hence high risk of selection bias
2 Women's demographic characteristics not reported
3 Unbalanced cohort; only 4% of adverse outcomes
4 High- risk population

Table 17: GRADE findings for association of presence of accelerations and adverse neonatal outcomes

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
Accelerations present (NICHD classification 2008)										
1 study (Liu 2015)	Prospective cohort	Serious [1]	No serious inconsistency	No serious indirectness	Serious[2]	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical ventilation in the first 24 hours)	Last 30 minutes before birth	NR (total N=4736)	OR[a] 0.6 (95% CI 0.4 to 0.9)	Very low
1 study (Liu 2015)	Prospective cohort	Serious [1]	No serious inconsistency	No serious indirectness	Serious[2]	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical ventilation	Last 30 minutes before birth	NR (total N=3994, caesarean births excluded)	OR[a] 0.8 (95% CI 0.5 to 1.2)	Very low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
						in the first 24 hours)				
1 study (Liu 2015)	Prospective cohort	Serious [1]	No serious inconsistency	No serious indirectness	Serious[2]	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical ventilation in the first 24 hours)	Last 30 minutes before birth	NR (total N=4647, participants with maternal fever excluded)	OR[a] 0.6 (95% CI 0.4 to 0.9)	Very low
1 study (Liu 2015)	Prospective cohort	Serious [1]	No serious inconsistency	No serious indirectness	Serious[2]	Neonatal mechanical ventilation	Last 30 minutes before birth	NR (total N=4605)	OR[a] 0.4 (95% CI 0.2 to 0.9)	Very low

CI confidence interval; NR not reported; OR odds ratio

a. Adjusted for maternal fever, parity, pregestational diabetes, previous caesarean birth, pre-eclampsia
1. Unclear if EFM tracing was interpreted by more than one observer
2. 95% CI crosses 0.75

Table 18: GRADE findings for predictive value of a reactive trace for adverse neonatal outcomes

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Reactivity (presence of at least 2 accelerations (NICHD classification 2008) within a 20-minute period)													
1 study (Graham 2014)	Case control	Very serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	Whole-body hypothermia treatment for suspected moderate to severe encephalopathy	Last 1 hour tracing before birth	117	41.0% (26.0 to 57.8)[a]	38.5% (27.9 to 50.2)[a]	0.67 (0.44 to 1.01)[a]	1.53 (1.13 to 2.07)[a]	Very low

CI confidence interval; NICHD National Institute of Child Health and Human Development
a Calculated by the 2017 NGA technical team
1 High risk of bias due to patient selection and timing

Table 19: GRADE findings for association between a reactive trace and adverse neonatal outcomes

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
Reactive trace (presence of at least two accelerations (defined according to NICHD classification 2008) within a 20-minute period										
1 study (Graham 2014)	Case control	Serious [1]	No serious inconsistency	No serious indirectness	Serious imprecision [2]	Whole-body hypothermia treatment for suspected moderate	Last 1 hour tracing before birth	64	OR[a] 0.50 (95% CI 0.22-1.12)	Very low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
						to severe encephalopathy				

CI confidence interval; NICHD National Institute of Child Health and Human Development; OR odds ratio
a Adjusted for chorioamnionitis
1 High risk of bias in relation to important potential confounders (these were not appropriately accounted for, except for chorioamnionitis)
2 CI crosses 0.75

I.4.1.4 Decelerations

Table 20: GRADE findings for predictive value of fetal heart rate early decelerations for adverse neonatal outcomes

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Early decelerations (NICHD classification 2008)													
1 study (Graham 2014)	Case control	Very serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	Whole-body hypothermia treatment for suspected moderate to severe encephalopathy	Last 1 hour tracing before birth	117	23.1% (11.7 to 39.7%)	94.9% (86.7 to 98.3%)	4.53[a]	0.81[a]	Very low

CI confidence interval; NICHD National Institute of Child Health and Human Development
a Calculated by the 2017 NGA technical team
1 High risk of bias due to participant selection and timing

Table 21: GRADE findings for association between decelerations (in general), early decelerations and prolonged decelerations and adverse neonatal outcomes

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
Decelerations present (NICHD classification 2008)										
1 study (Liu 2015)	Prospective cohort	Serious [1]	No serious inconsistency	No serious indirectness	Serious[2]	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical ventilation in the first 24 hours)	Last 30 minutes before birth	NR (total N=4736)	OR[a] 0.8 (95% CI 0.5 to 1.2)	Very low
Early decelerations (NICHD classification 2008)										
1 study (Liu 2015)	Prospective cohort	Serious [1]	No serious inconsistency	No serious indirectness	Serious[2]	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical	Last 30 minutes before birth	NR (total N=4736)	OR[a] 0.4 (95% CI 0.1 to 1.1)	Very low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
						ventilation in the first 24 hours)				
Early decelerations (NICHD classification 2008)										
1 study (Graham 2014)	Case control	Serious [3]	No serious inconsistency	No serious indirectness	Serious imprecision [2]	Whole-body hypothermia treatment for suspected moderate to severe encephalopathy	Last 1 hour tracing before birth	NR	OR[b] 0.58 (95% CI 0.35-0.94)	Very low
Prolonged decelerations (NICHD classification 2008)										
1 study (Liu 2015)	Prospective cohort	Serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical ventilation in the first 24 hours)	Last 30 minutes before birth	NR (total N=4736)	OR[a] 1.7 (95% CI 1.3 to 2.4)	Very low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Liu 2015)	Prospective cohort	Serious [1]	No serious inconsistency	No serious indirectness	Serious[4]	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical ventilation in the first 24 hours)	Last 30 minutes before birth	NR (total N=3994, caesarean births excluded)	OR[a] 1.8 (95% CI 1.2 to 2.8)	Very low
1 study (Liu 2015)	Prospective cohort	Serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical ventilation in the first 24 hours)	Last 30 minutes before birth	NR (total N=4647, participants with maternal fever excluded)	OR[a] 1.8 (95% CI 1.3 to 2.5)	Very low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Liu 2015)	Prospective cohort	Serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	Neonatal mechanical ventilation	Last 30 minutes before birth	NR (total N=4605)	OR[a] 2.6 (95% CI 1.4 to 4.7)	Very low

CI confidence interval; NICHD National Institute of Child Health and Human Development; NR not reported; OR odds ratio

a Adjusted for maternal fever, parity, pregestational diabetes, previous caesarean birth, pre-eclampsia
b Adjusted for chorioamnionitis
1 Unclear if EFM tracing interpretation was performed by more than one observer
2 95% CI crosses 0.75
3 High risk of bias in relation to important potential confounders (these were not appropriately accounted for, except for chorioamnionitis)
4 95% CI crosses 1.25

Table 22: GRADE findings for correlation of fetal heart rate early decelerations with neonatal convulsions

Quality assessment						Stage of labour	Number of women & baby pairs	Correlation coefficient (p value)	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				
Early decelerations[a]									
1 study (Ellison 1991	Case series	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	1st stage	135	r: 0.01 (p = ns)	Low
1 study (Ellison 1991	Case series	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	2nd stage	135	r: - 0.14 (p < 0.05)	Low

NS not significant

a Original cohort from Dublin RCT (MacDonald 1985), no definition of "deceleration" reported
1 Women with pre-existing medical and obstetric conditions were included

Table 23: GRADE findings for predictive value of fetal heart rate late decelerations for adverse neonatal outcomes

Quality assessment								Number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Definition of outcome	Stage of labour		Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Late decelerations (Krebs classification)													
1 study (Spencer 1997)	Case control	Serious[1, 2]	No serious inconsistency	Serious[3]	No serious imprecision	Encephalopathy	First 30 minutes of tracing	73	5.26% (1.48 to 12.36)[a]	100% (100 to 100)[a]	NC	0.95 (0.87 to 1.02)[a]	Low
1 study (Spencer 1997)	Case control	Serious[1, 2]	No serious inconsistency	Serious[3]	No serious imprecision	Encephalopathy	Last 30 minutes of tracing	73	47.2% (30.91 to 63.53)[a]	74.19 % (58.79 to 89.60)[a]	1.82 (0.91 to 3.64)[a]	0.71 (0.49 to 1.03)[a]	Low
Late decelerations (FIGO classification 1987)													
1 study (Holzmann 2015)	Prospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	Serious imprecision[5]	Fetal lactacidaemia (lactate > 4.8 mmol/l)	NR; 60 minutes prior to first fetal blood sampling	1070	57.14 % (29.65 to 81.19)[b]	82.52 % (77.50 to 86.64)[b]	3.27 (1.95 to 5.49)[b]	0.52 (0.28 to 0.95)[b]	Very low
1 study (Holzmann 2015)	Prospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	Serious imprecision[5]	Fetal lactacidaemia (lactate > 4.8 mmol/l)	NR; 60 minutes prior to last fetal blood sampling[6]	888	55.0% (32.0 to 76.2)[b]	82.4% (76.5 to 87.1)[b]	3.13 (1.91 to 5.10)[b]	0.55 (0.34 to 0.89)[b]	Very low
Multiple late decelerations, decreased variability or both													

Quality assessment						Definition of outcome	Stage of labour	Number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
1 study (Nelson 1996)	Cohort	Serious[2,5]	No serious inconsistency	Serious[3]	No serious imprecision	Cerebral palsy in low risk population	NR	378	13.8%	91.3%	1.40	0.95	Very low
"Recurrent" late decelerations with no acceleration (NICHD classification)													
1 study (Samesima 2005)	Cohort	Serious[5,6,7]	No serious inconsistency	Serious[8]	No serious imprecision	Umbilical artery pH < 7.1	2 hours before birth	301	68.7% (46 to 91.4)[a]	74.7% (65.3 to 84)[a]	2.71 (1.65 to 4.46)[a]	0.41 (0.20 to 0.87)[a]	Very low
"Recurrent" late decelerations with decreased variability (NICHD classification)													
1 study (Samesima 2005)	Cohort	Serious[5,6,7]	No serious inconsistency	Serious[8]	No serious imprecision	Umbilical artery pH < 7.1	2 hours before birth	301	62.5% (38.7 to 86.2)[a]	89.1% (82.4 to 95.8)[a]	5.76 (2.79 to 11.8)[a]	0.42 (0.22 to 0.79)[a]	Very low
Late decelerations (NICHD classification)													
1 study (Williams 2004)	Case series	Serious[7,8,9]	No serious inconsistency	Serious[10]	No serious imprecision	Seizure	1 hour before birth	50	32% (17.2 to 51.5)[a]	48% (30 to 56.5)[a]	0.61 (0.31 to 1.22)[a]	1.41 (0.86 to 2.30)[a]	Very low

CI confidence interval; FIGO International Federation of Gynecology and Obstetrics; NC not calculable; NICHD National Institute of Child Health and Human Development; NR not reported

a Calculated by the 2014 NCC-WCH technical team
b Calculated by the 2017 NGA technical team
1 Unclear who evaluated the traces

2 Small study with low statistical power
3 Unclear if women with pre-existing medical conditions were excluded
4 All women in the study underwent FBS, therefore may not be representative of the whole population. A single observer interpreted the CTG traces
5. 95% CI for the positive likelihood ratio crosses 5, and the negative likelihood ratio crosses 0.5
6. For the last sample in a particular woman, an exclusion criterion was active pushing prior to sampling
7 Unclear how and by whom data were analysed
8 Unclear if the assessors were blinded to outcomes
9 Poor reporting of results
10 Premature birth > 32 weeks included

Table 24: GRADE findings for association between fetal heart rate late decelerations and adverse neonatal outcome

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
Recurrent late decelerations										
1 study (Roy 2008)	Cohort	Serious [1,2]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord artery pH < 7.10	NR	56	n = 5 (9%)	Low
1 study (Roy 2008)	Cohort	Serious [1,2]	No serious inconsistency	No serious indirectness	No serious imprecision	Admission to NICU	NR	56	n = 10 (19%)	Low
Late decelerations (compared with normal tracing - NICHD classification)										
1 study (Hadar 2001)	Cohort	Serious [3]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord artery pH < 7.2 and BD ≥ 12	1st stage	45	OR 17.5 (95% CI 1.6 to 185.7) P = 0.01	Moderate
1 study (Sheiner 2001)	Case series	Serious [2,3]	No serious inconsistency	No serious indirectness	No serious imprecision	pH< 7.2 and BD ≥ 12	2nd stage	28	OR 3.9 (95% CI 1.1 to 13.1) P = 0.02	Low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Sheiner 2001)	Case series	Serious [2,3]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.2	2nd stage	57	OR 15.2 (95% CI 2.8 to 91.4) P < 0.001	Low
1 study (Sheiner 2001)	Case series	Serious [2,3]	No serious inconsistency	No serious indirectness	No serious imprecision	BD ≥ 12 mmol/l	2nd stage	28	OR 17.3 (95% CI 2.9 to 101.9) P = 0.002	Low
Late decelerations (compared with normal tracing – NICHD classification 2008)										
1 study (Graham 2014)	Case control	Serious [4]	No serious inconsistency	No serious indirectness	No serious imprecision	Whole-body hypothermia treatment for suspected moderate to severe encephalopathy	Last 1 hour tracing before birth	NR	OR[a] 1.10 (95% CI 1.00 to 1.21)	Very low
1 study (Liu 2015)	Cohort	Serious [5]	No serious inconsistency	No serious indirectness	Serious imprecision [6]	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical	Last 30 minutes before birth	NR (total N=4736)	OR[b] 0.8 (95% CI 0.6 to 1.1)	Very low

Quality assessment										
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Definition of outcome	Stage of labour	Number of babies with defined FHR pattern	Degree of association or number (percentage) of babies with defined outcome	Quality
						ventilation in the first 24 hours)				
Late decelerations										
1 study (Berkus 1999)	Case series	Serious [1,2]	No serious inconsistency	Serious[7]	No serious imprecision	Immediate adverse neonatal outcome[c]	1st stage	90	No statistically significant association (numerical data not reported)	Very low

BD base deficit; CI confidence interval; FHR fetal heart rate; NICHD National institute of Child Health and Human Development; NICU neonatal intensive care unit; NR not reported

a Adjusted for chorioamnionitis
b.Adjusted for maternal fever, parity, pregestational diabetes, previous caesarean birth, pre-eclampsia
c.Neonates were considered to have immediate adverse outcomes if they were admitted to level III neonatal intensive care unit for > 24 hours and required oxygen support (intubation > 6 hours, or > 24 hours of > 40% oxygen supplementation)
1 No definition for fetal rate patterns reported
2 Women's demographic characteristics not reported
3 Unclear if the assessors were blinded to outcomes
4 High bias in relation to important potential confounders (these were not appropriately accounted for, except for chorioamnionitis)
5 Unclear if electronic fetal monitoring tracing interpretation was performed by more than one observer
6 95% CI crosses 0.75
7 Unclear if women with pre-existing medical conditions were excluded

Table 25: GRADE findings for correlation of fetal heart rate late decelerations with neonatal convulsions

Quality assessment									
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Stage of labour	Number of women & baby pairs	Correlation coefficient (p value)	Quality
Late decelerations[a]									
1 study (Ellison 1991)	Case series	No serious	No serious inconsistency	Serious[1]	No serious imprecision	1st stage	135	r: 0.38 ($p < 0.001$)	Low

Quality assessment						Stage of labour	Number of women & baby pairs	Correlation coefficient (p value)	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				
		risk of bias							
1 study (Ellison 1991	Case series	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	2nd stage	135	r: -0.32 (p < 0.001)	Low

a Original cohort from Dublin RCT (MacDonald 1985), no definition of "deceleration" reported
1 Women with pre-existing medical and obstetric conditions were included

Table 26: GRADE findings for predictive value of variable fetal heart rate decelerations for adverse neonatal outcome

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Variable decelerations (NICHD classification)													
1 study (Williams 2004)	Case series	Serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	Seizure	1 hour before birth	50	36% (20.2 to 55.5)[a]	40% (23.4 to 59.3)[a]	0.6 (0.32 to 1.10)[a]	1.6 (0.91 to 2.80)[a]	Low
Severe variable decelerations (FIGO classification 1987)													
1 study (Holzmann 2015)	Prospective cohort	Very serious[2]	No serious inconsistency	No serious indirectness	Serious imprecision[3]	Fetal lactacidaemia (lactate > 4.8 mmol/l)	NR; 60 minutes prior to first fetal blood sampling	1070	75.00 % (52.95 to 89.40)[b]	68.41 % (63.17 to 73.22)[b]	2.37 (1.80 to 3.14)[b]	0.37 (0.18 to 0.73)[b]	Very low

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
1 study (Holzmann 2015)	Prospective cohort	Very serious[2]	No serious inconsistency	No serious indirectness	Serious imprecision[3]	Fetal lactacidaemia (lactate > 4.8 mmol/l)	NR; 60 minutes prior to last fetal blood sampling[c]	888	70.0% (50.4 to 84.6)[b]	70.1% (64.0 to 75.6)[b]	2.34 (1.73 to 3.16)[b]	0.43 (0.25 to 0.74)[b]	Very low
Loss of variability during decelerations													
1 study (Ozden 1999	Cohort	Serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH < 7.20	NR	167	63.9%	65%	1.80	0.56	Moderate
Slow return to baseline from decelerations													
1 study (Ozden 1999	Cohort	Serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH < 7.20	NR	167	27.8%	82.5%	1.50	0.89	Moderate
Loss of primary accelerations[d]													
1 study (Ozden 1999)	Cohort	Serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH < 7.20	NR	167	47.2%	82.5%	2.60	0.64	Moderate
Loss of secondary accelerations[e]													
1 study (Ozden 1999	Cohort	Serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH < 7.20	NR	167	38.9%	77.5%	1.60	0.80	Moderate
Biphasic decelerations[f]													

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
1 study (Ozden 1999)	Cohort	Serious[2]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH < 7.20	NR	13	22.2%	90.0%	2.22	0.86	Moderate

CI confidence interval; FIGO International Federation of Gynecology and Obstetrics; NICHD National Institute of Child Health and Human Development; NR not reported

a Calculated by the 2014 NCC-WCH technical team
b Calculated by the 2017 NGA technical team
c For the last sample in a particular woman, an exclusion criterion was active pushing prior to sampling
d Loss of primary accelerations: an initial acceleration followed by a W deceleration componen
e Loss of secondary accelerations: acceleration after a W deceleration component
f Variable deceleration classified into 7 subtypes according to poor prognostic features (PPFs):

1. *Loss of primary acceleration*
2. *Loss of secondary acceleration*
3. *Loss of variability during deceleration*
4. *Slow return to baseline*
5. *Biphasic deceleration*
6. *Prolonged secondary acceleration*
7. *Prolonged deceleration*

1 Small study with low statistical power
2 All women in the study underwent FBS, therefore may not be representative of the whole population. A single observer interpreted the CTG traces
3 95% CI for the negative likelihood ratio crosses 0.5
4 Small study with low statistical power

Table 27: GRADE findings for association between variable fetal heart rate decelerations and adverse neonatal outcome

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
"Mild or moderate" variable decelerations (Krebs classification)										
1 study (Berkus 1999)	Case series	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Immediate adverse neonatal outcome[a]	1st stage	1098	No statistically significant association (numerical data not reported)	Very low
1 study (Berkus 1999)	Case series	Serious [1,2,4]	No serious inconsistency	Serious[3]	No serious imprecision	Immediate adverse neonatal outcome[a]	2nd stage	1098	No statistically significant association (numerical data not reported)	Very low
Variable decelerations										
1 study (Roy 2008)	Cohort	Serious [1,5]	No serious inconsistency	No serious indirectness	No serious imprecision	Cord pH < 7.10	NR	38	n = 4 (10.5%)	Low
1 study (Roy 2008)	Cohort	Serious [1,5]	No serious inconsistency	No serious indirectness	No serious imprecision	Admission to NICU	NR	38	n = 7 (18.4%)	Low
Variable decelerations (compared with normal FHR trace - NICHD classification)										
1 study (Hadar 2001)	Cohort	Serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord artery pH < 7.2 and BD ≥ 12	1st stage	301	OR 3.9 (95% CI 1.3 to 11.7) P = 0.01	Moderate
1 study (Liu 2015)	Prospective cohort	Serious [6]	No serious inconsistency	No serious indirectness	Serious[7]	Neonatal respiratory morbidity (either any oxygen requireme	Last 30 minutes before birth	NR (total N=4736)	OR[b] 0.8 (95% CI 0.5 to 1.1)	Very low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
						nt at or after 6 hours of life or any mechanical ventilation in the first 24 hours)				
1 study (Liu 2015)	Prospective cohort	Serious [6]	No serious inconsistency	No serious indirectness	Serious[8]	Neonatal respiratory morbidity (either any oxygen requirement at or after 6 hours of life or any mechanical ventilation in the first 24 hours)	Last 30 minutes before birth	NR (total N=3994, caesarean births excluded)	OR[b] 3.4 (95% CI 1.2 to 9.5)	Very low
Variable decelerations (nadir < 70 bpm)[b] (compared with normal tracing - NICHD classification)										
1 study (Sheiner 2001)	Case series	Serious [5,9]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.2	1st stage	57	OR 16.3 (95% CI 3.8 to 80.5) P < 0.001	Low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
Variable decelerations (nadir < 70 bpm)b (compared with normal tracing - NICHD classification)										
1 study (Sheiner 2001)	Case series	Serious [5,9]	No serious inconsistency	No serious indirectness	No serious imprecision	BD ≥ 12 mmol/l	2nd stage	28	OR 10.5 (95% CI 1.9 to 56.4) P = 0.06	Low
Variable decelerations (nadir ≥ 70 bpm)c (compared with normal tracing - NICHD classification)										
1 study (Sheiner 2001)	Case series	Serious [5,9]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.2	1st stage	57	OR 5.1 (95% CI 1.4 to 21.4) P = 0.08	Low
Typical variable decelerations[e]										
1 study (Maso 2012)	Case series	Serious [10]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.2	2 hours before birth	63	n = 18 (28.6%)	Low
1 study (Maso 2012)	Case series	Serious [10]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.1	2 hours before birth	63	n = 6 (9.5%)	Low
1 study (Maso 2012)	Case series	Serious [10]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.0	2 hours before birth	63	n = 1 (1.6%)	Low
1 study (Maso 2012)	Case series	Serious [10]	No serious inconsistency	No serious indirectness	No serious imprecision	BD ≥ 12 mmol/l	2 hours before birth	63	n = 5 (7.9%)	Low
1 study (Maso 2012)	Case series	Serious [10]	No serious inconsistency	No serious indirectness	No serious imprecision	adverse composite neonatal outcome[e]	2 hours before birth	63	n = 6 (9.5%)	Low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
Atypical variable decelerations[f]										
1 study (Maso 2012)	Case series	Serious [10]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.2	2 hours before birth	27	n = 13 (48.2%)	Low
1 study (Maso 2012)	Case series	Serious [10]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.1	2 hours before birth	27	n = 2 (7.4%)	Low
1 study (Maso 2012)	Case series	Serious [10]	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.0	2 hours before birth	27	n = 0 (0%)	Low
1 study (Maso 2012)	Case series	Serious [10]	No Serious inconsistency	No serious indirectness	No serious imprecision	BD ≥ 12 mmol/l	2 hours before birth	27	n = 0 (0%)	Low
1 study (Maso 2012)	Case series	Serious [10]	No serious inconsistency	No serious indirectness	No serious imprecision	Adverse composite neonatal outcome[e]	2 hours before birth	27	n = 3 (11.1%)	Low
Variable decelerations (nadir ≥ 70 bpm)b (compared with normal tracing - NICHD classification)										
1 study (Sheiner 2001)	Case series	Serious [5,9]	No serious inconsistency	No serious indirectness	No serious imprecision	BD ≥ 12 mmol/l	2nd stage	28	OR 3.5 (95% CI 0.8 to 15.8) P = 0.101	Low
"Severe" variable decelerations (Krebs classification)										
1 study (Berkus 1999)	Case series	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Immediate adverse neonatal outcome[a]	1st stage	148	No statistically significant association (numerical data not reported)	Very low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Berkus 1999)	Case series	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Immediate Adverse neonatal outcome[a]	2nd stage	148	No statistically significant association (numerical data not reported)	Very low

BD base deficit; CI confidence interval; FHR fetal heart rate; NICHD National Institute of Child Health and Human Development; NICU neonatal intensive care unit; NR not reported; OR odds ratio

a Neonates were considered to have immediate adverse outcomes if they were admitted to level II, neonatal intensive care unit for > 24 hours and required oxygen support (intubation > 6 hours, or > 24 hours of > 40% oxygen supplementation)
b Adjusted for maternal fever, parity, pregestational diabetes, previous caesarean birth, pre-eclampsia
c Lowest point of the deceleration is below a FHR of 70 bpm
d Lowest point of the deceleration is at or above a FHR of 70 bpm
e Normal FHR baseline, normal variability and the presence of typical variable decelerations, without bradycardia. No definition for typical variable reported
f Composite neonatal outcomes: umbilical artery pH < 7 and/or APGAR score < 7 at 5 minutes and/or neonatal resuscitation in birth room and admission to neonatal intensive care unit for distress at birth
g Normal FHR baseline, normal variability and the presence of atypical variable decelerations, without bradycardia. Atypical variable defined in the presence of at least one of the following conditions: loss of primary or secondary rise in the baseline rate; slow return to baseline FHR after the contraction; prolong secondary rise in the baseline rate; biphasic deceleration; loss of variability during deceleration; continuation of baseline rate at lower level
1 Unclear if the assessors were blinded to outcomes
2 No separate data for pH reported
3 Unclear if women with pre-existing medical conditions were excluded
4 No definition for fetal rate patterns reported
5 Women's demographic characteristics not reported
6 Unclear if EFM tracing interpretation was performed by more than one person
7 95% CI crosses 0.75
8 95% CI crosses 1.25
9 Unclear if assessers were blinded
10 Incomplete data reported

Table 28: GRADE findings for association between variable fetal heart rate decelerations and maternal outcome

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of women with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
"Non-significant" variable decelerations (compared with normal FHR trace - NICHD classification)										
1 study (Salim 2010)	Cohort	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	Caesarean birth	1st stage	12	OR 2.25 (95% CI 0.80 to 6.87) P = 0.1	Moderate
"Severe" variable decelerations (compared with normal FHR trace - NICHD classification)										
1 study (Salim 2010)	Cohort	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	Caesarean birth	1st stage	25	OR 17.9 (95% CI 6.65 to 48.78) P = 0.0001	Moderate
"Non-significant" variable decelerations (compared with normal FHR trace - NICHD classification)										
1 study (Salim 2010)	Cohort	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	Vacuum birth	1st stage	8	OR 1.84 (95% CI 0.55 to 6.53) P = 0.3	Moderate
"Severe" variable decelerations (compared with normal FHR trace - NICHD classification)										
1 study (Salim 2010)	Cohort	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	Vacuum birth	1st stage	11	OR 6.91 (2.23 to 23.47) P = 0.001	Moderate

CI confidence interval; FHR fetal heart rate; NICHD National Institute of Child Health and Human Development; OR odds ratio
1 Unclear if women with pre-existing medical conditions were excluded

Table 29: GRADE findings for number of fetal heart rate decelerations (> 15 bpm/15 seconds) and association with fetal acadaemia

Quality assessment							Outcome		Effect		
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Stage of labour	Acidaemia[a]	No acidaemia	Relative (95% CI) compared to normal	Absolute (95% CI)	Quality
Number of decelerations (> 15 bpm/15 sec) (mean ± SD)											
1 study (Giannubilo 2006)	Case control	Serious[1, 2]	No serious inconsistency	Serious[2]	No serious imprecision	2nd stage	8.03 ± 3.77 n = 26	4.64 ± 3.84 n = 30	NC	24 more per 1000 (from 8 fewer to 58 more)	Very low

BPM beats per minute; CI confidence interval; NC not calculable; SD standard deviation

a Acidaemia defined as umbilical artery cord pH < 7.2
1 High risk of selection bias (non-consecutive cases)
2 Unclear if the trace assessors were blinded to outcomes

Table 30: Correlation of fetal heart rate decelerations and neonatal convulsions

Quality assessment						Stage of labour	Number of women & baby pairs	Correlation coefficient (p-value)	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				
Normal baseline and variability (no decelerations)									
1 study (Ellison 1991)	Case series	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	1st stage	135	r = -0.05 (P = ns)	Low
Moderate variable decelerations[a]									
1 study (Ellison 1991	Case series	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	1st stage	135	r: -0.02 (P = ns)	Low

Quality assessment						Stage of labour	Number of women & baby pairs	Correlation coefficient (p-value)	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				
Severe variable decelerations[a]									
1 study (Ellison 1991	Case series	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	1st stage	135	r: -0.04 (P = ns)	Low

NS not significant

a Original cohort from Dublin RCT (MacDonald 1985), no definition of decelerations reported
1 Women with pre-existing medical and obstetric conditions were included

