National Clinical Guideline Centre

Final

# Major trauma: service delivery

## Major trauma services: Service delivery for major trauma

*NICE Guideline NG40*

*Methods, evidence and recommendations*

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*Final*

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Royal College of Physicians

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Royal College of General Practitioners

Royal College of Nursing

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## Update information

**May 2025**: We changed references to 'Trauma Audit and Research Network' (TARN) in the main guideline to 'National Major Trauma Registry' (which has replaced TARN) in the section on monitoring and audit, and the recommendation for research on audit.

For the current recommendations, see
https://www.nice.org.uk/guidance/ng40/chapter/Recommendations



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National Institute for Health and Care Excellence

# Contents

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# Acknowledgements

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- Joanna Ashe, NCGC Senior Information Scientist
- Jill Cobb, NCGC Information Scientist
- Lina Gulhane, NCGC Joint Head of Information Science
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# 1 Foreword

Major trauma describes serious and often multiple injuries that may require lifesaving interventions. Trauma has a bimodal age distribution with the first peak in the under-20s and then the second peak in the over-65 age group. It is the biggest killer of people below 45 years in the UK and in those people that survive a traumatic injury; a large number will have permanent disabilities. The estimated costs of major trauma are between £0.3 and £0.4 billion a year in immediate treatment. The cost of any subsequent hospital treatments, rehabilitation, home care support or informal carer costs are unknown. The National Audit Office estimated that the annual lost economic output as a result of major trauma is between £3.3 billion and £3.7 billion.

In the UK over the last 25 years there has been substantial improvement in outcomes for patients.

This has been due to a variety of reasons, which include better education as well as improvements in pre-hospital, emergency department and hospital management.

More recently, the development of integrated trauma networks has aimed to organise regional trauma care in a way that provides coordinated multidisciplinary care at a time and place that benefits the patient most. The benefits of the networks are demonstrated by progressive improvements in patient outcomes reported by the Trauma Audit and Research Network (TARN).

There are still improvements to be made and the Department of Health asked NICE to develop the following four clinical guidelines and one service delivery guideline related to the management of people with traumatic injuries:

- **Spinal injury assessment**: assessment and imaging and early management for spinal injury (spinal column or spinal cord injury)
- Remit: Assessment and imaging of patients at high risk of spinal injury.
- **Complex fractures**: assessment and management of complex fractures
- Remit: Assessment and management of complex fractures (including pelvic fractures and open fractures of limbs)
- **Fractures**: diagnosis, management and follow-up of fractures
- Remit: Diagnosis, management and follow-up of fractures (excluding head and hip, pelvis, open and spinal)
- **Major trauma**: assessment and management of airway, breathing and ventilation, circulation, haemorrhage and temperature control
- Remit: Assessment and management of major trauma including resuscitation following major blood loss associated with trauma
- **Service delivery of trauma services**

These guidelines are related topics with overlap in populations and key clinical areas for review. The guidelines have been developed together to avoid overlap and ensure consistency. However, each guideline ‘stands alone’ and addresses a specific area of care. See section 3.3 for more information on how the suite of guidelines was developed.

In summary, these guidelines represent the best current evidence available to support the trauma practitioner to optimally manage trauma patients. By encouraging uniformity of care, both mortality and morbidity will fall further.

# 2 Introduction

A trauma service provides care for people who have sustained physical injuries. These injuries are often the result of an accident but can be sustained in other circumstances. Injuries range from minor to serious life-threatening trauma. The scope of this guidance is the delivery of services for people with major trauma in the initial phase of care, exploring areas of uncertainty and variation.

The National Audit Office (2000) reported that there is 'unacceptable variation in major trauma care in England depending upon where and when people are treated. Care for patients who have suffered major trauma, for example following a road accident or a fall, has not significantly improved in the past 20 years despite numerous reports identifying poor practice, and services are not being delivered efficiently or effectively.'

There is no doubt that the optimal management of a person with major trauma and potentially life-threatening injuries requires the right staff, with the right skills, in the right place at the right time.

The NHS Trauma Clinical Advisory Group (CAG) provides recommendations on the regionalisation of trauma care, setting out service standards for the provision and delivery of trauma care. Regionalisation of trauma services involves developing inclusive trauma systems through trauma networks.

A trauma network includes all providers of trauma care, particularly pre-hospital services, hospitals receiving acute trauma admissions and rehabilitation services. The network has appropriate links to the social care and the voluntary/community sector. Within a trauma network the specialist services needed to treat a person with major trauma are established regionally. Major trauma centres (MTC) are designated to deliver high quality specialist care, and accordingly an MTC is usually the optimal destination for a patient with major trauma.

Regional trauma networks were set up to ensure trauma care is delivered efficiently and effectively. The NHS Operating Framework for England 2011 – 2012 reiterated a commitment to ensure the implementation of regional trauma networks across England. Regions started implementing trauma systems in 2011/12 and have a commitment to ongoing delivery and implementation. The NHS standard contract for major trauma services sets out the minimum service required to provide care for major trauma patients who are delivered to a major trauma centre.

The scope of this guidance was not to evaluate the service configuration of trauma networks but to address service delivery issues that stakeholders have identified as needing further clarification in the trauma networks.

The key service areas are:

- Access to services
- Appropriate destination
- Continuity of care
- Documentation and transfer of information
- Audit
- Provision of information.

# 3 Development of the guideline

## What is NICE service delivery guidance?

NICE service delivery guidance is a set of recommendations for NHS provider organisations and others who provide or commission services for NHS patients. It is aimed at ambulance and hospital boards, managers, commissioners, practitioners and healthcare professionals. It will also be of interest to regulators and the public.

Service delivery guidance is based on the best available research evidence, with the aim of improving the quality of healthcare delivery. Predetermined and systematic methods are used to identify and evaluate the evidence relating to specific review questions.

NICE service delivery guidance can:

- support the commissioning of services
- support local decisions at a hospital and ward level
- support the education and training of healthcare professionals

Those responsible for providing or commissioning services for NHS patients should take this guideline fully into account. However this guideline does not override the need and importance of using professional judgement to make decisions appropriate to the circumstances.

The guidelines are produced using the following steps:

- Guideline topic is referred to NICE from the Department of Health
- Stakeholders register an interest in the guideline and are consulted throughout the development process
- The scope is prepared by the National Clinical Guideline Centre (NCGC)
- The NCGC establishes a Guideline Development Group
- Draft guidance is produced after the group assesses the available evidence and makes recommendations
- There is a consultation on the draft guidance
- The final guidance is published

The NCGC and NICE produce a number of versions of this guidance:

- The 'full guidance' contains all the recommendations, plus details of the methods used and the underpinning evidence
- The 'NICE guidance' lists the recommendations
- 'Information for the public' is written using suitable language for people without specialist medical knowledge
- NICE Pathways brings together all connected NICE guidance

This version is the full version. The other versions can be downloaded from the NICE website at www.nice.org.uk.

## Remit

NICE received the remit for this guideline from the Department of Health. They commissioned the NCGC to produce the guideline.

The remit for this guideline is: Service delivery of trauma services.

# Who developed this guideline?

As noted in section 1, the four clinical guidelines and service delivery guidance consist of related topics with overlap in populations and key clinical areas for review. The guidelines have been developed together to avoid overlap and ensure consistency. This required careful planning to ensure the guideline development groups had the support they needed. Senior clinical expertise was recruited in addition to the standard guideline development group.

**Project Executive Team**

The overlap in the content of the four clinical guidelines and the service delivery guidance required an approach that ensured coherence and avoided duplication across the guidelines. To address this, clinical experts from across the guidelines were recruited to form an umbrella group, the Project Executive Team (PET). The PET met quarterly throughout the development of the guidelines. At the PET meetings, the members provided expert advice to the technical team and GDGs on the crossover of reviews across guidelines. (See the list of project executive team members). Also see the list of Guideline Development Group members and the acknowledgements.

**Guideline Development Group expert members**

Expert members were healthcare professionals who worked across the four clinical guidelines and the service delivery guidance, and attended the GDGs that were relevant to their expertise. The expert members provided an additional level of coherence across the guidelines, helping to identify potential duplication in the areas of their expertise (see the list of the Guideline Development Group expert members).

**Guideline Development Group (GDG)**

Each guideline 'stands alone' and addresses a specific area of care. A dedicated, multidisciplinary Guideline Development Group (GDG), comprising health professionals, researchers and lay members developed this guidance. See the list of Guideline Development Group members and the acknowledgements.

The GDG was convened by the NCGC and chaired by Dr David Skinner in accordance with guidance from NICE.

The GDG met for two days every 6 weeks during the development of the guideline. At the start of the guideline development process all GDG members declared interests including consultancies, fee-paid work, share-holdings, fellowships and support from the healthcare industry. At all subsequent GDG meetings, members declared new and arising conflicts of interest.

Members were either required to withdraw completely, or for part of the discussion, if their declared interest made it appropriate. The details of declared interests and the actions taken are shown in Appendix B.

Staff from the NCGC provided methodological support and guidance for the development process. The technical team working on the guideline included a project manager, systematic reviewers, health economists and information scientists. The team undertook systematic searches of the literature, appraised the evidence, conducted meta-analysis and cost-effectiveness analysis where appropriate, and drafted the guideline in collaboration with the GDG.

## What this guideline covers

### Groups that will be covered

Adults, young people and children who present with a major traumatic injury or a suspected major traumatic injury.

### Key issues that will be covered

- Access to the services needed to provide care for people with suspected or confirmed major trauma
- Direct and indirect transfer to appropriate destination
- Location of services
- Competence of pre-hospital provider and receiving trauma team
- Continuity of care
- Rehabilitation assessment
- Patient documentation and transfer of information
- National audit systems to improve performance
- Provision of information and support for families and carers

For further details please refer to the scope in Appendix A and the review questions in Section 4.1.

## What this guideline does not cover

### Groups that will not be covered

- People who do not have a suspected or confirmed major traumatic injury
- People with burns
- People with spinal injuries

### Issues that will not be covered

- Prevention of trauma
- Major trauma resulting from burns
- Management and follow-up of pathological conditions (such as osteoporosis)

For further details please refer to the scope in Appendix A and the review questions in Section 4.1

## Relationships between the guideline and other NICE guidance

### Related NICE technology appraisals:

Pre-hospital initiation of fluid replacement therapy in trauma. NICE technology appraisal guidance 74 (2004)

### Related NICE clinical guidelines:

Patient experience in adult NHS services. NICE clinical guideline 138 (2012)

Falls. NICE clinical guideline 161 (2013)

Osteoporosis. NICE clinical guideline 146 (2012)

Organ donation. NICE clinical guideline 135 (2011)

Hip fracture. NICE clinical guideline 124 (2011)

Venous thromboembolism: reducing the risk. NICE clinical guideline 92 (2010)

When to suspect child maltreatment. NICE clinical guideline 89 (2009)

Head injury. NICE clinical guideline 176 (2014)

Post-traumatic stress disorder (PTSD). NICE clinical guideline 26 (2005)

Intravenous fluid therapy in adults in hospital. NICE clinical guideline 174 (2013)

Safe staffing for nursing in adult inpatient wards in acute hospitals. NICE safe staffing guideline 1 (2014).

Hip fracture in adults. NICE quality standard 16 (2012)

Falls in older people. NICE quality standard 86 (2015)

Blood transfusion. NICE guideline 24. (2015)

Intravenous fluid therapy in children and young people in hospital. NICE guideline 29 (2015)

**Related NICE guidance currently in development:**

Major trauma. NICE clinical guideline. Publication expected Feb 2016

Fractures. NICE clinical guideline. Publication expected Feb 2016

Complex fractures. NICE clinical guideline. Publication expected Feb 2016

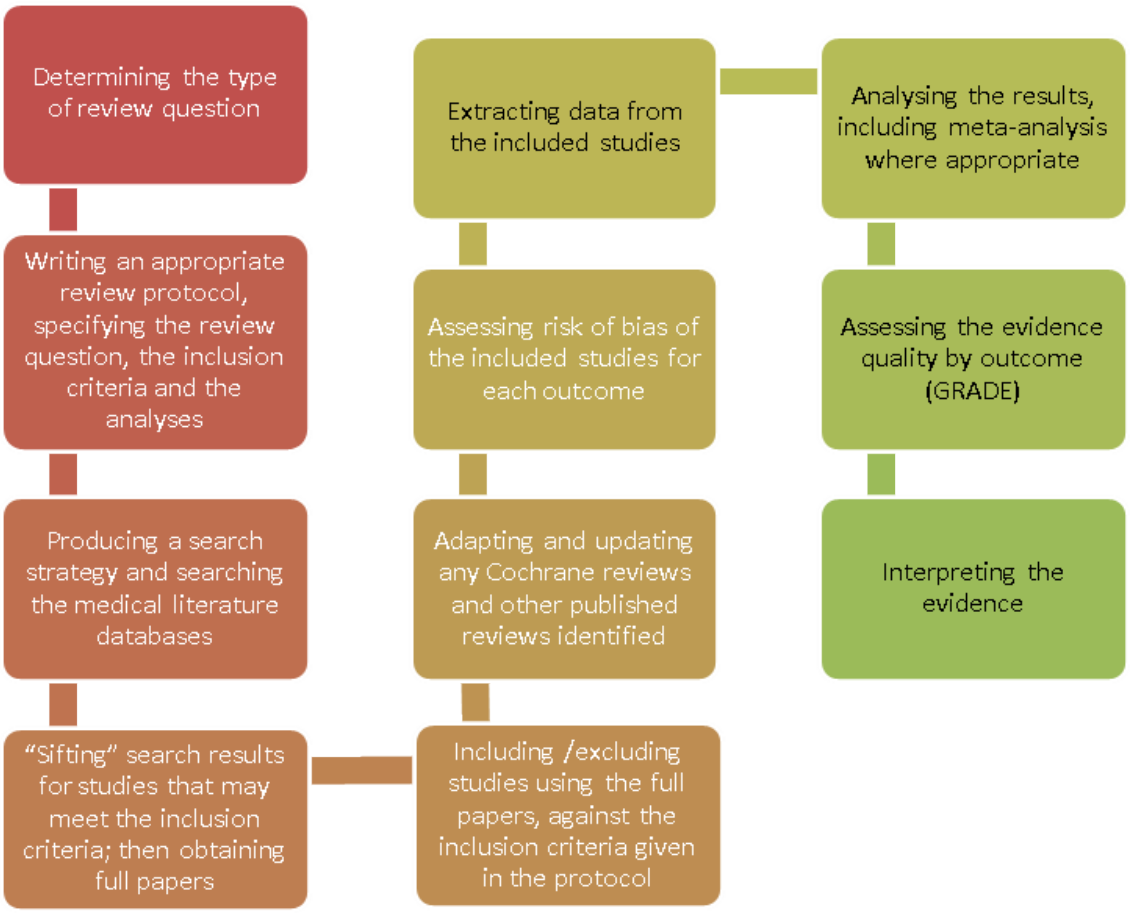
Spinal injuries assessment, NICE clinical guideline. Publication expected Feb 2016

# 4 Methods

This chapter sets out in detail the methods used to review the evidence and to generate the recommendations that are presented in subsequent chapters. This guidance was developed in accordance with the methods outlined in the NICE guidelines manual 2012[34].

Sections 4.1 to 4.3 describe the process to review clinical evidence (summarised in Figure 1) and section 4.4 outlines the process to review cost-effectiveness evidence.

**Figure 1: Step-by-step process of review of evidence in the guideline**




## Developing the review questions and outcomes

Review questions were developed within a PICO framework (patient, intervention, comparison and outcome) for intervention reviews. Review questions were developed within a framework of population, prognostic factor and outcomes for prognostic reviews, and within a framework of population, index tests, reference standard and target condition for reviews of diagnostic test accuracy. The purpose of this was to guide the literature searching process, critical appraisal and synthesis of evidence, and to facilitate the development of recommendations by the GDG. They were drafted by the NCGC technical team and refined and validated by the GDG. The questions were based on the key clinical areas identified in the scope (Appendix A).

A total of 14 review questions were identified.

Full literature searches, critical appraisals and evidence reviews were completed for all the specified review questions.

