Fetal lower urinary tract outflow obstruction prevents the unborn baby from passing urine. This can result in a reduction in the volume of amniotic fluid, and problems with the development of the baby’s lungs and kidneys. A vesico–amniotic shunt is a tube that it is inserted into the unborn baby’s bladder to drain the excess fluid into the surrounding space.

Introduction

This overview has been prepared to assist members of the Interventional Procedures Advisory Committee (IPAC) in making recommendations about the safety and efficacy of an interventional procedure. It is based on a rapid review of the medical literature and specialist opinion. It should not be regarded as a definitive assessment of the procedure.

Date prepared

This overview was prepared in April 2006.

Procedure names

- Fetal vesico-amniotic shunt for bladder outflow obstruction.
- Fetal vesico-amniotic shunt for obstructive uropathy.
- Fetal vesico-amniotic drain.

Specialty societies

- British Association of Perinatal Medicine.
- British Maternal and Fetal Medicine Society.
- Royal College of Paediatrics and Child Health.
- Royal College of Obstetricians and Gynaecologists.
Description

Indications

Fetal lower urinary tract outflow obstruction. This condition may be associated with various developmental abnormalities. The obstruction may result from a number of pathologies including urethral atresia, or posterior urethral valves and can be partial or complete. Severe obstruction may lead to oligohydramnios (i.e. reduction in amniotic fluid volume) and both pulmonary and/or renal dysplasia. Pulmonary and/or renal dysplasia may be severe enough to cause death soon after birth from respiratory or renal failure respectively; or it may require ventilatory support and/or renal dialysis or kidney transplantation. The long-term prognosis for children who will require dialysis or transplantation in infancy is very poor.

Current treatment and alternatives

Alternative treatment options include: expectant management, termination of pregnancy, repeat vesicoocenteses, or vesico-amniotic shunt

What the procedure involves

Fetal vescico-amniotic shunt for lower urinary tract outflow obstruction aims to decompress the obstructed fetal bladder and restore amniotic fluid dynamics and volume, thereby preventing oligohydramnios and pulmonary and/or renal hypoplasia. If vesico-amniotic shunt is considered, its timing is critical as it should ideally take place before the critical stages of lung and renal development have been completed. In some cases the fluid re-accumulates requiring repeated drainage procedures.

Fetal chromosomal analysis is usually performed before the procedure, to diagnose or exclude concomitant chromosomal abnormalities.

Under local anesthesia and ultrasound guidance, a metal cannula on a trochar is introduced though the mother’s abdominal and uterine wall into the amniotic cavity and subsequently inserted into the bladder of the fetus. The trochar is removed and the drainage catheter inserted into the cannula and positioned with one end in the bladder and the other in the amniotic cavity. Different types of drainage tubes may be used including a double pigtail catheter. The cannula is then removed and the final position confirmed by ultrasound. The success of the procedure is determined by the absence of abnormal re-accumulation of urine in the bladder of the fetus on serial ultrasound scans. If the fluid re-accumulates, or the catheter dislodged, the procedure may be repeated.

Criteria for case selection for treatment by vesico-amniotic shunting are not well defined.
**Efficacy**

The evidence on efficacy relates to a meta-analysis of 7 controlled trials and 9 case series, and 5 individual case series studies.

**Survival**

A meta-analysis of 3 controlled trials comparing outcomes following vesico-amniotic shunting with no treatment found that there was a statistically significant improvement in perinatal survival in favour of shunting, Odds Ratio 2.53 (95% confidence interval 1.08 to 5.93, p=0.03). This analysis was done excluding fetuses that were electively terminated. Postnatal survival for fetuses delivered alive (i.e. excluding in utero deaths and terminations) following shunting was better, although not significantly so, compared to no treatment, Odds Ratio 2.24 (95% confidence interval 0.89 to 5.59, p=0.09).

Among case series reports survival following vesico-amniotic shunting ranged between 91% (21/23) at one year of follow up in one study, six out of eight in a second, 53% (8/15) in a third, and two out of five surviving into infancy in a fourth study.