I.4.1.5 Combinations of fetal heart rate trace features

Table 31: GRADE findings for predictive value of combinations of features

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Tachycardia and reduced variability (FIGO classification 1987)													
1 study (Holzmann 2015)	Prospective cohort	Very serious[1]	No serious inconsistency	No serious indirectness	Serious imprecision[2]	Fetal lactacidaemia (lactate > 4.8 mmol/l)	NR; 60 minutes prior to first fetal blood sampling	1070	60.00 % (32.89 to 82.54)[a]	62.76 % (57.64 to 67.63)[a]	1.61 (1.04 to 2.49)[a]	0.64 (0.34 to 1.19)[a]	Very low
1 study (Holzm	Prospective cohort	Very serious[1]	No serious	No serious	No serious	Fetal lactacidaemia (lactate > 4.8 mmol/l)	NR; 60 minutes prior to	888	43.8% (20.8	59.3% (53.7	1.08 (0.61 to	0.94 (0.61	Very low

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
ann 2015)			inconsistency	indirectness	imprecision		last fetal blood sampling [b]		to 69.4)[a]	to 65.1)[a]	1.92) [a]	to1.46)[a]	
Multiple late decelerations, decreased variability or both													
1 study (Nelson 1996)	Cohort	Serious[3, 4]	No serious inconsistency	Serious[5]	No serious imprecision	Cerebral palsy in low-risk population	NR	378	13.8%	91.3%	1.40	0.95	Very low
"Recurrent" late decelerations with no accelerations (NICHD classification)													
1 study (Sameshima 2005)	Cohort	Serious[4, 6,7]	No serious inconsistency	Serious[8]	No serious imprecision	Umbilical artery pH < 7.1	2 hours before birth	301	68.7% (46 to 91.4)[c]	74.7% (65.3 to 84)[c]	2.71 (1.65 to 4.46)[c]	0.41 (0.20 to 0.87)[c]	Very low
"Recurrent" late decelerations with decreased variability (NICHD classification)													
1 study (Sameshima 2005)	Cohort	Serious[4, 6,7]	No serious inconsistency	Serious[8]	No serious imprecision	Umbilical artery pH < 7.1	2 hours before birth	301	62.5% (38.7 to 86.2)[c]	89.1% (82.4 to 95.8)[c]	5.76 (2.79 to 11.8)[c]	0.42 (0.22 to 0.79)[c]	Very low
Late decelerations plus reduced variability (FIGO classification 1987)													
1 study (Holzmann 2015)	Prospective cohort	Very serious[1]	No serious inconsistency	No serious indirectness	Very serious[9]	Fetal lactacidaemia (lactate > 4.8 mmol/l)	NR; 60 minutes prior to first fetal blood sampling	1070	33.33 % (9.04 to 69.08)[a]	91.47 % (87.20 to 94.46)[a]	3.91 (1.43 to 10.70)[a]	0.73 (0.46 to 1.16) [a]	Very low

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
1 study (Holzmann 2015)	Prospective cohort	Very serious[1]	No serious inconsistency	No serious indirectness	Serious[10]	Fetal lactacidaemia (lactate > 4.8 mmol/l)	NR; 60 minutes prior to last fetal blood sampling[b]	888	52.6% (29.5 to 74.8)[a]	88.1% (82.6 to 92.1)[a]	4.43 (2.51 to 7.82)[a]	0.54 (0.33 to 0.86)[a]	Very low
Severe variable decelerations plus reduced variability (FIGO classification 1987)													
1 study (Holzmann 2015)	Prospective cohort	Very serious[1]	No serious inconsistency	No serious indirectness	Very serious[9]	Fetal lactacidaemia (lactate > 4.8 mmol/l)	NR; 60 minutes prior to first fetal blood sampling	1070	40.00 % (13.69 to 72.63)[a]	90.77 % (86.41 to 93.88)[a]	4.33 (1.85 to 10.13)[a]	0.66 (0.40 to 1.10)[a]	Very low
1 study (Holzmann 2015)	Prospective cohort	Very serious[1]	No serious inconsistency	No serious indirectness	Serious[10]	Fetal lactacidaemia (lactate > 4.8 mmol/l)	NR; 60 minutes prior to last fetal blood sampling[b]	888	47.1% (23.9 to 71.5)[a]	89.9% (84.6 to 93.6)[a]	4.66 (2.42 to 8.95[a])	0.59 (0.38 to 0.92)[a]	Very low
Severe variable decelerations plus tachycardia (FIGO classification 1987)													
1 study (Holzmann 2015)	Prospective cohort	Very serious[1]	No serious inconsistency	No serious indirectness	Very serious[9]	Fetal lactacidaemia (lactate > 4.8 mmol/l)	NR; 60 minutes prior to last fetal blood	1070	57.14 % (29.65 to 81.19)[a]	90.77 % (86.41 to 93.88)[a]	6.19 (3.42 to 11.20)[a]	0.47 (0.26 to 0.87)[a]	Very low

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
							sampling [b]						
1 study (Holzmann 2015)	Prospective cohort	Very serious[1]	No serious inconsistency	No serious indirectness	Very serious[9]	Fetal lactacidaemia (lactate > 4.8 mmol/l)	NR; 60 minutes prior to last fetal blood sampling [b]	888	64.0% (42.6 to 81.3)[a]	91.3% (86.2 to 94.7)[a]	7.34 (4.27 to 12.61)[a]	0.39 (0.23 to 0.67)[a]	Very low

CI confidence interval; FIGO International Federation of Gynecology and Obstetrics; NICHD National Institute of Child Health and Human Development; NR not reported

a Calculated by the 2017 NGA technical team
b For the last sample in a particular woman, an exclusion criterion was active pushing prior to sampling
c Calculated by the 2014 NCC-WCH technical team
1 All women in the study underwent fetal blood sampling therefore may not be representative of the whole population. A single observer interpreted the CTG traces
2 95% CI for the negative likelihood ratio crosses 0.5
3 Small study with low statistical power
4 Unclear how and by whom the data were analysed
5 Unclear if women with pre-existing medical conditions were excluded
6 Unclear if the assessors were blinded to the outcomes
7 Poor reporting of results
8 Premature birth < 32 weeks included
9 95% CI for the positive likelihood ratio crosses 5 and 10, and negative likelihood ratio crosses 0.5
10 95% CI for the positive likelihood ratio crosses 5, and negative likelihood ratio crosses 0.5

I.4.1.6 Categorisation/classification of fetal heart rate traces

Table 32: GRADE findings for predictive value of published categorisation of fetal heart rate traces for adverse neonatal outcomes

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Krebs score (abnormal versus normal)													
1 study (Spencer 1997)	Case control	Serious[1]	No serious inconsistency	Serious[2, 3]	No serious imprecision	Encephalopathy	First 30 minutes of tracing	73	5.71% (1.98 to 13.40)[a]	96.97 % (96.97 to 100)[a]	1.80 (0.11 to 7.74)[a]	0.97 (0.90 to 1.17)[a]	Very low
FIGO classification (abnormal versus normal)													
1 study (Spencer 1997)	Case control	Serious[1]	No serious inconsistency	Serious[2, 3]	No serious imprecision	Encephalopathy	First 30 minutes of tracing	73	50% (34.10 to 65.90)[a]	74.29 % (59.81 to 88.77)[a]	1.94 (1.01 to 3.71)[a]	0.67 (0.46 to 0.97)[a]	Very low
Krebs score (abnormal versus normal)													
1 study (Spencer 1997)	Case control	Serious[1]	No serious inconsistency	Serious[2, 3]	No serious imprecision	Encephalopathy	Last 30 minutes of tracing	54	41.38 % (23.45 to 59.30)	84% (69.63 to 98.37)	2.58 (0.95 to 7.01)[a]	0.69 (0.49 to 0.99)[a]	Very low
FIGO classification (abnormal versus normal)													
1 study (Spencer 1997)	Case control	Serious[1]	No serious inconsistency	Serious[2, 3]	No serious imprecision	Encephalopathy	Last 30 minutes of tracing	67	88.89 % (78.2 to 99.16)[a]	48.39 % (30.79 to 65.98)[a]	1.72 (1.20 to 2.46)[a]	0.22 (0.08 to 0.61)[a]	Very low

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
"Ominous" first stage CTG (No definition reported)													
1 study (Gaffney 1994)	Cohort	No serious risk of bias	No serious inconsistency	Serious[4]	No serious imprecision	Encephalopathy	1st stage	96	32.50 % (17.98 to 47.02)[a]	92.31 % (85.06 to 99.55)[a]	4.22 (1.49 to 11.91)[a]	0.73 (0.58 to 0.9)[a]	Low
"Ominous" second stage CTG (No definition reported)													
1 study (Gaffney 1994)	Cohort	No serious risk of bias	No serious inconsistency	Serious4	No serious imprecision	Encephalopathy	2nd stage	96	45.65 % (31.26 to 60.05)[a]	70.31 % (59.12 to 81.51)[a]	1.53 (0.94 to 2.51)[a]	0.77 (0.56 to 1.05)[a]	Low
Pattern 1 (absent baseline variability [≥ 1 cycle] usually with late and/or prolonged deceleration)[c]													
1 study (Low 1999)	Case control	Serious[1]	No serious inconsistency	Serious[3]	No serious imprecision	Asphyxia	NR	142	17%	98%	8.50	0.84	Very low
Pattern 2 (minimal baseline variability [≥ 2 cycles] and late and/or prolonged deceleration [≥ 2 cycles])[c]													
1 study (Low 1999)	Case control	Serious[1]	No serious inconsistency	Serious[3]	No serious imprecision	Asphyxia	NR	142	46%	89%	4.18	0.60	Very low
Pattern 3 (minimal baseline variability [≥ 2 cycles] or late and/or prolonged deceleration [≥ 2 cycles])[c]													
1 study (Low 1999)	Case control	Serious[1]	No serious inconsistency	Serious[3]	No serious imprecision	Asphyxia	NR	142	75%	57%	1.70	0.43	Very low

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Pattern 4 (minimal baseline variability [1 cycles] and/or late and/or prolonged deceleration [1 cycle])[c]													
1 study (Low 1999)	Case control	Serious[1]	No serious inconsistency	Serious[3]	No serious imprecision	Asphyxia	NR	142	93%	29%	1.30	0.29	Very low
Fetal sleep pattern ≥ 50% of the tracing (NICHD classification) (fetal sleep pattern not defined)													
1 study (Menihan 2006)	Case control	Serious[1]	No serious inconsistency	Serious[3]	No serious imprecision	Sudden infant death	NR	142	40% (21.9 to 61.3)[a]	45.7% (34.6 to 57.3)[a]	0.70 (0.41 to 1.31)[a]	1.31 (0.84 to 2.03)[a]	Very low
"Abnormal" FHR pattern (NICHD classification)													
1 study (Hadar 2001)	Cohort	Serious[9]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical artery pH 7.1, 7.2 + Base deficit > 12	1st stage	601	78.3% (70.4 to 86.1)[a]	55.9% (51.5 to 60.3)[a]	1.77 (1.54 to 2.04)[a]	0.38 (0.26 to 0.56)[a]	Moderate
Category III (versus category 1) (NICHD classification 2008)													
1 study (Graham 2014)	Case control	Very serious[5]	No serious inconsistency	No serious indirectness	Very serious[6]	Whole-body hypothermia treatment for suspected moderate to severe encephalopathy	Last 1 hour tracing before birth	117	55.6% (22.7 to 84.7)[b]	87.5% (46.7 to 99.3)[b]	4.44 (0.65 to 30.44)[b]	0.51 (0.24 to 1.09)[b]	Very low
Category II (versus category 1) (NICHD classification 2008)													

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
1 study (Graham 2014)	Case control	Very serious[5]	No serious inconsistency	No serious indirectness	Serious[7]	Whole-body hypothermia treatment for suspected moderate to severe encephalopathy	Last 1 hour tracing before birth	117	88.2% (71.6 to 96.2)[b]	9.1% (4.0 to 18.4)[b]	0.97 (0.84 to 1.12)[b]	1.29 (0.40 to 4.19)[b]	Very low
Indeterminate FHR pattern (Category II, NICHD classification 2008)													
1 study (Sharbaf 2014)	Prospective cohort	Very serious[10]	No serious inconsistency	No serious indirectness	No serious imprecision[11]	Umbilical artery pH ≤7.2	In early labour during a 20-40 minute period	Mixed population of both low- and high-risk pregnancies N=818 (normal n=659, indeterminate n=159)	40.6% (24.2 to 59.2)	69.8% (62.5 to 76.2)	1.34 (0.84 to 2.16)[b]	0.85 (0.64 to 1.14)[b]	Low
1 study (Sharbaf 2014)	Prospective cohort	Very serious[10]	No serious inconsistency	No serious indirectness	No serious imprecision[11]	NICU admission	In early labour during a 20-40 minute period	Mixed population of both low- and high-risk pregnan	35.7% (22.0 to 52.0%)	81.4% (78.5 to 84.1%)	1.92 (1.25 to 2.96)[b]	0.79 (0.63 to 1.00)[b]	Low

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
								cies N=818 (normal n=659, indeterminate n=159)					
1 study (Sharbaf 2014)	Prospective cohort	Very serious[10]	No serious inconsistency	No serious indirectness[11]	No serious imprecision	NICU admission excluding preterm birth	In early labour during a 20-40 minute period	Mixed population of both low- and high-risk pregnancies N=818 (normal n=659, indeterminate n=159)	31.3%	81.9%	1.73[b]	0.84[b]	Low
1 study (Sharbaf 2014)	Prospective cohort	Very serious[10]	No serious inconsistency	No serious indirectness	Serious imprecision[12]	Neonatal death	In early labour during a 20-40 minute period	Mixed population of both low- and high-risk pregnancies N=818	100% (19.8 to 100)	80.8% (77.8 to 83.4)	5.2 (4.52 to 5.98) [b]	0 (NA)	Low

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
								(normal n=659, indeterminate n=159)					
1 study (Sharbaf 2014)	Prospective cohort	Very serious[10]	No serious inconsistency	No serious indirectness[11]	No serious imprecision	Umbilical artery pH ≤7.2	In early labour during a 20-40 minute period	Low-risk population only N=492 (normal n=410, indeterminate n=82)	26.7% (8.9 to 55.2)	83.7% (80.0 to 86.8)	1.63 (0.69 to 3.87)[b]	0.88 (0.65 to 1.19)[b]	Low
1 study (Sharbaf 2014)	Prospective cohort	Very serious[10]	No serious inconsistency	No serious indirectness[11]	No serious imprecision	NICU admission	In early labour during a 20-40 minute period	Low-risk population only N=492 (normal n=410, indeterminate n=82)	16.7% (4.4 to 42.2)	83.3% (79.6 to 86.5)	1.00 (0.35 to 2.86)[b]	1.00 (0.81 to 1.23)[b]	Low
1 study (Sharbaf 2014)	Prospective cohort	Very serious[10]	No serious inconsistency	No serious indirectness	No serious imprecision[11]	NICU admission excluding preterm birth	In early labour during a 20-40 minute period	Low-risk population only N=492 (normal n=410, indeterm	12.5%	83.2%	0.74[b]	1.05[b]	Low

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
								inate n=82)					
1 study (Sharbaf 2014)	Prospective cohort	Very serious[10]	No serious inconsistency	No serious indirectness	No serious imprecision[11]	Neonatal death	In early labour during a 20-40 minute period	Low-risk population only N=492 (normal n=410, indeterminate n=82)	NA	83.3% (79.7 to 86.4)	0[b] (NA)	1.20[b] (NA)	Low
"Stressed" or "distressed" FHR patterns (Dellinger classification)													
1 study (Dellinger 2000)	Cohort	Serious[13]	No serious inconsistency	No serious indirectness	No serious imprecision	NICU admission	1 hour before birth	898 (normal = 627, stressed n = 263, distressed n = 8)	46%	72%	1.64	0.75	Low
1 study (Dellinger 2000)	Cohort	Serious[13]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical artery pH < 7	1 hour before birth	898 (normal = 627, stressed n = 263, distressed n = 8)	100%	66%	2.9	0	Low
1 study	Cohort	Serious[13]	No serious	No serious	No serious	BE < -11	1 hour before birth	898 (normal = 627,	100%	66%	2.9	0	Low

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
(Dellinger 2000)			inconsistency	indirectness	imprecision			stressed n = 263, distressed n = 8)					
"Distressed" FHR patterns (Dellinger classification)													
1 study (Dellinger 2000)	Cohort	Serious[1][3]	No serious inconsistency	No serious indirectness	No serious imprecision	NICU admission	1 hour before birth	635 (normal = 627, distressed n = 8)	9%	99%	9.0	0.91	Low
1 study (Dellinger 2000)	Cohort	Serious[1][3]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical artery pH < 7	1 hour before birth	635 (normal = 627, distressed n = 8)	100%	98%	50	0	Low
1 study (Dellinger 2000)	Cohort	Serious[1][3]	No serious inconsistency	No serious indirectness	No serious imprecision	BE < -11	1 hour before birth	635 (normal = 627, distressed n = 8)	100%	98%	50	0	Low
Presence of 1 poor prognostic feature[d]													
1 study (Ozden 1999)	Cohort	Serious[2]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH < 7.20	NR	167	75%	55%	1.60	0.45	Moderate
Presence of 2 poor prognostic features)[d]													

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
1 study (Ozden 1999)	Cohort	Serious[2]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH < 7.20	NR	167	55.6%	70.0%	1.83	0.64	Moderate
Presence of 3 poor prognostic features)[d]													
1 study (Ozden 1999)	Cohort	Serious[2]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH < 7.20	NR	167	36.1%	82.5%	2.06	0.77	Moderate
Presence of 4 poor prognostic features[d]													
1 study (Ozden 1999)	Cohort	Serious[2]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH < 7.20	NR	167	22.2%	90%	2.22	0.86	Moderate
FHR baseline < 110 bpm, baseline variability < 5 bpm and non-reactive trace (NICHD classification)													
1 study (Larma 2007)	Case control	Serious[1][4]	No serious inconsistency	Serious[3]	No serious imprecision	Moderate HIE	Last hour of tracing	214	7.7%	98.9%	6.36	0.94	Very low

BE base excess; CI confidence interval; CTG cardiotocography; FHR fetal heart rate; FIGO International Federation of Obstetrics and Gynaecology; HIE hypoxic ischaemic encephalopathy; NA not applicable; NICHD National Institute of Child Health and Human Development; NICU neonatal intensive care unit; NR not reported

a Calculated by the 2014 NCC-WCH technical team
b Fetal asphyxia was classified as mild, moderate, or severe on the basis of umbilical artery base deficit (cut off >12 mmol/l) and neonatal encephalopathy and other organ system complications

FHR criteria predictive of fetal asphyxia:

- *Absent or minimal baseline variability and late or prolong decelerations*

The FHR patterns are based on the findings in six 10 minute cycles of FHR recording

- *Absent baseline variability, usually with repeat cycles (≥ 2) of the late or prolonged decelerations*
- *Repeat cycles (≥ 2) of both minimal baseline variability and late or prolonged decelerations*

- *Repeat cycles (≥ 2) of either minimal baseline variability or late or prolonged decelerations*
- *One cycle of either minimal baseline variability or late or prolong decelerations*
- *No cycle of either minimal baseline variability or late or prolonged decelerations*

c Calculated by the 2017 NGA technical team
d Variable deceleration classified into 7 subtypes according to poor prognostic features (PPFs):

1. *Loss of primary acceleration*
2. *Loss of secondary acceleration*
3. *Loss of variability during deceleration*
4. *Slow return to baseline*
5. *Biphasic deceleration*
6. *Prolonged secondary acceleration*
7. *Prolonged deceleration*

1 Unclear who evaluated the traces
2 Small study with low statistical power
3 Unclear if women with pre-existing medical conditions were excluded
4 Half of the study population had one or more antenatal complicating factor
5 Unclear if the assessors were blinded to outcomes
6 High risk of bias due to study design and timing
7 95% CI for the positive likelihood ratio crosses 5 and 10, and for the negative likelihood ratio crosses 0.5
8 95% CI for the negative likelihood ratio crosses 0.5
9 Unclear if consecutive enrolment of participants was performed, no blinding of assessors for CTG tracing findings when outcome was assessed, late preterm births were included, and events independent of CTG tracing may have influenced the outcome
10.1% of the population were late preterm (> 34 and < 37 weeks of gestation)
11 95% CI for the positive LR crosses 5
12 Under-powered cohort due to imbalance in number of participants in groups
13 Exclusion criteria not specified, high risk of selection bias

Table 33: GRADE findings for predictive value of published categorisations of fetal heart rate traces for mode of birth

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
"Pathological" FHR pattern (NICHD classification)													
1 study (Hadar 2001)	Cohort	Serious[1]	No serious	No serious	No serious	Spontaneous vaginal birth	2nd stage	301	45.31 %	28.8%	0.63 (0.54 to	1.89 (1.40 to	Moderate

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
			inconsistency	indirectness	imprecision				(40.9 to 49.7)[a]	(20.4 to 37.26)[b]	0.74)[a]	2.56)[a]	
1 study (Hadar 2001)	Cohort	Serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	Vacuum birth	2nd stage	301	73.33 % (60.41 to 86.25)[a]	51.8% (47.6 to 55.9)[a]	1.52 (1.25 to 1.85)[a]	0.51 (0.31 to 0.84)[a]	Moderate
1 study (Hadar 2001)	Cohort	Serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	caesarean birth	2nd stage	301	69.70 % (58.61 to 80.78)[a]	52.34 % (48.10 to 56.57)[a]	1.46 (1.21 to 1.75)[a]	0.57 (0.39 to 0.84)[a]	Moderate
"Stressed" or "distressed" FHR patterns (Dellinger classification)													
1 study (Dellinger 2000)	Cohort	Serious[2]	No serious inconsistency	No serious indirectness	No serious imprecision	Caesarean birth	1 hour before birth	898 (normal = 627, stressed n = 263, distressed n = 8)	35%	71%	1.20	0.91	Low
"Distressed" FHR patterns (Dellinger classification)													
1 study (Dellinger 2000)	Cohort	Serious[2]	No serious inconsistency	No serious indirectness	No serious imprecision	Caesarean birth	1 hour before birth	635 (normal = 627, distressed n = 8)	5%	99%	5.0	0.95	Low
Indeterminate FHR pattern (Category II, NICHD classification 2008)													

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
1 study (Sharbaf 2014)	Prospective cohort	Very serious[3]	No serious inconsistency	No serious indirectness[4]	No serious imprecision	Caesarean section	In early labour during a 20-40 minute period	Mixed population of both low- and high-risk pregnancies N=818 (normal n=659, indeterminate n=159)	30.9%	86.3%	2.26[b]	0.80[b]	Low
1 study (Sharbaf 2014)	Prospective cohort	Very serious[3]	No serious inconsistency	No serious indirectness[4]	No serious imprecision	Caesarean section	In early labour during a 20-40 minute period	Low-risk population only N=492 (normal n=410, indeterminate n=82)	28.6%	87.7%	2.33[b]	0.81[b]	Low

CI confidence interval; FHR fetal heart rate; NICHD National Institute of Child Health and Human Development; NR not reported

a Calculated by the 2014 NCC-WCH technical team
b Calculated by the 2017 NGA team
1 Unclear if the assessors were blinded to outcomes
2Under-powered cohort due to imbalance in number of participants in groups
3Unclear if consecutive enrolment of participants was performed, no blinding of assessors for CTG tracing findings when outcome was assessed, late preterm births were included, and events independent of CTG tracing may have influenced the outcome
4 8.1% of the population were late preterm (> 34 and < 37 weeks of gestation)

Table 34: GRADE findings for association between categorisation of fetal heart rate traces and adverse neonatal outcomes

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
"Pathological" FHR pattern (NICHD classification)										
1 study (Hadar 2001)	Cohort	Serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord artery pH < 7.2 and BD ≥ 12	2nd stage	301	OR 2.86 (95% CI 0.3 to 24.4) P = 0.33	Moderate
"Predictive" FHR pattern[a]										
1 study (Low 2001)	Case series	Serious [2]	No serious inconsistency	No serious indirectness	No serious imprecision	Moderate or severe asphyxia (BD > 12 at birth, encephalopathy and cardiovascular, respiratory and renal complications)	NR	23	n = 13 (56%)	Low
"Suspect" FHR pattern[a]										
1 study (Low 2001)	Case series	Serious [2]	No serious inconsistency	No serious indirectness	No serious imprecision	Moderate or severe asphyxia (BD > 12 at birth, encephalopathy and cardiovas	NR	23	n = 7 (30%)	Low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
						cular, respiratory and renal complications)				
"Non-predictive" FHR pattern[a]										
1 study (Low 2001)	Case series	Serious [2]	No serious inconsistency	No serious indirectness	No serious imprecision	Moderate or severe asphyxia (BD > 12 at birth, encephalopathy and cardiovascular, respiratory and renal complications)	NR	26	n = 3 (11.5%)	Low
"Abnormal" FHR tracing (compared with normal tracing - NICHD classification)										
1 study (Sheiner 2001)	Case series	Serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	pH< 7.2 and BD ≥ 12	1st stage	28	OR 3.4 (95% CI 1.3 to 8.7) P = 0.01	Low
Type 0 FHR tracing[b]										
1 study (Cardoso 1995)	Case series	Serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH (mean ± SD)	2nd stage	103	7.24 ± 0.06	Low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
Type 1a FHR tracing[b]										
1 study (Cardoso 1995)	Case series	Serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH (mean ± SD)	2nd stage	93	7.24 ± 0.07 P = ns	Very low
Type 1b FHR tracing[b]										
1 study (Cardoso 1995)	Case series	Serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH (mean ± SD)	2nd stage	19	7.15 ± 0.07 P = 0.0001	Low
Type 2a FHR tracing[b]										
1 study (Cardoso 1995)	Case series	Serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH (mean ± SD)	2nd stage	34	7.19 ± 0.06 P = 0.0001	Low
Type 2b FHR tracing[b]										
1 study (Cardoso 1995)	Case series	Serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH (mean ± SD)	2nd stage	13	7.06 ± 0.07 P = 0.0001	Low
Type 3 FHR tracing[b]										
1 study (Cardoso 1995)	Case series	Serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH	2nd stage	14	7.09 ± 0.06 P = 0.0001	Low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
						(mean ± SD)				
Type 4 FHR tracing[b]										
1 study (Cardoso 1995)	Case series	Serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH (mean ± SD)	2nd stage	15	7.19 ± 0.07 P = 0.01	Low
"Normal" FHR tracing[b]										
1 study (Gilstrap 1987)	Cohort	Serious [3,4]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH (mean ± SD)	1st stage	129	7.29 ± 0.6	Very low
Indeterminate FHR pattern (Category II, NICHD classification 2008)										
1 study (Sharbaf 2014)	Prospective cohort	Very serious [5]	No serious inconsistency	No serious indirectness	Serious[6]	Umbilical artery pH ≤7.2	"Early labour"	Mixed population of both low- and high-risk pregnancies N=159	RR 1.5 (95% CI 0.8 to 2.8)	Very low
1 study (Sharbaf 2014)	Prospective cohort	Very serious [5]	No serious inconsistency	No serious indirectness	Serious[6]	NICU admission	"Early labour"	Mixed population of both low- and high-risk pregnancies N=159	RR 2.3 (95% CI 1.2 to 4.2)	Very low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Sharbaf 2014)	Prospective cohort	Very serious [5]	No serious inconsistency	No serious indirectness	Serious[6]	NICU admission after excluding preterm birth	"Early labour"	Mixed population of both low- and high-risk pregnancies N=159	RR 2.0 (95% CI 1.0 to 4.1)	Very low
1 study (Sharbaf 2014)	Prospective cohort	Very serious [5]	No serious inconsistency	No serious indirectness	Very serious[7]	Umbilical artery pH ≤7.2	"Early labour"	Low-risk population only N=82	RR 1.05 (95% CI 0.4 to 3.0)	Very low
1 study (Sharbaf 2014)	Prospective cohort	Very serious [5]	No serious inconsistency	No serious indirectness	Very serious[7]	NICU admission	"Early labour"	Low-risk population only N=82	RR 1.0 (95% CI 0.3 to 3.4)	Very low
1 study (Sharbaf 2014)	Prospective cohort	Very serious [5]	No serious inconsistency	No serious indirectness	Very serious[7]	NICU admission after excluding preterm birth	"Early labour"	Low-risk population only N=82	RR 0.7 (95% CI 0.2 to 3.1)	Very low

BD base deficit; CI confidence interval; FHR fetal heart rate; NICHD National Institute of Child Health and Human Development; NR not reported; OR odds ratio; RR risk ratio; SD standard deviation

a Criteria for classification of FHR as predictive, suspect, and non-predictive of fetal asphyxia on the basis of a 10 minute cycle of FHR tracing