**Table 1: Review questions**

| Chapter | Review questions | Outcomes |
|---|---|---|
| Pre-hospital triage and appropriate destination | What is the accuracy of ambulance triage tools in people with major trauma? | Diagnostic accuracy<br>Accuracy to predict injury severity:<br>• Did it identify major trauma patients by ISS (>8, and >15)<br>• % patients transferred on after arrival to TU (within 24 hours) or onwards to MTC<br>• Appropriateness of initial destination<br>• Appropriateness of staff presence for treatment required (i.e. number of additional staff called to resuscitation). |
| Pre-alert | What is the accuracy of pre-alert? | Diagnostic accuracy (under or over triage)<br>• Appropriateness of initial destination<br>• Appropriateness of staff presence for treatment required (i.e. number of additional staff called to resuscitation). |
| Transfer of people with major trauma | Is it clinically and cost effective to provide a retrieval service? | Critical:<br>• Mortality up to 12 months<br>• Health-related quality of life<br>• Time taken to transfer<br>• Delay to admission at MTC<br>• Complications during/due to transfer<br>• Length of hospital stay |
| Tiered teams | What is the clinical and cost effectiveness of providing a tiered response to patients arriving at a MTC or TU? | • Mortality<br>• Quality of life<br>• Time in ED<br>• Time to definitive care<br>• Time to CT<br>• Missed/delayed diagnosis of injury<br>• Delays to transfer<br>• Complication rates<br>• Trauma team member time<br>• Hospital length of stay |
| Multidisciplinary ward care | Is there a benefit of multidisciplinary trauma ward care versus specialist ward care? | Critical:<br>• Mortality<br>• Health-related quality of life<br>• Length of hospital stay<br>• Time to definitive treatment<br>• Readmission to ICU and to hospital<br>• Unscheduled re-operation<br>• Patient and carer experience |
| Trauma | What trauma coordination approach is the | Critical outcomes: |

| Chapter | Review questions | Outcomes |
|---|---|---|
| coordinators | most clinically and cost effective? | • Mortality<br>• Heath-related quality of life (immediate and long term)<br>• Ongoing consequential morbidity<br>• Metrics of continuity of care<br>  ○ Length of stay (total across transfers, MTC)<br>  ○ Adverse incident report severity (red, amber, green)<br>• Time in acute setting<br>• Number of procedures<br>• Time to rehab prescription<br>• ICU length of stay<br>• Impact of traumatic event on concurrent morbidities<br>• Patient and carer satisfaction<br>• Staff satisfaction |
| Documentation | What are the barriers to the transfer of information and documentation from a) pre-hospital to the ED b) from the ED to surgery, other departments? | Themes identified in the review |
| Audit | Is audit and feedback effective for improving health provider performance and healthcare outcomes? | Compliance with desired practice<br>Patient outcomes |
| Audit | What features are needed in a national audit system to ensure that audit improves service performance as measured by patient outcomes? | Themes identified in the review |
| Paediatric training | What aspects (type and frequency) of paediatric training for trauma improve outcomes for providers which experience high volumes of adult trauma and experience of trauma in children? | • Quality of life<br>• Length of stay<br>• Hospitalisation<br>• Mortality<br>• Time to diagnosis<br>• Time to intervention<br>• Time to transfer<br>• Skill delivery<br>• Skill retention<br>• Other clinical outcomes |
| Information and support | How should information and support be provided to families and carers? | Themes identified in the review |
| Rehabilitation | What are the barriers to providing early rehabilitation following early rehabilitation assessment? What are the implications for service delivery? | These will be the barriers identified in the papers for example:<br>• Inadequate assessment<br>• Staff resources<br>• Patients factors (severity of illness, pain/discomfort)<br><br>Implications for service delivery of the barriers identified |

| Chapter | Review questions | Outcomes |
|---|---|---|
| Access to services and the skills required to deliver the service | What is the optimal timing of intubation or surgical airway? | Critical:<br>• Mortality up to 12 months<br>• Health-related quality of life<br>• Length of hospital stay<br>• Number of procedures<br>• Adverse events<br>• Glasgow Outcome Scale (head injury) |
| Access to services and the skills required to deliver the service | What is the optimal timing of interventional radiology? | Critical:<br>• Mortality<br>• Health-related quality of life<br>• Length of hospital stay<br>• Number of procedures<br>• Adverse events<br>• Amputation (for vascular compromise)<br><br>Data to be collected:<br>• Survival analysis data<br>• Important follow-up time points (4 hours, 24 hours, 7 days, 1 month, 1 year) |

# Searching for evidence

## Clinical literature search

The aim of the literature search was to systematically identify all published clinical evidence relevant to the review questions. Searches were undertaken according to the parameters stipulated within the NICE Guidelines Manual [2012].[34] Databases were searched using medical subject headings and free-text terms. Foreign language studies were not reviewed and, where possible, searches were restricted to articles published in the English language. All searches were conducted in MEDLINE, Embase, and the Cochrane Library, and were updated for the final time between 19 March and 31 March 2015. No papers added to the databases after this date were considered.

Search strategies were quality assured by cross-checking reference lists of highly relevant papers, analysing search strategies in other systematic reviews, and asking GDG members to highlight any additional studies. The questions, the study types applied, the databases searched, and the years covered can be found in Appendix F.

The titles and abstracts of records retrieved by the searches were sifted for relevance, with potentially significant publications obtained in full text. These were then assessed against the inclusion criteria.

## Health economic literature search

Systematic searches were undertaken to identify relevant health economic evidence within the published literature. The NHS Economic Evaluation Database (NHS EED), the Health Economic Evaluations Database (HEED) and Health Technology Assessment (HTA) database were searched using broad population terms and no date restrictions. A search was also run in MEDLINE and

Embase using a specific economic filter with population terms. Where possible, searches were restricted to articles published in the English language. Economic search strategies are included in Appendix F. All searches were updated for the final time between 19 March and 31 March 2015 except in HEED which ceased production in 2014. No papers added to the databases after this date were considered.

## Evidence gathering and analysis

The tasks of the research fellow are listed below and described in further detail in sections 4.3.1 to 4.3.6. The research fellow:

- Identified potentially relevant studies for each review question from the relevant search results by reviewing titles and abstracts, and deciding which studies should be ordered as full papers. Full papers were then obtained.
- Reviewed full papers against pre-specified inclusion/exclusion criteria to identify studies that addressed the review question in the appropriate population, and reported on outcomes of interest (see Appendix C for review protocols).
- Critically appraised relevant studies using the appropriate study design checklists as specified in the NICE Guidelines Manual [2012].[34]
- Critically appraised relevant studies with a qualitative study design checklist produced by NCGC (see Appendix P).
- Extracted key information about interventional study methods and results using Evibase, NCGC purpose-built software. Evibase produces summary evidence tables, with critical appraisal ratings. Key information about non-interventional study methods and results were manually extracted onto standard evidence tables and critically appraised separately (see Appendix G for the evidence tables).
- Generated summaries of the evidence by outcome. Outcome data is combined, analysed and reported according to study design:
  - Randomised data is meta-analysed where appropriate and reported in GRADE profiles
  - Observational data is presented as a range of values in GRADE profiles
  - Diagnostic data is meta-analysed if appropriate, or presented as a range of values in adapted GRADE profiles
  - Prognostic data is meta-analysed where appropriate and reported in GRADE profiles
  - Qualitative data is summarised across studies where appropriate and reported in themes
- A sample of a minimum of 20% of the abstract lists of the first three sifts by new reviewers were double-sifted by a senior research fellow. As no papers were missed by any reviewers, no further double-sifting was carried out. All of the evidence reviews were quality assured by a senior research fellow. This included checking:
  - Papers were included or excluded appropriately
  - A sample of the data extractions
  - Correct methods were used to synthesise data
  - A sample of the risk of bias assessments

### 4.3.1 Inclusion and exclusion criteria

The inclusion and exclusion of studies was based on the criteria defined in the review protocols (see Appendix C). Excluded studies by review question (with the reasons for their exclusion) are listed in Appendix J. The GDG was consulted about any uncertainty regarding inclusion or exclusion.

The key population inclusion criterion was:

- Major trauma is defined as an injury or a combination of injuries that is/are life- threatening and could be life-changing because it may result in long-term disability.

The key population exclusion criterion was:

- People who do not have a suspected or confirmed major traumatic injury
- People with burns
- People with spinal injuries (this will be covered in the NICE guideline on spinal injury assessment)

Conference abstracts were not automatically excluded from any review. No relevant conference abstracts were identified for this guideline. Literature reviews, posters, letters, editorials, comment articles, unpublished studies and studies not in the English language were excluded.

### 4.3.2 Type of studies

Randomised trials, non-randomised trials, and observational studies (including diagnostic or prognostic studies) were included in the evidence reviews as appropriate.

For most intervention reviews in this guideline, parallel randomised controlled trials (RCTs) were included because they are considered the most robust type of study design that could produce an unbiased estimate of the intervention effects. Crossover RCTs were not considered appropriate for any of the questions. If non-randomised studies were appropriate for inclusion i.e., non-drug trials with no randomised evidence, the GDG identified a-priori in the protocol the variables which must either be equivalent at baseline or that the analysis had to adjust for any baseline differences. If the study did not fulfil either criterion, it was excluded. See Appendix C for full details on the study design of studies selected for each review question.

For diagnostic reviews, diagnostic RCTs, cross-sectional and retrospective studies were included. For prognostic reviews, prospective and retrospective cohort studies were included. Case–control studies were not included.

Where data from observational studies were included, the results for each outcome were presented separately for each study and meta-analysis was not conducted.

### 4.3.3 Methods of combining evidence

#### 4.3.3.1 Data synthesis for intervention reviews

Where possible, meta-analyses were conducted to combine the data from the studies for each of the outcomes in the review question using RevMan5 software.[2]

All analyses were stratified for age (under 18 years and 18 years or over), which meant that different studies with predominant age groups in different age strata were not combined and analysed together. For some questions additional stratification was used, and this is documented in the individual question protocols (see Appendix C). If additional strata were used, this led to sub-strata (for example, two stratification criteria would lead to four sub-strata categories, or three stratification criteria would lead to nine sub-strata categories) which would be analysed separately.

**Analysis of different types of data**

Dichotomous outcomes

Fixed-effects (Mantel-Haenszel) techniques (using an inverse variance method for pooling) were used to calculate risk ratios (relative risk) for the binary outcomes, which included:

- Mortality up to 12 months

- Number of procedures
- Adverse events
- Time to definitive treatment
- Readmission to ICU and to hospital
- Unscheduled re-operation

The absolute risk difference was also calculated using GRADEpro software[1], using the median event rate in the control arm of the pooled results.

For binary variables where there were zero events in either arm, Peto odds ratios, rather than risk ratios, were calculated. Peto odds ratios are more appropriate for data with a low number of events.

Where there was sufficient information provided, Hazard Ratios were calculated in preference for outcomes such as mortality.

Continuous outcomes

The continuous outcomes were analysed using an inverse variance method for pooling weighted mean differences. These outcomes included:

- Health Related Quality of Life (HRQL)
- Length of stay (hospital/SCIC)
- Function and activities of daily living (including Glasgow Outcome Scale)

Where the studies within a single meta-analysis had different scales of measurement, standardised mean differences were used where each different measure in each study was 'normalised' to the standard deviation value pooled between the intervention and comparator groups in that same study.

The means and standard deviations of continuous outcomes are required for meta-analysis. However in cases where standard deviations were not reported, the standard error was calculated if the p-values or 95% confidence intervals were reported, and meta-analysis was undertaken with the mean and standard error using the generic inverse variance method in Cochrane Review Manager (RevMan5) software.[2] Where p values were reported as "less than", a conservative approach was undertaken. For example, if a p value was reported as "p ≤0.001", the calculations for standard deviations were based on a p value of 0.001. If these statistical measures were not available then the methods described in section 16.1.3 of the Cochrane Handbook (version 5.1.0, updated March 2011) were applied.

**Generic inverse variance**

If a study reported only the summary statistic and 95% confidence intervals the generic-inverse variance method was used to enter data into RevMan5[2]. If the control event rate was reported this was used to generate the absolute risk difference in GRADEpro.[1] If multivariate analysis was used to derive the summary statistic but no adjusted control event rate was reported no absolute risk difference was calculated.

**Heterogeneity**

Statistical heterogeneity was assessed for each meta-analysis estimate by considering the chi-squared test for significance at p<0.1, or an I-squared inconsistency statistic of >50%, as indicating significant heterogeneity. Where significant heterogeneity was present, a priori sub-grouping of studies was carried out for:

- Age: child (0-15 years); young people (16-17 years); adults (18-65 years; >65 years)

If the sub-group analysis reduced heterogeneity within all of the derived sub-groups, then each of the derived sub-groups were adopted as separate outcomes. For example, instead of the single outcome of '*missed diagnosis'*, this would be separated into two outcomes '*missed diagnosis in people aged <65'* and '*missed diagnosis in people aged 65 and over'*. Assessments of potential differences in effect between subgroups were based on the chi-squared tests for heterogeneity statistics between subgroups. Any subgroup differences were interpreted with caution as separating the groups breaks the study randomisation and as such are subject to uncontrolled confounding.

For some questions additional sub-grouping was applied, and this is documented in the individual question protocols (see Appendix C). These additional sub-grouping strategies were applied independently, so sub-units of sub-groups were not created, unlike the situation with strata. Other sub-grouping strategies were only used if the age category sub-group was unable to explain heterogeneity, then these further sub-grouping strategies were applied in order of priority. Again, once a sub-grouping strategy was found to explain heterogeneity from all derived sub-groups, further sub-grouping strategies were not used.

If all pre-defined strategies of sub-grouping were unable to explain statistical heterogeneity within each derived sub-group, then a random effects (DerSimonian and Laird) model was employed to the entire group of studies in the meta-analysis. A random-effects model assumes a distribution of populations, rather than a single population. This leads to a widening of the confidence intervals around the overall estimate, thus providing a more realistic interpretation of the true distribution of effects across more than 1 population. If, however, the GDG considered the heterogeneity was so large that meta-analysis was inappropriate, then the results were described narratively.

**Complex analysis /further analysis**

Network meta-analysis was considered for the comparison of interventional treatments, but was not pursued because of insufficient data available for the outcomes.

Where studies had used a cross-over design, paired continuous data were extracted where possible, and forest plots were generated in RevMan5[2] with the Generic Inverse Variance function. When a cross-over study had categorical data, the standard error (of the log RR) was calculated using the simplified Mantel Haenszel method for paired outcomes, when the number of subjects with an event in both interventions was known. Forest plots were generated in RevMan5[2] with the Generic Inverse Variance function. If paired continuous or categorical data were not available from the cross-over studies, the separate group data were analysed in the same way as data from parallel groups, on the basis that this approach would over-estimate the confidence intervals and thus artificially reduce study weighting resulting in a conservative effect. Where a meta-analysis had a mixture of studies using both paired and parallel group approaches, all data were entered into RevMan5[2] using the Generic Inverse Variance function.

#### 4.3.3.2 Data synthesis for diagnostic test accuracy reviews

Two separate review protocols were produced to reflect the two different diagnostic study designs:

**Diagnostic RCTs**

Diagnostic RCTs (sometimes referred to as test and treat trials) are a randomised comparison of two diagnostic tests, with study outcomes being clinically important consequences of diagnostic accuracy (patient outcomes similar to those in intervention trials, such as mortality). Patients are randomised to receive test A or test B, followed by identical therapeutic interventions based on the results of the test (ie someone with a positive result would receive the same treatment regardless of whether they were diagnosed by test A or test B). Downstream patient outcomes are then compared between the two groups. As treatment is the same in both arms of the trial, any differences in patient outcomes

will reflect the accuracy of the tests in correctly establishing who does and does not have the condition. Diagnostic RCTs were searched for first in preference to diagnostic accuracy studies (see below). Data was synthesised using the same methods for intervention reviews (see dichotomous or continuous outcomes above)

**Diagnostic accuracy studies**

For diagnostic test accuracy studies, a positive result on the index test was found if the patient had values of the measured quantity above or below a threshold value, and different thresholds could be used. Diagnostic test accuracy measures used in the analysis were: area under the Receiver Operating Characteristics (ROC) curve and, for different thresholds (if appropriate), sensitivity and specificity. The threshold of a diagnostic test is defined as the value at which the test can best differentiate between those with and without the target condition and, in practice, it varies amongst studies. For this guideline, sensitivity was considered more important than specificity due to the consequences of a missed injury. Coupled forest plots of sensitivity and specificity with their 95% CIs across studies (at various thresholds) were produced for each test, using RevMan5[2]. In order to do this, 2x2 tables (the number of true positives, false positives, true negatives and false negatives) were directly taken from the study if given, or else were derived from raw data or calculated from the set of test accuracy statistics.

Diagnostic meta-analysis was conducted where appropriate, that is, when 5 or more studies were available per threshold. Test accuracy for the studies was pooled using the bivariate method modelled in Winbugs®.[30] The bivariate method uses logistic regression on the true positives, true negatives, false positives and false negatives reported in the studies. Overall sensitivity and specificity and confidence regions were plotted (using methods outlined by Novielli et al. 2010[36,36]). For scores with less than five studies, median sensitivity and the paired specificity were reported where possible. If an even number of studies were reported the lowest value of the two middle pairs was reported.

Area under the ROC curve (AUC) data for each study was also plotted on a graph, for each diagnostic test. The AUC describes the overall diagnostic accuracy across the full range of thresholds. The following criteria are used for evaluating AUC:

- ≤0.50: worse than chance
- 0.50–0.60: very poor
- 0.61–0.70: poor
- 0.71–0.80: moderate
- 0.81–0.92: good
- 0.91–1.00: excellent or perfect test.

Heterogeneity or inconsistency amongst studies was visually inspected in the forest plots where there were similar thresholds).

#### 4.3.3.3 Data synthesis for risk prediction rules

Evidence reviews on risk prediction rules/tools results were presented separately for discrimination and calibration. The discrimination data was analysed according to the principles outlined under the section on data synthesis for diagnostic accuracy studies. Calibration data e.g., $R^2$ , if reported was presented separately to the discrimination data. The results were presented for each study separately along with the quality rating for the study. Inconsistency and imprecision were not assessed.

#### 4.3.3.4 Data synthesis for qualitative reviews

For each included paper sub-themes were identified and linked to a generic theme. An example of a sub-theme identified by patients and carers is 'keeping an open channel of communication about reasons for any delays in the emergency room' and this is linked to a broader generic theme of 'information'. In some cases, sub-themes would relate to more than one generic theme. A summary evidence table of generic themes and underpinning sub-themes was then produced alongside the quality of the evidence.

### 4.3.4 Appraising the quality of evidence by outcomes

#### 4.3.4.1 Interventional studies

The evidence for outcomes from the included RCT and observational studies were evaluated and presented using an adaptation of the 'Grading of Recommendations Assessment, Development and Evaluation (GRADE) toolbox' developed by the international GRADE working group (http://www.gradeworkinggroup.org/). The software (GRADEpro[1]) developed by the GRADE working group was used to assess the quality of each outcome, taking into account individual study quality and the meta-analysis results.

Each outcome was first examined for each of the quality elements listed and defined in Table 2.