**Morbidity**

**Need for dialysis or transplantation**

Among 18 infants surviving the neonatal period in one case series, 33% (6/18) of patients required dialysis or had renal transplantation. A second case series study following up 8 survivors of vesico-amniotic shunting for between 1.5 and 5.5 years reported poor renal function in 2 children who required dialysis and or kidney transplant. A third case series study of 6 surviving infants followed up for a mean period of 42 months reported that 2 infants required kidney transplantation. Another case series study reported good renal function (defined as creatinine clearance of >70ml/min) in 45% (8/18) of infants followed up for a mean period of 5.8 years. Lastly another case series study reported good renal function (serum creatinine level of <1.0mg/dl) in six out of eight infants at one year follow-up.

**Respiratory function**

In one case series asthma was reported in 39% (7/18 of patients), and recurrent pulmonary infections in 28% (5/18). A second case series of 6 surviving infants reported that 2 infants required ventilatory support. In one of the case series alluded to above, normal pulmonary function was reported in 55% (10/18) of infants.

**Need for catheterisation / bladder voiding / recurrent urinary infections**

Among 18 infants surviving the neonatal period in one case series, frequent urinary infections were reported in 50% (9/18) of patients, and 17% (3/18) had bladder dysfunction requiring catheterisation.

**Quality of life**
One case series including 18 children (out of a total of 23 fetuses originally included in the study) reported that the mean self-reported quality of life score (using the paediatric quality of life inventory 4.0) among infants who had been treated with a vesico-amniotic shunt was 84.19 points at 5.8 years follow up, which compares well with a score of 83.0 points in a healthy infant population2.

**Safety**

The evidence on safety relates to 5 case series studies.

**Prenatal complications**

The most commonly reported complication across the studies reviewed is shunt displacement. This was reported to have occurred in between 2 of 9, 28% (5/18)2, and 60% (9/15)4 of fetuses, often requiring replacement shunt placement.

One case series reported that premature rupture of membranes occurred in 6% (1/18) fetuses 4 days after the placement of the shunt2.

**Post-natal complications**

There was one report each of bladder prolapse at birth, and requirement for intermittent catheterisation.

**Literature review**

**Rapid review of literature**

The medical literature was searched to identify studies and reviews relevant to fetal vesico-amniotic shunt for lower urinary tract outflow obstruction. Searches were conducted via the following databases, covering the period from their commencement to 28 March 2006: Medline, PreMedline, EMBASE, Cochrane Library and other databases. Trial registries and the Internet were also searched. No language restriction was applied to the searches. (See appendix C for details of search strategy.)

The following selection criteria (Table 1) were applied to the abstracts identified by the literature search. If these criteria could not be determined from the abstracts the full paper was retrieved.
Table 1 Inclusion criteria for identification of relevant studies

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publication type</td>
<td>Clinical studies were included. Emphasis was placed on identifying good quality studies. Abstracts were excluded where no clinical outcomes were reported, or where the paper was a review, editorial, laboratory or animal study. Conference abstracts were also excluded because of the difficulty of appraising methodology.</td>
</tr>
<tr>
<td>Patient</td>
<td>Patients with bladder outflow obstruction.</td>
</tr>
<tr>
<td>Intervention/test</td>
<td>Vesico-amniotic shunt.</td>
</tr>
<tr>
<td>Outcome</td>
<td>Articles were retrieved if the abstract contained information relevant to the safety and/or efficacy.</td>
</tr>
<tr>
<td>Language</td>
<td>Non-English-language articles were excluded unless they were thought to add substantively to the English-language evidence base.</td>
</tr>
</tbody>
</table>

List of studies included in the overview

This overview is based on one meta-analysis and 5 case series

Other studies that were considered to be relevant to the procedure but were not included in the main extraction table (table 2) are listed in appendix A.

Existing reviews on this procedure

There was one meta-analysis relating to this procedure, which is described in table 2.

Related NICE guidance

There is no other NICE guidance related to this procedure.
Table 2 Summary of key efficacy and safety findings on fetal vesico-amniotic shunt for lower urinary tract outflow obstruction

<table>
<thead>
<tr>
<th>Study details</th>
<th>Key efficacy findings</th>
<th>Key safety findings</th>
<th>Comments</th>
</tr>
</thead>
</table>

Abbreviations used: OR – odds ratio, CI – confidence interval,
### Study details

#### Clark T J (2003)¹

**Meta analysis of controlled trials and case series**

**UK**  

**Study periods:** Not stated

**n= 342 cases in all studies included, with 76 drainage procedures (71 vesico-amniotic shunts) for pooled data analysis from 4 controlled trials.**

**Population:** Mean age not stated for each primary study.

Extensive literature searches carried out to the end of 2002. In total 9 case series (147 fetuses) and seven controlled trial (195 fetuses) (total number of active and control cases not defined)

Fetuses with ultrasonic evidence of lower urinary tract obstruction. Predicted fetal prognosis, based on gestational age, underlying pathology, renal damage, amniotic fluid volume, bladder refilling characteristics, and urinary biochemistry, varies both within and between primary studies included.