Predictive: Absent baseline variability (repetitive cycle) ≥ 1 and presence of late or prolong decelerations ≥ 2 or presence of minimal baseline variability (repetitive cycle) ≥ 2 and presence of late or prolonged decelerations ≥ 2

Suspect: Presence of minimal baseline variability (repetitive cycle ≥ 2) and late or prolong decelerations (repetitive cycle ≥ 0/1) or presence of minimal baseline variability (repetitive cycle ≥ 0/1) and late or prolonged decelerations ≥ 2 repetitive cycle

Non-predictive: Minimal baseline variability (repetitive cycle 1) and no late or prolonged decelerations

b No definition for "Normal" FHR tracing reported. Abnormal FHR defined as:

1. *Mild bradycardia (FHR 90 – 119 bpm)*
2. *Moderate bradycardia (FHR 60 – 89 bpm)*
3. *Marked or severe bradycardia (FHR below 60 bpm)*
4. *Tachycardia (FHR ≥ 160 bpm)*

1 Unclear if the assessors were blinded to outcomes
2 Small numbers of participants in severe category
3 No definition for FHR patterns reported
4 Women's demographic characteristics not reported
5 No adjustments for potential confounders, no description of statistical methods. Only 20-40 minutes of CTG tracing interpreted in 'early labour'
6 95% CI crosses 1.25
7 95% CI crosses 0.75 and 1.25

Table 35: GRADE findings for association between categorisation of fetal heart rate traces and mode of birth

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
Indeterminate FHR pattern (Category II, NICHD classification 2008)										
1 study (Sharbaf 2014)	Prospective cohort	Very serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	Caesarean section due to non-reassuring fetal heart rate pattern	"Early labour"	Mixed population of both low- and high-risk pregnancies N=159	RR 3.8 (95% CI 2.5 to 5.6)	Very low
1 study (Sharbaf 2014)	Prospective cohort	Very serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	Caesarean section due to non-reassuring fetal heart rate pattern	"Early labour"	Low-risk population only N=82	RR 3.7 (95% CI 2.1 to 6.9)	Very low

CI confidence interval; FHR fetal heart rate; NICHD National Institute of Child Health and Human Development; RR risk ratio

1 No adjustments for potential confounders, no description of statistical methods. Only 20-40 minutes of CTG tracing interpreted in 'early labour'

Table 36: GRADE findings for umbilical cord arterial pH in women with normal and abnormal fetal heart rate tracing

Quality assessment							Percentage and number of babies in each FHR tracing category				
Number of studies	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Stage of labour**	**"Normal"[a]**	**"Warning symptoms"[a]**	**"Severe functional hemodynamic"[a]**	**"Hypoxia"[a]**	**Quality**
Umbilical cord artery pH > 7.20											
1 study (Heinrich 1982)	Cohort	Serious[1,2]	No serious inconsistency	No serious indirectness	No serious imprecision	2nd stage (30 minutes prior to birth)	96.6% n = 1043	96.7% n = 1095	83% n = 357	60% n = 30	Low
Umbilical cord artery pH 7.25 – 7.20											
1 study (Heinrich 1982)	Cohort	Serious[1,2]	No serious inconsistency	No serious indirectness	No serious imprecision	2nd stage (30 minutes prior to birth)	2.5% n = 27	2.4% n = 48	11% n = 48	22% n = 11	Low
Umbilical cord artery pH < 7.20											
1 study (Heinrich 1982)	Cohort	Serious[1,2]	No serious inconsistency	No serious indirectness	No serious imprecision	2nd stage (30 minutes prior to birth)	0.9% n = 10	0.9% n = 11	6.0% n = 26	18% n = 9	Low

FHR fetal heart rate

a Categorisation:

Normal: Baseline 120 – 160 bpm, variability 10 – 25 bpm, sporadic variable accelerations, no variable or late decelerations
Warning: Tachycardia, variability < 10 bpm or > 25 bpm, periodic accelerations, moderate variable decelerations, early decelerations
Severe: Transient bradycardia, severe variable decelerations, prolonged decelerations
Hypoxia: Final bradycardia, variability 0 – 5 bpm, typical late decelerations

1 No definition for fetal rate patterns reported
2 Women's demographic characteristics not reported

I.4.2 High risk populations

I.4.2.1 Accelerations

Table 37: GRADE findings for association between absence of, or decreased, fetal heart rate accelerations and fetal metabolic acidosis

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
Absence or decreased FHR accelerations										
1 study (Low 1981)	Cohort	Serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	Fetal metabolic acidosis[a]	Last 4 hours prior to birth	280	Absence of, or decreased, FHR accelerations was not associated with fetal acidosis[b]	Moderate

FHR fetal heart rate

a Fetal metabolic acidosis is defined as an umbilical artery buffer base of < 36.1 mEq/l
b There was no statistical significant difference between the two groups (babies with metabolic acidosis and babies with no metabolic acidosis) in regard to decrease frequency or absence of FHR accelerations in the 12 FHR trace cycles (4 hours before birth) (no synthesis of statistical data reported).
1 No statistical analysis of data reported

I.4.2.2 Decelerations

Table 38: GRADE findings for association between no decelerations/early decelerations and adverse neonatal outcomes

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
Early decelerations[a]										
1 study (Cibils 1980)	Cohort	Very serious [1,2,3,]	No serious inconsistency	No serious indirectness	No serious imprecision	Fetal distress[b]	1st stage	247	Early decelerations group: 5% with fetal distress No decelerations groups: 4% with fetal distress	Low
Early decelerations[a]										
1 study (Cibils 1980)	Cohort	Very serious [1,2,3,]	No serious inconsistency	No serious indirectness	No serious imprecision	Neonatal death	1st stage	247	Early deceleration group: n = 1[d] No decelerations groups: n = 1[d]	Low

FHR fetal heart rate

a Early deceleration defined as a decrease of FHR of at least 10 bpm coinciding with a uterine contraction
b Fetal distress defined as presence of meconium stained liquor, sustained fetal tachycardia, markedly irregular heart beat
c Reason for neonatal death was congenital malformation in "no deceleration" group and congenital heart disease in "early deceleration" group
1 No exclusion criteria specified hence high risk of selection bias
2 Women's demographic characteristics not reported
3 Unclear how and by whom data were analysed

Table 39: GRADE findings for association between no decelerations /variable decelerations[a] and adverse neonatal outcomes

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
Variable decelerations										
1 study (Cibils 1978)	Cohort	Serious [1,2,3]	No serious inconsistency	No serious indirectness	No serious imprecision	Fetal distress[b]	1st stage	312	No deceleration: 4% with fetal distress Variable decelerations: 23% with fetal distress p < 0.0005	Low
Variable decelerations										
1 study (Cibils 1978)	Cohort	Serious [1,2,3]	No serious inconsistency	No serious indirectness	No serious imprecision	Neonatal death	1st stage	312	No deceleration: 0.2% Variable decelerations: 2.2% p < 0.0005	Low
Variable decelerations with late component										
1 study (Cibils 1978)	Cohort	Serious [1,2,3]	No serious inconsistency	No serious indirectness	No serious imprecision	Fetal distress[b]	1st stage	312	Variable deceleration with late component: 78% with fetal distress Variable decelerations without late component: 23% with fetal distress p < 0.0005	Low
Variable decelerations with late component										
1 study (Cibils 1978)	Cohort	Serious [1,2,3]	No serious inconsistency	No serious indirectness	No serious imprecision	Neonatal death	1st stage	312	Variable deceleration with late component: 11%	Low

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
									Variable decelerations without late component: 2.2% p = ns	
Variable decelerations										
(Low 1981)	Cohort	Serious [4]	No serious inconsistency	No serious indirectness	No serious imprecision	Fetal metabolic acidosis[c]	Last 20 minutes prior to birth	68	Variable decelerations were significantly associated with fetal metabolic acidosis[d]	Moderate

FHR fetal heart rate; NS not significant

a Variable deceleration defined as starts usually in the early part of the rise of contraction, FHR falling to between 60 and 90 bpm, sustained for 10 to 50 seconds and the recovery is rapid
b Fetal distress defined as presence of meconium stained liquor, sustained fetal tachycardia, markedly irregular heart beat
c Fetal metabolic acidosis is defined as an umbilical artery buffer base of < 36.1 mEq/l
d See evidence table for more information (no synthesis of statistical data reported).
1 No exclusion criteria specified hence high risk of selection bias
2 Women's demographic characteristics not reported
3 Unclear how and by whom data were analysed
4 No statistical analysis of data reported

Table 40: GRADE findings for association between no decelerations/late decelerations[a] and adverse neonatal outcomes

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
Late decelerations										

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**					
1 study (Cibils 1975)	Cohort	Serious [1,2,3]	No serious inconsistency	No serious indirectness	No serious imprecision	Neonatal morbidity or death[b]	60 minutes recording prior to 2nd stage or caesarean section	147	Late deceleration group: 7% No deceleration group: 0.5% p < 0.0001	Low
Late decelerations										
1 study (Cibils 1975)	Cohort	Serious [1,2,3]	No serious inconsistency	No serious indirectness	No serious imprecision	Neonatal morbidity or death in low birthweight babies < 2500g	60 minutes recording prior to 2nd stage or caesarean section	147	Late deceleration group: 15% No deceleration group: 5% p = NS	Low
Late decelerations										
1 study (Cibils 1975)	Cohort	Serious [1,2,3]	No serious inconsistency	No serious indirectness	No serious imprecision	Fetal distress during labour and after birth[c]	60 minutes recordings prior to 2nd stage or caesarean section	147	Distressed during labour: 50% Born “depressed”: 33%	Low
Late decelerations										
(Low 1981)	Cohort	Serious [4]	No serious inconsistency	No serious indirectness	No serious imprecision	Fetal metabolic acidosis[d]	Last hour	101	Late decelerations were significantly	Moderate

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
							prior to birth		associated with acidosis[e]	

FHR fetal heart rate, NS not significant

a Late deceleration defined: the beginning of the fall in FHR starts when the contraction reaches its apex or slightly later (usually > 20 seconds after the contraction began its relaxation). The recovery is slow the total duration of the deceleration is close to 60 seconds
b The only neonatal death in the "no deceleration" group was due to severe congenital heart disease. No more details on neonatal death reported
c Fetal distress defined as presence of meconium stained liquor, sustained fetal tachycardia, markedly irregular heart beat
d Fetal metabolic acidosis is defined as an umbilical artery buffer base of < 36.1 mEq/l
e See evidence table for more information (no synthesis of statistical data reported).
1 No exclusion criteria specified hence high risk of selection bias
2 Women's demographic characteristics not reported
3 Unclear how and by whom data were analysed
4 No statistical analysis of data reported

Table 41: GRADE findings for association between marked patterns of total decelerations[a], moderate/marked pattern of late decelerations[b] and fetal asphyxia

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
FHR deceleration patterns										
(Low 1977)	Cohort	Serious [1,2]	No serious inconsistency	No serious indirectness	No serious imprecision	Fetal asphyxia[c]	Four hours prior to birth	122	FHR deceleration patterns was not associated with fetal asphyxia	Low
FHR deceleration patterns										

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**					
(Low 1977)	Cohort	Serious [1,2]	No serious inconsistency	No serious indirectness	No serious imprecision	Fetal asphyxia[c]	Last 2 hours/last 1 hour to birth	122	An increased incidence of marked patterns of total deceleration and marked pattern of late decelerations	Low
FHR deceleration patterns										
(Low 1977)	Cohort	Serious [1,2]	No serious inconsistency	No serious indirectness	No serious imprecision	Fetal asphyxia[c]	Last 2 hours prior to birth	122	An increased incidence of marked patterns of total deceleration and moderate plus marked pattern of late decelerations	Low

FHR fetal heart rate

a Total decelerations defined as percentage of contractions associated with a deceleration in each two-hour period. It is classified as moderate (5% to 29% of contractions were associated with a deceleration) and marked (> 30% of contractions were associated with a deceleration)
b Late decelerations defined as percentage of contractions associated with a late deceleration in each two-hour period. It is classified as moderate (< 10% of contractions were associated with a late deceleration) and marked (≥ 10% of contractions were associated with a late deceleration)
c The fetal asphyxia group included n = 122 women in whom their baby had umbilical artery buffer base of < 2 SD below the mean, i.e., <36.1 mEq/l.
1 Women's demographic characteristics not reported
2 Unclear how and by whom data were analysed

Table 42: GRADE findings for predictive value of fetal heart rate decelerations for adverse neonatal outcomes in prolonged pregnancy (> 42 weeks of gestation)

Quality assessment								Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Definition of outcome	Stage of labour		Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	Quality
Late decelerations													
1 study (Cibils 1993)	Case series	Serious[1, 2,3]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH < 7.20	1st stage	707	39.1% (25 to 53.2)	67.7% (58.7 to 76.4)	1.20 (0.76 to 1.89)	0.90 (0.69 to 1.17)	Low
Variable decelerations													
1 study (Cibils 1993)	Case series	Serious[1, 2,3]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH < 7.20	1st stage	707	36.4% (23.8 to 50.1)	55.7% (46.5 to 64.7)	0.83 (0.53 to 1.28)	1.13 (0.85 to 1.53)	Low
No or early decelerations													
1 study (Cibils 1993)	Case series	Serious[1, 2,3]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical cord arterial pH < 7.20	1st stage	707	23.7% (11.2 to 35.9)	76.2% (68.5 to 84.9)	1.01 (0.54 to 1.88)	0.99 (0.82 to 1.20)	Low

CI confidence interval

1 No exclusion criteria specified hence high risk of selection bias
2 Women's demographic characteristics not reported
3 Unclear how and by whom data were analysed

I.4.2.3 Categorisation/classification of fetal heart rate traces

Table 43: GRADE findings for predictive value of published categorisations of fetal heart rate traces on adverse neonatal outcomes among high risk group

Quality assessment									Measure of diagnostic accuracy (95% CI)				
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Definition of outcome	Stage of labour	Total number of women & baby pairs	Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	Quality
Indeterminate FHR tracing (NICHD classification 2008)													
1 study (Sharbaf 2014)	Prospective cohort	Very serious[1]	No serious inconsistency	No serious indirectness	Serious imprecision[2]	Umbilical artery pH <=7.2	In early labour during a 20-40 minute period	326 (normal n=249, indeterminate n=77)	52.9% (28.5 to 76.1)[a]	80.0% (72.9 to 82.4)[a]	2.41 (1.47 to 3.95)[b]	0.60 (0.36 to 1.00)[b]	Very low
1 study (Sharbaf 2014)	Prospective cohort	Very serious[1]	No serious inconsistency	No serious indirectness	Serious imprecision[2]	NICU admission	In early labour during a 20-40 minute period	326 (normal n=249, indeterminate n=77)	50.0% (29.6 to 70.4)[a]	78.5% (73.3 to 82.9)[a]	2.32 (1.47 to 3.66)[b]	0.64 (0.43 to 0.95)[b]	Very low
1 study (Sharbaf 2014)	Prospective cohort	Very serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	NICU admission excluding preterm birth	In early labour during a 20-40 minute period	NR	50.0%[c]	79.9%[c]	2.49[b,c]	0.63[b,c]	Low

Quality assessment									Measure of diagnostic accuracy (95% CI)				
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Definition of outcome	Stage of labour	Total number of women & baby pairs	Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	Quality
1 study (Sharbaf 2014)	Prospective cohort	Very serious[1]	No serious inconsistency	No serious indirectness	Serious[3]	Neonatal death	In early labour during a 20-40 minute period	326 (normal n=249, indeterminate n=77)	100% (19.8 to 100)[a]	76.9% (71.8 to 81.3)[a]	4.32 (3.54 to 5.27)[b]	0 (NA)[b]	Very low
"Abnormal" FHR pattern (Category III, NICHD classification 2008)													
1 study (Sonicni 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	Serious[3]	NICU admission	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	100% (69.9 to 100)[b]	85.0% (77.4 to 90.5)[b]	6.68 (4.42 to 10.12)[b]	0 (NA)[b]	Very low
1 study (Sonicni 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	Serious[3]	Encephalopathy	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	100% (59.8 to 100)[b]	82.4% (74.6 to 88.3)[b]	5.70 (3.93 to 8.25)[b]	0 (NA)[b]	Very low

Quality assessment									Measure of diagnostic accuracy (95% CI)				
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Definition of outcome	Stage of labour	Total number of women & baby pairs	Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	Quality
1 study (Sonicni 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	Serious[3]	Moderate-severe neonatal encephalopathy	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	100% (39.6 to 100)[b]	80.0% (72.1 to 86.2)[b]	5.00 (3.57 to 7.01)[b]	0 (NA)[b]	Very low
1 study (Sonicni 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	Serious[3]	Death before NICU discharge	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	100% (31.0 to 100)[b]	79.4% (71.4 to 85.7)[b]	4.86 (3.49 to 6.76)[b]	0 (NA)[b]	Very low
1 study (Sonicni 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical artery pH <7	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118,	100% (77.1 to 100)[b]	88.5%(81.2 to 93.3)[b]	8.71 (5.32 to 14.27)[b]	0 (NA)[b]	Very low

Quality assessment									Measure of diagnostic accuracy (95% CI)				
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Definition of outcome	Stage of labour	Total number of women & baby pairs	Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	Quality
								category IIB n=57)					
1 study (Sonicni 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	Very serious[5]	Umbilical artery BE ≤ -12 mmol/l	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	86.4% (64.0 to 96.4)[b]	89.7% (82.4 to 94.4)[b]	8.42 (4.80 to 14.76)[b]	0.15 (0.05 to 0.44)[b]	Very low
1 study (Sonicni 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	Very serious[6]	Umbilical artery pH <7 and BE ≤ -12 mmol/l	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	100% (73.2 to 100)[b]	86.4% (78.8 to 91.6)[b]	7.35 (4.73 to 11.44)[b]	0 (NA)[b]	Very low
"Indeterminate" FHR pattern with minimal/absent baseline FHR variability and no FHR accelerations (Category IIB, NICHD classification 2008 with subcategorisation according to ACOG guidelines)													
1 study (Sonicni 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision	NICU admission	At least 1 hour and up to 5	314 (normal n=108, category III	100% (62.9 to 100)[b]	69.2% (61.3 to 76.2)[b]	3.25 (2.57 to	0 (NA)[b]	Very low

Quality assessment									Measure of diagnostic accuracy (95% CI)				
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Definition of outcome	Stage of labour	Total number of women & baby pairs	Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	Quality
							hours before birth	n=31, category IIA n=118, category IIB n=57)			4.11))[b]		
1 study (Sonicni 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision	Encephalopathy	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	100% (31.0 to 100)[b]	66.7% (58.8 to 73.8)[b]	3.00 (2.41 to 3.73)[b]	0 (NA)[b]	Very low
1 study (Sonicni 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision	Moderate-severe neonatal encephalopathy	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	100% (5.5 to 100)[b]	65.9% (58.0 to 73.0)[b]	2.93 (2.37 to 3.62)[b]	0 (NA)[b]	Very low
1 study (Sonicni 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision	Death before NICU discharge	At least 1 hour and up to 5	314 (normal n=108, category III	NA[b]	65.5% (57.6 to 72.6)[b]	0 (NA)[b]	1.53 (NA)[b]	Very low

Quality assessment									Measure of diagnostic accuracy (95% CI)				
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Definition of outcome	Stage of labour	Total number of women & baby pairs	Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	Quality
							hours before birth	n=31, category IIA n=118, category IIB n=57)					
1 study (Sonicni 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical artery pH <7	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	100% (56.1 to 100)[b]	68.4% (60.4 to 75.4)[b]	3.16 (2.51 to 3.97)[b]	0 (NA)[b]	Very low
1 study (Sonicni 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	Very serious[7]	Umbilical artery BE ≤ -12 mmol/l	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	82.4% (55.8 to 95.3)[b]	71.0% (62.8 to 78.0)[b]	2.83 (2.03 to 3.96)[b]	0.25 (0.09 to 0.70)[b]	Very low
1 study (Sonicni 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical artery pH <7 and BE ≤ -12 mmol/l	At least 1 hour and up to 5	314 (normal n=108, category III	100% (39.6 to 100)[b]	67.1% (59.2 to 74.2)[b]	3.04 (2.44 to 3.79)[b]	0 (NA)[b]	Very low

Quality assessment									Measure of diagnostic accuracy (95% CI)				
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Definition of outcome	Stage of labour	Total number of women & baby pairs	Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	Quality
							hours before birth	n=31, category IIA n=118, category IIB n=57)					
"Indeterminate" FHR pattern with moderate FHR variability or FHR accelerations (Category IIA, NICHD classification 2008 with subcategorisation according to ACOG guidelines)													
1 study (Sonicini 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision	NICU admission	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	100% (31.0 to 100)[b]	48.4% (41.7 to 55.2)[b]	1.94 (1.71 to 2.20)[b]	0 (NA)[b]	Very low
1 study (Sonicini 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision	Encephalopathy	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	(NA)[b]	47.8% (41.1 to 54.5)[b]	0 (NA)[b]	2.09 (NA)[b]	Very low

Quality assessment									Measure of diagnostic accuracy (95% CI)				
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Definition of outcome	Stage of labour	Total number of women & baby pairs	Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	Quality
1 study (Sonicni 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision	Moderate-severe neonatal encephalopathy	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	NA[b]	47.8% (41.1 to 54.5)[b]	0 (NA)[b]	2.09 (NA)[b]	Very low
1 study (Sonicni 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision	Death before NICU discharge	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	NA[b]	47.8% (41.1 to 54.5)[b]	0 (NA)[b]	2.09 (NA)[b]	Very low
1 study (Sonicni 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical artery pH <7	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	NA[b]	47.8% (41.1 to 54.5)[b]	0 (NA)[b]	2.09 (NA)[b]	Very low

Quality assessment									Measure of diagnostic accuracy (95% CI)				
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Definition of outcome	Stage of labour	Total number of women & baby pairs	Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	Quality
1 study (Sonicni 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical artery BE ≤ -12 mmol/l	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	40.0% (7.3 to 83.0)[b]	47.5% (40.8 to 54.3)[b]	0.76 (0.26 to 2.25)[b]	1.26 (0.61 to 2.61)[b]	Very low
1 study (Sonicni 2014)	Retrospective cohort	Very serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision	Umbilical artery pH <7 and BE ≤ -12 mmol/l	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	NA[b]	47.8% (41.1 to 54.5)[b]	0 (NA)[b]	2.09 (NA)[b]	Very low

ACOG American College of Obstetricians and Gynecologists; CI confidence interval; FHR fetal heart rate; NICHD National Institute of Child Health and Human Development; NICU neonatal intensive care unit

a 95% CI calculated by the 2017 NGA technical team
b Calculated by the 2017 NGA technical team
c 95% CI not calculable with the data reported by the study
1 Unclear if consecutive enrolment of participants was done; no blinding for CTG tracing findings when ascertainment of outcome was done; late preterm births were included; events independent of CTG tracing findings might have influenced the outcome
2 95% CI for the negative likelihood ratio crosses 0.5
3 95% CI for the positive likelihood ratio crosses 5

4 No random sampling; only one expert interpreted all the tracings; unclear if and why population was considered high risk; no blinding for CTG tracing findings when ascertainment of outcome was done; events independent of CTG tracing findings might have influenced the outcome
5 95% CI for the positive likelihood ratio crosses 5 and 10, and negative likelihood ratio crosses 0.1
6 95% CI for the positive likelihood ratio crosses 5 and 10
7 95% CI for the negative likelihood ratio crosses 0.1 and 0.5

Table 44: GRADE findings for predictive value of published categorisations of fetal heart rate traces on mode of birth among high risk group

Quality assessment						Definition of outcome	Stage of labour	Total number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Indeterminate FHR tracing (NICHD classification 2008)													
1 study (Sharbaf 2014)	Prospective cohort	Very serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	Caesarean section	In early labour during a 20-40 minute period	326 (normal n=249, indeterminate n=77)	33.1%[a]	83.4%[a]	1.99[a,b]	0.80[a,b]	Low
"Abnormal" FHR pattern (Category III, NICHD classification 2008)													
1 study (Sonicini 2014)	Retrospective cohort	Very serious[2]	No serious inconsistency	No serious indirectness	No serious imprecision	Instrumental birth	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	20.4% (13.0 to 30.3)[b]	73.9% (58.6 to 85.2)[b]	0.78 (0.42 to 1.47)[b]	1.08 (0.96 to 1.21)[b]	Very low

Quality assessment									Measure of diagnostic accuracy (95% CI)				
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Definition of outcome	Stage of labour	Total number of women & baby pairs	Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	Quality
1 study (Soncini 2014)	Retrospective cohort	Very serious[2]	No serious inconsistency	No serious indirectness	Serious[3]	Instrumental birth for suspected fetal distress	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	42.9% (28.1 to 58.9)[b]	86.6% (77.8 to 92.4)[b]	3.20 (1.73 to 5.91)[b]	0.66 (0.51 to 0.86)[b]	Very low
"Indeterminate" FHR pattern with minimal/absent baseline FHR variability and no FHR accelerations (Category IIB, NICHD classification 2008 with subcategorisation according to ACOG guidelines)													
1 study (Soncini 2014)	Retrospective cohort	Very serious[2]	No serious inconsistency	No serious indirectness	No serious imprecision	Instrumental birth	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	28.9% (20.6 to 38.7)[b]	55.7% (42.5 to 68.2)[b]	0.65 (0.43 to 0.98)[b]	1.28 (1.10 to 1.48)[b]	Very low
1 study (Soncini 2014)	Retrospective cohort	Very serious[2]	No serious inconsistency	No serious indirectness	Serious[4]	Instrumental birth for suspected fetal distress	At least 1 hour and up to 5 hours	314 (normal n=108, category III n=31, category IIA n=118,	54.7% (40.6 to 68.2)[b]	75.0% (65.8 to 82.5)[b]	2.19 (1.46 to 3.28)[b]	0.60 (0.45 to 0.82)[b]	Very low

Quality assessment									Measure of diagnostic accuracy (95% CI)				
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Definition of outcome	Stage of labour	Total number of women & baby pairs	Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	Quality
							before birth	category IIB n=57)					
"Indeterminate" FHR pattern with moderate FHR variability or FHR accelerations (Category IIA, NICHD classification 2008 with subcategorisation according to ACOG guidelines)													
1 study (Sonicni 2014)	Retrospective cohort	Very serious[2]	No serious inconsistency	No serious indirectness	No serious imprecision	Instrumental birth	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	49.7% (41.4 to 58.0)[b]	43.0% (32.1 to 54.6)[b]	0.87 (0.68 to 1.12)[b]	1.17 (0.96 to 1.42)[b]	Very low
1 study (Sonicni 2014)	Retrospective cohort	Very serious[2]	No serious inconsistency	No serious indirectness	Serious[4]	Instrumental birth for suspected fetal distress	At least 1 hour and up to 5 hours before birth	314 (normal n=108, category III n=31, category IIA n=118, category IIB n=57)	67.6% (55.6 to 77.7)[b]	55.3% (47.0 to 63.3)[b]	1.51 (1.19 to 1.91)[b]	0.59 (0.42 to 0.82)[b]	Very low

ACOG American College of Obstetricians and Gynecologists; CI confidence interval; FHR hetal heart rate; NICHD National Institute of Child Health and Human Development

a 95% CI not calculable from data reported in the article
b. Calculated by the 2017 NGA technical team

1 Unclear if consecutive enrolment of participants was done; no blinding for CTG tracing findings when ascertainment of outcome was done; late preterm births were included; events independent of CTG tracing findings might have influenced the outcome.
2 No random sampling; only one expert interpreted all the tracings; unclear if and why population was considered high risk; no blinding for CTG tracing findings when ascertainment of outcome was done; events independent of CTG tracing findings might have influenced the outcome
3 95% CI for the positive likelihood ratio crosses 5
4 95% CI for the negative likelihood ratio crosses 0.5

Table 45: GRADE findings for association between published categorisations of fetal heart rate traces and adverse neonatal outcomes

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
Indeterminate FHR tracing (NICHD classification 2008)										
1 study (Sharbaf 2014)	Prospective cohort	Very serious [1]	No serious inconsistency	No serious indirectness	Serious[2]	Umbilical artery pH <=7.2	Early labour during a 20-40 minute period	77	RR[a] 1.9 (95% CI 0.8 to 4.5)	Very low
1 study (Sharbaf 2014)	Prospective cohort	Very serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	NICU admission	Early labour during a 20-40 minute period	77	RR[a] 3.2 (95% CI 1.5 to 6.9)	Very low
1 study (Sharbaf 2014)	Prospective cohort	Very serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	NICU admission after excluding preterm birth	Early labour during a 20-40 minute period	NR	RR[a] 3.6 (95% CI 1.4 to 9.2)	Very low

CI confidence interval; FHR fetal heart rate; NICHD National Institute of Child Health and Human Development; NICU neonatal intensive care unit, NR not reported
a Presumably unadjusted (adjustments not reported).
1 No adjustment for potential confounders, no description of statistical methods. Only 20-40 minutes of CTG tracing interpreted in 'early labour'