**Table 2: Description of quality elements in GRADE for intervention studies**

| Quality element | Description |
|---|---|
| Risk of bias | Limitations in the study design and implementation may bias the estimates of the treatment effect. Major limitations in studies decrease the confidence in the estimate of the effect. Examples of such limitations are selection bias (often due to poor allocation concealment), performance and detection bias (often due to a lack of blinding of the patient, health care professional and assessor) and attrition bias (due to missing data causing systematic bias in the analysis). |
| Indirectness | Indirectness refers to differences in study population, intervention, comparator and outcomes between the available evidence and the review question. |
| Inconsistency | Inconsistency refers to an unexplained heterogeneity of effect estimates between studies in the same meta-analysis. |
| Imprecision | Results are imprecise when studies include relatively few patients and few events (or highly variable measures) and thus have wide confidence intervals around the estimate of the effect relative to clinically important thresholds. 95% confidence intervals denote the possible range of locations of the true population effect at a 95% probability, and so wide confidence intervals may denote a result that is consistent with conflicting interpretations (for example a result may be consistent with both clinical benefit AND clinical harm) and thus be imprecise. |
| Publication bias | Publication bias is a systematic underestimate or an overestimate of the underlying beneficial or harmful effect due to the selective publication of studies. A closely related phenomenon is where some papers fail to report an outcome that is inconclusive, thus leading to an over-estimate of the effectiveness of that outcome. |
| Other issues | Sometimes randomisation may not adequately lead to group equivalence of confounders, and if so this may lead to bias, which should be taken into account. Potential conflicts of interest, often caused by excessive pharmaceutical company involvement in the publication of a study, should also be noted. |

Details of how the four main quality elements (risk of bias, indirectness, inconsistency and imprecision) were appraised for each outcome are given below. Publication or other bias was only taken into consideration in the quality assessment if it was apparent.

### Risk of bias

The main domains of bias for randomised controlled trials are listed in Table 3. Each outcome had its risk of bias assessed within each paper first. For each paper, if there were no risks of bias in any domain, the risk of bias was given a rating of 0. If there was risk of bias in just one domain, the risk of bias was given a 'serious' rating of -1, but if there was risk of bias in two or more domains the risk of bias was given a 'very serious' rating of -2. A weighted average score was then calculated across all studies contributing to the outcome, by taking into account the weighting of studies according to study precision. For example if the most precise studies tended to each have a score of -1 for that outcome, the overall score for that outcome would tend towards -1.

**Table 3: Principle domains of bias in randomised controlled trials**

| Limitation | Explanation |
|---|---|
| Selection bias – sequence generation and allocation concealment | If those enrolling patients are aware of the group to which the next enrolled patient will be allocated, either because of a non-random sequence that is predictable, or because a truly random sequence was not concealed from the researcher, this may translate into systematic selection bias. This may occur if the researcher chooses not to recruit a participant into that specific group because of 1) knowledge of that participant's likely prognostic characteristics and 2) a desire for one group to do better than the other. |
| Performance and detection bias - Lack of patient and health care professional blinding | Patients, caregivers, those adjudicating and/or recording outcomes, and data analysts should not be aware of the arm to which patients are allocated. Knowledge of group can influence 1) the experience of the placebo effect, 2) performance in outcome measures, 3) the level of care and attention received, and 4) the methods of measurement or analysis, all of which can contribute to systematic bias. |
| Attrition bias | Attrition bias results from loss of data beyond a certain level (a differential of 10% between groups) which is not accounted for. Loss of data can occur when participants are compulsorily withdrawn from a group by the researchers (for example, when a per-protocol approach is used) or when participants do not attend assessment sessions. If the missing data are likely to be different from the data of those remaining in the groups, and there is a differential rate of such missing data from groups, systematic attrition bias may result. |
| Selective outcome reporting | Reporting of some outcomes and not others on the basis of the results can also lead to bias, as this may distort the overall impression of efficacy. |
| Other limitations | For example:<br>Stopping early for benefit observed in randomised trials, in particular in the absence of adequate stopping rules<br>Use of unvalidated patient-reported outcomes<br>lack of washout periods to avoid carry-over effects in cross-over trials<br>Recruitment bias in cluster randomised trials |

### Indirectness

Indirectness refers to the extent to which the populations, intervention, comparisons and outcome measures are dissimilar to those defined in the inclusion criteria for the reviews. Indirectness is important when these differences are expected to contribute to a difference in effect size, or may affect the balance of harms and benefits considered for an intervention. As for risk of bias, each outcome had its indirectness assessed within each paper first. For each paper, if there were no sources of indirectness, indirectness was given a rating of 0. If there was indirectness in just one source (for example in terms of population), indirectness was given a 'serious' rating of -1, but if there was indirectness in two or more sources (for example, in terms of population and treatment) the indirectness was given a 'very serious' rating of -2. A weighted average score was then calculated

across all studies contributing to the outcome, by taking into account study precision. For example if the most precise studies tended to have an indirectness score of -1 each for that outcome, the overall score for that outcome would probably tend towards -1.

**Inconsistency**

Inconsistency refers to an unexplained heterogeneity of results for an outcome across different studies. When estimates of the treatment effect across studies differ widely, this suggests true differences in underlying treatment effect, which may be due to differences in populations, settings or doses. When heterogeneity existed within an outcome (Chi square $p<0.1$ or $I^2$ inconsistency statistic of >50%), but no plausible explanation could be found, the quality of evidence for that outcome was downgraded. Inconsistency for that outcome was given a 'serious' score of -1 if the $I^2$ was 50-74, and a 'very serious' score of -2 if the $I^2$ was 75 or more.

If inconsistency could be explained based on pre-specified subgroup analysis (that is, each sub-group had an $I^2 < 50$), the GDG took this into account and considered whether to make separate recommendations on new outcomes based on the sub-groups defined by the assumed explanatory factors. In such a situation the quality of evidence was not downgraded for those emergent outcomes.

Since the inconsistency score was based on the meta-analysis results, the score represented the whole outcome and so weighted averaging across studies was not necessary.

**Imprecision**

The criteria applied for imprecision were based on the confidence intervals for the pooled estimate of effect, and the minimal important differences (MID) for the outcome. The MIDs are the threshold for appreciable benefits and harms, separated by a zone either side of the line of no effect where there is assumed to be no clinically important effect. If either of the 95% confidence intervals of the overall estimate of effect crossed one of the MID lines, imprecision was regarded as serious and a 'serious' score of -1 was given. This was because the overall result, as represented by the span of the confidence intervals, was consistent with two interpretations as defined by the MID (for example, no clinically important effect and either clinical benefit or harm). If both MID lines were crossed by either or both of the confidence intervals then imprecision was regarded as very serious and a 'very serious' score of -2 was given. This was because the overall result was consistent with three interpretations defined by the MID (no clinically important effect and clinical benefit and clinical harm). This is illustrated in Figure 2. As for inconsistency, since the imprecision score was based on the meta-analysis results, the score represented the whole outcome and so weighted averaging across studies was not necessary.

The position of the MID lines is ideally determined by values as reported in the literature. "Anchor-based" methods aim to establish clinically meaningful changes in a continuous outcome variable by relating or "anchoring" them to patient-centred measures of clinical effectiveness that could be regarded as gold standards with a high level of face validity. For example, the minimum amount of change in an outcome necessary to make a patient decide that they felt their quality of life had "significantly improved" might define the MID for that outcome. MIDs in the literature may also be based on expert clinician or consensus opinion concerning the minimum amount of change in a variable deemed to affect quality of life or health. For binary variables, any MIDs reported in the literature will inevitably be based on expert consensus, as such MIDs relate to all-or-nothing population effects rather than measurable effects on an individual, as so are not amenable to patient-centred "anchor" methods.

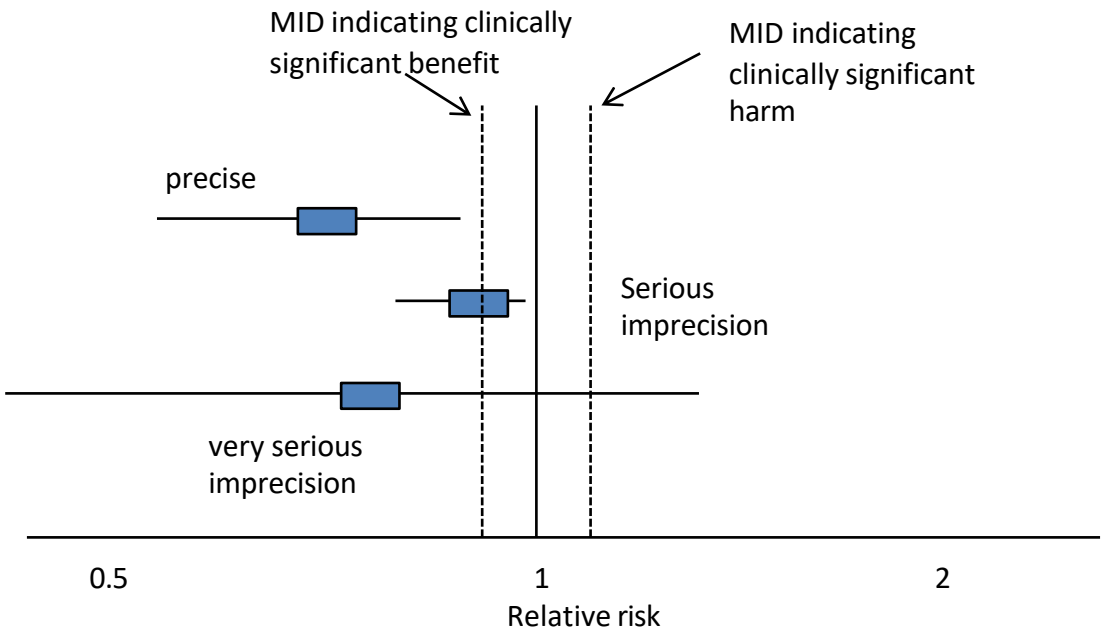
In the absence of literature values, the alternative approach to deciding on MID levels is the "default" method, as follows:

- For categorical outcomes the MIDs are taken as RRs of 0.75 and 1.25. For 'positive' outcomes such as 'patient satisfaction', the RR of 0.75 is taken as the line denoting the boundary between no clinically important effect and a clinically significant harm, whilst the RR of 1.25 is taken as the line denoting the boundary between no clinically important effect and a clinically significant benefit. For 'negative' outcomes such as 'bleeding', the opposite occurs, so the RR of 0.75 is taken as the line denoting the boundary between no clinically important effect and a clinically significant benefit, whilst the RR of 1.25 is taken as the line denoting the boundary between no clinically important effect and a clinically significant harm.
- For continuous outcome variables the MID is taken as half the median baseline standard deviation of that variable, across all studies in the meta-analysis. Hence the MID denoting the minimum clinically significant benefit will be a positive for a positive" outcome (for example, a quality of life measure where a higher score denotes better health), and negative for a "negative" outcome (for example, a VAS pain score). Clinically significant harms will be the converse of these. If baseline values are unavailable, then half the median comparator group standard deviation of that variable will be taken as the MID.
- If standardised mean differences have been used, then the MID will be set at the absolute value of + 0.5. This follows because standardised mean differences are mean differences normalised to the pooled standard deviation of the two groups, and are thus effectively expressed in units of "numbers of standard deviation". The 0.5 MID value in this context therefore indicates half a standard deviation, the same definition of MID as used for non-standardised mean differences.

The default MID value was subject to amendment after discussion with the GDG. If the GDG decided that the MID level should be altered, after consideration of absolute as well as relative effects, this was allowed, provided that any such decision was not influenced by any bias towards making stronger or weaker recommendations for specific outcomes.

For this guideline, no appropriate MIDs for continuous or dichotomous outcomes were found in the literature, and so the default method was used.

**Figure 2:** Illustration of precise and imprecise outcomes based on the confidence interval of dichotomous outcomes in a forest plot. Note that all three results would be pooled estimates, and would not, in practice, be placed on the same forest plot




**Overall grading of the quality of clinical evidence**

Once an outcome had been appraised for the main quality elements, as above, an overall quality grade was calculated for that outcome. The scores from each of the main quality elements (0, -1 or -2) were summed to give a score that could be anything from 0 (the best possible) to -8 (the worst possible). However scores were capped at -3. This final score was then applied to the starting grade that had originally been applied to the outcome by default, based on study design. For example, all RCTs started as HIGH and the overall quality became MODERATE, LOW or VERY LOW if the overall score was -1, -2 or -3 points respectively. The significance of these overall ratings is explained in Table 3. The reasons or criteria used for downgrading were specified in the footnotes of the GRADE tables.

On the other hand, observational interventional studies started at LOW, and so a score of -1 would be enough to take the grade to the lowest level of VERY LOW. Observational studies could, however, be upgraded if there was: a large magnitude of effect, a dose-response gradient, and if all plausible confounding would reduce a demonstrated effect.

**Table 4: Overall quality of outcome evidence in GRADE**

| Level | Description |
|---|---|
| High | Further research is very unlikely to change our confidence in the estimate of effect |
| Moderate | Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate |
| Low | Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate |
| Very low | Any estimate of effect is very uncertain |

#### 4.3.4.2 Prognostic studies

The quality of evidence for prognostic studies was evaluated according to the criteria given in Table 5. If data were meta-analysed the quality for pooled studies was presented. If the data was not pooled then a quality rating was presented for each study.

**Table 5: Description of quality elements for prospective studies**

| Quality element | Description of cases where the quality measure would be downgraded |
|---|---|
| Study design | If case control rather than prospective cohort |
| Patient recruitment | If potential for selection bias |
| Validity of risk factor measure(s) | If non-validated and no reasonable face validity |
| Validity of outcome measure | If non-validated and no reasonable face validity |
| Blinding | if assessors of outcome not blinded to risk factor measurement (or vice versa) |
| Adequate follow up (or retrospective) duration | If follow up/retrospective period inadequate to allow events to occur, or retrospective period so short that causality is in doubt because the outcome may have preceded the risk factor |
| Confounder consideration | If there is a lack of consideration of all reasonable confounders in a multivariable analysis |
| Attrition | If attrition is too high and there is no attempt to adjust for this. |
| Directness | If the population, risk factors or outcome differ from that in the review question. |

Because prognostic reviews were not usually based on multiple outcomes per study, quality rating was assigned by study. However if there was more than one outcome involved in a study, then the quality rating of the evidence statements for each outcome was adjusted accordingly. For example, if one outcome was based on an invalidated measurement method, but another outcome in the same study wasn't, the latter outcome would be graded one grade higher than the other.

Quality rating started at HIGH for prospective studies, and each major limitation (see Table 5) brought the rating down by one increment to a minimum grade of LOW, as explained for interventional studies.

#### 4.3.4.3 Diagnostic studies

Quality of evidence for diagnostic data was evaluated by study using the Quality Assessment of Diagnostic Accuracy Studies version 2 (QUADAS-2) checklists. Risk of bias and applicability in primary diagnostic accuracy studies in QUADAS-2 consists of 4 domains (see Figure 3):

- Patient selection
- Index test
- Reference standard
- Flow and timing

**Figure 3: Summary of QUADAS-2 with list of signalling, risk of bias and applicability questions.**

| Domain | Patient selection | Index test | Reference standard | Flow and timing |
|---|---|---|---|---|
| Description | Describe methods of patient selection. Describe included patients (prior testing, | Describe the index test and how it was conducted and | Describe the reference standard and how it was conducted and | Describe any patients who did not receive the index test(s) and/or reference standard or |

| Domain | Patient selection | Index test | Reference standard | Flow and timing |
|---|---|---|---|---|
| | presentation, intended use of index test and setting) | interpreted | interpreted | who were excluded from the 2x2 table (refer to flow diagram). Describe the time interval and any interventions between index test(s) and reference standard |
| Signalling questions (yes/no/unclear) | Was a consecutive or random sample of patients enrolled? | Were the index test results interpreted without knowledge of the results of the reference standard? | Is the reference standard likely to correctly classify the target condition? | Was there an appropriate interval between index test(s) and reference standard? |
| | Was a case-control design avoided? | If a threshold was used, was it pre-specified? | Were the reference standard results interpreted without knowledge of the results of the index test? | Did all patients receive a reference standard? |
| | Did the study avoid inappropriate exclusions? | | | Did all patients receive the same reference standard? |
| | | | | Were all patients included in the analysis? |
| Risk of bias; (high/low/unclear) | Could the selection of patients have introduced bias? | Could the conduct or interpretation of the index test have introduced bias? | Could the reference standard, its conduct or its interpretation have introduced bias? | Could the patient flow have introduced bias? |
| Concerns regarding applicability (high/low/unclear) | Are there concerns that the included patients do not match the review question? | Are there concerns that the index test, its conduct, or interpretation differ from the review question? | Are there concerns that the target condition as defined by the reference standard does not match the review question? | |

#### 4.3.4.4 Qualitative reviews

Table 6 below summarises the factors which were assessed to inform the quality rating for each sub-theme. A meta-synthesis of overarching themes as identified by the available qualitative evidence was presented with the quality rating.

**Table 6: Summary of factors assessed in qualitative reviews**

| Quality element | |
|---|---|
| Limitations of evidence | • Were qualitative studies/ surveys an appropriate approach?<br>• Were the studies approved by an ethics committee?<br>• Were the studies clear in what they seek to do?<br>• Is the context clearly described?<br>• Is the role of the researcher clearly described?<br>• How rigorous was the research design/methods?<br>• Is the data collection rigorous?<br>• Is the data analysis rigorous?<br>• Are the data rich (for qualitative study and open ended survey questions)?<br>• Are the findings relevant to the aims of the study?<br>• Are the findings and conclusions convincing? |
| Coherence of findings | • Do the sub-themes identified complement, reinforce or contradict each other? |

| Quality element | |
|---|---|
| Applicability of evidence | • Are the findings of the study applicable to the evidence review? For example population and setting |

### 4.3.5 Assessing clinical importance

The GDG assessed the evidence by outcome in order to determine if there was, or potentially was, a clinically important benefit, a clinically important harm or no clinically important difference between interventions. To facilitate this, binary outcomes were converted into absolute risk differences (ARDs) using GRADEpro software[1]: the median control group risk across studies was used to calculate the ARD and its 95% CI from the pooled risk ratio.

The assessment of clinical benefit, harm, or no benefit or harm was based on the point estimate of absolute effect for intervention studies which was standardised across the reviews. The GDG considered for most of the outcomes in the intervention reviews that if at least 100 participants per 1000 (10%) achieved (if positive) the outcome of interest in the intervention group compared to the comparison group then this intervention would be considered beneficial. The same point estimate but in the opposite direction would apply if the outcome was negative. For the critical outcomes of mortality any reduction represented a clinical benefit. For adverse events 50 events or more represented clinical harm. For continuous outcomes if the mean difference was greater than the minimally important difference then this resented a clinical benefit or harm. For outcomes such as mortality any reduction or increase was considered to be clinically important.