Intervention: vesico-amniotic shunt or open fetal bladder surgery Vs vesicocentesis alone. Most cases that underwent vesico-amniotic shunting had previously received a vesicocentesis.

**Mean follow-up:** Not stated for each primary study

Disclosure of interest: Not stated

---

### Key efficacy findings

**Fetal survival**

Of the 106 vesico-amniotic shunts included in nine case series, the overall fetal loss rate ranged from 0% to 100%.

There was a statistically significant improvement in fetal survival (excluding termination of pregnancy) with intervention compared to no intervention. OR 2.53 (95% CI 1.08 to 5.93) (p=0.03)

Also, there was a statistically significant improvement in fetal survival (including voluntary termination of pregnancy) with drainage compared to no intervention. OR 4.24 (95% CI 2.10 to 8.58) (p<0.001)

**Postnatal survival**

Excluding fetuses that died in utero or were electively terminated, there was an improvement in post natal survival with drainage compared to no treatment, although this difference was not statistically significant. OR 2.24 (95% CI 0.89 to 5.59) (p=0.09).

Fetuses with poor predicted prognosis at the time of intervention appear to benefit most from drainage, in subgroup analysis of two studies where this comparison was possible.

### Key safety findings

None reported. Inadequate description of the surgical intervention and variation in outcomes reported in primary studies meant that failure rates and complications of vesico-amniotic shunts could not be calculated.

### Comments

Study selection performed by two independent researchers York Centre for Reviews and Dissemination criteria used to assess study methodological quality characteristics for inclusion.

Primary studies used different criteria for case selection, employed different techniques for the procedure (including different shunting procedures and some cases of open fetal surgery), and different outcome measures. So there may be clinical heterogeneity between pooled studies.

Statistical heterogeneity between studies was calculated with the Chi-squared test, and the results was not significant, however, this test has low power to determine heterogeneity when a low number of studies are pooled.

Studies were pooled using a fixed-effects model to calculate the Peto Odds ratio intervention versus no treatment.

Meta analysis of observational data can produce spurious results as a consequence of confounding or selection bias.
<table>
<thead>
<tr>
<th>Study details</th>
<th>Key efficacy findings</th>
<th>Key safety findings</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baird J-M (2005)²</td>
<td><strong>Post nat al mortality</strong>&lt;br&gt;There were two neo-natal deaths from pulmonary hypoplasia (one had good and one poor prenatal prognosis). First year survival rate was 91% (21/23).&lt;br&gt;&lt;br&gt;Long term efficacy (at a mean follow-up of 5.8 years, for 18 out of 23 survivors)&lt;br&gt;&lt;br&gt;<strong>Growth:</strong> 17% (3/18) of children were &lt;5th centiles for both height and weight.&lt;br&gt;&lt;br&gt;<strong>Respiratory function:</strong> Normal pulmonary function was achieved in 55% (10/18) of infants, and acceptable renal function (creatinine clearance of &gt;70ml/min) was seen in 45% (8/18).&lt;br&gt;&lt;br&gt;<strong>Renal</strong>&lt;br&gt;Renal transplant 33% (6/18)&lt;br&gt;Mild renal insufficiency 22% (4/18)&lt;br&gt;Dialysis 33% (6/18)&lt;br&gt;&lt;br&gt;<strong>Respiratory</strong>&lt;br&gt;Asthma 39% (7/18)&lt;br&gt;Recurrent pulmonary infections 28% (5/18)&lt;br&gt;Sleep apnoea 11% (2/18)&lt;br&gt;&lt;br&gt;<strong>Bladder function and urinary infections:</strong> Spontaneous voiding was achieved in 61% (11/18) of infants, and 33% (6/18) had no urinary infections.&lt;br&gt;&lt;br&gt;<strong>Quality of life:</strong>&lt;br&gt;The Paediatric quality of life inventory PedsQL 4.0 scales was used to assesses quality of life both by child (where able to complete the form) and parents.&lt;br&gt;&lt;br&gt;Overall scores were 79.16 points (± 12.34) from the parents of 13 children who completed the questionnaire. This compares with 87.61 points for a healthy population, and 74.22 points in chronically ill children, based on results from another study. The overall child self-reported score was 84.19 points (± 12.84), which compare with 83.0 points in a healthy population and 77.19 points in chronically ill children.</td>
<td><strong>Prenatal complications</strong>&lt;br&gt;Overall, complications after shunting occurred in 44% (8/18) of fetuses.&lt;br&gt;&lt;br&gt;Complication</td>
<td>Rate (n=18)</td>
</tr>
</tbody>
</table>
### Study details
- **Johnson M P (1994)**
  - **Case series**
  - **USA**
  - **Study period:** not stated
  - **n=15**
  - **Population:** Gestational age at diagnosis from 14 to 24 weeks. Fetal karyotyping undertaken and only male fetuses were considered for shunting.
  - **Indications:** Cases with bladder outlet obstruction assessed ultrasonographically, and decreased amniotic fluid volume were included in the study.
  - **Technique:** Vesico-amniotic shunting by placement of a double pig-tailed shunt under continuous ultrasonic guidance.
  - **Follow-up = between 1.5 and 5.5 years**
  - Disclosure of interest: not stated.