2 95% CI crosses 1.25

Table 46: GRADE findings for association between published categorisations of fetal heart rate traces and mode of birth

Quality assessment						Definition of outcome	Stage of labour	Number of babies with defined FHR patterns	Degree of association or number (percentage) of babies with defined outcome	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
Indeterminate FHR tracing (NICHD classification 2008)										
1 study (Sharbaf 2014)	Prospective cohort	Very serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	Caesarean section due to non-reassuring fetal heart rate pattern	Early labour during a 20-40 minute period	77	RR[a] 3.4 (95% CI 2.0-5.7)	Very low

CI confidence interval;FHR fetal heart rate; NICHD National Institute of Child Health and Human Development; NICU neonatal intensive care unit

a Presumably unadjusted (adjustments not reported)
1 No adjustment for potential confounders, no description of statistical methods. Only 20-40 minutes of CTG tracing interpreted in 'early labour'

I.5 Care in labour as a result of cardiotocography

Table 47: GRADE findings for comparison of reducing or stopping oxytocin and not reducing or stopping oxytocin in the presence of an abnormal fetal heart rate tracing

Quality assessment							Number of women or babies		Effect		
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Reducing or stopping oxytocin	Not reducing or stopping oxytocin	Relative (95% CI)	Absolute (95% CI) and p-value (if reported)	Quality
Neonatal intensive care unit admission											

Quality assessment							Number of women or babies		Effect		
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Reducing or stopping oxytocin	Not reducing or stopping oxytocin	Relative (95% CI)	Absolute (95% CI) and p-value (if reported)	Quality
1 study (Clark 2015)	Prospective nonrandomised comparative study	Serious[1]	No serious inconsistency	Serious[2]	Serious[3]	None	91/2364 (3.8%)	276/5272 (5.2%)	RR 0.74 (0.58 to 0.93)	14 fewer per 1000 (from 4 fewer to 22 fewer)	Very low
Primary caesarean section											
1 study (Clark 2015)	Prospective nonrandomised comparative study	Serious[1]	No serious inconsistency	Serious[2]	No serious imprecision	None	630/2364 (26.6%)	923/5272 (17.5%)	RR 1.52 (1.39 to 1.66)	91 more per 1000 (from 68 more to 116 more)	Very low

CI confidence interval, RR relative risk

1 No adjustments made for potential confounders
2 All women underwent induced labour
3 95% CI crosses 0.75

Table 48: GRADE findings for comparison of outcomes before and after introduction of a 5-tier colour-coded fetal heart rate management system

Quality assessment							Number of women or babies		Effect		
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	After introduction of 5-tier colour-coded FHR management system	Before introduction of 5-tier colour-coded FHR management system	Relative (95% CI)	Absolute (95% CI) and p-value (if reported)	Quality
Cord artery pH < 7.15											
1 study (Katsuragi 2015)	Comparative observational study	Serious[1]	No serious inconsistency	No serious indirectness	Serious[2]	None	2/744 (0.27%)	11/688 (1.6%)	RR 0.17 (0.04 to 0.76)	13 fewer per 1000 (from 4 fewer to 15 fewer)	Very low
Cord artery BE < - 2 mmol/l											
1 study (Katsuragi 2015)	Comparative observational study	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	None	2/744 (0.27%)	11/688 (1.6%)	RR 0.17 (0.04 to 0.76)	13 fewer per 1000 (from 4 fewer to 15 fewer)	Very low

BE base excess; CI confidence interval; FHR fetal heart rate; RR relative risk
1 No adjustments were made for potential confounders
2 95% CI crosses 0.75

Table 49: GRADE findings for comparison of outcomes before and after introduction of consult-led (obstetric) review of abnormal cardiotocograph traces prior to decision to measure fetal scalp lactate

Quality assessment							Number of women or babies		Effect		
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Consultant-led	No consultant	Relative (95% CI)	Absolute (95% CI) and p-value (if reported)	Quality
Emergency caesarean section (any)											
1 study (Lowe 2016)	Retrospective cohort study	Serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	None	547/2487 (22%)	537/2225 (24.1%)	RR 0.93 (0.84 to 1.03)	17 fewer per 1000 (from 39 fewer to 7 more)	Very low
Emergency caesarean section (for fetal distress)											
1 study (Lowe 2016)	Retrospective cohort study	Serious[1]	No serious inconsistency	No serious indirectness	Very serious[2]	None	165/2487 (6.6%)	181/2225 (8.1%)	RR 0.82 (0.67 to 1)	15 fewer per 1000 (from 27 fewer to 0 more)	Very low
Emergency caesarean section (for failure to progress)											
1 study (Lowe 2016)	Retrospective cohort study	Serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	None	253/2487 (10.2%)	230/2225 (10.3%)	RR 0.98 (0.83 to 1.17)	2 fewer per 1000 (from 18 fewer to 18 more)	Very low
Emergency caesarean section (for reasons other than fetal distress or failure to progress)											
1 study (Lowe 2016)	Retrospective cohort study	Serious[1]	No serious inconsistency	No serious indirectness	Serious[3]	None	141/2487 (5.7%)	126/2225 (5.7%)	RR 1 (0.79 to 1.26)	0 fewer per 1000 (from 12 fewer to 15 more)	Very low

Quality assessment							Number of women or babies		Effect		
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Consultant-led	No consultant	Relative (95% CI)	Absolute (95% CI) and p-value (if reported)	Quality
Instumental birth											
1 study (Lowe 2016)	Retrospective cohort study	Serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	None	439/2487 (17.7%)	445/2225 (20%)	RR 0.88 (0.78 to 0.99)	24 fewer per 1000 (from 2 fewer to 44 fewer)	Very low
Normal vaginal birth											
1 study (Lowe 2016)	Retrospective cohort study	Serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	None	1460/2487 (58.7%)	1231/2225 (55.3%)	RR 1.06 (1.01 to 1.12)	33 more per 1000 (from 6 more to 66 more)	Very low
Cord pH < 7.1											
1 study (Lowe 2016)	Retrospective cohort study	Serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	None	20/2487 (0.8%)	49/2225 (2.2%)	RR 0.37 (0.22 to 0.61)	14 fewer per 1000 (from 9 fewer to 17 fewer)	Very low
Fetal scalp lactate > 4.8 mmol/l											
1 study (Lowe 2016)	Retrospective cohort study	Serious[1]	No serious inconsistency	No serious indirectness	Serious[2]	None	36/2487 (1.4%)	56/2225 (2.5%)	RR 0.58 (0.38 to 0.87)	11 fewer per 1000 (from 3 fewer to 16 fewer)	Very low
Admission to neonatal nursery											

Quality assessment							Number of women or babies		Effect		
Number of studies	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Consultant-led**	**No consultant**	**Relative (95% CI)**	**Absolute (95% CI) and p-value (if reported)**	**Quality**
1 study (Lowe 2016)	Retrospective cohort study	Serious[1]	No serious inconsistency	No serious indirectness	Very serious[4]	None	106/2487 (4.3%)	98/2225 (4.4%)	RR 0.97 (0.74 to 1.27)	1 fewer per 1000 (from 11 fewer to 12 more)	Very low
Fetal blood sampling performed											
1 study (Lowe 2016)	Retrospective cohort study	Serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	None	43/2487 (1.7%)	79/2225 (3.6%)	RR 0.49 (0.34 to 0.7)	18 fewer per 1000 (from 11 fewer to 23 fewer)	Very low

CI confidence interval; RR relative risk

1 No adjustments for potential confounders
2 95% CI crosses 0.75
3 95% CI crosses 1.25
4 95% CI crosses 0.75 and 1.25

I.6 Fetal scalp stimulation

Table 50: GRADE findings for predictive accuracy of no fetal heart rate acceleration following fetal scalp blood sampling puncture as stimulus

Quality assessment							Number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number. of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Fetal scalp pH < 7.20												
1 study (Edersheim 1987)	Case series	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	pH < 7.20 = 6/188 (3% of samples)	188 samples; 127 women & baby pairs	100% (Not calculable [NC])[a]	43.41% (36.21 to 50.61)[a]	1.77 (1.56 to 2.01)[a]	0 (NC)[a]	Very low
1 study (Elimian 1997)	Case series	Serious[2]	No serious inconsistency	Serious[1]	No serious imprecision	pH < 7.20 = 15/108 (14%)	108	100% (NC)[b]	53.76% (43.63 to 63.9)[b]	2.16 (1.73 to 2.69)[a]	0 (NC)[a] Useful	Low
1 study (Lazebnik 1992)	Case series	No serious risk of bias	No Serious inconsistency	Serious[3]	No serious imprecision	pH < 7.20 = 15/104 (14%)	104	73% (50.95 to 95.71)[b]	17% (9.08 to 24.63)[b]	0.88 (0.64 to 1.21)[a]	1.58 (0.61 to 4.12)[a]	Very low
1 study (Spencer 1991)	Case series	Serious[2]	No serious inconsistency	Serious[4]	No serious imprecision	pH < 7.20 = 6/138 (4%)	138	100% (NC)[a]	52.27% (43.75 to 60.79)[a]	2.10 (1.75 to 2.50)[a]	0 (NC)[a]	Very low
1 study (Umstad 1992)	Case series	No serious risk of bias	No serious inconsistency	Serious[5]	No serious imprecision	pH < 7.20 = 8/60 (13%)	60	62.5% (28.95 to 96.05)[b]	67.3% (54.56 to 80.06)[b]	1.91 (0.98 to 3.71)[a]	0.56 (0.22 to 1.39)[a]	Moderate

Quality assessment							Number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number. of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Fetal scalp pH < 7.21												
1 study (Clark 1982)	Case series	Serious[6]	No serious inconsistency	Serious[7]	No serious imprecision	pH < 7.21 = 19/200 (10%)	200	100% (NC)[a]	93.37% (89.75 to 96.99)[a]	15.08 (8.73 to 26.06)[a]	0 (NC)[a] Useful	Very low
Fetal scalp pH < 7.25												
1 study (Spencer 1991)	Case series	Serious[2]	No serious inconsistency	Serious[4]	No serious imprecision	pH < 7.25 = 17/138 (5%)	138	65.38% (47.10 to 83.67)[a]	53.57% (44.33 to 62.81)[a]	1.41 (1.00 to 1.96)[a]	0.87 (0.79 to 0.95)[a]	Very low
1 study (Umstad 1992)	Case series	No serious risk of bias	No serious inconsistency	Serious[5]	No serious imprecision	pH < 7.25 = 23/60 (38%)	60	82.6% (67.12 to 98.10)[b]	91.9% (83.10 to 100)[b]	10.19 (3,39 to 30.63)[a]	0.19 (0.08 to 0.46)[a]	Moderate
Apgar score < 7 at 5 minutes												
1 study (Spencer 1991)	Case series	Serious[2]	No serious inconsistency	Serious[4]	No serious imprecision	Apgar < 7 = 1/138 (0.7%)	138	100% (NC)[a]	50.36% (41.99 to 58.74)[a]	2.01 (1.70 to 2.38)[a]	0 (NC)[a]	Very low

CI confidence interval, NC not calculable

a Calculated by the 2014 NCC-WCH technical team
b As reported in study, confidence intervals calculated by the 2014 NCC-WCH technical team
1 Included gestational age > 34 weeks and unclear whether any included women were considered high risk
2 Unclear whether FHR tracing assessor blinded to outcome. Period of FHR observation following stimulation not reported
3 Positive predictive test defined as mean change in FHR < 15 bpm (rather than absence of an acceleration). Insufficient reporting of population, and inclusion and exclusion criteria to assess indirectness
4 Included gestational age < 37 weeks and unclear whether any women were considered high risk
5 Included gestational age > 36 weeks and unclear whether any included women were considered high risk
6 Unclear whether consecutive women were included in the study
7 Insufficient reporting of population and inclusion and exclusion criteria to assess indirectness

Table 51: GRADE findings for predictive accuracy of no fetal heart rate acceleration following digital massage as stimulus

Quality assessment							Number of women & baby pairs	Measure of diagnostic accuracy				Quality
Number. of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Fetal scalp pH < 7.20												
1 study (Elimian 1997)	Case series	Serious[1]	No serious inconsistency	Serious[2]	No serious imprecision	pH < 7.20 = 15/108 (14%) 15 sec of stimulation	108	100% (Not calculable [NC])[a]	54.84% (44.72 to 64.95)[a]	2.21 (1.77 to 2.77)[b]	0 (NC)[b]	Low
Fetal scalp pH ≤7.20												
1 study (Trochez 2005)	Case series	Serious[3]	No serious inconsistency	Serious[4]	No serious imprecision	pH < 7.20 = 5/70 (7% of samples) Vaginal examination (VE) acting as stimulus	70 samples; 54 women & baby pairs	40% (7.26 to 82.96)[a]	69.23% (56.4 to 79.76)[a]	1.3 (0.27 to 6.24)[a]	0.87 (0.44 to 1.70)[a]	Very low
Umbilical cord pH ≤7.20												
1 study (Trochez 2005)	Case series	Serious[5]	No serious inconsistency	Serious[4]	Serious[6]	pH < 7.20 = 5/70 (7% of samples) VE acting as stimulus	34 women & baby pairs	40% (0 to 82.94)[b]	75.86% (60.29 to 91.44)[b]	1.66 (0.47 to 5.80)[b]	0.79 (0.38 to 1.67)[b]	Very low

Quality assessment							Number of women & baby pairs	Measure of diagnostic accuracy				Quality
Number. of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Apgar score < 7 at 5 minutes												
1 study (Trochez 2005)	Case series	Serious[7]	No serious inconsistency	Serious[4]	No serious imprecision	Apgar < 7 = 4/50 (8%) VE acting as stimulus	50	50% (1 to 99)[b]	69.57% (56.27 to 82.66)[b]	1.64 (0.56 to 4.80)[b]	0.72 (0.26 to 1.95)[b]	Very low

NC not calculable, VE vaginal examination

a As reported in study, confidence intervals calculated by the 2014 NCC-WCH technical team
b Calculated by the 2014 NCC-WCH technical team
1 Unclear whether FHR tracing assessor blinded to outcome, period of FHR observation following stimulation not reported
2 Included gestational age > 34 weeks and unclear whether any included women were considered high risk
3 Data were available for 78% of those eligible for study
4 Method and time period of stimulation not reported. Unclear whether any included women were considered high risk
5 Data available for 63% of those included in study
6 Wide confidence intervals (more than 40%) for two or three out of sensitivity, specificity, PPV and NPV
7 Data available for 93% of those included in study

Table 52: GRADE findings for predictive accuracy of no fetal heart rate acceleration following Allis clamp as stimulus

Quality assessment							Number of women & baby pairs	Measure of diagnostic accuracy				Quality
Number. of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Fetal scalp pH < 7.20												
1 study (Arulkumaran 1987)	Case series	Very serious[1]	No serious inconsistency	Serious[2]	No serious imprecision	pH < 7.20 = 2/50 (4%)	50	100% (not calculable [NC])[a]	83.33% (72.79 to 93.88)[a]	6.0 (3.19 to 11.30)[a]	0 (NC)[a]	Very low
1 study (Clark 1984)	Case series	Serious[3]	No serious inconsistency	Very serious[4]	No serious imprecision	pH < 7.20 = 19/64 (30%)	64	100% (NC)[a]	33.33% (19.56 to 47.11)[a]	1.5 (1.22 to 1.84)[a]	0 (NC)[a]	Very low
Caesarean section												
1 study (Arulkumaran 1987)	Case series	Very serious[1]	No serious inconsistency	Serious[2]	No serious imprecision	Caesarean sections = 10/50 (20%)	50	60% (29.64 to 90.36)[a]	90% (80.70 to 99.30)[a]	6.0 (2.08 to 17.29)[a]	0.44 (0.21 to 0.96)[a]	Very low

NC not calculable

a Calculated by the 2014 NCC-WCH technical team
1 Unclear whether consecutive women were included. Period of fetal heart rate (FHR) observation following stimulation not reported
2 Insufficient reporting of population and inclusion and exclusion criteria to assess indirectness
3 Unclear whether consecutive women were included
4 Population were unborn babies who had not responded with an acceleration to initial digital scalp stimulation. Included gestational age < 37 weeks and > 42 weeks

Table 53: GRADE findings for predictive accuracy of no fetal heart rate acceleration following 3 or 5 seconds of vibroacoustic stimulation

Quality assessment							Number of women & baby pairs	Measure of diagnostic accuracy				Quality
Number. of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Fetal scalp pH < 7.20												
1 study (Edersheim 1987)	Case series	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	pH < 7.20 = 6/188 (3%) 3-second VAS	188 samples; 127 woman & baby pairs	100% (Not calculable[NC])[a]	63.74% (56.75 to 70.72)[a]	2.76 (2.27 to 3.24)[a]	0 (NC)[a]	Very low
1 study (Lin 2001)	Case series	Serious[2]	No serious inconsistency	Very serious[3]	No serious imprecision	pH < 7.20 = 31/113 (27%) 3-second VAS	113	39% (21.56 to 55.86)[b]	93% (87.05 to 98.32)[b]	5.29 (2.18 to 12.86)[a]	0.66 (0.50 to 0.88)[a]	Very low
1 stud (Umstad 1992)	Case series	No serious risk of bias	No serious inconsistency	Serious[4]	No serious imprecision	pH < 7.20 = 8/60 (13%) 3-second VAS	60	100% (NC)[b]	59.6% (46.28 to 72.95)[b]	2.48 (1.78 to 3.45)[a]	0 (NC)[a]	Moderate
1 study (Bartelsmeyer 1995)	Case series	Serious[5]	No serious inconsistency	Serious[6]	No serious imprecision	pH < 7.20 = 14/104 (13%) 5-second VAS	104	79% (57.08 to 100)[a]	52.22% (41.9 to 62.54)[a]	1.64 (1.12 to 2.33)[a]	0.41 (0.15 to 1.14)[a]	Low

Quality assessment							Number of women & baby pairs	Measure of diagnostic accuracy				Quality
Number. of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
1 study (Ingermarsson 1989)	Case series	Serious[5]	No serious inconsistency	Serious[6]	serious imprecision[7]	pH < 7.20 = 4/51 (8%) 5-second VAS	51	50% (1 to 99)[a]	68.97% (52.13 to 85.80)[a]	1.61 (0.53 to 4.94)[a]	0.73 (0.26 to 1.99)[a]	Very low
1 study (Irion 1996)	Case series	No serious risk of bias	No serious inconsistency	Serious[8]	No serious imprecision	pH < 7.20 = 31/421 (7.4%) 5-second VAS	421 samples; 253 woman & baby pairs	77.42% (62.70 to 92.14)[a]	51.54% (46.58 to 56.50)[a]	1.60 (1.29 to 1.98)[a]	0.44 (0.23 to 0.85)[a]	Moderate
1 study (Polzin 1988)	Case series	No serious risk of bias	No serious inconsistency	Serious[6]	No serious imprecision	pH < 7.20 = 10/100 (10%) 5-second VAS	100	90% (71.41 to – 100)[a]	84.44% (76.96 to 91.93)[a]	5.79 (3.43 to 9.77)[a]	0.11 (0.02 to 0.76)[a]	Very low
Fetal scalp pH < 7.25												
1 study (Smith 1986)	Case series	Very serious[9]	No serious inconsistency	Serious[10]	No serious imprecision	pH < 7.25 = 18/64 (28%) < 3 second VAS	64	100% (NC)[a]	65.22% (51.45 to 78.98)[a]	2.88 (1.94 to 4.27)[a]	0 (NC)[a]	Very low
1 study (Umstad 1992)	Case series	No serious	No serious	Serious[4]	No serious	pH < 7.20 =	60	100% (NC)[b]	83.8% (71.91 to 95.66)[b]	6.17 (2.96 to 12.83)[a]	0 (NC)[a]	Moderate

Quality assessment							Number of women & baby pairs	Measure of diagnostic accuracy				Quality
Number. of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
		risk of bias	inconsistency		imprecision	8/60 (13%) 3-second VAS						
1 study (Irion 1996)	Case series	No serious risk of bias	No serious inconsistency	Serious[8]	No serious imprecision	pH < 7.25 = 130/421 (31%) 5-second VAS	421 samples; 253 women & baby pairs	65.38% (57.21 to 73.56)[a]	56.01% (50.31 to 61.72)[a]	1.49 (1.24 to 1.78)[a]	0.62 (0.48 to 0.80)[a]	Moderate
1 study (Polzin 1988)	Case series	No serious risk of bias	No serious inconsistency	Serious[6]	Serious[7]	pH < 7.25 = 22/100 (22%) 5-second VAS	100	45.45% (24.65 to 66.26)[a]	83.33% (75.06 to 91.60)[a]	2.73 (1.39 to 5.36)[a]	0.65 (0.44 to 0.97)[a]	Very low
Umbilical cord pH < 7.10												
1 study (Chauhan 1999)	Case series	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.10 = 8/271 (3%) 3-second VAS	271	44% (11.98 to 76.91)[b]	91% (87.79 to 94.65)[b]	5.06 (2.21 to 11.59)[a]	0.61 (0.34 to 1.09)[a]	Low
Umbilical cord pH < 7.00												
1 study (Chauhan 1999)	Case series	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	pH < 7.00 = 4/271 (1.5%) 3-second VAS	271	50% (1 to 99)[b]	91% (87.14 to 94.13)[b]	5.34 (1.87 to 15.24)[a]	0.55 (0.21 to 1.47)[a]	Low

Quality assessment							Number of women & baby pairs	Measure of diagnostic accuracy				Quality
Number. of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
1 study (Anyaegbunam 1994)	Case series[c]	No serious risk of bias	No serious inconsistency	Very serious[11]	No serious imprecision	pH < 7.20 = 18/316 (6%) 5-second VAS	316	22.2% (3.02 to 41.43)[a]	77.18% (72.42 to 81.95)[a]	0.97 (0.40 to 2.37)[a]	1.00 (0.78 to 1.30)[a]	Low
Caesarean section												
1 study (Chauhan 1999)	Case series	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision	N caesarean sections = 8/271 (3%) 3-second VAS	271	37% (3.95 to 71.05)[b]	92% (87.39 to 94.35)[b]	4.11 (1.55 to 10.87)[a]	0.69 (0.40 to 1.18)[a]	Low
1 study (Sarno 1990)	Case series	No serious risk of bias	No serious inconsistency	Serious[12]	Serious[7]	N caesarean sections = 16/201 (8%) 3-second VAS	201	31.2% (8.54 to 53.96)[b]	95.1% (92.04 to 98.24)[b]	6.42 (2.44 to 16.89)[a]	0.72 (0.52 to 1.01)[a]	Low
Apgar score < 7 at 5 minutes												
1 study (Lin 2001)	Case series	Serious[2]	No serious inconsistency	Very serious[3]	No serious imprecision	Apgar < 7 = 3/113 (3%) 3-second VAS	113	100% (NC)b	86% (79.95 to 92.78)[b]	7.33 (4.58 to 11.74)[a]	0 (NC)[a]	Very low

Quality assessment							Number of women & baby pairs	Measure of diagnostic accuracy				Quality
Number. of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
1 study (Sarno 1990)	Case series	No serious risk of bias	No serious inconsistency	Serious[12]	No serious imprecision	Apgar < 7 = 6/201 (3%) 3-second VAS	201	33.3% (0 to 71.50)[b]	93.8% (90.47 to 97.22)[b]	5.42 (1.54 to 19.05)[a]	0.71 (0.40 to 1.25)[a]	Moderate
1 study (Anyaegbunam 1994)	Case series[c]	No serious risk of bias	No serious inconsistency	Very serious[11]	No serious imprecision	Apgar < 7 = 10/316 (3%) 5-second VAS	316	30% (1.60 to 58.40)[a]	77.45% (72.77 to 82.13)[a]	1.33 (0.50 to 3.51)[a]	0.90 (0.60 to 1.36)[a]	Low
1 study (Bartelsmeyer 1995)	Case series	Serious[5]	No serious inconsistency	Serious[6]	No serious imprecision	Apgar < 7 = 6/104 (6%) 5-second VAS	104	83.33% (53.51 to 100)[a]	52.04% (42.15 to 61.93)[a]	1.74 (1.15 to 2.62)[a]	0.32 (0.05 to 1.93)[a]	Low
1 study (Polzin 1988)	Case series	No serious risk of bias	No serious inconsistency	Serious[6]	No serious imprecision	Apgar < 7 = 6/100 (6%) 5-second VAS	100	50% (9.99 to 90.01)[a]	57.45% (47.45 to 67.44)[a]	1.18 (0.51 to 2.71)[a]	0.87 (0.38 to 1.97)[a]	Very low
Poor perinatal outcome[d]												
1 study (Tannirandorn 1993)	Case series	Serious[2]	No serious inconsistency	Very serious[13]	Serious[7]	Poor perinatal outcome = 7/140 (5%)	140	71.4% (37.96 to 100)[b]	99.2% (97.78 to 100)[b]	95 (12.75 to 707.63)[a]	0.29 (0.09 to 0.93)[a]	Very low

Quality assessment							Number of women & baby pairs	Measure of diagnostic accuracy				Quality
Number. of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
						3-second VAS						

NC not calculable, VAS vibroacoustic stimulation

a Calculated by the 2014 NCC-WCH technical team
b As reported in study, confidence intervals calculated by the 2014 NCC-WCH technical team
c Study reported only data for those receiving VAS intervention (cases) in a randomised controlled trial
d Poor perinatal outcome comprises perinatal death, 5 minute Apgar score < 7, fetal distress requiring caesarean section, thick meconium stained amniotic fluid, NICU admission
1 Included gestational age > 34 weeks and unclear whether any included women were considered high risk
2 Unclear whether consecutive women were included in the study
3 Included gestational age < 34 weeks. Women with diabetes, hypertension, pre-eclampsia and unborn babies with intrauterine growth restriction were included (numbers not reported)
4 Included gestational age > 36 weeks and unclear whether any included women were considered high risk
5 Unclear whether consecutive women were included and unclear whether FHR tracing assessor blinded to outcome
6 Included gestational age < 37 weeks and unclear whether any included women were considered high risk
7 Wide confidence intervals (more than 40%) for two or three out of sensitivity, specificity, PPV and NPV
8 Included gestational age > 30 weeks
9 Unclear whether consecutive women were included in the study. Duration of VAS was not standardised (< 3 seconds of VAS was performed)
10 Insufficient reporting of population and inclusion and exclusion criteria to assess indirectness
11Unclear whether any included women were considered high risk. All FHR traces for included women were "reassuring"
12 59% of women had at least one complication of pregnancy (complications not reported)
13 32% of women had at least one antenatal complication, included gestational age > 42 weeks. Composite measure of poor perinatal outcome

I.7 Fetal blood sampling as an adjunct to cardiotocography

Table 54: GRADE findings for comparison of cardiotocography plus fetal blood sampling with intermittent auscultation (Alfirevic 2013) or cardiotocography alone in labour (Stein 2006)

Quality assessment							Number of women		Effect		
Number of studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations: CTG or IA	Continuous CTG and FBS	IA or CTG with no FBS	Relative (95% CI)	Absolute (95% CI)	Quality
Instrumental vaginal birth											
1 meta-analysis of 5 studies (Alfirevic 2013)	Randomised trials	No serious risk of bias	No serious inconsistency	Very serious[1]	No serious imprecision	IA	775/7460 (10.4%)	592/7368 (8.0%)	RR 1.25 (1.13 to 1.38)	20 more per 1000 (from 10 more to 31 more)	Low
1 study (Stein 2006)	Observational study	Serious[2]	No serious inconsistency	Serious[3]	No serious imprecision	CTG	4790/12893 (37.2%)	15015/36667 (40.9%)	RR 0.91 (0.88 to 0.93)	37 fewer per 1000 (from 29 fewer to 49 fewer)	Very low
Caesarean section											
1 meta-analysis of 6 studies (Alfirevic 2013)	Randomised trials	No serious risk of bias	Serious[4]	Very serious[1]	No serious imprecision	IA	305/7582 (4.0%)	224/7492 (3.0%)	RR 1.50 (1.10 to 2.06)	15 more per 1000 (from 3 more to 32 more)	Very low
Cord blood acidosis (pH < 7.0)											
1 study (Alfirevic 2013)	Randomised trial	No serious risk of bias	No serious inconsistency	Very serious[1]	No serious imprecision	IA	5/540 (0.93%)	11/535 (2.1%)	RR 0.45 (0.16 to 1.29)	11 fewer per 1000 (from 17 fewer to 6 more)	Low