This assessment was carried out by the GDG for each critical outcome, and an evidence summary table was produced to compile the GDG's assessments of clinical importance per outcome, alongside the evidence quality and the uncertainty in the effect estimate (imprecision).

### 4.3.6 Clinical evidence statements

Clinical evidence statements are summary statements that are presented after the GRADE profiles, summarising the key features of the clinical effectiveness evidence presented. The wording of the evidence statements reflects the certainty/uncertainty in the estimate of effect. The evidence statements were presented by outcome and encompassed the following key features of the evidence:

- The number of studies and the number of participants for a particular outcome
- An indication of the direction of clinical importance (if one treatment is beneficial or harmful compared to the other or whether there is no difference between the two tested treatments).
- A description of the overall quality of evidence (GRADE overall quality).

## 4.4 Evidence of cost-effectiveness

The GDG is required to make decisions based on the best available evidence of both clinical and cost effectiveness. Guideline recommendations should be based on the expected costs of the different options in relation to their expected health benefits (that is, their 'cost effectiveness') rather than the total implementation cost.[34] Thus, if the evidence suggests that a strategy provides significant health benefits at an acceptable cost per patient treated, it should be recommended even if it would be expensive to implement across the whole population.

Evidence on cost effectiveness related to the key clinical issues being addressed in the guideline was sought. The health economist:

- Undertook a systematic review of the published economic literature.

- Undertook new economic analysis in priority areas.

### 4.4.1 Literature review

The Health Economist:

- Identified potentially relevant studies for each review question from the economic search results by reviewing titles and abstracts – full papers were then obtained.
- Reviewed full papers against pre-specified inclusion / exclusion criteria to identify relevant studies (see below for details).
- Critically appraised relevant studies using the economic evaluations checklist as specified in The Guidelines Manual[35]
- Studies initially considered eligible but which were then excluded can be found in Appendix K with reasons for exclusion explained.

#### 4.4.1.1 Inclusion and exclusion criteria

Full economic evaluations (studies comparing costs and health consequences of alternative courses of action: cost–utility, cost-effectiveness, cost-benefit and cost-consequence analyses) and comparative costing studies that addressed the review question in the relevant population were considered potentially applicable as economic evidence.

Studies that only reported cost per hospital (not per patient) or only reported average cost effectiveness without disaggregated costs and effects were excluded. Abstracts, posters, reviews, letters/editorials, foreign language publications and unpublished studies were excluded. Studies judged to have an applicability rating of 'not applicable' were excluded (this included studies that took the perspective of a non-OECD country).

Remaining studies were prioritised for inclusion based on their relative applicability to the development of this guideline and the study limitations. For example, if a high quality, directly applicable UK analysis was available other less relevant studies may not have been included. Where exclusions occurred on this basis, this is noted in the relevant section.

For more details about the assessment of applicability and methodological quality see the economic evaluation checklist (The Guidelines Manual[35], Appendix H) and the health economics review protocol in Appendix C.

### 4.4.2 Undertaking new health economic analysis

As well as reviewing the published economic literature for each review question, as described above, new economic analysis was attempted by the Health Economist in priority areas. Priority areas for new health economic analysis were agreed by the GDG after formation of the review questions and consideration of the available health economic evidence.

As this was a service delivery guideline, the model attempted tried to cover various areas of the clinical pathway including their interactions; novel methods such as conceptual modelling were used to initiate this work. The various stages and approach adopted are described in more detail in Chapter 6 and Appendix M.

Additional systematic reviews to inform the modelling activity were conducted and these are presented in Appendix L. Model structure, inputs and assumptions were explained to and agreed by the GDG members during meetings, and they commented on subsequent revisions.

See Appendix M for details of the health economic analysis/analyses attempted for the guideline.

### 4.4.3 Cost-effectiveness criteria

NICE's report 'Social value judgements: principles for the development of NICE guidance' sets out the principles that GDGs should consider when judging whether an intervention offers good value for money [33].

In general, an intervention was considered to be cost effective if either of the following criteria applied (given that the estimate was considered plausible):

a. The intervention dominated other relevant strategies (that is, it was both less costly in terms of resource use and more clinically effective compared with all the other relevant alternative strategies), or
b. The intervention cost less than £20,000 per quality-adjusted life-year (QALY) gained compared with the next best strategy.

If the GDG recommended an intervention that was estimated to cost more than £20,000 per QALY gained, or did not recommend one that was estimated to cost less than £20,000 per QALY gained, the reasons for this decision are discussed explicitly in the 'from evidence to recommendations' section of the relevant chapter with reference to issues regarding the plausibility of the estimate or to the factors set out in the 'Social value judgements: principles for the development of NICE guidance' [33].

#### In the absence of economic evidence

When no relevant published studies were found, and a new analysis was not prioritised, the GDG made a qualitative judgement about cost effectiveness by considering expected differences in resource use between options and relevant UK NHS unit costs, alongside the results of the clinical review of effectiveness evidence.

The UK NHS costs reported in the guideline are those that were presented to the GDG and were correct at the time recommendations were drafted. They may have changed subsequently before the time of publication. However, we have no reason to believe they have changed substantially.

## 4.5 Developing recommendations

Over the course of the guideline development process, the GDG was presented with:

- Evidence tables of the clinical and economic evidence reviewed from the literature. All evidence tables are in Appendix G.
- Summary of clinical and economic evidence and quality as presented in chapters 6-17.
- Forest plots and summary ROC curves (Appendix I)
- A description of the methods and results of the cost-effectiveness analysis undertaken for the guideline (Appendix M)

Recommendations were drafted on the basis of the GDG interpretation of the available evidence, taking into account the balance of benefits, harms and costs. When clinical and economic evidence was of poor quality, conflicting or absent, the GDG drafted recommendations based on their expert opinion. The considerations for making consensus based recommendations include the balance between potential harms and benefits, economic or implications compared to the benefits, current practices, recommendations made in other relevant guidelines, patient preferences and equality issues. The consensus recommendations were done through discussions in the GDG. The GDG also considered whether the uncertainty was sufficient to justify delaying making a recommendation to await further research, taking into account the potential harm of failing to make a clear recommendation (See section 5.2).

The main considerations specific to each recommendation are outlined in the Evidence to Recommendation Section preceding the recommendation section.

### 4.5.1 Research recommendations

When areas were identified for which good evidence was lacking, the guideline development group considered making recommendations for future research. Decisions about inclusion were based on factors such as:

- the importance to patients, including patient safety, or the population
- national priorities
- potential impact on the NHS and future NICE guidance
- ethical and technical feasibility

### 4.5.2 Validation process

The guidance is subject to an eight week public consultation and feedback as part of the quality assurance and peer review the document. All comments received from registered stakeholders are responded to in turn and posted on the NICE website when the pre-publication check of the full guideline occurs.

### 4.5.3 Updating the guideline

Following publication, and in accordance with the NICE guidelines manual, NICE will consider whether the evidence base has progressed sufficiently to alter the guideline recommendations and warrant an update.

### 4.5.4 Disclaimer

Those responsible and accountable for commissioning trauma services should take this guideline fully into account. However, this guideline does not override the need for, and importance of, using professional judgement to make decisions appropriate to the circumstances.

The National Clinical Guideline Centre disclaims any responsibility for damages arising out of the use or non-use of these guidelines and the literature used in support of these guidelines.

### 4.5.5 Funding

The National Clinical Guideline Centre was commissioned by the National Institute for Health and Care Excellence to undertake the work on this guideline.

# 5 Guideline summary

## 5.1 Full list of recommendations

1. Provide a pre-hospital major trauma triage tool to differentiate between patients who should be taken to a major trauma centre and those who should be taken to a trauma unit for definitive management.
2. Choose a pre-hospital major trauma triage tool that includes assessment of physiology and anatomical injury and takes into account the different needs of older patients, children and other high-risk populations (such as patients who take anticoagulants, pregnant women and patients with comorbidities).
3. Support pre-hospital care providers using the major trauma triage tool with immediate clinical advice from the ambulance control centre.
4. Train pre-hospital care providers to use the major trauma triage tool.
5. Monitor and audit use of the major trauma triage tool as part of the major trauma network's quality improvement programme.
6. Be aware that the optimal destination for patients with major trauma is usually a major trauma centre. In some locations or circumstances intermediate care in a trauma unit might be needed for urgent treatment, in line with agreed practice within the regional trauma network.
7. Spend only enough time at the scene to give immediate life-saving interventions.
8. Divert to the nearest trauma unit if a patient with major trauma needs a life-saving intervention, such as drug-assisted rapid sequence induction of anaesthesia and intubation, that cannot be delivered by the pre-hospital team.
9. Provide a structured system for recording and receiving pre-alert information. Ensure that the information recorded includes:
    - age and sex of the injured person
    - time of incident
    - mechanism of injury
    - injuries suspected
    - signs, including vital signs, and Glasgow Coma Scale
    - treatment so far
    - estimated time of arrival at emergency department
    - special requirements
    - the ambulance call sign, name of the person taking the call and time of call.
10. Ensure that a senior nurse or trauma team leader receives the pre-alert information and determines the level of trauma team response according to agreed and written local guidelines.
11. Ensure that the trauma team leader is easily identifiable to receive the handover and the trauma team is ready to receive the information.

12. Ensure that pre-hospital documentation, including the recorded pre-alert information, is made available to the trauma team quickly and placed in the patient's hospital notes.
13. Ensure that multispecialty trauma teams are activated immediately in trauma units to receive patients with major trauma.
14. Do not use a tiered team response in trauma units.
15. Have a paediatric trauma team available immediately for children (under 16s) with major trauma.
16. Consider a tiered team response to receive patients in major trauma centres. This may include:
    - a standard multispecialty trauma team or
    - a standard multispecialty trauma team plus specialist involvement (for example, code red for major haemorrhage) and mobilisation of supporting departments and services such as transfusion, interventional radiology and surgery.

    How the tiered teams may look in UK MTCs:
17. Spend only enough time to give life-saving interventions at the trauma unit before transferring patients for definitive treatment.
18. Be aware that the major trauma centre is the ultimate destination for definitive treatment.
19. Provide a protocol for the safe and rapid transfer of patients who need definitive specialist intervention.
20. Train clinical staff involved in the care of patients with major trauma in the transfer protocol.
21. Review the transfer protocol regularly.
22. Ensure that patients with major trauma who need critical interventions at a major trauma centre leave the sending emergency department within 30 minutes of the decision to transfer.
23. Hospital major trauma services should have responsibility and authority for the governance of all major trauma care in hospital.
24. Provide a dedicated major trauma service for patients with major trauma that consists of:
    - a dedicated trauma ward for patients with multisystem injuries
    - a designated consultant available to contact 24 hours a day, 7 days a week who has responsibility and authority for the hospital trauma service and leads the multidisciplinary team care
    - acute specialist trauma rehabilitation services
    - acute specialist services for the paediatric and elderly populations
    - a named member of clinical staff (a key worker, often a senior nurse) assigned at each stage of the care pathway who coordinates the patient's care.
25. The key worker should:
    - act as a single point of contact for patients, family members and carers, and the healthcare professionals involved in their care

- provide information on how the hospital and the trauma system works (major trauma centres, trauma units and teams)
- attend ward rounds and ensure that all action plans from the ward round are carried out in a timely manner
- provide patient advocacy
- ensure that there is a management plan and identify any conflicts
- organise ongoing care including discharge planning, transfers and rehabilitation.

26. Ensure that pre-hospital documentation is standardised within a trauma network, for example using the Royal College of Physicians' Professional guidance on the structure and content of ambulance records.

27. Ensure that hospital documentation is standardised within a trauma network and there are systems that allow healthcare professionals access to all relevant and current clinical data at different points in the care pathway. This could be by using compatible electronic medical records such as a picture archiving and communication system (PACS) and an image exchange portal.

28. Ensure that there is a major trauma audit programme to evaluate systems, services and processes as part of the major trauma network's quality improvement programme.

29. Ensure that a major trauma audit programme includes:

- regular review of audits undertaken locally and regionally
- registration with the Trauma Audit and Research Network (TARN)
- accurate and complete data submission to TARN
- quarterly review of TARN reports.

30. A national trauma audit system should collect and analyse data to enable providers of major trauma services to review their local, regional and national major trauma performance.

31. Provide education and training courses for healthcare professionals who deliver care to children (under 16s) with major trauma that include the following components:

- safeguarding
- taking into account the radiation risk of CT to children when discussing imaging for them
- the importance of the major trauma team, the roles of team members and the team leader, and working effectively in a major trauma team
- managing the distress families and carers may experience and breaking bad news
- the importance of clinical audit and case review.

32. Establish a protocol for providing information and support to patients, family members and carers.

33. The trauma team structure should include a clear point of contact for providing information to patients, family members and carers.

34. Allocate a dedicated member of staff to contact the next of kin and provide support for unaccompanied children and vulnerable adults.

35. Document all key communications with patients, family members and carers about the management plan.

36. For patients who are being transferred from an emergency department to another centre, provide verbal and written information that includes:

    - the reason for the transfer
    - the location of the receiving centre and the patient's destination within the receiving centre
    - the name and contact details of the person who was responsible for the patient's care at the initial hospital

37. Ensure that drug-assisted rapid sequence induction of anaesthesia and intubation (RSI) is available for patients with major trauma who cannot maintain their airway and/or ventilation, and be aware that RSI should:

    - be performed as soon as possible and within 45 minutes of the initial call to the emergency services and
    - preferably be provided at the scene of the incident and not by diverting to a trauma unit.

38. Ensure that interventional radiology and definitive open surgery are equally and immediately available for haemorrhage control in all patients with active bleeding. (For more information see the section on interventional radiology in the NICE guideline 'Major trauma' and the section on controlling pelvic haemorrhage in the NICE guideline 'Fractures (complex)').

    (For more information see the section on airway management in pre-hospital and hospital settings in the NICE guideline 'Major trauma'.)

39. Ensure that people with major trauma have access to services that can provide the interventions recommended in this guideline and in the NICE guidelines on non-complex fractures, complex fractures, major trauma and spinal injury. See Table 55 and Table 56 for the recommendations for pre-hospital and hospital management of major trauma that might have particular implications for service delivery.

40. Ensure that each healthcare professional within the trauma service has the training and skills to deliver, safely and effectively, the interventions they are required to give, in line with the NICE guidelines on non-complex fractures, complex fractures, major trauma and spinal injury.

41. Enable each healthcare professional who delivers care to patients with major trauma to have up-to-date training in the interventions they are required to give.

## 5.2 Key research recommendations

**1. What is the clinical and cost effectiveness of collecting long-term outcomes in a national trauma audit system?**

2. **What are the barriers to people with major trauma receiving early rehabilitation after rehabilitation assessment? What changes to services are needed to overcome these barriers?**

3. **Is it clinically and cost effective to provide a dedicated service to transfer patients with major trauma from the emergency department for ongoing care?**

4. **A national pre-hospital triage tool for major trauma should be developed and validated.**

# 6 Pre-hospital triage to the appropriate destination

## 6.1 Introduction

Within a trauma network the specialist services needed to treat a person with major trauma are established regionally. Major trauma centres (MTC) are designated to deliver high quality specialist care and accordingly the regional MTC is usually the optimal destination for a patient with major trauma. To ensure the effective and efficient running of a trauma network accurate pre-hospital triage is critical. Under triage, where a patient with major trauma is transferred to an emergency department not in the MTC, can lead to delay in definitive treatment and has been associated with poor patient outcome. There are also risks of over triage where a patient with relatively minor injuries is transferred directly to an MTC, overwhelming the resources of the system and potentially impacting on the care of other patients.

Multiple field-based trauma decision tools have attempted to standardise criteria for triage and ensure consistency of decision making to minimise under and over triage, but there is currently no national or international consensus for an optimal triage tool. This review aimed to identify a triage tool that accurately identified people with major trauma to be transported to a MTC.

## 6.2 Review question: What is the accuracy of ambulance triage tools in people with major trauma?

For full details see review protocol in Appendix C.

**Table 7: PICO characteristics of review question**

| | |
|---|---|
| **Population** | Children, young people and adults experiencing trauma |
| **Index test(s)/comparator(s)** | Clinical Triage Tools<br>Clinical assessments<br><br>Include studies that compare the different tools<br><br>Above Plus/minus Clinical judgement |
| **Reference standard(s)** | Later clinical findings – ISS Score, Mortality, ICU admission, combinative clinical findings |
| **Statistical measure/outcomes** | Diagnostic accuracy<br>Any additional outcomes related to ensuring the right people are available to receive the patient |
| **Study design** | Observational studies |

## 6.3 Clinical evidence

Twenty-one studies using 7 different triage tools were identified in the initial search. Sixteen studies were excluded by the GDG as the tools identified did not include established criteria used to identify major trauma and were outside of current practice (for example, the Trauma Score).

Of the 6 studies using the ACS-COT triage tool two were conducted in the United States, two in Australia and two in Europe. The GDG discussed the high incidence of penetrating trauma in US populations and felt it was inappropriate to group these together with other regions (if penetrating trauma could not be separated) or to use US data to make recommendations in the NHS.

One of the four remaining studies reported a reference standard combining clinical outcomes (that is, ICU admission within 24 hours) and an ISS >15. The GDG felt it was inappropriate to pool these in diagnostic analysis and focus on the ISS score which was considered to be the best predictor or major trauma.

Four remaining studies were included in the review [8,12,19,20,37,42]. Evidence from these are summarised in the clinical evidence profile below. See also the study selection flow chart in Appendix D, forest plots in Appendix I, study evidence tables in Appendix G and exclusion list in Appendix J.