### Key efficacy findings
- **Survival**
  - Of the 15 cases shunted 47% (7/15) died in utero or neonatally. Of those who died, 3 had predicted good prognosis (based on fetal urine samples and progressive improvement after repeated drainage), and 4 were determined to have a poor prognosis.

- **Renal function**
  - Of the 8 survivors good renal function (serum creatinine level at one year of ≤1.0 mg/dl) was reported in 6 infants.
  - Poor renal function requiring dialysis and awaiting transplant was reported in 2 of 8 infants

### Key safety findings
- **Prenatal complications**
  - **Complication**
    - Shunt displacement into the amniotic space
    - Shunt displacement intraperitoneally, resulting in urinary ascites
  - **Rate (n=15)**
    - 40% (6/15)
    - 20% (3/15)

### Comments
- A mixture of prospectively identified (n=28) and retrospectively reviewed cases (n=6) for case accrual.
- In eight fetuses that were followed up without shunting, three obstructions resolved after initial vesicocectomies. Four resulted in intrauterine death, and one neonatal death due to pulmonary hypoplasia. It is not clear why these cases were not treated.
- Authors state the importance of serial vesicocentises and subsequent improvement in urine values before shunting.
- Authors suggest that fetuses that should be excluded from treatment include those with congenital abnormalities, female or those with chromosomal abnormalities, those with small for age kidneys, and those with renal cortical cysts.
- One fetus treated was one of twins.
- Authors state that fetal deaths occurred following an interval of at least one week after the shunt placement.
<table>
<thead>
<tr>
<th>Study details</th>
<th>Key efficacy findings</th>
<th>Key safety findings</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>McLorie G (2001)</strong>*&lt;sup&gt;3&lt;/sup&gt;</td>
<td><strong>Pre-natal outcomes</strong>&lt;br&gt;No incidents of preterm labour or chorioamnionitis reported. &lt;br&gt;Bladders were successfully drained in 100% (9/9) of cases. Amniotic fluid was restored to 89% (8/9) of fetuses. &lt;br&gt;100% (8/8) of fetuses were delivered following at least 30 weeks gestation (one parent elected termination following shunt insertion).</td>
<td><strong>Pre-natal complications</strong>&lt;br&gt;Complication: Shunt dislodgement&lt;br&gt;Shunt dislodgement requiring repeat insertion procedure&lt;br&gt;Rate (n=9): 22% (2/9)</td>
<td>Retrospective study of consecutive cases. &lt;br&gt;Indications for shunting were present in 13% (12/89) fetuses with bladder outflow obstruction. Shunting was accepted by 9 out of 12 parents. &lt;br&gt;Authors state that accurate diagnosis of obstruction with bladder distension, and oligohydramnios is a prerequisite for consideration of shunt treatment. &lt;br&gt;All surviving patients underwent some form of postnatal treatment (pyelostomy or vesicostomy) &lt;br&gt;The experience of clinicians undertaking the shunt placement is not stated. &lt;br&gt;The outcome for one fetus with bladder outlet obstruction where no shunt was inserted (parental choice) was stillbirth.</td>
</tr>
</tbody>
</table>