Quality assessment							Number of women		Effect		
Number of studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations: CTG or IA	Continuous CTG and FBS	IA or CTG with no FBS	Relative (95% CI)	Absolute (95% CI)	Quality
1 study (Stein 2006)	Observational study	Serious[2]	No serious inconsistency	Serious[3]	No serious imprecision	CTG	64/12893 (0.5%)	307/36667 (0.8%)	RR 0.59 (0.45 to 0.78)	3 fewer per 1000 (from 2 fewer to 5 fewer)	Very low
Cerebral palsy											
1 meta-analysis of 2 studies (Alfirevic 2013)	Randomised trials	Serious[5]	No serious inconsistency	Very serious[1]	No serious imprecision	IA	28/6609 (0.42%)	17/6643 (0.26%)	RR 1.74 (0.97 to 3.11)	2 more per 1000 (from 0 fewer to 5 more)	Very low
Neonatal resuscitation											
1 study (Stein 2006	Observational study	Serious[2]	No serious inconsistency	Serious[3]	No serious imprecision	CTG	652/12893 (5.1%)	2273/36667 (6.2%)	RR 0.82 (0.75 to 0.89)	11 fewer per 1000 (from 7 fewer to 15 fewer)	Very low
Neonatal seizures											
1 meta-analysis of 5 studies (Alfirevic 2013)	Randomised trials	No serious risk of bias	No serious inconsistency	Very serious[1]	No serious imprecision	IA	19/7542 (0.25%)	39/7462 (0.52%)	RR 0.49 (0.29 to 0.84)	3 fewer per 1000 (from 1 fewer to 4 fewer)	Low
Apgar score <7 at 5 minutes											
1 study (Stein 2006	Observational study	Serious[2]	No serious inconsistency	Serious[3]	No serious imprecision	CTG	78/12893 (0.6%)	314/36667 (0.86%)	RR 0.71 (0.55 to 0.9)	2 fewer per 1000 (from 1 fewer to 4 fewer)	Very low

CI confidence interval, CTG cardiotocogrpahy, FBS fetal blood sampling, IA intermittent auscultation, RR relative risk

1 Comparison group had intermittent auscultation rather than cardiotocography alone, which was the primary focus of the guideline review question

2 Data were obtained from maternal birth register
3 Women with high-risk pregnancy comprised study sample
4 I^2 = 54%
5 40% weight of the meta analysis contributed by a study with unclear allocation concealment and attrition bias (20% of participants excluded) If necessary, insert table footnotes directly underneath

Table 55: GRADE findings for distribution of fetal blood sampling findings and ST guideline indication to intervene[a]: marked acidosis (cord artery pH < 7.06)

Quality assessment							Number of babies / number of fetal scalp blood samples		Effect		
Number of studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	Marked acidosis	Control	Relative (95% CI)	Absolute (95% CI)	Quality
Women with abnormal FBS (pH < 7.20)											
1 study (Noren 2007)	Observational study	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	None	24/53 (45.3%)	4/53 (7.5%)	RR 6 (2.23 to 16.11)	377 more per 1000 (from 93 more to 1000 more)	Very low
ST indication to intervene[a]											
1 study (Noren 2007)	Observational study	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	None	41/53 (77.4%)	20/53 (37.7%)	RR 2.05 (1.41 to 2.98)	396 more per 1000 (from 155 more to 747 more)	Very low
No ST indication to intervene (adequately monitored)											
1 study (Noren 2007)	Observational study	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	None	5/46 (10.9%)	22/42 (52.4%)	RR 0.21 (0.09 to 0.5)	414 fewer per 1000 (from 262 fewer to 477 fewer)	Very low

CI confidence interval, FBS fetal blood sampling, RR relative risk

a The ST log automatically notified the staff if any ST events occurred and intervention was required in case of combined CTG and ST changes. Intervention was also indicated by occurrence of preterminal CTG (complete loss of variability and reactivity). No intervention was recommended if CTG was normal, irrespective of the ST wave analysis.
1 Study population consisted of women with high risk pregnancy, induced labour, augmentation of labour and women with meconium stained liquor

Table 56: GRADE findings for distribution of fetal blood sampling and ST guideline indication to intervene: moderate acidaemia (cord artery pH 7.06 – 7.09)

Quality assessment							Number of women		Effect		
Number of studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	Moderate acidaemia	Control	Relative (95% CI)	Absolute (95% CI)	Quality
Women with abnormal FBS (pH < 7.20)											
1 study (Noren 2007)	Observational study	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	None	15/44 (34.1%)	0/44 (0%)	RR 31 (1.91 to 502.54)	NC	Very low
ST indication to intervene[a]											
1 study (Noren 2007)	Observational study	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	None	24/44 (54.5%)	10/44 (22.7%)	RR 2.4 (1.31 to 4.41)	318 more per 1000 (from 70 more to 775 more)	Very low
No ST indication to intervene (adequately monitored)											
1 study (Noren 2007)	Observational study	No serious risk of bias	No serious inconsistency	Serious[1]	Serious[2]	None	16[b]/40 (40%)	22/32 (68.8%)	RR 0.58 (0.37 to 0.91)	289 fewer per 1000 (from 62 fewer to 433 fewer)	Very low

CI confidence interval, RR relative risk

a The ST log automatically notified the staff if any ST events occurred and intervention was required in case of combined CTG and ST changes. Intervention was also indicated by occurrence of preterminal CTG (complete loss of variability and reactivity). No intervention was recommended if CTG was normal, irrespective of the ST wave analysis.
b All newborns had Apgar score > 7 at 5 minutes apart from one baby born by ventouse who recovered quickly and did not require special care.
1 Study population consisted of women with high risk pregnancy, induction of labour, augmentation of labour and women with meconium stained liquor
2 Wide CI

Table 57: GRADE findings for participants with abnormal or intermediary cardiotocogram[a] noted at start of ST analysis recording

Quality assessment							Number of women		Effect		
Number of studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	Moderate acidaemia + marked acidosis	Control	Relative (95% CI)	Absolute (95% CI)	Quality
Normal FBS and normal STAN											
1 study (Noren 2007)	Observational study	No serious risk of bias	No serious inconsistency	Serious[1]	Serious[2]	None	20/37 (54.1%)	23/24 (95.8%)	RR 0.56 (0.41 to 0.77)	422 fewer per 1000 (from 220 fewer to 565 fewer)	Very low
Normal FBS and abnormal STAN											
1 study (Noren 2007)	Observational study	No serious risk of bias	No serious inconsistency	Serious[1]	Very serious[3]	None	1/37 (2.7%)	0/24 (0%)	RR 1.97 (0.08 to 46.55)	NC	Very low
Abnormal FBS and normal STAN											
1 study (Noren 2007)	Observational study	No serious risk of bias	No serious inconsistency	Serious[1]	Very serious[3]	None	3/37 (8.1%)	0/24 (0%)	RR 1.97 (0.08 to 46.55)	NC	Very low
Abnormal FBS and abnormal STAN											
1 study (Noren 2007)	Observational study	No serious risk of bias	No serious inconsistency	Serious[1]	Serious[2]	None	13/37 (35.1%)	1/24 (4.2%)	RR 8.43 (1.18 to 60.35)	310 more per 1000 (from 7 more to 1000 more)	Very low

CI confidence interval, FBS fetal blood sampling, RR relative risk

a Out of 121 cases with abnormal CTG (with normal and abnormal ST analysis) n = 84 (69%) showed a cord pH < 7.10. ST analysis indicated the need to intervene in 70/84 (83%)
1 Study population consisted of high risk pregnancy, induced labour, augmentation of labour and women with meconium stained liquor
2 Wide CI

3 Very wide CI

Table 58: GRADE findings for additional fetal blood sampling when using ST analysis of fetal electrocardiogram

Quality assessment							Number of women		Effect		
Number of studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	According to trial protocol[a]	Not according to trial protocol[a]	Relative (95% CI)	Absolute (95% CI)	Quality
FBS pH > 7.25[b]											
1 study (Becker 2011)	Observational study	Serious[1]	No serious inconsistency	Serious[2]	Serious[3]	None	112/171 (65.5%)	96[c]/126 (76.2%)	RR 0.86 (0.74 to 0.99)	107 fewer per 1000 (from 8 fewer to 198 fewer)	Very low
FBS pH 7.20 to 7.25[b]											
1 study (Becker 2011)	Observational study	Serious[1]	No serious inconsistency	Serious[2]	Serious[3]	None	33/171 (19.3%)	15[d]/126 (11.9%)	RR 1.62 (0.92 to 2.85)	74 more per 1000 (from 10 fewer to 220 more)	Very low
FBS pH < 7.20[b]											
1 study (Becker 2011)	Observational study	Serious[1]	No serious inconsistency	Serious[2]	Very serious[4]	None	17/171 (9.9%)	10[e]/126 (7.9%)	RR 1.25 (0.59 to 2.64)	20 more per 1000 (from 33 fewer to 130 more)	Very low

CI confidence interval, FBS fetal blood sampling, RR relative risk

a In the trial protocol FBS was recommended in three situations:
(1) Start of ST analysis registration with an intermediary or abnormal CTG trace
(2) Abnormal CTG trace for more than 60 minutes without ST events
(3) Poor ECG signal quality in the presence of an intermediary or abnormal CTG trace.
b Classification at sample level not at participant level
c n = 19/96 had at least one ST event, n = 77/96 had no ST indication to intervene
d n = 5/15 had at least one ST event, n = 10/15 had no ST indication to intervene
e n = 8/10 had at least one ST event, n = 2/10 had no ST indication to intervene

1 Large number of women with at least on FBS performed was excluded from the analysis for various reasons that were not specified. Data from a published randomised trial were used.
2 Study populations consisted of women with a high risk pregnancy
3 Wide CI
4 Very wide CI

I.8 Fetal blood sampling – time to result

Table 59: GRADE findings for the time from the decision to perform a fetal blood sample to having the scalp pH result

Quality assessment							Number of women (number of samples)	Median / minutes (IQR) or number of events/total (%)	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations			
Time from decision to result of fetal blood sample									
1 study (Tuffnell 2006)	Case series	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	None	74 (100)	18 (12 to 25)	Very low
1 study (Annappa 2008)	Case series	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	None	72 (107)	17 (11 to 22)	Very low
1 study (Rimmer 2016)	Case series	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	None	112 (199)	10 (NR)[a]	Very low
Proportion of samples where the time from decision to result of fetal blood sample was longer than 30 minutes									
1 study (Tuffnell 2006)	Case series	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	None	74 (100)	8/89[b] (9.0%)	Very low
1 study (Annappa 2008)	Case series	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	None	72 (107)	5/107 (4.7%)	Very low

Quality assessment							Number of women (number of samples)	Median / minutes (IQR) or number of events/total (%)	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations			
1 study (Rimmer 2016)	Case series	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	None	112 (199)	15/199 (7.5%)	Very low

IQR interquartile range, NR not reported

a IQR not reported; range reported as 2 to 39
b 1 out of the 100 samples were not adequate for analysis
1 Study population was not restricted to low-risk women

I.9 Predictive value of fetal blood sampling

Table 60: GRADE findings for lactate compared with pH for fetal blood sampling

Quality assessment							Number of women		Effect		Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Lactate	pH	Relative (95% CI)	Absolute (95% CI)	
Mode of birth: spontaneous vaginal birth											
1 meta-analysis of 2 studies (East 2011)	Randomised trials	No serious risk of bias	Serious[1]	Serious[2]	Serious[3]	None	709/1667 (42.5%)	709/1652 (42.9%)	RR 0.91 (0.67 to 1.24)	39 fewer per 1000 (from 142 fewer to 103 more)	Very low
Mode of birth: assisted vaginal birth											
1 meta-analysis of 2 studies (East 2011)	Randomised trials	No serious risk of bias	No serious inconsistency	Serious[2]	No serious imprecision	None	415/1667 (24.9%)	455/1652 (27.5%)	RR 0.9 (0.81 to 1.01)	28 fewer per 1000 (from 52 fewer to 3 more)	Moderate

Quality assessment							Number of women		Effect		Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Lactate	pH	Relative (95% CI)	Absolute (95% CI)	
Mode of birth: caesarean section											
1 meta-analysis of 2 studies (East 2011)	Randomised trials	No serious risk of bias	No serious inconsistency	Serious[2]	No serious imprecision	None	472/1667 (28.3%)	432/1652 (26.2%)	RR 1.09 (0.97 to 1.22)	24 more per 1000 (from 8 fewer to 58 more)	Moderate
Mode of birth: operative birth for non-reassuring fetal status											
1 study (East 2011)	Randomised trial	No serious risk of bias	No serious inconsistency	Serious[4]	No serious imprecision	None	580/1496 (38.8%)	571/1496 (38.2%)	RR 1.02 (0.93 to 1.11)	8 more per 1000 (from 27 fewer to 42 more)	Moderate
Neonatal death											
1 study (East 2011)	Randomised trial	No serious risk of bias	No serious inconsistency	Serious[4]	No serious imprecision	None	0/1496 (0%)	3/1496[a] (0.2%)	RR 0.14 (0.01 to 2.76)	2 fewer per 1000 (from 2 fewer to 4 more)	Moderate
Neonatal encephalopathy											
1 study (East 2011)	Randomised trial	No serious risk of bias	No serious inconsistency	Serious[4]	No serious imprecision	None	6/1496 (0.4%)	6/1496 (0.4%)	RR 1 (0.32 to 3.09)	0 fewer per 1000 (from 3 fewer to 8 more)	Moderate
Admission to neonatal intensive care unit											
1 study (East 2011)	Randomised trial	No serious risk of bias	No serious inconsistency	Serious[4]	No serious imprecision	None	167/1496	164/1496 (11%)	RR 1.02	2 more per 1000	Moderate

Quality assessment							Number of women		Effect		
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Lactate	pH	Relative (95% CI)	Absolute (95% CI)	Quality
							(11.2%)		(0.83 to 1.25)	(from 19 fewer to 27 more)	
Apgar score < 7 at 5 minutes											
1 meta-analysis of 2 studies (East 2011)	Randomised trials	No serious risk of bias	No serious inconsistency	Serious[2]	No serious imprecision	None	50/1667 (3%)	44/1652 (2.7%)	RR 1.13 (0.76 to 1.68)	3 more per 1000 (from 6 fewer to 18 more)	Moderate
Metabolic acidaemia (arterial pH < 7.05 and base deficit > 12 mmol/l)											
1 study (East 2011)	Randomised trial	Serious[5]	No serious inconsistency	Serious[4]	No serious imprecision	None	44/1360 (3.2%)	47/1315 (3.6%)	RR 0.91 (0.6 to 1.36)	3 fewer per 1000 (from 14 fewer to 13 more)	Low
Umbilical arterial pH < 6.98[b]											
1 study (East 2011)	Randomised trial	Serious[6,7]	No serious inconsistency	Serious[8]	Very serious[9]	None	4/171 (2.3%)	8/156 (5.1%)	RR 0.46 (0.14 to 1.49)	28 fewer per 1000 (from 44 fewer to 25 more)	Very low
Umbilical arterial pH < 7.00											
1 study (East 2011)	Randomised trial	Serious[10]	No serious inconsistency	Serious[4]	No serious imprecision	None	21/1376 (1.5%)	24/1322 (1.8%)	RR 0.84 (0.47 to 1.5)	3 fewer per 1000 (from 10 fewer to 9 more)	Low
Umbilical arterial pH < 7.10											

Quality assessment							Number of women		Effect		Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Lactate	pH	Relative (95% CI)	Absolute (95% CI)	
1 study (East 2011)	Randomised trial	Serious[10]	No serious inconsistency	Serious[4]	No serious imprecision	None	121/1376 (8.8%)	131/1322 (9.9%)	RR 0.89 (0.7 to 1.12)	11 fewer per 1000 (from 30 fewer to 12 more)	Low
Umbilical arterial lactate > 4.68 mmol/l[b]											
1 study (East 2011)	Randomised trial	Serious[6,7]	No serious inconsistency	Serious[8]	Serious[3]	None	20/171 (11.7%)	29/156 (18.6%)	RR 0.63 (0.37 to 1.07)	69 fewer per 1000 (from 117 fewer to 13 more)	Very low
Umbilical arterial base deficit > 19.2[b]											
1 study (East 2011)	Randomised trial	Serious[6,7]	No serious inconsistency	Serious[8]	Very serious[9]	None	1/171 (0.58%)	3/156 (1.9%)	RR 0.3 (0.03 to 2.89)	13 fewer per 1000 (from 19 fewer to 36 more)	Very low

CI confidence interval, RR relative risk

a These three deaths occurred in babies with diaphragmatic hernias (n = 2) or congenital cardiac fibrosis. None of the babies was acidaemic at birth.
b These thresholds were chosen by the trial authors according to the 1st or 99th centiles of normal values, which are reported in another of their studies
1 High heterogeneity (I^2 > 60%)
2 Study populations were not restricted to low risk women, although one study (over 67% of the weight of the meta-analysis) excluded women with multiple pregnancy and who were in labour before
34 weeks
3 Wide confidence interval
4 Study included all women with singleton pregnancies, cephalic presentation at more than 34 weeks and an indication for FBS; therefore, other high risk women are included
5 11% of babies have missing data for this outcome
6 Method of randomisation not reported
7 Outcomes for women with protocol violations (1/172 in the lactate arm and 13/169 from the pH arm) are excluded from the final analysis; therefore data could not be analysed by intention-to-treat
8 Study included women who had an abnormal heart rate during labour and for whom FBS was considered necessary; therefore, an unknown proportion of women are not low risk

9 Very wide confidence interval
10 10% of babies have missing data for this outcome

Table 61: GRADE findings for predictive accuracy of fetal blood sampling for composite neonatal outcomes

Quality assessment						Definition of outcome	Maximum interval between sample and birth (minutes)	Number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Fetal scalp pH < 7.25													
1 study (Young 1980)	Case series	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	Either 5 minute Apgar < 7 **or** 1 minute Apgar < 7 plus the need for positive pressure resuscitation	60	96	50.00% (15.35 to 84.65)[a]	81.82% (73.76 to 89.88)[a]	2.75 (1.21 to 6.26)[a]	0.61 (0.30 to 1.23)[a]	Low
Fetal scalp pH ≤ 7.21													
1 study (Bakr 2005)	Prospective observational study	Serious[2]	No serious inconsistency	Serious[3,4]	No serious imprecision	Any of the following: - Apgar < 7 at 5 minutes - Secondary respiratory distress	Unknown	150	82% (65 to 91)	52% (42 to 61)	1.69 (1.33 to 2.16)[a]	0.36 (0.18 to 0.71)[a]	Low

Quality assessment									Measure of diagnostic accuracy (95% CI)				
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Definition of outcome	Maximum interval between sample and birth (minutes)	Number of women & baby pairs	Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	Quality
						- Transfer to NICU - Arterial pH ≤ 7.15 - Neonatal death							
Fetal scalp pH < 7.20													
1 study (Young 1980)	Case series	No serious risk of bias	No serious inconsistency	Serious[1]	Serious[5]	Either 5 minute Apgar < 7 **or** 1 minute Apgar < 7 plus the need for positive pressure resuscitation	60	96	37.50% (3.95 to 71.05)[a]	96.59% (92.80 to 100)[a]	11.00 (2.64 to 45.8)[a]	0.65 (0.38 to 1.11)[a]	Very low

CI confidence interval, NICU neonatal intensive care unit

a Calculated by the 2014 NCC-WCH technical team
1 Specific details of the women for whom FBS was taken within 60 minutes of birth are not reported; however, out of the whole study population, there were a high proportion of women who would not be considered low risk: 16% had pre-eclamptic toxaemia, 7% had babies with confirmed IUGR, 18% had babies who were pre- or post-mature, and 44% had been induced with oxytocin
2 No details about mode of birth or timing of intervention are reported; therefore, it is not possible to evaluate what effect this had on the babies
3 Unclear whether women had low risk pregnancy because no characteristics of the study population are reported
4 Some women would have had an interval of more than 60 minutes between FBS and birth; however, this study has been included because the mean (36.7) and standard deviation (15.3) suggest that this proportion would have been small
5 Wide confidence intervals (more than 40%) for two or three out of sensitivity, specificity, PPV and NPV

Table 62: GRADE findings for predictive accuracy of fetal blood sampling for Apgar score at 5 minutes

Quality assessment							Maximum interval between sample and birth (minutes)	Number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Definition of outcome			Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Fetal scalp pH ≤ 7.25													
1 study (Wiberg-Itzel 2008)	Randomised trial	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	Apgar score < 7	60	508	57.14% (35.98 to 78.31)[a]	55.85% (51.44 to 60.26)[a]	1.29 (0.88 to 1.90)[a]	0.77 (0.47 to 1.27)[a]	Moderate
1 study (Kerenyi 1970)	Case series	Serious[2,3]	No serious inconsistency	Serious[4]	Serious[5]	Apgar score < 7	60	23	66.67% (13.32 to 100)[a]	15.00% (0 to 30.65)[a]	0.78 (0.35 to 1.78)[a]	2.22 (0.33 to 15.01)[a]	Very low
Fetal scalp pH < 7.21													
1 study (Wiberg-Itzel 2008)	Randomised trial	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	Apgar score < 7	60	508	47.62% (26.26 to 68.98)	74.33% (70.45 to 78.21)	1.86 (1.16 to 2.98)	0.70 (0.47 to 1.06)	Moderate
1 study (Kerenyi 1970)	Case series	Serious[2,3]	No serious inconsistency	Serious[4]	Serious[5]	Apgar score < 7	60	23	66.67% (13.32 to 100)[a]	60.00% (38.53 to 81.47)[a]	1.67 (0.64 to 4.37)[a]	0.56 (0.11 to 2.86)[a]	Very low
Fetal scalp pH < 7.10													
1 study (Kerenyi 1970)	Case series	Serious[2,3]	No serious inconsistency	Serious[4]	Serious[5]	Apgar score < 7	60	23	66.67% (13.32 to 100)[a]	95.00% (85.45 to 100)[a]	13.33 (1.68 to 105.79)[a]	0.35 (0.07 to 1.74)[a]	Very low

Quality assessment							Maximum interval between sample and birth (minutes)	Number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Definition of outcome			Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Fetal scalp lactate ≥ 4.2 mmol/l													
1 study (Wiberg-Itzel 2008)	Randomised trial	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	Apgar score < 7	60	684	85.71% (72.75 to 98.68)[a]	51.83% (48.01 to 55.65)[a]	1.78 (1.50 to 2.11)[a]	0.28 (0.11 to 0.69)[a]	Moderate
Fetal scalp lactate > 4.8 mmol/l													
1 study (Wiberg-Itzel 2008)	Randomised trial	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	Apgar score < 7	60	684	82.14% (67.96 to 96.33)[a]	62.80% (59.11 to 66.50)[a]	2.21 (1.81 to 2.70)[a]	0.28 (0.13 to 0.63)[a]	Moderate
Base deficit > 10 mEq/l													
1 study (Kerenyi 1970)	Case series	Serious[2,3,10]	No serious inconsistency	Serious[4]	No serious imprecision	Apgar score < 7	60	19	0[a] (NC)	83.33% (66.12 to 100)[a]	0[a] (NC)	1.20 (0.98 to 1.48)[a]	Very low
Base deficit > 12.5 mEq/l													
1 study (Kerenyi 1970)	Case series	Serious[2,3,10]	No serious inconsistency	Serious[4]	No serious imprecision	Apgar score < 7	60	19	0[a] (NC)	94.44% (83.86 to 100)[a]	0[a] (NC)	1.06 (0.95 to 1.18)[a]	Very low
1 study (Khazin 1969)	Case series	Serious[2,3]	No serious inconsistency	Serious[11]	Serious[5]	Apgar score < 7	30	130	42.86% (6.20 to 79.52)[a]	90.24% (85.00 to 95.49)[a]	4.39 (1.60 to 12.06)[a]	0.63 (0.33 to 1.21)[a]	Very low

CI confidence interval, NR not reported, NC not calculable

a Calculated by the 2014 NCC-WCH technical team
1 Study included all women with singleton pregnancies, cephalic presentation at more than 34 weeks and an indication for FBS; therefore, other high risk women are included
2 Unclear how study sample was selected because inclusion and exclusion criteria are not reported
3 Mode of birth is not reported; therefore, it is not possible to evaluate whether mode of birth had any differential impact on the condition of the babies
4 13/23 (57%) of women had pregnancies complicated by at least one of: cephalopelvic disproportion (7) toxaemia (3), prematurity (1), eclampsia/preeclampsia (1), premature or prolonged rupture of membranes (2), diabetes (1), or meconium staining (1)
5 Wide confidence intervals (more than 40%) for two or three out of sensitivity, specificity, PPV and NPV
6 Point of assessment of Apgar score is not reported
7 Unclear whether women had low risk pregnancy
8 Study sample only includes women who had an operative birth (NB proportion of caesarean sections and instrumental vaginal births are not reported)
9 It is not specifically reported that FBS within 60 minutes of birth was analysed; however, the authors report that the average period between last sample and birth was 15.7 minutes and that the samples taken within an hour of birth were given special consideration. Therefore, the majority of samples analysed are likely to have been within 60 minutes of birth.
10 4/23 women (17%) have missing base deficit values
11 80/194 (41%) of women had complications in labour such as diabetes, premature rupture of membranes, post-dates, toxaemia. No further details are reported

Table 63: GRADE findings for correlation of fetal blood sampling with high and low Apgar scores at 5 minutes

Quality assessment						Definition of outcome	Maximum interval between sample and birth (minutes)	Number of women & baby pairs	Correlation coefficient (p-value)	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
Correlation of fetal scalp pH with low Apgar scores										
1 study (Hon 1969)	Case series	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Apgar score of 1-6	60	41	r: 0.3880 (p < 0.01)	Very low
1 study (Hon 1969)	Case series	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Apgar score of 1-6	45	41	r: 0.3880 (p < 0.01)	Very low
1 study (Hon 1969)	Case series	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Apgar score of 1-6	30	40	r: 0.3591 (p < 0.05)	Very low

Quality assessment						Definition of outcome	Maximum interval between sample and birth (minutes)	Number of women & baby pairs	Correlation coefficient (p-value)	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Hon 1969)	Case series	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Apgar score of 1-6	15	24	r: 0.4261 (p < 0.05)	Very low
1 study (Hon 1969)	Case series	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Apgar score of 1-6	5	8	r: 0.6171 (p < 0.05)	Very low
Correlation of fetal scalp base deficit with low Apgar scores										
1 study (Khazin 1969)	Case series	Serious [1,2]	No serious inconsistency	Serious[4]	No serious imprecision	Apgar score of 1-6	60	13	r: -0.8362 (p < 0.005)	Very low
1 study (Khazin 1969)	Case series	Serious [1,2]	No serious inconsistency	Serious[4]	No serious imprecision	Apgar score of 1-6	45	13	r: -0.8362 (p < 0.005)	Very low
1 study (Khazin 1969)	Case series	Serious [1,2]	No serious inconsistency	Serious[4]	No serious imprecision	Apgar score of 1-6	30	12	r: -0.8359 (p < 0.005)	Very low
1 study (Khazin 1969)	Case series	Serious [1,2]	No serious inconsistency	Serious[4]	No serious imprecision	Apgar score of 1-6	15	6	r: -0.9366 (p < 0.005)	Very low
1 study (Khazin 1969)	Case series	Serious [1,2]	No serious inconsistency	Serious[4]	No serious imprecision	Apgar score of 1-6	5	1	r: NA (p-value: NA)	Very low
Correlation of fetal scalp pH with high Apgar scores										
1 study (Hon 1969)	Case series	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Apgar score of 7 - 10	60	595	r: 0.0607 (p > 0.05)	Very low

Quality assessment						Definition of outcome	Maximum interval between sample and birth (minutes)	Number of women & baby pairs	Correlation coefficient (p-value)	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Hon 1969)	Case series	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Apgar score of 7 - 10	45	555	r: 0.0019 (p > 0.05)	Very low
1 study (Hon 1969)	Case series	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Apgar score of 7 - 10	30	503	r: 0.0044 (p > 0.05)	Very low
1 study (Hon 1969)	Case series	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Apgar score of 7 - 10	15	400	r: -0.0120 (p > 0.05)	Very low
1 study (Hon 1969)	Case series	Serious [1,2]	No serious inconsistency	Serious[3]	No serious imprecision	Apgar score of 7 - 10	5	151	r: -0.0534 (p > 0.05)	Very low
Correlation of fetal scalp base deficit with high Apgar scores										
1 study (Khazin 1969)	Case series	Serious [1,2]	No serious inconsistency	Serious[4]	No serious imprecision	Apgar score of 7 - 10	60	309	r: -0.0960 (p > 0.05)	Very low
1 study (Khazin 1969)	Case series	Serious [1,2]	No serious inconsistency	Serious[4]	No serious imprecision	Apgar score of 7 - 10	45	287	r: -0.0663 (p > 0.05)	Very low
1 study (Khazin 1969)	Case series	Serious [1,2]	No serious inconsistency	Serious[4]	No serious imprecision	Apgar score of 7 - 10	30	253	r: -0.1383 (p < 0.05)	Very low
1 study (Khazin 1969)	Case series	Serious [1,2]	No serious inconsistency	Serious[4]	No serious imprecision	Apgar score of 7 - 10	15	197	r: -0.1454 (p > 0.05)	Very low