**Table 8: Summary of studies included in the review**

| Study | Population | Index test(s) | Reference test | Comments |
|---|---|---|---|---|
| Cheung 2013 | People under 16 years sustaining injury or trauma and admitted to a receiving unit direct from the scene of the incident. | UK Trauma tools: East Midlands, London, North West, Northern, South West London, Wessex, Paediatric Trauma Score | ISS>15 | • Unclear statement regarding enrolment |
| Dinh 2012 | Patients directly transported by a regional ambulance service due to trauma. | ACS-SCOT | Primary outcome: ISS >15<br>Secondary outcome: Later clinical findings including: Death, ISS>15, ICU admission with mechanical ventilation for more than 24 hours, urgent surgery | Registry data<br>• Unclear statement regarding enrolment<br>• 232 patients were excluded due to incomplete documentation. |
| Do 2014 | Trauma patients attending a trauma centre and transported by ambulance (also self-attendees). | ACS-SCOT | ISS>15 | Registry data<br>• Study reports paediatric and adult populations separately.<br>• Unclear statement regarding enrolment |
| Ocak 2009 | Adult trauma patients transported by ambulance from an accident scene. | ACS-SCOT | ISS >15 | • Patients selected differentially for either arm (consecutive and randomised). |

**Table 9: Diagnostic accuracy profile for ACS-SCOT in detecting major trauma with sufficient data for meta-analysis**

| Index Test (threshold) | No of studies | n | Risk of bias | Inconsistency | Indirectness | Imprecision | Sensitivity % (median/range/ 95% CI) | Specificity % (median/range/ 95% CI) | Quality |
|---|---|---|---|---|---|---|---|---|---|
| Index Test ACS-SCOT for detecting Major Trauma in Adults | | | | | | | | | |
| ACS-SCOT | 3 | 4900 | Serious[a] | Serious[b] | None | Serious[c] | 0.63 [0.57-0.69]<br>0.76 [0.70-0.82]<br>0.84 [0.77-0.90]<br><br>Median 0.76 [0.70-0.82] | 0.75 [0.74-0.77]<br>0.97 [0.96-0.98]<br>0.77 [0.70-0.84]<br><br>Median 0.97 [0.96-0.98] | VERY LOW |

*(a) Studies were downgraded by one increment for limitations in one risk of bias domain or by two increments for risk of bias in two or more domains. Studies were assessed using the QUADAS –II criteria. Risk of bias domains: patient selection, index test, reference standard, flow and timing.*

*(b) Inconsistency was assessed by inspection of the sensitivity/specificity RevMan 5[2] plots, or summary receiver operating characteristics curves (ROC).*

*(c) The judgement of precision for sensitivity and specificity separately was based on visual inspection of the confidence region in the diagnostic meta-analysis, where diagnostic meta-analysis has not been conducted imprecision was assessed using the confidence interval of the median sensitivity value. For studies with only AUC data precision was based on the corresponding 95%CI. Downgrading by one increment was applied for confidence intervals 10-20% or by two increments for confidence intervals more than 20%. If no variance data was available (imprecision could not be assessed) the studies were downgraded by one increment.*

**Table 10: Diagnostic accuracy profile for ACS-SCOT in detecting Major Trauma (Children)**

| Index Test (threshold) | No of studies | n | Risk of bias | Inconsistency | Indirectness | Imprecision | Sensitivity % (median/range/ 95% CI) | Specificity % (median/range/ 95% CI) | Quality |
|---|---|---|---|---|---|---|---|---|---|
| Index Test ACS-SCOT for detecting Major Trauma in Children | | | | | | | | | |
| ACS-SCOT | 1 | 238 | Serious[a] | None | None | Very serious[b] | 0.73 [0.39-0.94] | 0.96 [0.92-0.98] | VERY LOW |

*(a) Studies were downgraded by one increment for limitations in one risk of bias domain or by two increments for risk of bias in two or more domains. Studies were assessed using the QUADAS –II criteria. Risk of bias domains: patient selection, index test, reference standard, flow and timing.*

*(b) The judgement of precision for sensitivity and specificity separately was based on visual inspection of the confidence region in the diagnostic meta-analysis, where diagnostic meta-analysis has not been conducted imprecision was assessed using the confidence interval of the median sensitivity value. For studies with only AUC data precision was based on the corresponding 95%CI. Downgrading by one increment was applied for confidence intervals 10-20% or by two increments for confidence intervals more than 20%. If no variance data was available (imprecision could not be assessed) the studies were downgraded by one increment.*

**Table 11: Diagnostic accuracy profile for UK Tools in detecting Major Trauma (Children)**

| Index Test (threshold) | No of studies | n | Risk of bias | Inconsistency | Indirectness | Imprecision | Sensitivity % (median/range/ 95% CI) | Specificity % (median/range/ 95% CI) | Quality |
|---|---|---|---|---|---|---|---|---|---|
| Index Test UK Tools for detecting Major Trauma in Children | | | | | | | | | |
| London | 1 | 701 | Serious[a] | None | None | None | 0.96 (0.92-0.98) | 0.28 (0.24-0.33) | MODERATE |
| East Midlands | 1 | 701 | Serious[a] | None | None | None | 0.97 (0.93-0.99) | 0.17 (0.14- 0.21) | MODERATE |
| North West | 1 | 701 | Serious[a] | None | None | None | 0.93 (0.89-0.96) | 0.20 (0.17-0.24) | MODERATE |
| Northern | 1 | 701 | Serious[a] | None | None | None | 0.91 (0.87-0.95) | 0.23 (0.19-0.27) | MODERATE |
| South West London | 1 | 701 | Serious[a] | None | None | None | 0.88 (0.83-0.92) | 0.41 (0.37-0.46) | MODERATE |
| Wessex | 1 | 701 | Serious[a] | None | None | None | 0.77 (0.71-0.83) | 0.47 (0.43-0.52) | MODERATE |

*(a) Studies were downgraded by one increment for limitations in one risk of bias domain or by two increments for risk of bias in two or more domains. Studies were assessed using the QUADAS –II criteria. Risk of bias domains: patient selection, index test, reference standard, flow and timing.*

## 6.4 Economic evidence

### Published literature

One economic evaluation relating to this review question was identified but was excluded due to a limited applicability.[32] This is reported in Appendix K, with reasons for exclusion given.

See also the economic article selection flow chart in Appendix E.

### New cost-effectiveness analysis

This area was prioritised for new cost-effectiveness analysis. However the economic modelling could not be developed. Details are provided in Appendix M.

## 6.5 Evidence statements

### Clinical

#### ACS-COT adults

Very low quality evidence from 3 prospective studies comprising 4900 adults showed that the ACS-COT tool has a median (95% CI) sensitivity of 0.76 (0.70 to 0.82) and a corresponding specificity of 0.97 (0.96 to 0.98) for diagnosing patients with an ISS>15.

#### ACS-COT children

Very low quality evidence from a single prospective study comprising 238 children showed that the ACS-COT tool has a mean (95% CI) sensitivity of 0.73 (0.39 to 0.94) and a corresponding specificity of 0.96 (0.92 to 0.98) for diagnosing patients with an ISS>15.

#### UK Triage Tools children

Moderate quality evidence from a single prospective study comprising 701 children showed that 6 UK-based triage tools have a median (95% CI) sensitivity of 91% (0.87–0.95) and a corresponding specificity of 0.23 (0.19 to 0.27) for diagnosing patients with an ISS>15.

### Economic

No relevant economic evaluations were included.

## 6.6 Recommendations and link to evidence

| | |
|---|---|
| **Recommendations** | **Pre-hospital triage tool**<br><br>**Recommendations for ambulance trust boards, medical directors and senior managers in ambulance trusts**<br><br>**1. Provide a pre-hospital major trauma triage tool to differentiate between patients who should be taken to a major trauma centre and those who should be taken to a trauma unit for definitive management.** |

| | |
|---|---|
| | **2. Choose a pre-hospital major trauma triage tool that includes assessment of physiology and anatomical injury and takes into account the different needs of older patients, children and other high-risk populations (such as patients who take anticoagulants, pregnant women and patients with comorbidities).**<br><br>**3. Support pre-hospital care providers using the major trauma triage tool with immediate clinical advice from the ambulance control centre.**<br><br>**4. Train pre-hospital care providers to use the major trauma triage tool.**<br><br>**5. Monitor and audit use of the major trauma triage tool as part of the major trauma network's quality improvement programme.**<br><br>**Appropriate destination**<br><br>**Recommendations for pre-hospital care providers**<br><br>**6. Be aware that the optimal destination for patients with major trauma is usually a major trauma centre. In some locations or circumstances intermediate care in a trauma unit might be needed for urgent treatment, in line with agreed practice within the regional trauma network.**<br><br>**7. Spend only enough time at the scene to give immediate life-saving interventions.**<br><br>**8. Divert to the nearest trauma unit if a patient with major trauma needs a life-saving intervention, such as drug-assisted rapid sequence induction of anaesthesia and intubation, that cannot be delivered by the pre-hospital team.** |
| Description of current UK services | UK regional pre-hospital emergency services have developed decision tools (largely based on the ACS-COT Trauma Triage Rule) to identify the patients with major trauma. These tools support practitioners in identifying the patient's injuries and the severity of those injuries. Some decision tools have a scoring system and the score will determine where to transport the patient. Patients with major trauma are usually transported to a MTC. There are some exceptions and this based on local services.<br><br>The algorithm-based tools are individually applied and are triggered by a range of physiological, anatomic and mechanical criteria associated with the patient and their injury. Special considerations and modifications of the tools are also considered for factors such as age.<br><br>There is no national or definitive triage tool or criteria and these vary between pre-hospital emergency services. |
| Relative values of different outcomes | Diagnostic outcomes (such as sensitivity) will be reported as primary outcomes. Sensitivity has been selected as the most important outcome as failure to triage a patient with major trauma to an MTC is associated with a |

| | |
|---|---|
| | worse clinical outcome. The GDG also considered over-triage (1-specificity) rates as these are commonly reported in the literature. Accuracy to predict injury severity (usually reported as an ISS score >15 in adults) was used as the reference standard to determine a patient who should be triaged to a MTC. |
| Trade-off between clinical benefits and harms | **Appropriate destination**<br>The aim of this review was to ensure that patients with injuries as a result of trauma are taken to the appropriate destination. The GDG noted the principle that in a trauma network patients with major trauma should usually go directly to a major trauma centre for treatment.<br><br>For the majority of patients with major trauma direct transport to a MTC is the best destination for their immediate survival and long term recovery. Patients who are taken to TUs may not receive timely specialist care and require transfer to the MTC which inevitably results in a delay in their treatment.<br><br>The GDG did note that in the case of a patient with injuries that cannot be stabilised in the pre hospital setting and are unlikely to survive the journey to a MTC (where a TU is closer) the patient should be taken immediately to the nearest TU. Please see the access to services chapter, section 17.3.1 on the review about the timing of airway management. This set of recommendations make it clear that if a person's airway cannot be maintained safely by RSI or a supraglottic device in the pre hospital setting (i.e., they still have a compromised airway or ventilation) then they should be taken to the nearest ED.<br><br>Decision making using a trauma triage tool is subject to local service provision. In some regions specialised orthopaedic services are situated within a TU and not a MTC. The GDG also discussed scenarios when triage to an MTC was not possible (such as remote hospitals in severe weather) and the subsequent service effects (that is, contingency planning for TU to act as the MTC).<br><br>**Adults**<br>The evidence presented to the GDG on 3 studies in adults showed a relatively large range for sensitivity (0.63-0.84) and specificity (0.75 to 0.97) using the ACS-COT tool.<br><br>**Children**<br>Triage of children using the ACS-COT tool was reported separately in a single European study but included a small sample size of 238 patients. The tool demonstrated a sensitivity of 0.73, but this had a large confidence interval (0.39-0.94) due to the small sample size. Specificity was high 0.96 [95%CI 0.92-0.98]. A single study by Cheung et al., reported diagnostic data for 6 UK-based triage tools using the same 701 patients. Sensitivity ranged from 0.77 to 0.97 and specificity 0.17 to 0.47.<br><br>The GDG discussed the variation in diagnostic outcomes between the tools in both adults and children, and believed this was due to different criteria required for triggering the tools. The GDG discussed how many of the tools would result in unacceptable under and/or over-triage rates.<br><br>**Triage tools**<br>The GDG discussed the evidence and decided that the low quality evidence and lack of information about the measures in the tools meant they could not recommend a specific tool. |

| | |
|---|---|
| | The GDG noted that the measures used to assess the patient's condition are not reported in the studies and this limited the GDG ability to comment on both the tool's performance and on which assessments could be useful.<br>The GDG recognised that an accurate triage tool can be useful to support clinical decision making and in directing practitioners where to transport a patient to ensure they get optimal care.<br>Therefore, the GDG recommended the use of a triage tool without specifying the tool or the specific criteria to be included. The GDG emphasised the need for a triage tool to consider assessment of physiology and anatomical injury as a minimum.<br><br>Triage based on mechanism of injury alone was not recommended as the GDG were aware that mechanism of injury alone does not have predictive clinical significance in triage of major trauma patients without physiological distress and anatomical suspicion. Moreover, the GDG mentioned that some pre-hospital services have removed mechanism of injury from their triage tool.<br><br>The GDG indicated that the elderly population are often under triaged and that triage tools should consider this population as relatively minor injuries can have a severe impact. Conversely, the GDG pointed out that children are often over triaged but indicated that the risk of missing major trauma in children is likely to be more serious. The GDG felt it was important that tools be developed to specifically consider these populations and other high risk populations (such as pregnancy).<br><br>The GDG discussed the Importance of clinical judgement in decision making noting that that experienced pre-hospital providers and trained doctors could overrule the triage tool in specific circumstances. Equally, non-experienced providers will use the tool, and the GDG felt it was important that immediate clinical support advice should be provided centrally by all ambulance trusts. The GDG recommended that 24/7 triage support system should be provided and felt this would improves under-triage and over-triage rates. |
| Trade-off between net health benefits and resource use | **Triage tools**<br>No economic or clinical evidence was identified on the accuracy of triage tools; therefore, the cost effectiveness of available tools could not be assessed.<br>There is a trade-off between over triaging and under triaging. If the initial triaging decision is incorrect, the patient could incur critical delay in reaching the appropriate service to treat their condition. Under triaging is associated with potential clinical harm as patients would have a delay in the appropriate treatment (assumed to be provided only in a MTC), and in addition there will be costs of transfer of such patients to the appropriate place of treatment and additional downstream costs associated with clinical complications associated with delayed treatment. Whilst over triage to an MTC does not carry safety risks to the patient concerned, inappropriate trauma team activation can cause disruption to the MTC hospital services detracting staff and diverting resources from other patients. In many geographical locations, the MTC may be far from the patient's residence and unnecessary repatriation transfer costs to their local provider would be incurred.<br><br>On the other hand, under triage could result in direct clinical harm for the patient as well as unnecessary resource use. However, the rarity of major traumatic incidents alongside the expertise available to stabilise at TUs should be taken into account when considering the risk of under triage and subsequent absolute harm that may be incurred.<br><br>**Training** |

| | |
|---|---|
| | The experience and competency of the attending pre-hospital staff member may impact on the interpretation of the triage tool and alter its accuracy, therefore, training in the use of triage tools may be associated with incremental costs but these were thought to be easily offset if the healthcare professional who received the training is able to use the skills on several patients, as the cost is occurred only once but it would increase the health gain of all the patients attended by them. |
| Quality of evidence | The quality of evidence was Very low for the pooled analysis with ACS-COT in adults. The evidence was at high risk of bias, with the major limitation being unclear reporting of patient selection. There was also considerable imprecision and inconsistency in the reported sensitivities and specificities of the pooled adult studies.<br><br>The single study which reported the diagnostic accuracy of the ACS-COT triage tool in children was at Very low quality. The evidence was at a high risk of bias due to unclear reporting of patient selection with very serious imprecision and large range of sensitivity (0.39-0.94). The UK-based study by Cheung et al., was also at a serious risk of bias due to patient's selection but considered to be at an overall moderate quality level.<br><br>The GDG mentioned that the source of evidence for each study was important. Trauma registries (such as TARN) may be bias as they only collect data on moderately or seriously injured children and this may not fully capture over-triage of each tool. For true assessment the tools should be assessed in an unselected population. |
| Barriers to implementation | The GDG discussed current practice and the barriers to implementing the recommendations. Firstly, no standardised triage tool has been developed and standardised in the pre-hospital setting across the UK. This would require extensive research and subsequent training of pre-hospital clinicians, but the GDG felt a nationally recognised and robust trauma triage tool and protocol would be clinically and economically beneficial. The GDG also discussed the benefit of a current UK audit of triage tools. Databases such as TARN could be used to aid this data collection and analyses. |
| Other considerations | The GDG discussed the application of the tool in an urban and rural setting, and the impact this could have on patient management. The GDG pointed out that London has 4 MTCs and that the pre-hospital provider could access each centre relatively quickly. Other areas (such as Cornwall) are subject to longer transfer times, and additional clinical judgement is required when triaging these patients. In particular, patients with conditions requiring immediate medical intervention, which cannot be provided by the pre-hospital provider, should be re-directed to a local trauma centre for management. Additionally, the GDG indicated that the patients should be made safe and transferred to the MTC without delay, as this would result in a better outcome for the patient (see chapter9 Transfer of people with major trauma). The GDG accepted that delays in transfer to final destination were common in many systems currently and wanted to make a direct recommendation to prevent this<br><br>The GDG also recommended continuous training and audit of the tools to ensure competency. The GDG gave examples of pre-hospital networks in which training was successful and emphasised the importance of feedback and how networks have improved triage. |

# 7 Pre-alert processes

## 7.1 Introduction

Once the decision has been made to transport a patient with major trauma to the ED it is important that the receiving hospital is prepared for the patient, avoiding the chaotic situation of a seriously ill patient turning up unannounced. A pre-alert call is vital to ensure staff with the right expertise are in the ED waiting for the patient. The alert allows the trauma team to be diverted from other tasks and time to get to the resuscitation room.

Accurate pre-alert information on the patient's injuries and condition is important to ensure the appropriate specialists are in the ED. While a multidisciplinary trauma team with all specialties provides immediate specialist knowledge and practical skills this is a costly hospital resource and not necessary for all situations. An efficient use of resources is to make sure that only the people that are needed are in the ED.