| Case series | **Post natal outcomes**<br>Death: Two of eight neonates (25%) who were treated with a shunt died shortly after birth from severe restrictive pulmonary disease. <br>Renal function: Two of the surviving six (out of eight) neonates required kidney transplantation. Normal renal function (creatinine clearance of >70ml/min) was seen in 50% (3/6) infants, and 83% (5/6) of infants were voiding freely. <br>Respiratory function: Two of the surviving six (out of eight) neonates required ventilatory support. | **Post natal complications**<br>Complication: Bladder prolapse at birth requiring emergency vesicostomy<br>Requirement for intermittent catheterisation<br>Rate (n=6): 17% (1/6) | |
| Canada | Population: Fetuses of between 20 and 28 weeks of gestation | Disclosure of interest: Not stated |
| Study period: 1989 and 1998 | n=9 | |
| n=9 | Indications: Bilateral hydronephrosis with bladder outflow obstruction, oligohydramnios, and a decrease in fetal urine hypertonicity. | |
| Technique: Following pre-procedural assessment of renal function by diagnostic bladder taps, shunting performed with a double pigtail catheter placed in the bladder and amniotic cavity. | Mean follow-up = 42 months | |

Abbreviations used: OR – odds ratio, CI – confidence interval,
### Study details

<table>
<thead>
<tr>
<th>Shimada K (1998)</th>
</tr>
</thead>
</table>

**Case series**

- **Japan**
- **Study period:** not stated
- **n=6 (5 had vesico-amniotic shunting, 1 had an open pyelo-amniotic shunt)**
  - **Population:** Mean gestational age at diagnosis 18 weeks, Male = 67%, Prune belly syndrome =50%. Gestational age at delivery 31 to 37 weeks.
  - **Indications:** 4 fetuses had experienced a decrease in amniotic fluid volume.
  - **Technique:** Patients underwent shunting and, after birth, received neonatal respiratory and circulatory care. Infants surviving the neo-natal period were referred for specialist urological management.

**Mean follow-up range 4 to 60 months**

- **Disclosure of interest:** Not stated.

### Key efficacy findings

#### Pre-natal outcomes

- None reported

#### Post-natal outcomes

- **Respiratory function:** Good long term pulmonary function was achieved in 4 of 6 infants.
  - **Respiratory**
    - Frequent infections: 33% (2/6)
    - Intermittent home oxygen support: 17% (1/6)

- **Renal function:** 2 of 6 infants had a solitary functioning kidney. A nadir creatinine clearance level of <0.4 mg/dl was reported in 5 of 6 infants during their first year of life.

### Key safety findings

#### Complications

- **All complications reported relate to the post neo-natal period (not defined)**
  - **Urological**
    - Antegrade valve ablation for posterior urethral valves: 20% (1/5)
    - Recurrent urinary tract infection requiring antireflux surgery: 60% (3/5)
    - Hypoplastic urethra: 100% (5/5)
    - Intermittent catheterisation with inadequate detrusor muscle activity: 100% (5/5)

### Comments

- No details are available with regard to survival following shunting, it is not stated what fraction of the fetuses treated these 6 cases represent. Therefore there is an unknown potential for selection bias.
- Separate reporting for the 5 fetuses who received vesico-amniotic shunting only for some of the examined outcomes
- The cases were transferred to the study institution from 4 sites, it is not clear how much experience of shunt placement each centre may have had.
- The severity and aetiology of urological abnormality varies between cases.
- Four neonates required ventilatory support.
<table>
<thead>
<tr>
<th>Study details</th>
<th>Key efficacy findings</th>
<th>Key safety findings</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Makino Y (2000)</td>
<td><strong>Survival</strong>&lt;br&gt;Of the 5 fetuses treated 1 died in utero at 19 weeks gestation (hydrops present, and tight cord coiling around the neck), 2 died in the neonatal period (at 2 and 7 hours), and 2 survived into infancy.</td>
<td><strong>Complications</strong>&lt;br&gt;In one 4 year old infant with cloacal anomaly there was psychomotor developmental delay, and signs of clonic convulsions. In a patient with prune belly syndrome there was psychomotor developmental delay and hydrocephalus at final follow up at 18 months.</td>
<td>Not stated whether the cases are sequential, or selected. Authors state that earlier placement of shunts (before 20 weeks) may have avoided hypoplasia Authors state that greater standardisation is required for patient selection Expected prognosis at baseline was defined for each fetus but not discussed in results.</td>
</tr>
<tr>
<td>Case series</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study period: 1995 to 1998</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population: Mean gestational age at diagnosis = 20.8 weeks, mean gestational age at shunting = 24.2 weeks, prune belly syndrome n=2, cloacal anomaly n=1, urethral stenosis n=1, sacrococcygeal teratoma n=1. The mean gestational age at delivery was 30.6 weeks, and weight was 1.958 Kg.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indications: Fetuses without chromosomal defects, with oligohydramnios, and good renal function as defined by urinalysis.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technique: Following serial vesicocenteses, a double basket catheter was inserted under ultrasound guidance.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Follow-up = 18 to 48 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disclosure of interest: Not stated</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Validity and generalisability of the studies