Quality assessment						Definition of outcome	Maximum interval between sample and birth (minutes)	Number of women & baby pairs	Correlation coefficient (p-value)	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 study (Khazin 1969)	Case series	Serious [1,2]	No serious inconsistency	Serious[4]	No serious imprecision	Apgar score of 7 - 10	5	84	r: -0.1517 (p > 0.05)	Very low

NA not applicable

1 Unclear how study sample was selected because inclusion and exclusion criteria are not reported
2 Mode of birth is not reported; therefore, it is not possible to evaluate whether mode of birth had any differential impact on the condition of the babies
3 Unclear if women had low risk pregnancy
4 80/194 (41%) of women had complications in labour such as diabetes, premature rupture of membranes, post-dates, toxaemia. No further details are reported

Table 64: GRADE findings for predictive accuracy of fetal blood sampling for arterial pH at birth

Quality assessment						Definition of outcome	Maximum interval between sample and birth (minutes)	Number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
Fetal scalp pH ≤ 7.25													
1 study (Wiberg-Itzel 2008)	Randomised trial	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	Metabolic acidaemia, defined as pH < 7.05 and base deficit > 12 mmol/l	60	508	65.00% (44.10 to 85.90)[a]	56.15% (51.74 to 60.55)[a]	1.48 (1.06 to 2.08)[a]	0.62 (0.34 to 1.14)[a]	Moderate

Quality assessment						Definition of outcome	Maximum interval between sample and birth (minutes)	Number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
1 study (Kerenyi 1970)	Case series	Serious[2,3]	No serious inconsistency	Serious[4]	No serious imprecision	pH < 7.10	60	21	100%[a] (NC)	22.22% (3.02 to 41.43)[a]	1.29 (1.00 to 1.65)[a]	0[a] (NC)	Very low
1 study (Wiberg-Itzel 2008)	Randomised trial	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	pH < 7.00	60	508	63.64% (35.21 to 92.06)[a]	55.73% (51.37 to 60.10)[a]	1.44 (0.91 to 2.27)[a]	0.65 (0.30 to 1.43)[a]	Moderate
Fetal scalp pH < 7.21													
1 study (Wiberg-Itzel 2008)	Randomised trial	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	Metabolic acidaemia, defined as pH < 7.05 and base deficit > 12 mmol/l	60	508	50.00% (28.09 to 71.91)[a]	74.39% (70.51 to 78.26)[a]	1.95 (1.23 to 3.10)[a]	0.67 (0.43 to 1.05)[a]	Moderate
1 study (Bakr 2005)	Prospective observational study	Serious[8]	No serious inconsistency	Serious[5,9]	No serious imprecision	pH ≤ 7.15	Unknown	150	72% (58 to 82)	53% (42 to 63)	1.54 (1.17 to 2.02)[a]	0.53 (0.34 to 0.83)[a]	Low
1 study (Kerenyi 1970)	Case series	Serious[2,3]	No serious inconsistency	Serious[4]	Serious[10]	pH < 7.10	60	21	100%[a] (NC)	66.67% (44.89 to 88.44)[a]	3.00 (1.56 to 5.77)[a]	0.00[a] (NC)	Very low

Quality assessment						Definition of outcome	Maximum interval between sample and birth (minutes)	Number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
1 study (Wiberg-Itzel 2008)	Randomised trial	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	pH < 7.00	60	508	45.45% (16.03 to 74.88)[a]	73.84% (69.98 to 77.71)[a]	1.74 (0.89 to 3.38)[a]	0.74 (0.43 to 1.27)[a]	Moderate
Fetal scalp pH < 7.10													
1 study (Kerenyi 1970)	Case series	Serious[2,3]	No serious inconsistency	Serious[4]	Serious[10]	pH < 7.10	60	21	33.33% (0 to 86.68)[a]	94.44% (83.86 to 100)[a]	6.00 (0.50 to 72.21)[a]	0.71 (0.31 to 1.58)[a]	Very low
Fetal scalp lactate ≥ 4.2 mmol/l													
1 study (Wiberg-Itzel 2008)	Randomised trial	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	Metabolic acidaemia, defined as pH < 7.05 and base deficit > 12 mmol/l	60	684	100%[a] (NC)	51.04% (47.26 to 54.81)[a]	2.04 (1.89 to 2.21)[a]	0.00[a] (NC)	Moderate
1 study (Wiberg-Itzel 2008)	Randomised trial	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	pH < 7.00	60	684	76.00% (59.26 to 92.74)[a]	51.29% (47.47 to 55.11)[a]	1.56 (1.24 to 1.97)[a]	0.47 (0.23 to 0.94)[a]	Moderate
Fetal scalp lactate > 4.8 mmol/l													
1 study (Wiberg-Itzel 2008)	Randomised trial	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	metabolic acidaemia, defined as pH < 7.05	60	684	76.00% (59.26 to 92.74)[a]	62.37% (58.67 to 66.07)[a]	2.02 (1.59 to 2.57)[a]	0.38 (0.19 to 0.78)[a]	Moderate

Quality assessment						Definition of outcome	Maximum interval between sample and birth (minutes)	Number of women & baby pairs	Measure of diagnostic accuracy (95% CI)				Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision				Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	
						and base deficit > 12 mmol/l							
1 study (Wiberg-Itzel 2008)	Randomised trial	No serious risk of bias	No serious inconsistency	Serious[1]	No serious imprecision	pH < 7.00	60	684	100%[a] (NC)	61.87% (58.20 to 65.54)[a]	2.62 (2.38 to 2.89)[a]	0.00[a] (NC)	Moderate
Fetal scalp base deficit > 10 mEq/l													
1 study (Kerenyi 1970)	Case series	Serious[2,3,11]	No serious inconsistency	Serious[4]	No serious imprecision	pH < 7.10	60	18	0%[a] (NC)	81.25% (62.12 to 100)[a]	0[a] (NC)	1.23 (0.97 to 1.56)[a]	Very low
Fetal scalp base deficit > 12.5 mEq/l													
1 study (Kerenyi 1970)	Case series	Serious[2,3,11]	No serious inconsistency	Serious[4]	No serious imprecision	pH < 7.10	60	18	0%[a] (NC)	93.75% (81.89 to 100)[a]	0[a] (NC)	1.07 (0.94 to 1.21)[a]	Very low

CI confidence interval, NC not calculable, NR not reported

a Calculated by the 2014 NCC-WCH technical team
b Values reported in the table are as reported in the study; however, they do not match the 2x2 data reported, therefore the 2014 NCC-WCH technical team calculations have also been quoted
1 Study included all women with singleton pregnancies, cephalic presentation at more than 34 weeks and an indication for FBS; therefore, other high risk women are included
2 Unclear how this study sample was selected because inclusion and exclusion criteria are not reported
3 Mode of birth is not reported; therefore, it is not possible to evaluate whether mode of birth had any differential impact on the condition of the babies
4 13/23 (57%) of women had pregnancies complicated by at least one of: cephalopelvic disproportion (7) toxaemia (3), prematurity (1), eclampsia/preeclampsia (1), premature or prolonged rupture of membranes (2), diabetes (1), or meconium staining (1)
5 Unclear whether women had low risk pregnancy because no characteristics of the study population are reported

6 Study sample only includes women who had an operative birth (NB proportion of caesarean sections and instrumental vaginal births are not reported)
7 It is not specifically reported that FBS within 60 minutes of birth was analysed; however, the authors report that the average period between last sample and birth was 15.7 minutes and that the samples taken within an hour of birth were given special consideration. Therefore, the majority of samples analysed are likely to have been within 60 minutes of birth.
8 No details about mode of birth or when they intervened are reported; therefore, it is not possible to evaluate what effect this had on the babies
9 Some women would have had an interval of more than 60 minutes between FBS and birth; however, this study has been included because the mean (36.7) and standard deviation (15.3) suggest that this proportion would have been small
10 Wide confidence intervals (more than 40%) for two or three out of sensitivity, specificity, PPV and NPV
11 5/23 (22%) have missing data for either the base deficit or arterial pH value

Table 65: GRADE findings for correlation of fetal scalp blood sample values with umbilical artery values at time of birth

Quality assessment						Definition of outcome	Maximum interval between sample and birth (minutes)	Number of women & baby pairs	Correlation coefficient	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
Correlation of fetal scalp pH										
1 study (Kubli 1968)	Case series	Very serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	Artery pH at time of birth	5	31	r: 0.76	Very low
Correlation of fetal scalp base excess										
1 study (Kubli 1968)	Case series	Very serious [1]	No serious inconsistency	No serious indirectness	No serious imprecision	Artery base excess at time of birth	5	31	r: 0.90	Very low

1 Unclear how this sample was selected - no inclusion/exclusion criteria are reported and it is not clear why only 31 out of the 77 (40.3%) women recruited have data reported for this correlation

I.10 Women's experience of fetal monitoring

There are no GRADE tables for this review question.

I.11 Cardiotocography with electrocardiogram analysis compared with cardiotocography alone

Table 66: GRADE findings for comparison of continuous cardiotocography plus fetal electrocardiogram PR interval analysis with continuous cardiotocography alone in labour

Quality assessment							Number of women		Effect		
Number of studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	CTG plus fetal ECG	CTG alone	Relative (95% CI)	Absolute (95% CI)	Quality
Caesarean section											
1 study (Neilson 2015)	Randomised trial	Serious[1]	No serious inconsistency	Serious[2]	Serious[3]	None	79/482 (16.4%)	98/475 (20.6%)	RR 0.79 (0.61 to 1.04)	43 fewer per 1000 (from 80 fewer to 8 more)	Very low
Instrumental vaginal birth											
1 study (Neilson 2015)	Randomised trial	Serious[1]	No serious inconsistency	Serious[4]	Serious[3]	None	116/482 (24.1%)	122/475 (25.7%)	RR 0.94 (0.75 to 1.17)	15 fewer per 1000 (from 64 fewer to 44 more)	Very low
Assisted birth (caesarean section or instrumental vaginal birth)											
2 studies (Neilson 2015; van Wijngaarden 1996)	Randomised trials	Serious[5]	No serious inconsistency	Serious[4]	Serious[3]	None	231/594 (38.9%)	262/577 (45.4%)	RR 0.86 (0.75 to 0.98)	64 fewer per 1000 (from 9 fewer to 114 fewer)	Very low
Fetal blood sampling											
2 studies (Neilson 2015; van Wijngaarden 1996)	Randomised trials	Serious[1,5]	Very serious[6]	Serious[2,4]	Very serious[3,7]	None	86/594 (14.5%)	109/577 (18.9%)	RR 0.48 (0.12 to 1.95)	98 fewer per 1000 (from 166 fewer to 179 more)	Very low
Perinatal death											

Quality assessment							Number of women		Effect		
Number of studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	CTG plus fetal ECG	CTG alone	Relative (95% CI)	Absolute (95% CI)	Quality
1 study (Neilson 2015)	Randomised trial	Serious[1]	No serious inconsistency	Serious[2]	Very serious[3, 7]	None	1/482[a] (0.21%)	0/475 (0%)	RR 2.96 (0.12 to 72.39)	NC	Very low
Cord pH ≤ 7.15 (acidosis at birth)											
1 study (van Wijngaarden 1996)	Randomised trial	Serious[5]	No serious inconsistency	Serious[4]	Very serious[3, 7]	None	8/84 (9.5%)	14/100 (14%)	RR 0.68 (0.3 to 1.54)	45 fewer per 1000 (from 98 fewer to 76 more)	Very low
Admission to neonatal intensive care unit											
1 study (Neilson 2015)	Randomised trial	Serious[1]	No serious inconsistency	Serious[2]	Very serious[3, 7]	None	22/482 (4.6%)	28/475 (5.9%)	RR 0.77 (0.45 to 1.33)	14 fewer per 1000 (from 32 fewer to 19 more)	Very low
Apgar score < 7 at 5 minutes											
1 study (Neilson 2015)	Randomised trial	Serious[1]	No serious inconsistency	Serious[2]	Very serious[3, 7]	None	3/482 (0.62%)	7/475 (1.5%)	RR 0.42 (0.11 to 1.62)	9 fewer per 1000 (from 13 fewer to 9 more)	Very low
Neonatal intubation											
1 study (Neilson 2015)	Randomised trial	Serious[1]	No serious inconsistency	Serious[2]	Very serious[3, 7]	None	6/482 (1.2%)	8/475 (1.7%)	RR 0.74 (0.26 to 2.11)	4 fewer per 1000 (from 13 fewer to 19 more)	Very low

CI confidence interval, CTG cardiotocography, ECG electrocardiogram, NC not calculable RR relative risk

a Baby was born by forceps, the cord blood pH was 7.14 and the base excess was -12 mmol/l. Apgar was 8 at 1 minute and 9 at 5 minutes. The baby was in good condition for 36 hours then had respiratory arrest on the postnatal ward and died 12 hours later. No reason for this sudden death was found

1 For unclear reason the result is reported for 92.2% of the study population. Subgroup analysis of babies born with a low arterial pH showed no action for fetal distress had been taken in nearly 75% of cases, suggesting the study protocol was violated within the trial groups (Strachan 2000)

2 Inclusion criteria for the study were women in labour with perceived need for continuous fetal heart rate monitoring, adverse obstetric history, prematurity, suspected fetal growth restriction, antepartum haemorrhage, breech presentation, multiple pregnancy, epidural analgesia, induction or augmentation of labour, abnormal cardiotocography, meconium, and previous caesarean section (Strachan 2000)

3 CI touches or crosses 0.75.

4 Inclusion criteria for the study were high-risk labour women according to maternal factors (e.g. any disease with potential adverse fetal effects), obstetric factors (e.g. prematurity) and intrapartum factors (e.g. breech presentation) (van Wijngaarden 1996)

5 Participants were women deemed at high risk pregnancy; no details of allocation concealment; blinding not possible; full clinical data available only for 86% of sample mainly due to labour suite staff errors (n=17) in collecting ECG data and inability to obtain analysable ECG waveform signal (van Wijngaarden 1996)

6 $I^2 > 75\%$

7 CI touches or crosses 1.25

Table 67: GRADE findings for comparison of continuous cardiotocography plus fetal electrocardiogram ST waveform analysis with continuous cardiotocography alone in labour

Quality assessment							Number of women		Effect		
Number of studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	CTG plus fetal ECG	CTG alone	Relative (95% CI)	Absolute (95% CI)	Quality
Spontaneous vaginal birth											
2 studies (Belfort 2015; Olofsson 2014)	Randomised trials	Serious[1]	No serious inconsistency	Serious[2]	No serious imprecision	None	10046/13229 (75.9%)	9949/13217 (75.3%)	RR 1.01 (0.99 to 1.02)	8 more per 1000 (from 8 fewer to 15 more)	Low
Caesarean section											
1 meta-analysis of 6 studies (Neilson 2015)	Randomised trials	Serious[1]	No serious inconsistency	Serious[3]	No serious imprecision	None	1810/13229 (13.7%)	1779/13217 (13.5%)	RR 1.02 (0.96 to 1.08)	3 more per 1000 (from 5 fewer to 11 more)	Low
Instrumental vaginal birth											

Quality assessment							Number of women		Effect		
Number of studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	CTG plus fetal ECG	CTG alone	Relative (95% CI)	Absolute (95% CI)	Quality
1 meta-analysis of 6 studies (Neilson 2015)	Randomised trials	Serious[1]	No serious inconsistency	Serious[4]	No serious imprecision	None	1373/13229 (10.4%)	1489/13217 (11.3%)	RR 0.92 (0.86 to 0.99)	9 fewer per 1000 (from 1 fewer to 16 fewer)	Low
Fetal blood sampling											
1 meta-analysis of 4 studies (Neilson 2015)	Randomised trials	Serious[5]	Very serious[6]	Serious[7]	Serious[8]	None	486/4870 (10%)	738/4801 (15.4%)	RR 0.61 (0.41 to 0.91)	60 fewer per 1000 (from 14 fewer to 91 fewer)	Very low
Fetal and neonatal death											
1 meta-analysis of 6 studies (Neilson 2015)	Randomised trials	Serious[1]	No serious inconsistency	Serious[9]	Very serious[8, 10]	None	11/13229 (0.08%)	6/13217 (0.05%)	RR 1.71 (0.67 to 4.33)	0 more per 1000 (from 0 fewer to 2 more)	Very low
Cord pH < 7.05 and base deficit > 12 mmol/l											
1 meta-analysis of 6 studies (Neilson 2015)	Randomised trials	Serious[1]	Serious[11]	Serious[12]	Serious[8]	None	81/12850 (0.63%)	121/12832 (0.94%)	RR 0.72 (0.43 to 1.2)	3 fewer per 1000 (from 5 fewer to 2 more)	Very low
Neonatal encephalopathy											
1 meta-analysis of 6 studies (Neilson 2015)	Randomised trials	Serious[1]	No serious inconsistency	Serious[13]	Serious[8]	None	12/13210 (0.09%)	20/13200 (0.15%)	RR 0.61 (0.3 to 1.22)	1 fewer per 1000 (from 1 fewer to 0 more)	Very low
Admission to neonatal intensive care unit											

Quality assessment							Number of women		Effect		
Number of studies	**Design**	**Limitations**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**CTG plus fetal ECG**	**CTG alone**	**Relative (95% CI)**	**Absolute (95% CI)**	**Quality**
1 meta-analysis of 6 studies (Neilson 2015)	Randomised trials	Serious[1]	No serious inconsistency	Serious[14]	No serious imprecision	None	1113/13210 (8.4%)	1155/13200 (8.8%)	RR 0.96 (0.89 to 1.04)	4 fewer per 1000 (from 10 fewer to 3 more)	Low
Apgar score < 7 at 5 minutes											
1 meta-analysis of 5 studies (Neilson 2015)	Randomised trials	Serious[1]	No serious inconsistency	Serious[3]	No serious imprecision	None	103/7678 (1.3%)	107/7624 (1.4%)	RR 0.95 (0.73 to 1.24)	1 fewer per 1000 (from 3 fewer to 3 more)	Low
Apgar score ≤ 3 at 5 minutes											
1 study (Belfort 2015)	Randomised trial	Serious[15]	No serious inconsistency	No serious indirectness	Serious[10]	None	17/5532 (0.31%)	6/5576 (0.11%)	RR 2.86 (1.13 to 7.24)	2 more per 1000 (from 0 more to 7 more)[a]	Low
Neonatal intubation											
1 meta-analysis of 2 studies (Neilson 2015)	Randomised trials	Serious[16]	No serious inconsistency	Serious[17]	Very serious[3, 10]	None	49/6246 (0.78%)	36/6298 (0.57%)	RR 1.37 (0.89 to 2.11)	2 more per 1000 (from 1 fewer to 6 more)	Very low

CI confidence interval, CTG cardiotocography, ECG electrocardiogram, HIE hypoxic ischaemic encephalopathy, RR relative risk

a When expressed per 10,000 women, the absolute effect is 20 more per 10,000 (from 1 more to 67 more)

1 Four studies with serious limitations included

- *Westerhuis 2010 – women with high- risk pregnancy are the study population, there was no blinding for women or clinicians, and a secondary analysis of 61 babies with adverse outcomes [metabolic acidosis in umbilical cord artery, pH < 7.00, signs of severe HIE and perinatal death] showed the trial protocol was violated in 11 [42%] and 13 [19%] participants in the study and control groups, respectively*
- *Amer Wahlin 2001 – women with high-risk pregnancy were included and a modified intention-to-reat analysis was performed (excluding non-cephalic and preterm babies)*

- *Ojala 2006 – n = 5 participants in the CTG group and n = 78 in the ECG group had technical difficulties in achieving satisfactory monitoring*
- *Belfort 2015 – no details of randomisation procedure reported, participant blinding not possible, protocol sub-committee was unaware of study group assignment and conducted chart review of all participants that met primary outcome criteria*

2 40% of weight of meta-analysis is from trials that recruited women with high-risk pregnancy (Westerhuis 2010 and Amer Wahlin 2001; see footnote 1); 44% of weight of meta-analysis is from a trial with serious limitations (Belfort 2015, see footnote 1)
3 33% of the weight of meta-analysis is from trials that recruited women with high-risk pregnancy (Westerhuis 2010 and Amer Wahlin 2001; see footnote 1); 44% of weight of meta-analysis is from a trial with serious limitations (Belfort 2015; see footnote 1)
4 60% of the weight of meta-analysis is from trials that recruited women with high-risk pregnancy (Westerhuis 2010 and Amer-Wahlin 2001; see footnote 1)
5 Two studies with serious limitations included

- *Amer Wahlin 2001 – women with high-risk pregnancy were included and a modified intention-to-treat analysis was performed (excluding non-cephalic and preterm babies)*
- *Ojala 2006 – n = 5 participants in the CTG group and n = 78 in the ECG group had technical difficulties in achieving satisfactory monitoring*

6 $I^2 > 75\%$
7 Women with high-risk pregnancy were included in the study (Amer-Wahlin 2001)
8 CI touches or crosses 0.75
9 57% of weight of meta-analysis is from trials that recruited women with high-risk pregnancy (Westerhuis 2010 and Amer Wahlin 2001; see footnote 1)
10 CI touches or crosses 1.25
11 $I^2 > 50\%$ and < 75%
12 48% of the weight of meta-analysis is from trials that recruited women with high-risk pregnancy (Westerhuis 2010 and Amer Wahlin 2001; see footnote 1)
13 44% of the weight of meta-analysis is from trials that recruited women with high-risk pregnancy (Westerhuis 2010 and Amer-Wahlin 2001; see footnote 1)
14 54% of the weight of meta-analysis is from trials that recruited women with high-risk pregnancy (Westerhuis 2010 and Amer Wahlin 2001; see footnote 1)
15 One study with no details of randomisation procedure reported; participant blinding not possible (protocol subcommittee was unaware of study group assignment and conducted chart review of all cases that met primary outcome criteria)
16 Two studies with serious limitations included

- *Ojala 2006 – sample n = 5 in CTG group and n = 78 in the ECG group had technical difficulties in achieving satisfactory monitoring*
- *Belfort 2015 – protocol sub-committee review of subset of records revealed that management protocols had not been correctly followed in some cases by staff. Of 2427 women assigned to the CTG plus ECG group who had records assessed, n=163 (7%) did not receive care according to STAN guidelines [95 did not receive expedited birth when recommended, 68 had birth expedited despite recommendation for continued observation])*

17 75% of the weight of meta-analysis is from a trial with serious limitations (Belfort 2015; see footnote 1)

I.12 Automated interpretation of cardiotocograph traces

Table 68: GRADE profile for predictive accuracy of computerised cardiotocograph interpretation to identify adverse outcomes

Quality assessment								Measure of diagnostic accuracy (95% CI)				
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Definition of outcome	Total number of CTGs	Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	Quality
CTG interpretation identified as abnormal[a] by a computer software program												
1 (Chung 1995)	Retrospective cohort	Serious[1]	No serious inconsistency	Serious[2]	Very serious[3]	pH < 7.15	73	87.50 (46.7 to 99.3)[b]	75.40 (62.9 to 84.9)[b]	3.55 (2.16 to 5.86)[b]	0.17 (0.03 to 1.05)[b]	Very low
CTG interpretation of an outcome as abnormal[c] by a computer software program												
1 (Nielsen 1988)	Retrospective cohort	Serious[1]	No serious inconsistency	Serious[2]	Very serious[4]	1-minute Apgar score below 7 or acidosis (umbilical arterial pH < 7.15 or base excess below -10 meq/l), or primary resuscitation needed	50	68.8 (41.5 to 87.9)[b]	94.1 (78.9 to 99.0)[b]	11.7 (2.9 to 46.7)[b]	0.33 (0.16 to 0.69)[b]	Very low

CAS Cardiotocographic Assessment System; CI confidence interval; CTG cardiotocograph; FHR fetal heart rate

a An abnormal trace was defined by one or more of the following criteria

- *tachycardia (fetal heart rate > 160 bpm) for more than 30 minutes during labour*
- *bradycardia (fetal heart rate < 110 bpm) for more than 30 minutes during labour*
- *low variation (standard deviation of the fetal heart rate of ≤ 3 bpm) for more than 60 minutes during labour*
- *more than five late decelerations (minima of the FHR occurring 20-60 seconds after the maxima of the contraction) during labour*
- *more than 10 variable decelerations (minima of the FHR occurring more than 20 seconds prior to, or 60 seconds after, the maxima of the contraction) during labour*

b Calculated by the 2017 NGA technical team

c A computer system (CA) calculates the probability of the CTG belonging to a compromised infant by calculating a discriminant function, and a CTG is considered pathological if the probability is above 0.5. The computer system's calculation of the probability of a compromised infant is for each CTG based on the experience from the other 49 CTGs, thus excluding the possibility of "self-recognition"
1 Selection of cases for assessment not well described and it is unclear whether a consecutive or random sampling approach was taken
2 The reference standard used was different to that specified in the guideline review protocol (arterial cord pH <7.05)
3 CI for the negative likelihood ratio crosses two boundaries (from very useful (< 0.1) to not very useful (> 0.5)
4 CI for the positive likelihood ratio crosses two boundaries (from very useful (> 10) to not very useful (< 5))

Table 69: GRADE profile for comparison of computerised cardiotocograph interpretation with human interpretation

Quality assessment						Comparison	Total number of CTGs	Intraclass correlation coefficient (95% CI)	Kappa statistic (95% CI)	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
Baseline FHR										
1 (Chen 2014)[a]	Retrospective cohort	Serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	A computerised algorithm using LabVIEW 2010 software, compared to 8 individual obstetricians	62	0.91 (0.88 to 0.94)	NC	Low
1 (Costa 2010a)[b]	Retrospective cohort	No serious risk of bias	No serious inconsistency	No serious indirectness	Very serious[2]	The OmniView SisPorto 3.5 system was compared to interpretation by 3 obstetricians (results are shown compared to the consensus	50	0.85 (0.46 to 0.93)	NC	Very low

Quality assessment						Comparison	Total number of CTGs	Intraclass correlation coefficient (95% CI)	Kappa statistic (95% CI)	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
						view of the group)				
1 (Mongelli 1997)[c]	Retrospective cohort	No serious risk of bias	No serious inconsistency	No serious indirectness	No serious imprecision[3]	A computer algorithm was compared to interpretation by 12 clinical experts	60	> 0.9 (CI not reported)	NC	Moderate
1 (Taylor 2000)[d]	Prospective cohort	Serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision[3]	A computer algorithm was compared to independent interpretation by 7 obstetricians	24	Range: 0.91 to 0.98	NC	Moderate
1 (Todros 1996)[e]	Retrospective cohort	No serious risk of bias	No serious inconsistency	Serious[5]	No serious imprecision[3]	The 2CTG system was compared to interpretation by 4 obstetricians.	63	Range: 0.18 to 0.48	NC	Low
Variability										
1 (Chen 2014)[a]	Retrospective cohort	Serious[1]	No serious inconsistency	No serious indirectness	Very serious[6]	A computerised algorithm using LabVIEW 2010 software, compared to 8	62	NC	0.68 (0.51 to 0.84)	Very low

Quality assessment						Comparison	Total number of CTGs	Intraclass correlation coefficient (95% CI)	Kappa statistic (95% CI)	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
						individual obstetricians				
1 (Taylor 2000)[f]	Prospective cohort	Serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision[3]	A computer algorithm was compared to independent interpretation by 7 obstetricians	24	NC	Range: 0.00 to 0.34	Moderate
1 (Todros 1996)[g]	Retrospective cohort	No serious risk of bias	No serious inconsistency	Serious[5]	No serious imprecision[3]	The 2CTG system was compared to interpretation by 4 obstetricians	63	Range: 0.16 to 0.74	NC	Low
1 (Wolfberg 2008)[h]	Retrospective cohort	Serious[7]	No serious inconsistency	No serious indirectness	No serious imprecision[3]	A computer algorithm was compared to interpretation by 4 perinatologists	30	0.62 (range 0.27 to 0.68)	NC	Low
Accelerations										
1 (Chen 2014)[a]	Retrospective cohort	Serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	A computerised algorithm using LabVIEW 2010 software, compared to 8	62	0.85 (0.80 to 0.90)	NC	Low

Quality assessment						Comparison	Total number of CTGs	Intraclass correlation coefficient (95% CI)	Kappa statistic (95% CI)	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
						individual obstetricians				
1 (Taylor 2000)[i]	Prospective cohort	Serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision[3]	A computer algorithm was compared to independent interpretation by 7 obstetricians	24	Range 0.06 to 0.80	NC	Moderate
1 (Todros 1996)[j]	Retrospective cohort	No serious risk of bias	No serious inconsistency	Serious[5]	No serious imprecision[3]	The 2CTG system was compared to interpretation by 4 obstetricians	63	NC	Range: 0.37 to 0.64	Low
Decelerations										
1 (Taylor 2000)[i]	Prospective cohort	Serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision[3]	A computer algorithm was compared to independent interpretation by 7 obstetricians	24	Range: 0.82 to 0.92	NC	Moderate
1 (Todros 1996)[k]	Retrospective cohort	No serious risk of bias	No serious inconsistency	Serious[5]	No serious imprecision[3]	The 2CTG system was compared to interpretation by 4 obstetricians	63	NC	Range: 0.41 to 0.54	Low
Early decelerations										