The decision by pre-hospital practitioners to activate a pre-alert call is based on experience and the triage tool. The placement of an appropriate pre-alert call to activate a trauma team and the communication of the right information is a challenging task while simultaneously managing a severely injured unstable patient.

The criteria communicated to the ED to activate a trauma team for the resuscitation of severely injured patients is variable across the UK. Important information from the scene may fail to reach the hospital resuscitation team because of inadequate collection, loss through third party transmission and incomplete handover. Standardised pre-alert information and procedures agreed within a trauma network and supported by training could help to manage this situation, supporting both the pre-hospital and hospital teams to make the right decisions for the patient.

## 7.2 Review question: What is the accuracy of pre-alert?

For full details see review protocol in Appendix C.

**Table 12: PICO characteristics of review question**

| | |
|---|---|
| **Population** | Children, young people and adults experiencing trauma |
| **Tool** | Pre-alert |
| **Outcomes** | Diagnostic accuracy<br>Any additional outcomes related to ensuring the right people are available to receive the patient |
| **Study design** | Observational |

## 7.3 Clinical evidence

No clinical studies were identified.

One study[6,6] on the accuracy of new pre-alert tool for by ambulance crews transporting patients to Aberdeen Royal Infirmary was excluded because it was in all patients taken to the resuscitation area but the number of patients with trauma was not reported. The study reports the sensitivity and specificity of the tool. The second study[7,7] took place at King's College Hospital, South London. Data were collected on patients for whom "blue calls" were made to an A&E department over three months of 1998. Patients with life threatening conditions who were brought by non-blue light ambulance were identified during the same period. 26% of the patients were trauma. The study

reported on the mortality, completeness of pre-hospital documentation and the 'appropriateness' of the pre-alert. The GDG decided that the inclusion of this indirect evidence was not useful for decision making as the make-up of the team in responding to a trauma call is more complex than in other critical situations.

## 7.4 Economic evidence

### Published literature

No relevant economic evaluations were identified.

See also the economic article selection flow chart in Appendix E.

### New cost-effectiveness analysis

This area was prioritised for new cost-effectiveness analysis. However the economic modelling could not be developed. Details are provided in Appendix M.

## 7.5 Evidence statements

### Clinical

No clinical studies were identified.

### Economic

No relevant economic evaluations were identified.

## 7.6 Recommendations and link to evidence

| | |
|---|---|
| **Recommendations** | **Recommendations for medical directors, senior managers and senior pre-hospital care providers within a trauma network**<br><br>**9. Provide a structured system for recording and receiving pre-alert information. Ensure that the information recorded includes:**<br>• **age and sex of the injured person**<br>• **time of incident**<br>• **mechanism of injury**<br>• **injuries suspected**<br>• **signs, including vital signs, and Glasgow Coma Scale**<br>• **treatment so far**<br>• **estimated time of arrival at emergency department**<br>• **special requirements**<br>• **the ambulance call sign, name of the person taking the call and time of call.**<br><br>**At the emergency department**<br><br>**Recommendations for senior managers and senior doctors and nurses** |

| | |
|---|---|
| | **in emergency departments**<br><br>**10. Ensure that a senior nurse or trauma team leader receives the pre-alert information and determines the level of trauma team response according to agreed and written local guidelines.**<br><br>**11. Ensure that the trauma team leader is easily identifiable to receive the handover and the trauma team is ready to receive the information.**<br><br>**12. Ensure that pre-hospital documentation, including the recorded pre-alert information, is made available to the trauma team quickly and placed in the patient's hospital notes.** |
| Description of current UK services | Emergency departments receiving trauma are alerted by the ambulance control centre that a patient is on their way. The way this is done and the information that is communicated is different across the UK. ATMISTER+ is a minimum data set that is frequently referred to in local pre-alert protocols. |
| Relative values of different outcomes | The GDG centred discussions around sensitivity (an indication of the false negative rate). False negatives (a negative test result when there is a major trauma) may cause considerable clinical and health economic harms. For example, failure to alert an ED to a major trauma patient could lead to unnecessary delay in treatment.<br><br>The GDG also considered specificity, a false positive, as these results in the ED activating a trauma call and mobilising staff unnecessarily. |
| Trade-off between clinical benefits and harms | The GDG expressed the need for standardised pre-alert procedures and handover documentation. They highlighted the potential harms of not alerting an ED to a critically ill patient resulting in not being adequately prepared with the right staff in the right place.<br><br>The pre-alert and the handover should be structured according to a minimal dataset, such as ATMISTER+, as too much information can hinder transfer. Creating such a pro-forma would enable anyone to receive the information and achieve consistency across services and the country. The triage tool could be used but has a lot of information and due to variations in tools across the country, the use of these to inform standard documentation was not considered appropriate for the task.<br><br>Information should be conveyed in a structured way verbally (by telephone or on the screen if available initially and then in person when the patient is transferred) , as well as in a written format to the trauma team leader and the team on arrival at the ED. The structure of documenting the information at the receiving hospital should be based on the same structure.<br><br>The GDG emphasised the importance of an experienced professional receiving the pre-alert, this is to ensure a judgement can be made on the level of response and trauma team activation that is needed. The person receiving the handover from the pre hospital practitioners should be easily identifiable and should be the trauma team leader. The trauma team leader should brief the trauma team before arrival of the patient, discussing pre-hospital information, assigning tasks, checking equipment and anticipating problems. It is essential that the trauma team leader is available to receive the information so that they can direct other members of the team based on the information received. |

| | |
|---|---|
| | The GDG recognised the existence of a scoring system such as the National Early Warning Score (NEWS) which can be used to record and monitor physiology during the initial pre-hospital and/or hospital and throughout the patient's hospital stay. |
| Trade-off between net health benefits and resource use | No economic evidence was identified.<br><br>The GDG considered having a structured system for pre-alert procedures and recording information to be cost effective as this would minimise harm from not alerting an ED to a critically ill patient and on the other hand, it would ensure resources are not incorrectly used for the trauma team activation for non-critical patients.<br><br>If the right resources are not deployed for the right patient at the right time this can result in delayed treatment for the patient and additional costs at a later stage in the patient's recovery in treating potentially avoidable complications.<br><br>If staff are deployed for a trauma call and are not needed this takes away resources from other clinical areas and patients.<br><br>The resource implications of having this system in place were considered to be not significant and having experienced professional receiving the pre-alert would save unnecessary costs due to unnecessary trauma team activation. |
| Quality of evidence | No evidence was identified |
| Barriers to implementation | Standardising information and documentation requires planning and the resource to do this.<br><br>An effective pre-alert system requires the people using the system to be trained. Resource is needed to organise and deliver the training and for staff to have protected time to attend the training. |
| Other considerations | The GDG also agreed on the following consensus recommendations on the general principles of documentation and the transfer of information for a patient with major trauma injuries. See chapter 12 for more detail on the general principles of documenting and transferring information. |

# 8 Receiving trauma teams

## 8.1 Introduction

Major trauma centres (MTCs) and trauma units (TUs) have been established to improve outcomes for severely injured trauma patients, as well as for a large number of less seriously injured trauma patients[39]. It is important that the resources of both MTCs and TUs are used wisely in order to optimise quality care and ensure resource allocation is cost effective. In many EDs a multidisciplinary team of health professionals is activated prior to patient arrival so that they are ready to provide expert assessment and initial treatment for the trauma patient[15]. There is a potential trade-off between having the correct people available (everyone shows up) which can lead to over triage and unwarranted loss of skilled hours; and not having enough specialists which may result in a failure to recognise the severity of injuries leading to clinical deterioration, or a time delay getting the correct staff to resuscitation and complications resulting from delayed diagnosis or treatment[15,50]. Tiered trauma teams, based on pre-hospital triage tools, may provide a clinical and cost-effective solution. Tiered trauma team systems aim to better match the personnel and resources of the trauma team to the immediacy of the patients need for care[21]. This review compares the clinical and cost effectiveness of tiered trauma teams where the most severely ill trauma patients are met with 'higher-tier' trauma response teams featuring specialist members and other patients are met with modified versions of the trauma response team.

## 8.2 Review question: What is the clinical and cost effectiveness of providing a tiered response to patients arriving at a MTC or TU?

For full details see review protocol in Appendix C.

**Table 13: PICO characteristics of review question**

| | |
|---|---|
| **Population** | Children, young people and adults who have had a traumatic incident. |
| **Intervention and comparisons** | Any trauma team combination as described by the literature compared with any other combination.<br><br>Examples:<br>Basic – emergency department (ED) consultant, ED registrar (st4), nurse (grade 6 or 7)<br>Standard – ED consultant, ED registrar (st4), 2 nurses (grade 6 or 7), anaesthetist (registrar, st4), OT surgeon (st4), general surgeon (st4), radiographer. If paediatric patient then paediatric surgeon, paediatric anaesthetist and paediatrician.<br>Advanced – Orthopaedic, vascular, plastic or cardio-thoracic surgeons, obstetrics and gynaecology, urology, maxillofacial, paediatric, neurosurgery, radiologist. |
| **Outcomes** | Critical:<br>• Mortality<br>• Quality of life<br>• Important:<br>• Time in ED<br>• Time to definitive care<br>• Time to CT<br>• Missed/delayed diagnosis of injury<br>• Delays to transfer<br>• Complication rates<br>• Trauma team member time |

| | |
|---|---|
| | • Hospital length of stay |
| **Study design** | RCTs or observational |

## 8.3 Clinical evidence

We searched for randomised trials and observational cohort studies comparing the effectiveness of different systems of trauma response teams. Three papers were included in the review[21,28,50]; these are summarised in Table 14 below. Evidence from these studies is summarised in the clinical evidence summary (Table 16). See also the study selection flow chart in Appendix D, study evidence tables in Appendix G, forest plots in Appendix I, GRADE tables in Appendix H and excluded studies list in Appendix J.

All three included studies are before-and-after cohort studies. Two studies[21,50] compare an initial period of non-tiered response with a later period following the implementation of a two-tiered response. In both cases, the initial period featured a response team which would later become the 'higher-tier' response team responding to all trauma activations. Both 'after' periods featured the implementation of a second 'lower-tier' response team and introduction of different triage tools to determine which tiered team should be activated for the in-coming patient(s). The third study[28] compares an initial period of two-tiered response with a later period following the implementation of a three-tiered response. For the three-tiered period the earlier full trauma team is split into two categories where the new 'middle' tier team does not immediately include the trauma attending and anaesthetist. Details of specific team membership and corresponding triage tools are provided in Table 15.

**Table 14: Summary of studies included in the review**

| Study | Intervention and comparison | Setting | Outcomes | Comments |
|---|---|---|---|---|
| Eastes 2001[21] | Comparison 2 years before and 2 years after implementation of a two-tiered trauma response team.<br><br>See Table 15 for details on triage tools used and tiered trauma team membership. | Level 1 trauma centre<br>(USA) | Mortality<br>Hospital length of stay<br><br>ED length of stay, Time to OR, and Time to ICU presented as median only and only provided for those admitted to hospital (not able to be analysed) | Univariate analysis only for comparison of outcomes before and after introduction of tiered teams. Matched at baseline for age, injury severity and depth of shock (admission systolic BP).<br>Risk of bias re allocation by time: the post (two-tiered) period corresponded to the opening of a 24-hour ED observation unit. Those discharged from here were not counted as hospital admissions (discharged home from ED: POST 16%; PRE 2%) |
| Kaplan 1997[28] | Comparison 3 months before and 3 months after implementation of a three-tiered trauma response team.<br><br>See Table 15 for details on triage tools | Level 1 trauma centre<br>(USA) | Mortality<br>Complications<br>ED length of stay | Univariate analysis only for comparison of outcomes before and after introduction of 3rd tiered team. Matched at baseline for age and injury severity. No measurement of depth of shock at baseline reported but matched for |

| Study | Intervention and comparison | Setting | Outcomes | Comments |
|---|---|---|---|---|
| | used and tiered trauma team membership. | | | "probability of survival by TRISS score". |
| Tinkoff 1996[50] | Comparison 6 months before and 6 months after implementation of a two-tiered trauma response team.<br><br>See Table 15 for details on triage tools used and tiered trauma team membership. | Level 1 trauma centre<br>(USA) | ED length of stay | Univariate analysis only for comparison of outcomes before and after introduction of tiered teams. Matched at baseline for age and injury severity. No measurement of depth of shock at baseline reported but matched for "Revised Trauma Score" and "probability of survival".<br>Due to outcome reporting style the outcome includes 'trauma consultations' which were trauma service admissions that did not meet triage criteria – stable trauma patients without life-threatening or limb-threatening injury but requiring hospitalisation. |

**Table 15: Summary of triage criteria and trauma team membership reported by included studies**

| Study | Highest-tier | Middle-tier | Lowest-tier |
|---|---|---|---|
| Triage criteria | | | |
| Eastes 2001[21] | **Criteria for FULL trauma activation**<br>Airway problems (intubated or attempted intubation)<br>Breathing difficulty (respiratory rate <10 or >29 breaths/minute)<br>Systolic BP <90 mmHg<br>GCS <11<br>Penetrating injury to head neck or torso<br>Flail chest<br>Paralysis<br>Pelvic instability<br>Amputation proximal to the wrist or ankle<br>Major crush injury to torso or upper thigh. | Not applicable | **Criteria for MOD trauma activation**<br>GCS >11 and <13<br>Two or more long bone fractures<br>Fall >20 feet<br>Ejection from vehicle<br>Death in same passenger compartment<br>Extrication time >20 minutes<br>Rollover motor vehicle crash<br>Auto vs. pedestrian <5 mph<br>Special consideration age <5 or >65 years<br>Paramedic discretion: motorcycle, all-terrain vehicle or bicycle crash, significant intrusion/impact, hostile environment, pre-existing medical illness, presence of intoxicants, pregnancy. |
| Kaplan 1997[28] | **CATEGORY I trauma team**<br>**Two- tiered system (PRE)**<br>Results from emergency | **CATEGORY II trauma team (three tier system only)**<br>Distal extremity, penetrating | **Routine trauma consultation team**<br>**Two-tiered system (PRE)** |

| Study | Highest-tier | Middle-tier | Lowest-tier |
|---|---|---|---|
| | medical services based on mechanisms or vital signs<br>Initial trauma score ≤12<br>Request of emergency medicine attending<br>Multiple simultaneous victims<br>**Three-tiered system (POST)**<br>Penetrating trauma to head, neck, chest, abdomen, groin and proximal extremities<br>Haemodynamic instability: SBP <90 mmHg, HR >120 bpm<br>Airway trauma or respiratory distress<br>GCS < 13, confusion, violence, altered sensorium, paralysis, focal neurological deficit<br>Major amputation<br>Any patients/situation deemed appropriate by the responsible attending in emergency medicine or trauma (that is, multiple victims) | injury without vascular compromise<br>Haemodynamic stability with significance mechanism of injury<br>Helicopter transports that do not meet category I criteria<br>Major burns without airway involvement<br>Any patient/situation deemed appropriate by the responsible emergency medicine or trauma attending (that is, EMS requests a trauma alert but provides no other information) | Any trauma patient not meeting category I<br>**Three-tiered system (POST)**<br>Any trauma patient not meeting the criteria of outlined in highest or middle tier |
| Tinkoff 1996[50] | **Criteria for TRAUMA CODE activation**<br>Witnessed cardiac arrest<br>Obvious ventilator compromise (respiratory rate <10 or >35)<br>Systolic BP <90 despite ALS<br>GCS <8<br>Obvious major vascular injury with external haemorrhage<br>Severe maxillofacial injury<br>Multiple open fractures<br>Major amputation proximal to elbow and knee<br>Suspected head injury (GCS <12) with major torso or extremity injury suspected or present<br>Gunshot wound to neck, trunk or groin<br>Shotgun or buckshot wounds<br>Major impaling to neck, torso or proximal extremity<br>Haemodynamic deterioration<br>Simultaneous arrival of 3+ multi-trauma patients | Not applicable | **Criteria for TRAUMA ALERT activation**<br>Respiratory rate <10 or >30 breaths/minute<br>Systolic BP <90 mmHg<br>Unresponsive to voice (GCS ≤12)<br>Penetrating injury to head, neck, torso, extremities proximal to elbow or knee<br>Flail chest<br>Combo trauma with burns (10%) or inhalation injuries<br>Two or more long bone fractures<br>Pelvic fractures<br>Limb paralysis<br>Amputation proximal to wrist and ankle<br>Ejection from vehicle<br>Death in same passenger compartment<br>Extrication time >20 minutes<br>Rollover motor vehicle crash<br>High-speed crash (initial speed >10 mph, velocity change >20 mph, major auto deformity, intrusion into passenger |

| Study | Highest-tier | Middle-tier | Lowest-tier |
|---|---|---|---|
| | | | compartment)<br>Auto v. pedestrian <5 mph<br>Motorcycle crash >20 mph<br>Extremities of age <12 or >60 years<br>Hostile environment<br>Other medical illness<br>Presence of intoxicants<br>Pregnancy |
| Trauma team membership | | | |
| Eastes 2001[21] | **FULL trauma team**<br>Staff trauma surgeon<br>Chief trauma resident<br>Staff ED physician<br>ED resident<br>Staff anaesthesiologist<br>Anaesthesiologist resident<br>Respiratory care practitioner<br>ED nurses (3)<br>ED specialist<br>Radiology technician<br>Transport aid | Not applicable | **MOD trauma team**<br>Staff trauma surgeon<br>Chief trauma resident<br>Staff ED physician<br>ED resident<br>ED nurses (2)<br>ED specialist<br>Radiology technician |
| Kaplan 1997[28] | **CATEGORY I trauma team**<br>Emergency medicine physician<br>Post-graduate emergency medicine resident and/or<br>Post-graduate year one emergency medicine intern<br>ED nurse<br>Attending surgeon<br>PGY-4 or PGY-5 surgery resident<br>PGY-3 or PGY-1 general surgery resident<br>Trauma nurse coordinator (daytime)<br>Nurse shift supervisor (night time)<br>Anaesthetist<br>OR charge nurse<br>Respiratory therapist<br>Radiology technician/CT scan technologist<br>Social worker<br>Orderly | **CATEGORY II trauma team**<br>As for category I but no trauma attending, no anaesthesia personnel and no OR personnel. However, all these members will be notified by the pager system and are available on demands | **Routine trauma consultation team**<br>Emergency medicine physician<br>Post-graduate emergency medicine resident and/or<br>Post-graduate year one emergency medicine intern<br>ED nurse |
| Tinkoff 1996[50] | **CODE trauma team**<br>Emergency medicine attending physician<br>Emergency medicine residents | Not applicable | **ALERT trauma team**<br>Emergency medicine attending physician<br>Emergency medicine residents |

| Study | Highest-tier | Middle-tier | Lowest-tier |
|---|---|---|---|
| | (1-4)<br>Trauma service residents (1-2)<br>ED nurse – procedure<br>ED nurse – documentation<br>Respiratory therapist<br>Trauma chief resident<br>Anaesthesia<br>Trauma attending physician<br>X-ray technician/runner<br>ED technician<br>Trauma service nurse (daytime)<br><br>Also: Operating room, CT technologist and ICU all prepare to receive patient immediately. Blood bank preps universal donor blood. | | (1-3)<br>Trauma service residents (1-2)<br>ED nurse – procedure<br>ED nurse – documentation<br>Respiratory therapist<br>Trauma chief resident<br>X-ray technician/runner<br>ED technician<br>Trauma service nurse (daytime)<br><br>Also: Operating room, CT technologist, ICU and blood bank are alerted. |