- Some studies report outcomes with the denominator of fetuses treated, and some based on survivors only.
- Some studies describe different aetiologies of bladder outflow obstruction, but do not report outcomes based on these subgroups.

Specialist Advisors’ opinions

Specialist advice was sought from consultants who have been nominated or ratified by their Specialist Society or Royal College.

Dr B Martin, Prof. M Kilby, Mr K Hinshaw, Dr S Cooper, Mr G Mason

- All advisors considered this to be an established procedure.
- The intended benefits of shunting are live birth, with preserved renal function and avoidance of pulmonary hypoplasia
- Reported and anecdotal adverse events include preterm labour, shunt blockage or displacement leading to failure to drain the bladder, fetal trauma, and babies born with end stage renal failure
- Additional theoretical complications include fetal hydrops, urinary ascites, trauma to maternal organs, and maternal infection.
- Practitioners need to be skilled in ultrasonic guided surgery, and high quality equipment is required.
- There is an ongoing trial at Birmingham recruiting 200 fetuses for a randomised controlled trial comparing shunting to conservative management.
- There is some controversy over the type and size of shunt to use.

Issues for consideration by IPAC

- Uncertainties remain as to the effectiveness of the procedure particularly in its ability to prevent renal damage.
- If dialysis is required in the first few months of life, 80% die before transplantation. If a patient is subsequently transplanted as a young child, a new transplant is usually required by the age of 10. Many such children develop malignancy by their 18th birthday.
- Efficacy outcomes may, at least in part, be influenced by presence or absence of underlying concomitant conditions and, therefore case selection is important.
- The prognosis for fetuses without intervention is poor.
- Fetuses may have concomitant genetic defects that may not be evident at the time of diagnosis of lower urinary tract outflow obstruction.
References


Appendix A: Additional papers on fetal vesico-amniotic shunt for lower urinary tract outflow obstruction not included in table 2

The following table outlines the studies that are considered potentially relevant to the overview but were not included in the main data extraction table (Table 2). It is by no means an exhaustive list of potentially relevant studies.