Quality assessment						Comparison	Total number of CTGs	Intraclass correlation coefficient (95% CI)	Kappa statistic (95% CI)	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 (Chen 2014)[a]	Retrospective cohort	Serious[1]	No serious inconsistency	No serious indirectness	Serious[8]	A computerised algorithm using LabVIEW 2010 software was compared to 8 individual obstetricians	62	0.78 (0.71 to 0.84)	NC	Very low
Late decelerations										
1 (Chen 2014)[a]	Retrospective cohort	Serious[1]	No serious inconsistency	No serious indirectness	Serious[2]	A computerised algorithm using LabVIEW 2010 software was compared to 8 individual obstetricians	62	0.67 (0.59 to 0.76)	NC	Very low
1 (Taylor 2000)[l]	Prospective cohort	Serious[4]	No serious inconsistency	No serious indirectness	No serious imprecision[3]	A computer algorithm was compared to independent interpretation by 7 obstetricians	24	Range: 0.68 to 0.85	NC	Moderate
Variable decelerations										

Quality assessment						Comparison	Total number of CTGs	Intraclass correlation coefficient (95% CI)	Kappa statistic (95% CI)	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 (Chen 2014)[a]	Retrospective cohort	Serious[1]	No serious inconsistency	No serious indirectness	Serious[9]	A computerised algorithm using LabVIEW 2010 software was compared to 8 individual obstetricians	62	0.60 (0.51 to 0.70)	NC	Very low
Prolonged decelerations										
1 (Chen 2014)[a]	Retrospective cohort	Serious[1]	No serious inconsistency	No serious indirectness	Very serious[6]	A computerised algorithm using LabVIEW 2010 software was compared to 8 individual obstetricians	62	NC	0.82 (0.58 to 1.00)	Very low
Recurrent decelerations										
1 (Chen 2014)[a]	Retrospective cohort	Serious[1]	No serious inconsistency	No serious indirectness	Serious[10]	A computerised algorithm using LabVIEW 2010 software was compared to 8	62	NC	0.82 (0.67 to 0.97)	Very low

Quality assessment						Comparison	Total number of CTGs	Intraclass correlation coefficient (95% CI)	Kappa statistic (95% CI)	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
						individual obstetricians				
Overall categorisation of CTG										
1 (Chen 2014)[m]	Retrospective cohort	Serious[1]	No serious inconsistency	No serious indirectness	Serious[10]	A computerised algorithm using LabVIEW 2010 software, compared to 8 individual obstetricians	62	NC	0.80 (0.67 to 0.94)	Very low
1 (Parer 2010)[h]	Retrospective cohort	Serious[11]	No serious inconsistency	No serious indirectness	No serious imprecision[3]	PeriCALM computer software was used to analyse the CTGs, and compared to the interpretation of 5 experts, who were asked to use a strict, rule-based system to categorise CTGs into a five-tier system of severity	30	NC	Exact agreement with the majority clinical decision: 0.52 (CI not reported)	Low

Quality assessment						Comparison	Total number of CTGs	Intraclass correlation coefficient (95% CI)	Kappa statistic (95% CI)	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
1 (Keith 1995)[m]	Retrospective cohort	Serious[12]	No serious inconsistency	No serious indirectness	No serious imprecision[3]	A computer algorithm was compared to a panel of 17 experts, who rated each 15 minute segment of the CTG according to a five-tier system	50	0.31 (CI notreported), p < 0.001	NC	Low
Prediction of umbilical artery blood pH										
1 (Costa 2010b)	Randomised comparative study	No serious risk of bias	No serious inconsistency	No serious indirectness	Very serious[13]	CTG traces were interpreted by expert clinicians. Half of the traces were standard, and half were annotated with analysis from the OmniView SisPorto system. The ability of clinicians to predict umbilical	204 (100 visual interpretation only; 104 visual interpretation with computer analysis available)	NC	Agreement between the three clinicians: 1) with visual interpretation only: 0.29 (0.08 to 0.47) 2) with computer analysis and visual interpretation: 0.52 (0.34 to 0.66)	Low

Quality assessment						Comparison	Total number of CTGs	Intraclass correlation coefficient (95% CI)	Kappa statistic (95% CI)	Quality
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision					
						arterial pH with and without the additional information provided by the computer was assessed. Further, the agreement in interpretation of the trace was compared between observers, with and without the computerised analysis				

BPM beats per minute; CTG cardiotocograph; FHR fetal heart rate; ICC intraclass correlation coefficient; NC not calculable

a NICHD 2008 criteria
b For baseline estimation, a previously developed very reproducible definition was used: "it is a single value, corresponding to the mean FHR of the lowest stable horizontal segment(s) lasting at least 2 min. For the selection of these segments the following conditions should preferably be met: long-term variability <15 bpm, absence of fetal movements and uterine contractions and mean FHR within physiological limits"
c A low-frequency line which would be stable under noisy conditions yet responsive to both gradual or sudden changes in the baseline. For this, the concept of modal values was developed. Values in a narrow modal range were used to calculate the mean and to generate a low frequency baseline FHR
d The running baseline FHR was produced by a three-stage iterative process that generated progressively improved intermediate baselines before obtaining the final baseline. Prior to this process the signal was low-pass filtered using a third-order, zero-phase (two-pass) Butterworth filter with a cut-off frequency of 0.008 Hz. This gave a coarse starting baseline. The iterative process consisted of the following: by selective thresholds removal of components of the fetal heart rate signal associated with accelerations and decelerations; linear interpolation across the gaps, and low-pass filtering. The selective thresholds started with deviations of ± 5 bpm from the initial baseline for the first bpm for values above and below the baseline respectively for the third iteration, to produce the final baseline. After removal of the deviations, the signal

was interpolated and an improved intermediate baseline generated after applying a low-pass Butterworth filter with a cut-off frequency of 0.006 Hz. This was a lower cut-off frequency than that used for obtaining the starting baseline, because many of the deviations from the baseline had already been removed in the first filtering process that generated the starting baseline. The mean value of the baseline for the period gave the baseline FHR for the segment
e Categorised in 10 bpm
f Classified as normal (≥ 5 bpm) or reduced (< 5 bpm)
g Long-term variability (amplitude < 5 bpm, between 5 and 10 bpm, >10 bpm)
h NICHD 1997criteria
i FIGO 1987 criteria
j The number of large accelerations (amplitude >15 bpm above the baseline lasting >15 minutes)
k The number of decelerations (amplitude >20 bpm below the baseline lasting >30 minutes or amplitude >10 bpm lasting > 60 minutes)
l Occurred where the minimum value was 20-60 seconds after the peak of a contraction
m CTGs were categorised as normal, intermediate or abnormal
1 Participant recruitment was not random or consecutive. CTGs were specifically chosen to represent different types of abnormality
2 The CI for the ICC crosses the threshold from fair (0.40 to 0.59) to excellent agreement (> 0.75)
3 CIs are not reported and not calculable, therefore imprecision cannot be accurately assessed; the outcome has, however, not been downgraded for consistency with grading by the 2014 NCC-WCH technical team in other review questions
4 Methods of participant recruitment not reported. Random selection of 24 CTGs out of a total of 30 was reported, but it is unclear why this step was taken, and how CTGs were randomly selected
5 Women with premature gestations (from 30 weeks) were included, and it is unclear whether all CTGs were recorded intrapartum
6 The CI for the Kappa statistic crosses the threshold from fair (0.40 to 0.59) to excellent agreement (> 0.75)
7 Insufficient data were reported on selection of CTGs for analysis
8 The CI for the ICC crosses the threshold from good (0.60 to 0.74) to excellent agreement (> 0.75)
9 The CI for the ICC crosses the threshold from fair (0.40 to 0.59) to good agreement (0.60 to 0.74)
10 The CI for the Kappa statistic crosses the threshold from good (0.60 to 0.74) to excellent agreement (> 0.75)
11 Selection of CTGs not well described. The reference standard was based on experts following a specific rule-based system to interpret CTGs, and not using the method that they would use routinely in clinical practice
12 Selection of CTGs for assessment not fully reported. Results were reported clearly for participants with a completely normal outcome (normal birth, gases and neonatal outcome) and for those with an abnormal outcome (birth asphyxia or acidosis) but not for those who had intervention for birth but a normal perinatal outcome
13 The 95% CI for the kappa statistic crosses the threshold from poor (< 0.40) to fair (0.40 to 0.59) for visual interpretation and the threshold from poor (< 0.40) to good (0.60 to 0.74) for computer plus visual interpretation

Appendix J: Fetal heart rate classifications

The following tables are reproduced from CG190. They provide details of fetal heart rate classification systems used in studies included for the review question about interpretation of cardiotocograph traces.

NICHD 2008 fetal heart rate definitions (based on original 1997 definitions)

Pattern definition baseline

- The mean FHR rounded to increments of 5 bpm during a 10 minute segment, excluding accelerations, decelerations, and periods of marked FHR variability
- The baseline must be for a minimum of 2 minutes (not necessarily contiguous) in any 10-minute segment, or the baseline for that segment is defined as ‘‘indeterminate’’
- Tachycardia baseline FHR > 160 bpm
- Bradycardia baseline FHR < 110 bpm

Baseline variability

- Fluctuations in the FHR baseline that are irregular in amplitude and frequency.
- Variability is measured from the peak to the trough of the FHR fluctuations and is quantified in bpm. Variability is classified as follows:
    - absent—amplitude range undetectable
    - minimal—amplitude range detectable but ≤ 5 bpm
    - moderate—amplitude range 6– 25 bpm
    - marked—amplitude range > 25 bpm

Acceleration

- A visually apparent abrupt increase (onset to peak < 30 seconds) in the FHR from the baseline
- At 32 weeks of gestation and beyond, an acceleration has a peak at least 15 bpm above baseline and a duration of at least 15 seconds but < 2 minutes
- Before 32 weeks of gestation, an acceleration has peak at least 10 bpm above baseline and a duration of at least 10 seconds but < 2 minutes
- Prolonged acceleration lasts ≥ 2 minutes but < 10 minutes
- If an acceleration lasts ≥ 10 minutes, it is a baseline change

Early deceleration

- In association with a uterine contraction, a visually apparent, gradual (onset to nadir ≥ 30 seconds) decrease in FHR with return to baseline
- In general, the nadir of the deceleration occurs at the same time as the peak of the contraction

Late deceleration

- In association with a uterine contraction, a visually apparent, gradual (onset to nadir ≥ 30 seconds) decrease in FHR with return to baseline
- In general, the onset, nadir, and recovery of the deceleration occur after the beginning, peak, and end of the contraction, respectively

Variable deceleration

- An abrupt (onset to nadir < 30 seconds), visually apparent decrease in the FHR below the baseline
- The decrease in FHR is at least 15 bpm and lasts at least 15 seconds but < 2 minutes

NICHD 2008 fetal heart rate definitions (based on original 1997 definitions)

Prolonged deceleration

- Visually apparent decrease in the FHR at least 15 bpm below the baseline lasting at least 2 minutes but < 10 minutes from onset to return to baseline

Sinusoidal pattern

- Visually apparent, smooth, sine wave-like undulating pattern in FHR baseline with a cycle frequency of 3-5 bpm that persists for ≥ 20 minutes

bpm beats per minute, FHR fetal heart rate, NICHD National Institute of Child Health and Human Development

NICHD three-tier fetal heart rate classification system

Category I

- FHR tracings include all of the following:
  - baseline rate 110– 160 bpm
  - baseline FHR variability moderate
  - accelerations present or absent
  - late or variable decelerations absent
  - early decelerations present or absent

Category II

- All FHR tracings not categorised as Category I or Category III

Category III

- FHR tracings include either absent baseline FHR variability or the following:
  - recurrent late decelerations
  - recurrent variable decelerations
  - bradycardia
  - sinusoidal pattern

bpm beats per minute, FHR fetal heart rate, NICHD National Institute of Child Health and Human Development

FIGO 1987 fetal heart rate pattern

Normal

- Baseline FHR: 110–150 bpm
- Variability (amplitude bpm): 6–25 bpm
- Deceleration/30 minutes: none, except for sporadic, mild with short duration
- Acceleration: presence of ≥ 2 during a 10-minute period

Suspicious

- Baseline FHR: 100–110 or 15 –170 bpm
- Variability (amplitude bpm): 5–10 for 40 minutes or increased variability > 25 bpm
- Deceleration/30 minutes: variable (sporadic deceleration of any type unless severe)
- Acceleration: absent for > 40 minutes

Abnormal (pathological)

- Baseline FHR: < 100 or > 170 bpm
- Variability (amplitude bpm): < 5 for 40 minutes
- Deceleration: severe variable, severe repeated early, prolonged, late or sinusoidal*

*A sinusoidal pattern is regular with cyclic changes in the FHR baseline, such as the sine wave. The frequency is < 6 cycles/minutes, the amplitude is at least 10 bpm and duration should be ≥ 20 minutes.

bpm beats per minute, FHR fetal heart rate, FIGO International Federation of Obstetrics and Gynecology

Krebs 1982

FHR scoring for internal FHR monitoring; for each individual criterion 0, 1 or 2 points may be given producing a total score of 0–10

Abnormal: total score 0–3
Suspicious: total score 4–6
Normal: total score 7–10

Score = 0

- Baseline FHR: < 100 or > 180 bpm
- Variability (amplitude bpm): < 3
- Variability (frequency bpm): < 3
- Acceleration/30 minutes: 0
- Deceleration/30 minutes: late, severe variable, atypical variable

Score = 1

- Baseline FHR: 100–119 or 161– 180 bpm
- Variability (amplitude bpm): 3–5 or > 25
- Variability (frequency bpm): 3– 6
- Acceleration/30 minutes: 1–4
- Deceleration/30 minutes: moderate variable

Score = 2

- Baseline FHR: 120–160 bpm
- Variability (amplitude bpm): 6– 25
- Variability (frequency bpm): > 6
- Acceleration/30 minutes: > 4
- Deceleration/30 minutes: none, early

bpm beats per minute, FHR fetal heart rate

Low 2001

Normal accelerations

- Accelerations: from onset to peak ≤ 30 seconds; amplitude ≥ 15 bpm ; duration ≥ 15 seconds; no relation to contraction

Prolonged accelerations

- Accelerations: from onset to peak ≤ 30 seconds; amplitude ≥ 15 bpm ; duration > 120 or < 300 seconds; no relation to contraction

Variable decelerations

- From onset to peak ≤ 30 seconds; amplitude ≥ 15 bpm ; duration ≥ 15 seconds; variable relation to contraction

Early decelerations

- From onset to peak > 30 seconds; amplitude ≥ 15 bpm ; duration > 30 seconds; early relation to contraction

Late decelerations

- From onset to peak > 30 seconds; amplitude ≥ 15 bpm; duration > 30 seconds; late relation to contraction

Low 2001
Prolonged decelerations • Amplitude ≥ 15 bpm; duration > 120 or < 300 seconds; variable relation to contraction

bpm beats per minute, FHR fetal heart rate

Dellinger 2000
Normal pattern • Baseline FHR: 110–160 bpm, minimal to moderate variability, with or without accelerations Stress pattern • Baseline FHR: > 160 bpm for > 5 minutes, minimal to moderate variability, moderate to severe variable decelerations, late decelerations or sinusoidal pattern Distress pattern • Baseline FHR: < 110 bpm for > 5 minutes, moderate to severe variable decelerations with absent variability, late decelerations with absent variability, 110–160 bpm with absent variability and no accelerations

bpm beats per minute, FHR fetal heart rate

Appendix K: Health economics

K.1 Fetal blood sampling

K.1.1 Review question

What is the cost effectiveness of fetal blood sampling with lactate level compared to pH analysis?

K.1.2 Review of published evaluations

No published economic evaluations were identified in the literature search for this review question.

K.1.3 New economic evaluation

Current practise in the UK NHS is to measure pH of the fetal blood sample. The clinical review of the predictive value of fetal blood sampling (FBS) identified literature on using lactate levels instead of pH. The comparative clinical outcome data did not find statistically significant differences between the 2 forms of analysis. Further research was recommended by the 2014 and 2017 Guideline Committees to compare the two measurements.

The 2014 Committee discussed the use of lactate levels and commented on the ease of using lactate levels instead of pH analysis. Less blood is required therefore fewer fetal scalp punctures are needed to obtain the sample. This means there is likely to be a greater success rate with lactate levels (in the meta-analysis the success rate was 97% for lactate levels compared to 89% for pH analysis). New equipment would be needed for measuring lactate levels, whereas blood gas analysers are found in all obstetric units and can be used for pH analysis.

To give a better understanding of the trade-offs between measurements of lactate levels compared to continuing the use of pH, an analysis of the costs was developed in Excel for the 2014 Committee. The cost analysis was updated in 2016 for the 2017 Committee to reflect the most recently available costs (2014/15 rather than 2012/13). The motivation and conclusions of the cost analysis are those developed by the 2014 Committee and endorsed by the 2017 Committee.

K.1.3.1 Methods

Costs

Lactate levels can be measured on some blood gas analysers, but not all. Therefore it is likely that new lactate test meters will be needed. A lactate meter is a hand-held device. The lifespan of these meters is not known. The specification shows that the battery life will give approximately 1,000 tests. For the base-case analysis it is conservatively assumed that the meter will last only as long as the battery life. As these are hand-held devices they are more likely to become lost or broken and so may not last as long as blood gas analysers. The suggested costs for equipment and consumables for measuring lactate levels are shown in Table 70.

Table 70: Equipment costs and consumables for measuring lactate levels[a]

Item	Price	Unit cost	Notes
Lactate test meter	£384	£0.38	Lactate Pro. 1,000 tests within battery life
Test strips	£42	£1.68	25/box
Cost per sample		£2.06	

a http://www.habdirect.co.uk (accessed 29.09.16)

The blood gas analyser is a standard piece of equipment in an obstetric unit. The 2014 Guideline Committee estimated that FBS would represent approximately one-tenth of the use of the machine. Therefore the analyser would still be needed if it was not used for FBS and the capital cost of the blood gas analyser and service contract was not included in this analysis. The consumable costs for measuring pH levels are shown in Table 72.

Table 71: Annual consumable costs for blood gas analysers and number of samples analysed[a]

Item	N	Price (excluding VAT)
Ampoule adaptor box 150	2	£79.02
Printer paper 6 packs	2	£85.66
Waste bottle pack	9	£247.32
Rinse solution pack	7	£568.61
Fluid packs	10	£1,873.60
Auto-TROL plus B, level 1, 40 ampoules	9	£731.07
Auto-TROL plus B, level 2, 40 ampoules	9	£731.07
Auto-TROL plus B, level 3, 40 ampoules	9	£731.07
Rolls of paper 6 pack	8	£366.80
Total annual costs (2011)		£5,414
Total annual costs (2015)[b]		£5,891
Number of samples		7,845
Cost per sample		£0.75

a Personal communication University Hospitals Bristol (20.08.12), University Hospitals Bristol has an obstetric unit at St Michael's hospital with 5,600 births per year (www.BirthchoiceUK.com accessed 22.08.12)

b Costs inflated using the Health Service Cost Index (PSSRU 2013)

A sample of the baby's blood is taken from the scalp. This technique is the same regardless of whether lactate or pH is measured. The costs for staff to take a sample are estimated in Table 72. Associated staff costs may favour pH measurements as it was noted by the 2014 Committee that using a blood gas analyser would require staff to leave the room to go to the machine, whereas the lactate monitor is hand-held and would be in the room where birth occurs.

Table 72: Staff costs for fetal blood sampling

Staff	Cost per hour	Unit cost	Notes
Registrar	£60	£20	Assuming taking a sample takes 20 minutes
Specialty trainee year 2	£42	£14	PSSRU 2015 (costs including qualifications, 48-hour week)

Outcomes

The review of clinical evidence showed no statistically significant differences in maternal or neonatal outcomes. The 2014 Guideline Committee did not identify any outcomes where the difference was considered clinically significant.

K.1.3.2 Results

The success rates reported in the clinical review were used to calculate the mean staff costs for taking a sample as shown in Table 73. For the base-case analysis it was assumed that successful tests would have only 1 sample taken, whereas unsuccessful tests require 2 samples. This is a conservative assumption as a successful test can require 2, 3 or even 4 attempts to obtain a sample. The rate would depend on the experience of staff.

Table 73: Results of cost analysis with success rate relating to number of samples taken

Method	Success rate	Staff costs for taking sample	Total cost per FBS
pH	89.6%	89.6% x (£20+ £0.75) + 10.4% x (£20+ £0.75) x 2	£22.91
Lactate	97.8%	97.8% x (£20 + £2.06) + 2.2% x (£20 + £2.06) x 2	£22.55

FBS fetal blood sample

The cost per test is lower for the pH sample when using a blood gas analyser, but as the success rates are lower than for taking a lactate sample the analysis suggests that lactate sampling is slightly less expensive than pH testing. The difference in cost per test is small (£0.36 less for lactate).

Using the base-case inputs, for the cost per sample for measuring lactate to be more expensive than the pH measurement it would need to be at least £2.42 (Table 74).

If FBS using lactate is easier and therefore a more junior member of staff can take the sample, then it becomes even less expensive (£6.49 less expensive with lactate; Table 74). Also, if FBS using lactate takes less time (15 minutes rather than 20 minutes) the cost for the registrar's time would be £15 compared to £20, and this would again make lactate measurement less expensive (Table 74).

If more experienced staff take the sample then there may be less difference in the success rate between the alternative methods. If the success rate with pH sampling is at least 91.4%

compared to 97.8% with lactate, then lactate sampling will be the lower cost approach (Table 74).

Table 74: Sensitivity analysis of cost per sample and success rate

Method	Success rate	Staff costs for taking sample	Total cost per FBS
Varying the cost per sample for measuring lactate			
pH	89.6%	89.6% x (£20+ £0.75) + 10.4% x (£20+ £0.75) x 2	£22.91
Lactate	97.8%	97.8% x (£20 + £2.42) + 2.2% x (£20 + £2.42) x 2	£22.91
Lactate sample taken by a specialty trainee rather than a registrar			
pH	89.6%	89.6% x (£20+ £0.75) + 10.4% x (£20+ £0.75) x 2	£22.91
Lactate	97.8%	97.8% x (£14 + £2.06) + 2.2% x (£14 + £2.06) x 2	£16,41
Registrar takes only 15 minutes to take a lactate sample compared to 20 minutes for a pH sample			
pH	89.6%	89.6% x (£20+ £0.75) + 10.4% x (£20+ £0.75) x 2	£22.91
Lactate	97.8%	97.8% x (£15 + £2.06) + 2.2% x (£15 + £2.06) x 2	£17.44
Greater success with pH			
pH	91.4%	91.4% x (£20+ £0.75) + 8.6% x (£20+ £0.75) x 2	£22.53
Lactate	97.8%	97.8% x (£20 + £2.06) + 2.2% x (£20 + £2.06) x 2	£22.55

FBS fetal blood sample

K.1.3.3 Discussion

The results of the original 2014 cost analysis (using 2012/13 costs) indicated that FBS using lactate was suitable as a first choice although pH is an option if it is not possible to measure lactate. The 2017 Committee updated the cost analysis using 2014/15 costs. The success rate of lactate measurement is higher, meaning fewer attempts to take a sample, which is preferable for women. As the lactate monitor is a hand-held device it can be brought into the room where birth occurs and clinical staff would not need to come in and out of the room, women may be less exposed and this again would be preferable. If it is easier to take a lactate sample then it may be possible for the FBS to be taken by a senior midwife or a specialty trainee obstetrician rather than a registrar which would result in further cost savings.

The greater failure rate with pH sampling may lead to more intervention in birth, for instance an increase in caesarean sections. As the review of clinical evidence did not demonstrate a difference in the caesarean section rate between the alternative approaches to testing this was not considered in the cost analysis. However, if this were the case then testing pH would increase cost compared to lactate.

It is not considered good practice to develop cost minimisation analyses, where the comparators are considered to be equally effective and only costs are considered. If there is no statistically significant difference that does not mean that there is no difference between the 2 approaches. However, given that the difference here between the alternative approaches is minimal and no outcome was highlighted to show a difference that was clinically significant, it did not seem necessary for decision making to conduct a full analysis

that would incorporate a great deal of uncertainty surrounding the results. The results of the cost analysis described here are provided as a guide to decision making. The differences in costs are small and mainly influenced by success rates of each type of measurement. As the clinical evidence for lactate measurements was limited compared to that for pH measurements, further clinical evidence could enable better economic evaluation of this area.

K.2 Cardiotocography with electrocardiogram analysis compared with cardiotocography alone

K.2.1 Review question

Is the use of fetal electrocardiogram (ECG) analysis with continuous cardiotocograph (CTG) cost effective compared to continuous CTG alone?

K.2.2 Introduction

In the original (2007) NICE guideline on intrapartum care for healthy women and their babies (CG55), data were reported showing that ECG ST waveform analysis reduced instrumental vaginal birth and neonatal encephalopathy. In the 2014 update (CG190), new evidence showed the rate of neonatal encephalopathy was no longer statistically significantly different when adding ECG ST analysis or using CTG alone. However, the rate of admission to the neonatal care unit (NICU) was significantly lower in the CTG plus ECG ST group whereas the difference had been reported as non-significant in CG55. In the 2014 update as well as the original guideline, women in the CTG plus ECG ST group had a significantly lower incidence of instrumental vaginal birth compared with women monitored with CTG only. This finding was maintained in the review of clinical evidence undertaken for the 2017 Committee in 2016, whereas the 2014 finding of a reduced rate of admission to NICU did not hold true in the review of clinical evidence undertaken for the 2017 Committee.

There are disadvantages to using ECG analysis in conjunction with CTG. Monitoring using ECG analysis requires the invasive procedures of amniotomy and insertion of a fetal scalp electrode. Amniotomy may be associated with an increase in pain associated with uterine contractions. The application of a fetal scalp electrode can be associated with a small increase in the risk of trauma to and infection in the baby.

K.2.3 Review of published evaluations

A literature search identified 2 cost-effectiveness analyses comparing CTG with ST analysis to CTG alone (Heintz 2008[a], Vijgen 2011[b]). Neither of the analyses was conducted in the UK, and so they were not useful as evidence for the guideline.

K.2.4 New economic evaluation

Two forms of fetal ECG were identified in the reviews of clinical evidence undertaken for the 2007, 2014 and 2017 Guideline Committees: PR interval analysis and ST waveform analysis. For PR analysis there was no statistically or clinically significant difference for any of the

[a] Heintz,E., Brodtkorb,T.H., Nelson,N., Levin,L.A., The long-term cost-effectiveness of fetal monitoring during labour: a comparison of cardiotocography complemented with ST analysis versus cardiotocography alone, BJOG: An International Journal of Obstetrics and Gynaecology, 115, 1676-1687, 2008

[b] Vijgen,S.M., Westerhuis,M.E., Opmeer,B.C., Visser,G.H., Moons,K.G., Porath,M.M., Oei,G.S., van Geijn,H.P., Bolte,A.C., Willekes,C., Nijhuis,J.G., van,Beek E., Graziosi,G.C., Schuitemaker,N.W., van Lith,J.M., van den Akker,E.S., Drogtrop,A.P., Van Dessel,H.J., Rijnders,R.J., Oosterbaan,H.P., Mol,B.W., Kwee,A., Cost-effectiveness of cardiotocography plus ST analysis of the fetal electrocardiogram compared with cardiotocography only, Acta Obstetricia et Gynecologica Scandinavica, 90, 772-778, 2011

health outcomes included in the economic evaluation. Therefore, an economic model was developed for the 2014 Committee based on CTG plus ECG ST analysis. This superseded a costing analysis presented in CG55, which was developed for ECG ST analysis. The costing analysis compared the additional equipment costs in purchasing ST analysis equipment to potential savings from reduced operative vaginal births and caesarean sections. The net cost of ECG ST analysis was £3.4 million.

The 2014 economic model was updated for the 2017 Committee to reflect the updated clinical evidence and the most recently available costs (2014/15 rather than 2012/13). The results reported below refer to the evidence and costs considered by the 2017 Committee.

The purpose of fetal monitoring is to identify fetal hypoxia before it is sufficient to lead to damaging acidosis and long-term neurological adverse outcome for the baby. Monitoring should provide a balance between correctly identifying babies who require intervention without over-identification which would result in too high levels of intervention.

The economic analysis undertaken for the guideline was designed to address the question of whether CTG monitoring plus ECG ST waveform analysis is more cost effective than CTG monitoring alone.

The analysis was conducted from the perspective of the UK NHS. The discount rate used was 3.5% for both costs and QALYs. As noted above, the cost year used was 2014/15.