**Table 16: Clinical evidence summary: Two-tiered response team versus non-tiered response team in a level 1 trauma centre**

| Outcome | Number of studies (number of participants) | Imprecision | GRADE rating | Absolute difference (with 2-tiered) | Control event rate (per 1000) | Control event rate for continuous outcomes |
|---|---|---|---|---|---|---|
| Mortality | 1 (n=4073) | Serious | VERY LOW | 19 fewer per 1000 (from 5 fewer to 29 fewer) | 63 | - |
| Hospital length of stay (days) | 1 (n=3607) | None | VERY LOW | 0.6 days lower (1.12 to 0.08 lower) | - | 6.2 days |
| ED length of stay (minutes) - All patients (code, alert or consultation) | 1 (n=1044) | None | VERY LOW | 48 minutes lower (65.35 to 30.65 lower) | - | 289 minutes |
| ED length of stay (minutes) - Code patients only | 1 (n=219) | Serious | VERY LOW | 28 minutes lower (59.38 lower to 3.38 higher) | - | 195 minutes |

**Table 17: Clinical evidence summary: Three-tiered response team versus two-tiered response team in a level 1 trauma centre**

| Outcome | Number of studies (number of participants) | Imprecision | GRADE rating | Absolute difference (with 3-tiered) | Control event rate (per 1000) | Control event rate for continuous outcomes |
|---|---|---|---|---|---|---|
| Mortality (post ED presentation) | 1 (n=437) | Very serious | VERY LOW | 2 fewer per 1000 (from 31 fewer to 63 more) | 56 | - |
| Mortality (post hospital admission) | 1 (n=437) | Very serious | VERY LOW | 25 fewer per 1000 (from 39 fewer to 16 more) | 46 | - |
| Survival | 1 (n=437) | None | VERY LOW | 9 more per 1000 (from 38 fewer to 47 more) | 949 | - |

| Outcome | Number of studies (number of participants) | Imprecision | GRADE rating | Absolute difference (with 3-tiered) | Control event rate (per 1000) | Control event rate for continuous outcomes |
|---|---|---|---|---|---|---|
| Complications | 1<br>(n=437) | Serious | VERY LOW | 41 fewer per 1000<br>(from 73 fewer to 18 more) | 112 | - |
| Complication rate per person | 1<br>(n=437) | None | VERY LOW | 0.05 lower<br>(0.14 lower to 0.04 higher) | - | 0.17 |
| ED length of stay (hours) | 1<br>(n=437) | None | VERY LOW | 0.45 hours lower<br>(0.93 lower to 0.03 higher) | - | 3.98 hours |

**Table 18: Narrative evidence summary: Two-tiered response team versus non-tiered response team in a level 1 trauma centre**

| Outcomes | Number of studies (number of participants) | Two-tiered team (median) | Non-tiered team (median) |
|---|---|---|---|
| ED length of stay (hours) | 1 (n=3607/4073 only those admitted to hospital) | 1.5 | 0.7 |
| Time to OR (hours) | 1 (n=3607/4073 only those admitted to hospital) | 1.3 | 1.0 |
| Time to ICU (hours) | 1 (n=3607/4073 only those admitted to hospital) | 1.5 | 1.4 |

## 8.4 Economic evidence

### Published literature

No relevant economic evaluations were identified.

See also the economic article selection flow chart in Appendix E.

### New cost-effectiveness analysis

This area was prioritised for new cost-effectiveness analysis. However the economic modelling could not be developed. Details are provided in Appendix M.

### Unit costs

In the absence of cost effectiveness evidence, we estimated the cost per hour of the health care staff involved in different systems of trauma response teams. The table below reports the cost of basic, standard, and advanced team response as per the example of team compositions provided in the review question protocol.

**Table 19: Staff cost of tiered-team response**

| Strategy | Health care professional | Unit cost per hour (£) | Source |
|---|---|---|---|
| BASIC | ED consultant | 101 | PSSRU 2014 - consultant medical |
| | ED registrar (st4) | 40 | PSSRU 2014 - registrar |
| | Nurse (grade 6 or 7) | 46.5 | PSSRU 2014 - average between nurse grade 6 and 7 |
| | **Total** | **187.5** | |
| STANDARD | ED consultant | 101 | PSSRU 2014 - consultant medical |
| | ED registrar (st4) | 40 | PSSRU2014 - registrar |

| Strategy | Health care professional | Unit cost per hour (£) | Source |
|---|---|---|---|
| | Nurse 1 (grade 6 or 7) | 46.5 | PSSRU 2014 - average between nurse grade 6 and 7 |
| | Nurse 2 (grade 6 or 7) | 46.5 | PSSRU 2014- average between nurse grade 6 and 7 |
| | Anaesthetist (registrar st4) | 40 | PSSRU 2014 - registrar |
| | OT surgeon (st4) | 102 | PSSRU 2014 - consultant surgeon |
| | Radiographer | 35 | PSSRU 2014 - hospital radiographer |
| | **Total** | **411** | |
| ADVANCED | ED consultant | 101 | PSSRU 2014 - consultant medical |
| | ED registrar (st4) | 40 | PSSRU 2014 - registrar |
| | Nurse 1 (grade 6 or 7) | 46.5 | PSSRU 2014 - average between nurse grade 6 and 7 |
| | Nurse 2 (grade 6 or 7) | 46.5 | PSSRU 2014 - average between nurse grade 6 and 7 |
| | Anaesthetist (registrar st4) | 40 | PSSRU 2014 - registrar |
| | OT surgeon (st4) | 102 | PSSRU 2014 - consultant surgeon |
| | Radiographer | 35 | PSSRU 2014 - hospital radiographer |
| | Orthopaedic, vascular, plastic or cardio-thoracic surgeon | 102 | PSSRU 2014 - consultant surgeon |
| | **Total** | **513** | |

*Source: PSSRU 2014*[17]

## 8.5 Evidence statements

### Clinical

### Two-tiered systems compared with non-tiered systems

Very low quality evidence from one cohort study of 3607 to 4073 participants suggested no clinical difference in the outcomes of mortality and hospital length of stay, with serious to no imprecision.

Very low quality evidence from one cohort study [50] suggested a 1044 participants showed a clinically important reduction in ED length of stay for all patients when a three-tiered system is used, with none to serious imprecision .

**Three-tiered systems compared with two-tiered systems**

Very low quality evidence from one study of 437 participants suggested a benefit for a three-tiered system with respect to mortality and overall complications, with no to very serious imprecision.

Very low quality evidence from the same study suggested no clinical difference between tiered systems for survival for complication rates per person or ED length of stay, with no imprecision.

**Economic**

No relevant economic evaluations were identified.

## 8.6 Recommendations and link to evidence

| | |
|---|---|
| **Recommendations** | **Recommendations for senior managers in trauma units**<br><br>**13. Ensure that multispecialty trauma teams are activated immediately in trauma units to receive patients with major trauma.**<br><br>**14. Do not use a tiered team response in trauma units.**<br><br>**15. Have a paediatric trauma team available immediately for children (under 16s) with major trauma.**<br><br>**Recommendations for senior managers and senior doctors and nurses in major trauma centres**<br><br>**16. Consider a tiered team response to receive patients in major trauma centres. This may include:**<br>• **a standard multispecialty trauma team or**<br>• **a standard multispecialty trauma team plus specialist involvement (for example, code red for major haemorrhage) and mobilisation of supporting departments and services such as transfusion, interventional radiology and surgery.** |
| Description of current UK services | The need for a full multispecialty trauma team when a patient requires all the expertise is undisputed. There are circumstances when this may not be necessary and a person may need the expertise of specific specialties. In this case the trauma team may systematically evaluate patients where the extent of injury is unclear. A pre-alert (using something similar to the ATMISTer+ structure) helps identify when a higher level of specialists need to be mobilised for specific trauma calls (some MTC's call this a code red). For example, a smaller multidisciplinary team may be activated in response to certain mechanistic triggers and a larger specialist-focused team may be activated according to additional specific physiological and anatomical criteria (based on a pre-defined triage strategy). It is important to note the link between an |

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| | effective triage tool and pre alert system and an appropriate trauma team. |
| Relative values of different outcomes | Mortality and complications are critical outcomes from the patient perspective. The evidence base comprises mainly outcomes related to clinical care rather than resource use. The ED length of stay, while also being an important part of the patient experience, is somewhat of a proxy system-related outcome to the effect of tiered teams on wider hospital resource use.<br><br>No evidence was identified on the effect of tiered teams with respect to the critical patient-related outcome of quality of life. Similarly, no evidence was identified on important system-related outcomes of time to definitive care or CT, missed/delayed diagnosis of injury, delays to transfer or trauma team members' time. |
| Trade off between clinical benefits and harms | The GDG acknowledged that the case for tiered trauma teams in the context of MTCs is predominantly volume based with respect to trauma calls having the ability to disrupt the running, and dominate the resources, of the wider hospital (for example, theatre utilisation, increase use of imaging modalities and their associated specialist staff, pulling anaesthetists and other specialists away from pre-scheduled surgeries). Therefore, when looking at the 'standard multi-speciality' and 'advanced' response, it is not just about the clinical outcome but also the full pathway of the patient (including booking operating rooms, prepping the blood banks and ICU).<br><br>The idea of 'trauma fatigue' was also discussed. If multiple specialists are expected to attend to all trauma calls no matter whether their particular speciality has been confirmed as necessary or not, they may become less likely to respond appropriately or in a timely manner and this will be to the detriment of the patient (it is important to note that for TUs the opposite is the case): if the specialists there are only called to a limited amount of 'higher-level' cases, their experience and skill set will decline due to the already much lower number of trauma cases they are likely to be seeing. Therefore, the GDG felt that a tiered response was not recommended for TUs and all members of the standard multidisciplinary should attend all trauma calls).<br><br>Based on the available evidence which includes both patient outcomes (mortality and complications) and proxy system outcomes (ED length of stay) it can be concluded that while the positive effect sizes are not large, the use of tiered teams does not appear to cause the patient harm. |
| Trade-off between net health benefits and resource use | A tiered trauma response is designed to allow for the appropriate members of staff and specialties to be on scene depending on a number of factors indicating the patient's level of trauma.<br><br>Having staff waiting in hospital that may not need to be there for the majority of trauma cases is unlikely to be cost effective because of the opportunity cost of the time of those staff. The small trauma population also affects the cost effectiveness of the make-up of the trauma team because there is likely to be considerable 'down time' waiting for patients due to the infrequency of trauma and some specialties may also not be required for most cases. Also, the resources put on standby for the arrival of the patient have an opportunity cost to other patients that could have used them at that time, for example, theatres and imaging suites. On the other hand, if they are needed and there is a delay to their arrival, then this could be detrimental to the patient.<br><br>Having a tiered team can cater for the level of trauma that is being brought in and allocate specialties more efficiently; however, this appropriate team being present is highly dependent on the information provided from the pre-hospital |

| | |
|---|---|
| | arena and the level of pre-alert that is raised prior to the arrival of the patient in hospital.<br><br>Paediatric trauma is even less common than in adults, and therefore, having a paediatric clinician as a standard part of the trauma may not be cost effective, and would have a larger opportunity cost, but some MTCs are for children and adults, therefore, these specialties are generally part of a tiered team if a child trauma has occurred.<br><br>A tiered team is already in existence in MTCs; therefore, this recommendation is unlikely to lead to a large change in practice. However, the correct implementation of the appropriate team is highly dependent on the pre-hospital information provided. |
| Quality of evidence | The evidence for all reported outcomes was Very low. This is primarily because of the serious limitations related to the research designs and imprecision around the effect sizes. Although the papers were generally matched at baseline for the key confounders listed in the protocol, due to the before-and-after nature of the study designs, we cannot be sure that there are no other systemic changes that may bias the results in favour of implementing tiered teams.<br><br>All the evidence is from Level 1 major TUs in the USA. While these may be comparable to UK MTCs in their trauma team membership and experience, they cannot be used to inform processes at UK TUs. No evidence relative to UK TUs was identified. |
| Barriers to implementation | The GDG suggested that most UK MTCs already operate with a level of tiered team response protocol. This relies heavily on the information gathered in the pre-alert. Therefore, any concerns around implementation will link to identification and standardisation of the information provided by pre-hospital staff as part of the pre-alert process. |
| Other considerations | **The experience of TUs compared with MTCs**<br>TUs cannot offer the advanced level of a higher tier with 'called-in' specialists; so therefore, it is not possible for TUs to offer a tiered response. TUs should always mount a standard multi-specialist team response to a trauma call. In TUs there is less likely to be as much activity that you are pulling the specialists away from (in comparison with larger, higher volume hospitals designated as MTCs).<br><br>Smaller volume centres are unlikely to have all the expertise and less specialist experience of trauma situations if they are tiered and therefore not called to every case (perhaps as little as once every 3 months).<br><br>MTCs need to be able to offer the advanced tier based on pre-alert information. The highest tier (including specialists) will be based on criteria included in the pre-alert (for example, pre-hospital blood transfusion, HEMS code red, major bodily trauma/wounds, paediatric trauma, whether the injured person is likely to require activation of massive transfusion protocol and require urgent surgery).<br>Note: Definition of high volume trauma is on average >1 trauma case a day<br><br>**Paediatric considerations**<br>Most MTCs do not see enough paediatric trauma to justify a separate paediatric-specific tiered response. However, it would be imperative that a paediatric surgeon or someone able to provide paediatric airway control is |

called as part of a higher tier response.

The GDG discussed that paediatric trauma involves a higher number of walk-ins and this makes a quicker/larger trauma team response more appropriate given the importance of their missed pre-hospital triage.

**Tiered team membership**

How the tiered teams may look in UK MTCs:

- ED response: ED consultant or ED registrar (st 3 or 4 equivalent), nurse (grade 6 or 7)
- Standard multi-specialty trauma team: ED response plus a second nurse, anaesthetist registrar (st 4), Orthopaedic surgeon (st 4), general surgeon (st 4), radiographer. If paediatric trauma: paediatric surgeon, anaesthetist and paediatrician.
- Specialist involvement: multi-specialty trauma team plus specialist surgeon(s): orthopaedic, vascular, cardio/thoracic, obstetrics and gynaecology, urology, maxillofacial, neurological, plastics, paediatric and radiologist.

# 9 Transfer between emergency departments

## 9.1 Introduction

It is imperative that a person with major trauma is in the right place to receive the best definitive treatment as quickly as possible. In chapter 6 it is recognised that within a trauma network a major trauma centre (MTC) is usually the optimal place for a person with major trauma to be transported to for treatment. However there are circumstances where this is not the case and this chapter focuses on the situation where the critically ill trauma patient has required immediate medical intervention and has been taken to the nearest trauma unit (TU). Once the patient is stabilised at the trauma unit it is important they are transferred to a MTC as soon as possible to receive the specialist care they need.

While in adult trauma care the practice is usually to send a team from the TU but the question of who best should accompany the patient on the transfer is unanswered. Transfers may be undertaken by the local TU clinical team or a specialised retrieval service sent by the receiving specialist unit. The former option would mean that the patient could be sent off immediately without delay but with non-specialist staff that may not be able to provide the urgent specialised treatment needed during transfer. Whilst the specialist retrieval team can provide this urgent care its use is associated with a delay caused by waiting for the team to arrive for pick up at the sending centre. The purpose of this review was to determine if providing a specialist retrieval service is clinically and cost effective.

## 9.2 Review question: Is it clinically and cost effective to provide a retrieval service?

For full details see review protocol in Appendix C.

**Table 20: PICO characteristics of review question**

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|---|---|
| **Population** | Critically injured trauma patients (that is, those who would trigger an advanced response at a MTC) |
| **Objective** | To determine whether it is clinically and cost effective to provide a dedicated trauma retrieval service to transfer patients from ED to further care |
| **Intervention** | Retrieval service for secondary transfer |
| **Comparison** | Transfer by TU clinical team |
| **Outcomes** | Critical:<br>• Mortality up to 12 months<br>• Health-related quality of life<br>• Time taken to transfer<br>• Delay to admission at MTC<br>• Complications during transfer/due to transfer<br>Important:<br>• Length of hospital stay |
| **Study design** | RCTs or observational |

## 9.3 Clinical evidence

No clinical evidence was found relevant to this review.

See also the study selection flow chart in Appendix D and excluded studies list in Appendix J.

## 9.4 Economic evidence

### Published literature

No relevant economic evaluations were identified.

See also the economic article selection flow chart in Appendix E.

## 9.5 Evidence statements

### Clinical

No relevant studies were identified.