<table>
<thead>
<tr>
<th>Article title</th>
<th>Number of patients/ follow-up</th>
<th>Direction of conclusions</th>
<th>Reasons for non-inclusion in Table 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austin JC, Canning DA, Johnson MP, Flake AW, Carr MC. Vesicoamniotic shunt in</td>
<td>Case report n=1 FU=?</td>
<td>Female fetus with prune belly syndrome, delivery by caesarean at 39 weeks</td>
<td>Case series are included in table 2</td>
</tr>
<tr>
<td>Chan FY, Borzi P, Cincotta R, Burke J, Tudehope D. Limb constriction as a</td>
<td>Case report n=1 FU=2 years</td>
<td>Case of catheter end wrapping round the left thigh</td>
<td>Case series are included in table 2</td>
</tr>
<tr>
<td>complication of intra-uterine vesico-amniotic shunt: fetoscopic release.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fetal Diagnosis &amp; Therapy 2002; 17(5):315-320.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freedman AL, Johnson MP, Smith CA, Gonzalez R, Evans Ml. Long-term outcome</td>
<td>Case series n=34 FU=2 years</td>
<td>13 deaths and 21 survivors</td>
<td>Potential the same cases as in Clarke (2003)</td>
</tr>
<tr>
<td>in children after antenatal intervention for obstructive uropathies.[see</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gehring JE, Cain MP, Casale AJ, Kaefer M, Rink RC. Abdominal wall hernia: an</td>
<td>Case report n=3 FU=to deliver</td>
<td>All 3 cases had good pulmonary development, 2 had renal failure requiring dialysis.</td>
<td>Case series are included in table 2</td>
</tr>
<tr>
<td>uncommon complication of in utero vesicoamniotic shunt placement. Urology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irwin BH, Vane DW. Complications of intrauterine intervention for treatment</td>
<td>Case report n=1 FU=?</td>
<td>Dislodgement of initial shunt and failure of replacement shunt</td>
<td>Case series are included in table 2</td>
</tr>
<tr>
<td>Reference</td>
<td>Case report</td>
<td>n</td>
<td>FU</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------</td>
<td>---</td>
<td>----</td>
</tr>
<tr>
<td>Kim SK, Won HS, Shim JY, Kim KS, Lee PR, Kim A. Successful vesicoamniotic shunting of posterior urethral valves in the first trimester of pregnancy. Ultrasound in Obstetrics &amp; Gynecology 2005; 26(6):666-668</td>
<td>Case report</td>
<td>1</td>
<td>36</td>
</tr>
<tr>
<td>Robichaux AG, III, Mandell J, Greene MF, Benacerraf BR, Evans Mi. Fetal abdominal wall defect: a new complication of vesicoamniotic shunting. Fetal Diagnosis &amp; Therapy 1991; 6(1-2):11-13.</td>
<td>Case report</td>
<td>2</td>
<td>to</td>
</tr>
<tr>
<td>Szaflik K, Kozarzewski M, Adamczewski D. Fetal bladder catheterization in severe obstructive uropathy before the 24th week of pregnancy. Fetal Diagnosis &amp; Therapy 1998; 13(3):133-135.</td>
<td>Case series</td>
<td>5</td>
<td>?</td>
</tr>
</tbody>
</table>
Appendix B: Related published NICE guidance for fetal vesico-amniotic shunt for lower urinary tract outflow obstruction

<table>
<thead>
<tr>
<th>Guidance programme</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interventional procedures</td>
<td>None applicable</td>
</tr>
<tr>
<td>Technology appraisals</td>
<td>None applicable</td>
</tr>
<tr>
<td>Clinical guidelines</td>
<td>None applicable</td>
</tr>
<tr>
<td>Public health</td>
<td>None applicable</td>
</tr>
</tbody>
</table>
Appendix C: Literature search for fetal vesico-amniotic shunt for lower urinary tract outflow obstruction

<table>
<thead>
<tr>
<th>Database</th>
<th>Date searched</th>
<th>Version searched</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cochrane Library</td>
<td>28.3.06</td>
<td>2006 Issue 1</td>
</tr>
<tr>
<td>CRD databases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Embase</td>
<td></td>
<td>1980–2006 week 12</td>
</tr>
<tr>
<td>Medline</td>
<td></td>
<td>1966–March week 3</td>
</tr>
<tr>
<td>Medline</td>
<td></td>
<td>2006</td>
</tr>
<tr>
<td>Premedline</td>
<td></td>
<td>1966–present</td>
</tr>
<tr>
<td>CINAHL</td>
<td></td>
<td>1982–March week 4</td>
</tr>
<tr>
<td>CINAHL</td>
<td></td>
<td>2006</td>
</tr>
<tr>
<td>British Library Inside Conferences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NRR</td>
<td></td>
<td>2006 Issue 1</td>
</tr>
<tr>
<td>Controlled Trials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Registry</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The following search strategy was used to identify papers in Medline. A similar strategy was used to identify papers in other databases.

1 vesico amniotic.tw.
2 vesicoamniotic.tw.
3 bladder drain$.tw.
4 (pigtail adj (catheter$ or shunt$)).tw.
5 (drain$ adj2 (catheter$ or shunt$)).tw.
6 Urinary Diversion/
7 Urologic Surgical Procedures/
8 or/1-7
9 exp Urethral Obstruction/
10 lower urinary tract obstruction$.tw.
11 obstructive uropathy.tw.
12 (bladder adj (outflow or outlet) adj obstruct$).tw.
13 Hydronephrosis/
14 hydronephrosis.tw.
15 urethral hypoplasia.tw.
16 or/9-15
17 8 and 16
18 (fet$ or foet$ or utero$ or inutero$ or intrauterine).tw.
19 (antenatal$ or prenatal$).tw.
20 fetal diseases/su
21 Fetus/su [Surgery]
22 or/18-21
23 17 and 22