K.2.4.1 Methods

Outcomes

Monitoring is necessary to identify babies in distress. In these cases, intervention (a caesarean section or instrumental birth) is necessary. Good monitoring will allow accurate identification of these situations, and prevent unnecessary intervention where possible.

Figure K.1 shows a schematic of the model. The clinical evidence did not report the outcomes of the baby in relation to mode of birth, only by method of monitoring.

Figure K.1: Model schematic

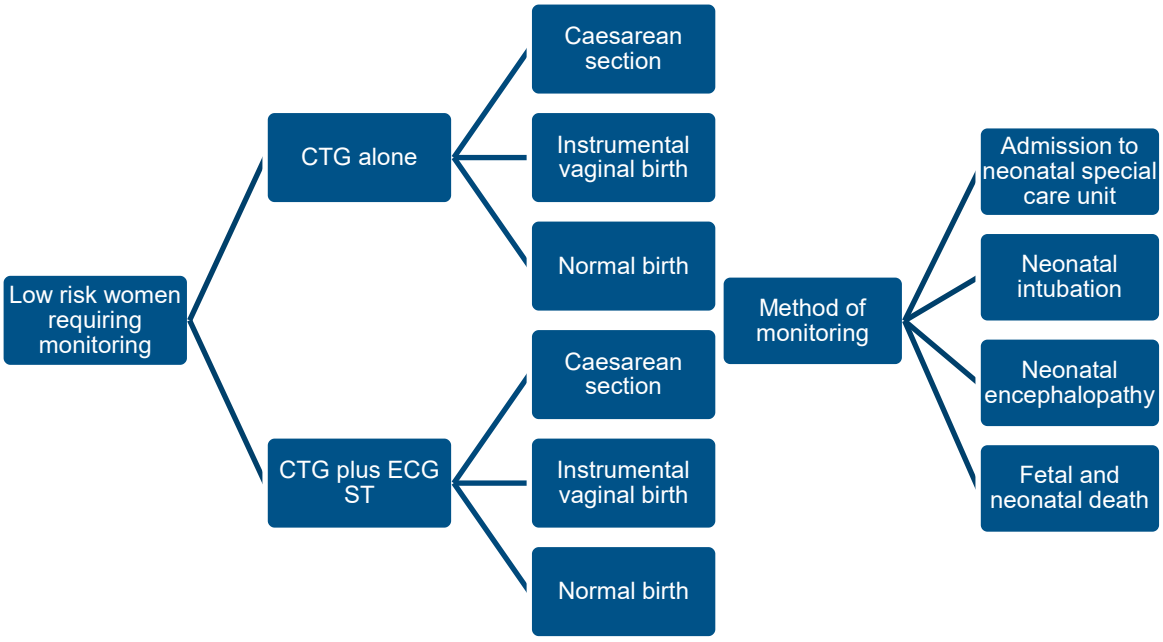


Table 75 reports the relative risks of various outcomes with continuous CTG plus ECG ST monitoring compared to continuous CTG alone in terms of type of birth (normal, instrumental or caesarean section) and adverse neonatal outcomes.

Table 75: Outcomes for low-risk women who require monitoring with CTG plus ECG ST compared to CTG monitoring alone (Belfort 2015; Ojala 2006; Neilson 2015)

Outcome	RR	Lower 95% CI	Upper 95% CI
Caesarean section	1.02	0.96	1.08
Instrumental vaginal birth	0.92	0.86	0.99
Fetal and neonatal death	1.71	0.67	4.33
Neonatal encephalopathy	0.61	0.30	1.22
Admission neonatal special care unit	0.96	0.89	1.04
Neonatal intubation	1.37	0.89	2.11

CI confidence interval, RR relative risk

The number of instrumental vaginal births was statistically significantly lower for CTG plus ECG ST analysis. No other outcomes were found to be statistically significantly different.

Costs

Cost inputs are summarised in Table 76.

The main cost would be purchase of equipment for ST analysis. The ST monitor is fully automated, but if the ST analysis shows a problem then training would be required to interpret the scan to decide whether to intervene. Midwives would be trained to interpret the ST analysis with obstetricians called if there were a problem.

The clinical review included serious adverse outcomes for the baby such as neonatal death and neonatal encephalopathy. The economic model should include long-term costs associated with these outcomes, however, identifying good quality inputs for long-term costs of neonatal intubation was a problem for previous economic evaluations in NICE guidelines (NICE 2011[c]; NICE 2012[d]) and for the Birthplace study (Schroeder 2011[e]) and so long-term costs were not included in this analysis.

Table 76: Model inputs – costs of ST monitor, birth, and outcomes, and QALYs

Item	Unit cost	Notes	Source
Cost of purchasing STAN	£25,346	Approximate cost, it would depend on the number of machines bought	Personal communication OKB Medical Limited (31/7/12) Uprated from CG190 for inflation using HCHS Index (PSSRU 2015)

[c] NICE 2011 Caesarean section CG132
[d] NICE 2012 Antibiotics for early-onset neonatal infection CG149
[e] Schroeder L, Petrou S, Patel N, Hollowell J, Puddicombe D, Redshaw M, et al. Birthplace cost-effectiveness analysis of planned place of birth: individual level analysis. Birthplace in England research programme. Final report part 5. NIHR Service Delivery and Organisation programme; 2011

Item	Unit cost	Notes	Source
Cost per use of STAN	£4.92	See calculations below	
Cost per fetal scalp electrode	£7.33	£366 for box of 50, single use	www.oncallmedicalsupplies.co.uk (accessed 19.08.16)
Normal birth	£1,193	NZ30C (Non-elective short stay)	NHS reference costs 2014/15
Caesarean section	£3,895	NZ51C (Non-elective long stay)	NHS reference costs 2014/15
Instrumental vaginal birth	£3,082	NZ42C (Non-elective long stay)	NHS reference costs 2014/15
Fetal and neonatal death	£1,394	PB04C (Neonatal Diagnoses (Admitted from other location or born in hospital) with CC Score 1-3)	NHS reference costs 2014/15
Admission neonatal special care unit	£533	XA03Z (Neonatal Critical Care, Special Care, without External Carer)	NHS reference costs 2014/15
Neonatal intubation	£123	GC consensus for staff involvement plus consumables	Staff costs (PSSRU 2013) uprated from CG190 for inflation using HCHS Index (PSSRU 2015) consumables costs (oncallmedicalsupplies.com, dsmedical.co.uk)
Neonatal encephalopathy	£1,394	PB04C (Neonatal Diagnoses (Admitted from other location or born in hospital) with CC Score 1-3)	NHS reference costs 2014/15
	QALY losses per year		
Neonatal mortality	1	Life expectancy 80 years	Caesarean guideline 2011
Neonatal encephalopathy	0.16	Life expectancy 80 years, mild cerebral palsy as a proxy	Caesarean guideline 2011
	Lifetime QALY gains		
Healthy birth	27.68	Life expectancy 80 years	Office for National Statistics

GC 2014 Guideline Committee, STAN ST analysis, QALY quality adjusted life year

Purchasing a ST monitor is a capital cost, requiring an upfront payment. The monitor can be used for approximately 6 years before it needs to be replaced (assumption taken from CG55). There are two facets to capital costs.

- Opportunity cost – this is the money spent on the monitor that could have been invested in another venture. This cost is calculated by applying an interest rate on the sum invested in the capital.
- Depreciation cost – the monitor has a certain lifespan and depreciates over time, and will eventually need to be replaced.

The usual practice for economic evaluation is to calculate an 'annual equivalent cost'. This is calculated by annuitising the initial capital outlay over the expected life of the monitor. A unit cost can be calculated based on the typical use of the monitor pro rata. Calculating the equivalent annual cost means making allowance for the differential timing of costs by discounting.

The formula for calculating the equivalent annual cost is:

$E = K – [S / (1+r)^n] / A(n,r)$

Where:

E = equivalent annual cost

K = purchase price of the monitor

S = resale value

r = discount (interest) rate

n = equipment lifespan

A(n,r) = annuity factor (n years at interest rate r)

Using an average length of labour of approximately 9 hours (taken from the Birthplace study [Schroeder 2012[f]], for planned births in an obstetric unit for 'low-risk' women) then the cost per use of the ST monitor is approximately £4.92.

Quality adjusted life years

The review of clinical evidence included serious outcomes for the baby such as neonatal death and neonatal encephalopathy. As in the discussion above in relation to costs, long-term outcomes such as life-years lost and reduced quality of life should be included in the economic model but no good quality evidence of long-term effects was identified. Therefore the estimates used in the NICE guideline on caesarean section (NICE 2011[g]) were used for this model (Table 76). The caesarean section guideline used mild cerebral palsy as a proxy for neonatal encephalopathy.

The quality adjusted life year (QALY) losses from fetal and neonatal death, and from neonatal encephalopathy, are subtracted from lifetime QALY gains from healthy births related to monitoring. The life expectancy of the baby at birth (80 years) was estimated from the Office for National Statistics (ONS 2011[h]) interim life tables. It is assumed that remaining life years are lived in full health and that QALYs are discounted using an annual discount rate of 3.5%.

K.2.4.2 Results

Women having CTG monitoring plus ECG ST analysis are more likely to have a normal birth, therefore less likely to have an intervention during birth, and fewer adverse neonatal outcomes such as admission to a special care unit, or neonatal encephalopathy. There was no difference in the rates of fetal and neonatal death in the clinical evidence identified for the guideline (Table 77).

[f] Schroeder L, Petrou S, Patel N, Hollowell J, Puddicombe D, Redshaw M, et al. Birthplace cost-effectiveness analysis of planned place of birth: individual level analysis. Birthplace in England research programme. Final report part 5. NIHR Service Delivery and Organisation programme; 2011

[g] NICE 2011 Caesarean section CG132

[h] Office for National Statistics. Life expectancy at birth and at 65 for health areas in the UK, 2003-05 to 2007-09. June 2011

Table 77: Outcomes for 1,000 low-risk women having electronic fetal monitoring

	CTG alone	CTG plus ECG ST
Normal births	753	759
Instrumental births	113	104
Caesarean section	135	137
Neonatal intubation	6	8
Admission special care unit	88	84
Neonatal encephalopathy	2	1
Fetal and neonatal death	0.5	0.8

CTG cardiotocograph, ECG electrocardiogram

The incremental cost effectiveness results show CTG alone is less expensive and also more effective than CTG plus ECG (Table 78 and Table 79). The number of fetal and neonatal deaths was slightly higher in the CTG plus ECG ST group (0.078% versus 0.045%, although the difference was not statistically significant) and this drives the greater QALY loss.

Table 78: Probabilistic costs, effects, incremental costs and effects per woman needing monitoring and incremental cost-effectiveness ratio for the comparison of CTG monitoring alone and CTG monitoring plus ECG ST analysis

Monitoring	Costs	Effects	Incremental costs	Incremental effects	ICER
CTG alone	£1,820	27.666			
CTG plus ECG ST	£1,822	27.656	£2	-0.010	Dominated

CTG cardiotocograph, ECG electrocardiogram, ICER incremental cost effectiveness ratio

Table 79: Deterministic costs, effects, incremental costs and effects per woman needing monitoring and incremental cost-effectiveness ratio for the comparison of CTG monitoring alone and CTG monitoring plus ECG ST analysis

Monitoring	Costs	Effects	Incremental costs	Incremental effects	ICER
CTG alone	£1,819	27.666			
CTG plus ECG ST	£1,820	27.660	£1	-0.006	Dominated

CTG cardiotocograph, ECG electrocardiogram, ICER incremental cost effectiveness ratio

K.2.4.3 Sensitivity analyses

A number of sensitivity analyses were undertaken to explore the impact of potential changes in the clinical evidence.

If the rate of neonatal encephalopathy were the same between adding ECG ST analysis and using CTG alone then the direction of the results would not change (Table 80).

Table 80: Sensitivity analysis – rate of neonatal encephalopathy is equal in both groups; costs, effects, incremental costs and effects per woman needing monitoring and incremental cost-effectiveness ratio for the comparison of CTG monitoring alone and CTG monitoring plus ECG ST monitoring

Monitoring	Costs	Effects	Incremental costs	Incremental effects	ICER
CTG alone	£1,818	27.669			

Monitoring	Costs	Effects	Incremental costs	Incremental effects	ICER
CTG plus ECG ST	£1,819	27.660	£1	-0.009	Dominated

CTG cardiotocograph, ECG electrocardiogram, ICER incremental cost effectiveness ratio

If the rate of mortality were the same between the 2 monitoring strategies then CTG plus ECG ST would dominate CTG alone; it would be both less expensive and more effective (Table 81).

Table 81: Sensitivity analysis – rate of fetal and neonatal death is equal in both groups; costs, effects, incremental costs and effects per woman needing monitoring and incremental cost-effectiveness ratio for the comparison of CTG monitoring alone and CTG monitoring plus ECG ST monitoring

Monitoring	Costs	Effects	Incremental costs	Incremental effects	ICER
CTG alone	£1,819	27.657			
CTG plus ECG ST	£1,819	27.660	£0	0.003	Dominant

CTG cardiotocograph, ECG electrocardiogram, ICER incremental cost effectiveness ratio

As the majority of outcomes were not found to be statistically significantly different between the 2 monitoring strategies, the model was run with these outcomes equal for both groups, and with a different treatment effect only for instrumental vaginal births included in the analysis. In this analysis, CTG plus ECG ST dominates CTG alone (Table 82).

Table 82: Sensitivity analysis – all outcomes not statistically significantly different are held the same; costs, effects, incremental costs and effects per woman needing monitoring and incremental cost-effectiveness ratio for the comparison of CTG monitoring alone and CTG monitoring plus ECG ST monitoring

Monitoring	Costs	Effects	Incremental costs	Incremental effects	ICER
CTG alone	£1,819	27.666			
CTG plus ECG ST	£1,814	27.666	-£5	0.000	Dominant

CTG cardiotocograph, ECG electrocardiogram, ICER incremental cost effectiveness ratio

If the long-term effects were discounted by 1.5% instead of 3.5% the number of QALYs would increase, but as the long-term effects were small the increase would make little difference to the results (Table 83).

Table 83: Sensitivity analysis – discount rate for benefits 1.5%; costs, effects, incremental costs and effects per woman needing monitoring and incremental cost-effectiveness ratio for the comparison of CTG monitoring alone and CTG monitoring plus ECG ST monitoring

Monitoring	Costs	Effects	Incremental costs	Incremental effects	ICER
CTG alone	£1,819	47.071			
CTG plus ECG ST	£1,820	47.060	£1	-0.011	Dominated

CTG cardiotocograph, ECG electrocardiogram, ICER incremental cost effectiveness ratio

Probabilistic sensitivity analysis

A probabilistic sensitivity analysis (PSA) was run in line with NICE recommendations for economic modelling. The inputs for the PSA are listed in Table 84.

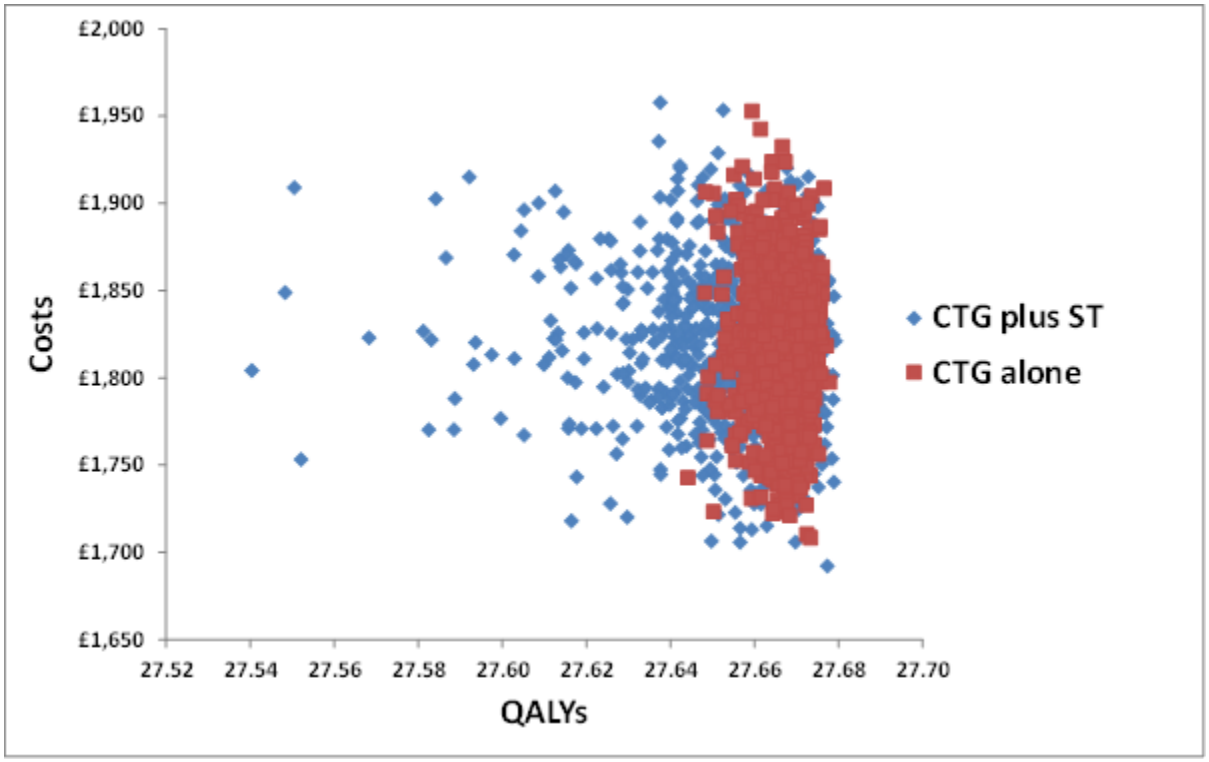
Table 84: Probabilistic sensitivity analysis inputs as calculated in Excel

Item	Distribution	Parameters	
Outcome		**Alpha**	**Beta**
CTG monitoring alone			
Normal birth	Deterministic		
Caesarean section	Beta	1489	11728
Instrumental vaginal birth	Beta	1779	11438
Fetal and neonatal death	Beta	6	13212
Neonatal encephalopathy	Beta	20	13180
Admission neonatal special care unit	Beta	1155	12045
Neonatal intubation	Beta	36	6262
CTG plus ECG ST monitoring		**Relative risk**	**Standard error**
Normal birth	Deterministic		
Caesarean section	Log Normal	1.02	0.031
Instrumental vaginal birth	Log Normal	0.92	0.034
Fetal and neonatal death	Log Normal	1.71	0.478
Neonatal encephalopathy	Log Normal	0.61	0.362
Admission neonatal special care unit	Log Normal	0.96	0.039
Neonatal intubation	Log Normal	1.37	0.220
Cost		**Mean**	**Standard deviation**
Cost of purchasing STAN	Deterministic		
Cost per use of STAN	Deterministic		
Cost per fetal scalp electrode	Deterministic		
Normal birth	Normal	£1,193	£49
Caesarean section	Normal	£3,895	£103
Instrumental vaginal birth	Normal	£3,082	£60
Fetal and neonatal death	Normal	£1,394	£79
Admission neonatal special care unit	Normal	£533	£13
Neonatal intubation			
Staff costs	Deterministic		
Consumables	Deterministic		
Neonatal encephalopathy	Normal	£1,394	£79
QALY loss per year			
Neonatal mortality	Deterministic		
Neonatal encephalopathy	Deterministic		

CTG cardiotocograph, ECG electrocardiogram, QALY quality adjusted life year

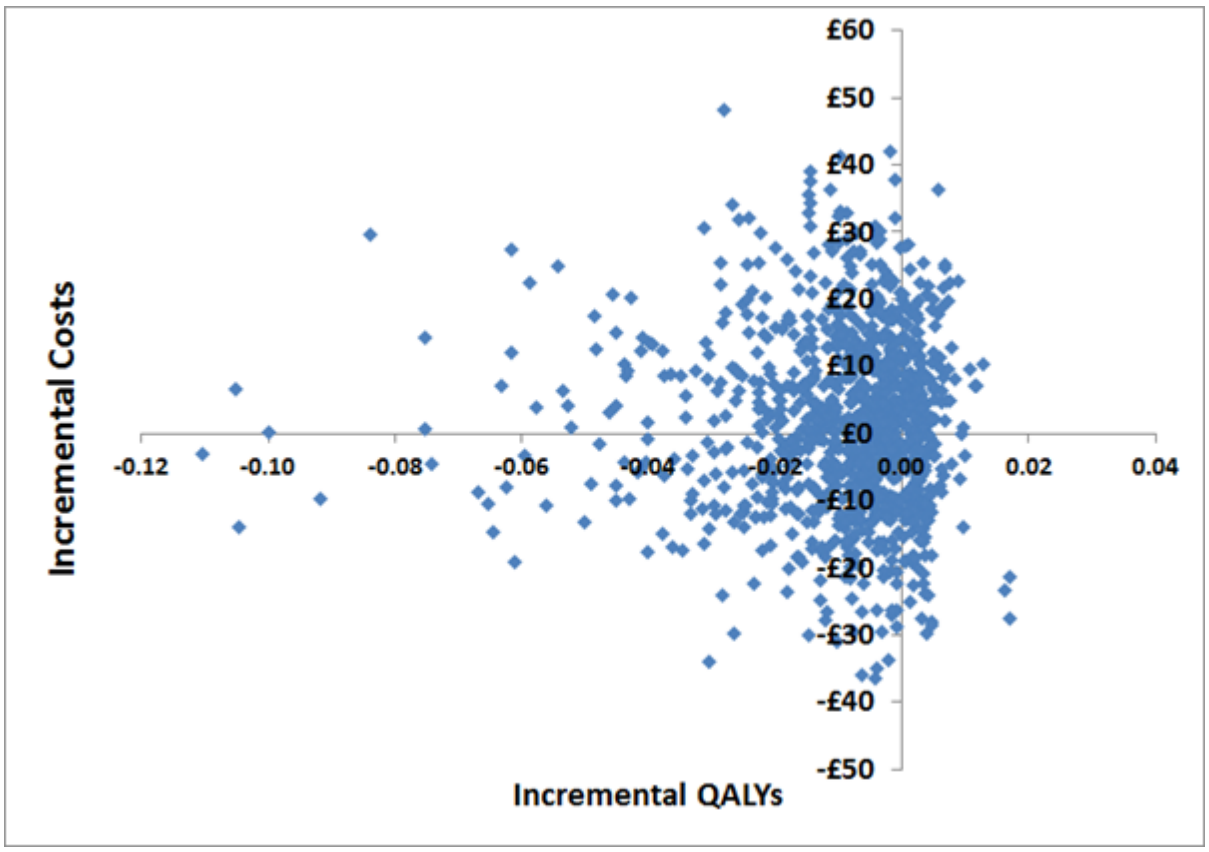
The difference between the 2 monitoring strategies was small, as can be seen in Figure 51 where there is considerable overlap of the points for each strategy.

Figure 51: Probabilistic sensitivity analysis of costs and QALYs of CTG monitoring alone and CTG plus ECG ST monitoring



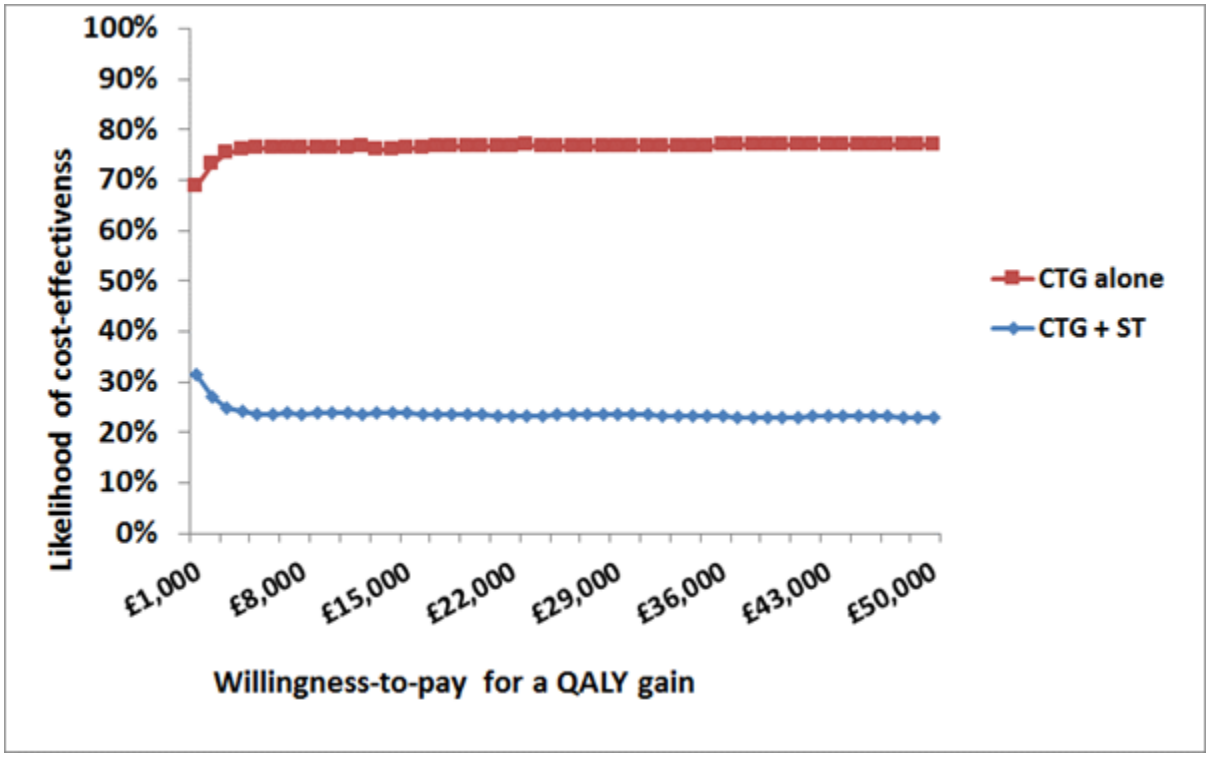
In Figure 52, showing the incremental costs and QALYs of CTG plus ECG ST monitoring over CTG monitoring alone, it can be seen that approximately 40% of the simulations lie in the north-west quadrant, where CTG alone dominates. CTG alone is the cheaper strategy in approximately 50% of the simulations and more effective in approximately 75% of simulations.

Figure 52: Probabilistic sensitivity analysis of incremental costs and incremental QALYs of CTG plus ECG ST monitoring compared to CTG monitoring alone



In the threshold analysis, Figure 53, CTG alone always had the highest probability of being the more cost effective strategy, irrespective of the willingness to pay for a QALY gain.

Figure 53: Threshold analysis of CTG monitoring and CTG plus ECG ST monitoring



K.2.4.4 Discussion

The economic model suggests that adding ECG ST monitoring to CTG monitoring has a negligible impact on costs. The additional costs of the intervention are very small in relation to the costs of 'downstream' outcomes that could potentially be affected. However, the clinical evidence suggested that the addition of ECG ST monitoring made little difference to the downstream outcomes. There was a statistically significant reduction in instrumental births with ST monitoring but the effect size was relatively small. Furthermore, the point estimate for fetal and neonatal death indicated increased risk with ST monitoring, albeit with very wide confidence intervals (CIs). Therefore, the model did not provide evidence of a clinical benefit of ECG ST monitoring.

These results seen in the clinical trial setting may not transfer to the real world. The clinical staff involved in the studies may be better trained to use the monitoring equipment, and they may have fewer women to attend to and therefore provide better care in the study setting.

The clinical evidence was presented for each outcome separately. For modelling it is useful to know how the outcomes fit into the pathway of care, for instance the numbers of babies with neonatal encephalopathy according to mode of birth. Such evidence would give a greater understanding of how monitoring improves final outcomes.

Long-term costs of neonatal encephalopathy were not included as data on long-term outcomes and costs could not be identified. As the point estimate of neonatal encephalopathy was reduced when ECG ST monitoring was added to CTG monitoring then adding these long-term costs and outcomes would strengthen the case for adding ECG ST monitoring. The costs of training were also not included as information on the amount of training required, how often, and how many staff would need to be trained was not available.

If the training requirements for CTG plus ECG ST monitoring were significantly higher than those for CTG alone then the additional costs would make ST analysis a more expensive option.

Other clinical outcomes were not reported in the studies and could impact the cost effectiveness results. ECG analysis requires invasive procedures: amniotomy, which may increase the pain of uterine contractions; and the application of a fetal scalp electrode, which can be associated with a small increase in the risk of infection in the baby.

K.2.4.5 Conclusion

This analysis suggests that adding ECG ST analysis to CTG monitoring has a negligible cost impact and that it does not provide any benefit in terms of health-related quality of life. Wide CIs and relatively small point estimates of effect sizes imply some uncertainty in results but PSA does not make a case for adding ECG ST analysis to CTG monitoring at this time.