### Economic

No relevant economic evaluations were identified.

## 9.6 Recommendations and link to evidence

| | |
|---|---|
| **Recommendations** | **Recommendations for senior doctors and nurses in trauma units**<br><br>**17. Spend only enough time to give life-saving interventions at the trauma unit before transferring patients for definitive treatment.**<br><br>**18. Be aware that the major trauma centre is the ultimate destination for definitive treatment.**<br><br>**Recommendations for ambulance and hospital trust boards, medical directors and senior managers**<br><br>**19. Provide a protocol for the safe and rapid transfer of patients who need definitive specialist intervention.**<br><br>**20. Train clinical staff involved in the care of patients with major trauma in the transfer protocol.**<br><br>**21. Review the transfer protocol regularly.**<br><br>**Recommendation for senior managers in hospital trusts and senior doctors and nurses in emergency departments**<br><br>**22. Ensure that patients with major trauma who need critical interventions at a major trauma centre leave the sending emergency department within 30 minutes of the decision to transfer.** |
| Description of current UK services | The configuration of trauma services into trauma networks means that specialised services are usually located within a MTC. For this reason a MTC is usually the optimal place for patients with major trauma to be treated. The GDG have noted in chapter 6 that there are circumstances where this is not the case and a patient with major trauma is located in a trauma unit. These |

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| | reasons include, the patient was under triaged, they self-presented, their clinical condition deteriorated or they were transported to the nearest hospital facility for life-saving treatment or stabilisation.<br><br>The consequence of this situation is that the specialised services needed are not easily accessible. The question of the location of services, outreach and how to access specialist care is an issue across the patient pathway. The GDG chose to focus on the immediate life threatening situation where patient has been diverted to a TU as this an area that varies across the UK.<br><br>There are some hospital trusts in the UK that have implemented a dedicated transfer service, where clinicians with the skills required for the transfer of critically injured patients are always available to transfer patients requiring urgent specialised treatment between hospitals. This is not the norm and more typically staff from the sending TU are required to transfer the patient to a MTC. |
| Relative values of different outcomes | The GDG specified mortality (up to 12-months), health-related quality of life, time taken to transfer, delay to admission to MTC, complications arriving during or due to transfer, and length of hospital stay as critical outcomes in the evaluation of a retrieval service compared to transfer by TU clinical team. |
| Trade-off between clinical benefits and harms | No clinical evidence was found for this review.<br><br>In the absence of any evidence, the GDG were unable to make recommendations on the use of specialist retrieval teams for the transfer of major trauma patients from emergency departments to major trauma centres.<br>While the GDG were unable to make a specific recommendation on the personnel transferring the patient they noted that rapid transfer is critical to avoid delay in diagnosis and treatment and to prevent mortality and reduce morbidity. Taking this into account the GDG recommended that a patient should be transferred within 30 minutes of the decision to transfer. This timing recommendation emphasises the need to avoid any delay in treatment. It is also important that only life-saving interventions are undertaken in the trauma unit, 30 minutes is to remind the team that the MTC is the ultimate destination for the patient to receive definitive treatment.<br><br>The GDG emphasized the importance of a transfer protocol and that all staff are trained in the protocol. The protocol should include the training and skills escorts should have to manage the patient during the transfer, and detail the equipment and processes surrounding transferring critically ill or injured patients. |
| Trade-off between net health benefits and resource use | No economic evidence was included for this review. The GDG considered the importance of reducing delays to treatment and its consequences in terms of mortality and resource use.<br><br>A dedicated retrieval service is already in operation in some hospitals in the UK, however, for most hospitals, this will require the implementation of a new service. Ensuring the availability of appropriately skilled staff 24/7 is likely to be costly; however this was thought to be outweighed by a reduction in mortality and further resource use.<br><br>The GDG decided to recommend that a patient should be transferred within 30 minutes from the decision in order to avoid delay in diagnosis and treatment and to prevent mortality and reduce morbidity. This recommendation may be associated with an increase in cost as health care professionals have to be available for a transfer to a MTC within 30 minutes. |

| | |
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| | Overall the GDG judged this to be a cost effective use of resources as it would improve patient outcomes and reduce harms from delay in treatment.<br><br>All hospitals in the UK should already have a protocol for the onward transfer of critically ill patients who require specialist treatment. However, the GDG felt that greater awareness of the protocol, through staff training, would be beneficial in ensuring that transfers are carried out in a timely manner. |
| Quality of evidence | There was no clinical evidence identified for this question. The GDG chose to make a research recommendation, while making recommendations for the safe transfer of patients. |
| Barriers to implementation | The implementation of a dedicated transfer/retrieval service will be a new service for most hospitals in the UK, and therefore will require initial reorganisation to ensure that additional staff are available. |
| Other considerations | The GDG felt that it was important for all hospitals to audit and review cases where patients requiring transfer experienced delay, to ensure that any barriers to the timely transfer of critically injured patients are identified and can be resolved. |

# 10 A trauma service providing continuity of care

## 10.1 Introduction

Patients with major trauma may have more than one injury and frequently require more than one specialist's input in their management. Furthermore, the patient's journey may span different wards, dependency settings and hospitals, with transfer or shared care between Major Trauma Centres (MTCs), Trauma Units (TUs), District General Hospitals (DGHs) and community and specialist units. It is acknowledged that multidisciplinary team (MDT) working is likely to bring benefit, however, when the team involved in the patient's care may work in different settings, it is less clear how shared or transferred care can be optimised. There is current concern that a lack of continuity of care may be occurring leading to suboptimal outcomes for the patient and for the system.

Patient outcomes may be improved by timely access to appropriate care through improved coordination and communication. Length of hospital stay may be reduced through timely discharge and communication with onward support services. Furthermore, length of time spent in more costly higher dependency settings may be reduced through timely transfer of care.

Whilst there is general consensus that improved communication and liaison between different providers of care would benefit patient care and system functioning, there is uncertainty in how this is best achieved and the exact mechanisms of improvement. MDT management, the role of the trauma coordinator (see chapter 11 ), patient documentation and transfer of information (see chapter 12) chapter can all be viewed as means to improve continuity of care.

**MDT management**

The MDT refers not only to the different kinds of practitioners involved (such as, physicians, surgeons, nurses, physiotherapists and therapists), but also the different specialties. In the review that follows on MDT management, we refer to a team of all these professionals with expertise between them covering all the major specialties involved in multisystem care: including orthopaedics, neurosurgery, vascular.

The issue around how best to implement MDT management is restricted to MTCs, and not applicable to TUs. TUs should only be managing patients with multi-system injuries when an initial lifesaving intervention is needed in the ED before transfer to an MTC or after repatriation. If this is the case the TU should not have a need for multidisciplinary wards or trauma teams.

One means of exploring the impact of MDT management is to look at ward structure and oversight. However, multidisciplinary ward rounds in isolation are only one component of a patient's care package. If the ward round is multidisciplinary but the rest of the care is not, then would you define that as multidisciplinary care? Care is only multidisciplinary if the patient receives the input from all the specialties and professionals they need, on an on-going basis, throughout their recovery period from the team members.

Yet a starting point for exploring the evidence-base around the complex relationships and interventions of multidisciplinary care must be found. Furthermore, the definition of specialty in this context as a comparator is required. In medicine, 'discipline' is often used in a similar way to how we would use the concept 'specialty'. A neurosurgical ward will have an MDT of doctors, nurses and therapists, but they are only good at one 'discipline'. For them to be truly multidisciplinary they need representatives with expertise in each different specialty involved in trauma care. Care is not truly multidisciplinary irrespective of the ward or lead consultant. Care is usually specialised if it is on a specialised ward, with little expertise available in other specialties.

Therefore, to explore the evidence on how to optimise MDT management, the evidence review's focus is the ward and the lead consultant as a surrogate for identifying the ward.

MDT management may be assisted by improved coordination, and may have a role in rehabilitation, audit and performance assessment.

## 10.2 Review question: Is there a benefit of multidisciplinary trauma ward care versus specialist ward care?

For full details see review protocol in Appendix C.

**Table 21: PICO characteristics of review question**

| | |
|---|---|
| **Population** | Children, young people and adults who have suspected or confirmed major trauma and use trauma services |
| **Objective** | To determine what is the most effective model of ward care for major trauma patients |
| **Intervention** | Multidisciplinary trauma ward (trauma consultant)<br>Multidisciplinary trauma ward (sub-speciality consultant)<br>Speciality ward |
| **Comparison** | A comparison of the above<br>Non-speciality/general ward |
| **Outcomes** | Critical:<br>• Mortality<br>• Health-related quality of life<br>• Time to definitive treatment<br>Important:<br>• Length of hospital stay<br>• Readmission to ICU and to hospital<br>• Unscheduled re-operation<br>• Patient and carer experience |
| **Study design** | RCTs or observational |

## 10.3 Clinical evidence

No RCTs were identified relevant to this review. Two retrospective cohort studies[18,23] were included in the review and these are summarised in Table 22. Evidence from these studies is summarised in the clinical evidence summaries below.

Please also see the study selection flow chart in Appendix D, study evidence tables in Appendix G, forest plots in Appendix I, GRADE tables in Appendix H and excluded studies list in Appendix J.

**Table 22: Summary of studies included in the review**

| Study | Intervention and comparison | Population | Outcomes | Comments |
|---|---|---|---|---|
| Davenport 2010[18] | Specialist ward care at Royal Hospital London (2000-2002) vs. multidisciplinary ward care at Royal Hospital London (2003-2004) vs. multidisciplinary | All patients meeting criteria for Trauma Audit and Research Network (TARN) and the Royal London Hospital (RLH) trauma registries; | Mortality, hospital and critical care length of stay | No information provided to describe specialist ward care or general ward care.<br>Between the years of 2000-2002, the hospital provided specialist ward care for |

| Study | Intervention and comparison | Population | Outcomes | Comments |
|---|---|---|---|---|
| | ward + dedicated trauma ward at Royal Hospital London (2005) vs. specialist ward care in the UK (TARN) vs. general ward care in the UK (TARN) | UK (n=75,325), ISS >8 | | patients (unclear definition) Multidisciplinary ward care was provided by the Royal London Hospital in 2003–2004. This service had overall responsibility for all trauma patients. A formal performance review programme was implemented to review the process of care for all deaths and serious morbidities, and quality assure the implementation of management guidelines. Local acute hospitals were given a single access point for secondary transfers. The unit adopted a policy of automatic acceptance, and duty of care was transferred to the receiving trauma centre. In 2005, the multidisciplinary service was augmented with the opening of a dedicated trauma ward. |
| Groven 2011[23] | Multidisciplinary ward (trauma team leader) vs. general ward care | Patients (median age = 34 years) admitted to the trauma centre with ISS >8. Norway (n=7247) | Mortality | Multidisciplinary ward care led by a surgical trauma team leader in cooperation with a consultant anaesthesiologist. The service coincided with the development of a clinical governance structure, a performance improvement framework, and specific educational programs for physicians and nurses. General ward care included clinicians treating both trauma and elective cases, however full trauma |

| Study | Intervention and comparison | Population | Outcomes | Comments |
|---|---|---|---|---|
| | | | | care provided, including specified trauma team activation and an institutional trauma manual. Internal audit identified multiple deviations from standards of care. |

**Multidisciplinary ward care versus general ward care**

**Table 23: Clinical evidence summary: Multidisciplinary ward versus general ward care**

| Outcome | Number of studies (number of participants) | Imprecision | GRADE rating | Absolute difference (MDM versus General) | Control event rate (per 1000) | Control event rate for continuous outcomes |
|---|---|---|---|---|---|---|
| Mortality (ISS >8) | 1 (n=7247) | Serious | VERY LOW | 29 fewer per 1000 (from 18 fewer to 37 fewer) | 84 | - |
| Mortality (ISS >15) | 1 (n=3028) | Serious | VERY LOW | 69 fewer per 1000 (from 46 fewer to 88 fewer) | 191 | - |
| Mortality (ISS >24) | 1 (n=1608) | Serious | VERY LOW | 102 fewer per 1000 (from 66 fewer to 135 more) | 300 | - |

**Table 24: Clinical evidence summary: Multidisciplinary ward plus trauma ward versus general ward care**

| Outcome | Number of studies (number of participants) | Imprecision | GRADE rating | Absolute difference (MDM + TU versus General) | Control event rate (per 1000) | Control event rate for continuous outcomes |
|---|---|---|---|---|---|---|
| Mortality (all patients) | 1 (n=56109) | No serious imprecision | VERY LOW | 42 more per 1000 (from 18 more to 75 more) | 42 | - |
| Mortality (ISS >15) | 1 (n=5949) | Serious | VERY LOW | 92 fewer per 1000 (from 24 fewer to 141 fewer) | 272 | - |
| Mortality (ISS>24) | 1 (n=2725) | No serious imprecision | VERY LOW | 209 fewer per 1000 (from 116 fewer to 278 fewer) | 464 | - |

**Multidisciplinary ward care versus Specialist ward care**

**Table 25: Clinical evidence summary: Multidisciplinary ward plus trauma ward versus specialist ward care**

| Outcome | Number of studies (number of participants) | Imprecision | GRADE rating | Absolute difference (MDM + TU versus Specialist) | Control event rate (per 1000) | Control event rate for continuous outcomes |
|---|---|---|---|---|---|---|
| Mortality (all patients) | 1 (n=17493) | Serious | VERY LOW | 4 more per 1000 (from 20 fewer to 38 more) | 80 | - |
| Mortality (ISS >15) | 1 (n=5198) | Serious | VERY LOW | 48 fewer per 1000 (from 98 fewer to 21 more) | 228 | - |
| Mortality (ISS>24) | 1 (n=2921) | Serious | VERY LOW | 93 fewer per 1000 (from 159 fewer to 0 more) | 346 | - |

**Table 26: Clinical evidence summary: Multidisciplinary ward plus trauma ward versus specialist ward**

| Outcome | Number of studies (number of participants) | Imprecision | GRADE rating | Absolute difference (MDM versus MDM + TU) | Control event rate (per 1000) | Control event rate for continuous outcomes |
|---|---|---|---|---|---|---|
| Mortality (all patients) | 1 (n=864) | Serious | VERY LOW | 31 fewer per 1000 (from 60 fewer to 12 more) | 116 | - |
| Mortality (ISS >15) | 1 (n=334) | No serious imprecision | VERY LOW | 164 fewer per 1000 (from 79 fewer to 219 fewer) | 342 | - |
| Mortality (ISS>24) | 1 (n=217) | No serious imprecision | VERY LOW | 218 fewer per 1000 (from 105 fewer to 299 fewer) | 475 | - |

### Multidisciplinary ward care versus multidisciplinary ward care plus trauma ward

**Table 27: Clinical evidence summary: Multidisciplinary ward versus multidisciplinary ward plus TU**

| Outcome | Number of studies (number of participants) | Imprecision | GRADE rating | Absolute difference (MDM versus MDM + TU) | Control event rate (per 1000) | Control event rate for continuous outcomes |
|---|---|---|---|---|---|---|
| Critical length of stay (days; ISS >15)a | 1 (n=2000) | No serious imprecision | VERY LOW | MD 1 higher (0.37 to 1.63 higher) | - | 2 |
| Critical length of stay (days; ISS >24)a | 1 (n=2000) | No serious imprecision | VERY LOW | MD 2 higher (0.17 to 3.83 higher) | - | 3 |
| Hospital length of stay (days; ISS >15)a | 1 (n=2000) | No serious imprecision | VERY LOW | MD 7 higher (2.84 to 11.16 higher) | - | 13 |
| Hospital length of stay (days; ISS >24)a | 1 (n=2000) | No serious imprecision | VERY LOW | MD 11 higher (4.46 to 17.54 higher) | - | 14 |

*(a) Data is analysed from a subgroup of patients; 1000 patients admitted immediately prior and 1000 patients admitted immediately following the introduction of the trauma ward*

### Specialist ward care versus general ward care

**Table 28: Clinical evidence summary: Specialist ward care versus general ward care**

| Outcome | Number of studies (number of participants) | Imprecision | GRADE rating | Absolute difference (Specialist versus General) | Control event rate (per 1000) | Control event rate for continuous outcomes |
|---|---|---|---|---|---|---|
| Mortality (all patients) | 1 (n=72842) | No serious imprecision | VERY LOW | 37 more per 1000 (from 32 more to 43 more) | 42 | - |
| Mortality (ISS >15) | 1 (n=10801) | No serious imprecision | VERY LOW | 44 fewer per 1000 (from 30 fewer to 60 fewer) | 272 | - |
| Mortality (ISS>24) | 1 (n=5410) | Serious | VERY LOW | 116 fewer per 1000 (from 93 fewer to 139 more) | 464 | - |

**Narrative findings**

In addition to the unadjusted mortality data reported in Groven 2011[23], the authors report the additional survivors in each group compared with the expected mortality as predicted using Trauma and Injury Severity Score (TRISS) methodology, with National Trauma Data Bank 2005 coefficients. This methodology calculates the expected mortality status of each patient, based on their age, GCS, RTS, and ISS scores at baseline. The authors report the W-statistic, which represents excess survivors per 100 patients compared with TRISS, with its confidence interval. The authors considered non-overlapping confidence intervals across the two groups to indicate a statistically significant difference.

**Table 29: Additional survivors per 100 patients as compared with TRISS**

| Population | Multidisciplinary ward care | General ward care |
|---|---|---|
| Patients ISS >8 | W = 1.44, CI = .90 – 1.99 (n=4659) | W = .06, CI = -.70 – .82 (n=2582) |
| Patients ISS >15 | W = 3.40, CI = 2.18 – 4.62 (n=1947) | W = -.01, CI = -1.71 – 1.69 (n=1081) |
| Patients ISS >24 | W = 6.08, CI = 4.00 – 8.17 (n=994) | W = .11, CI = -2.59 – 2.81 (n=614) |

In addition to the unadjusted mortality data reported in Davenport 2009[18], the authors report the additional survivors as compared with the expected mortality rate as predicted using TRISS methodology for each of the interventions. The W-statistic represents the excess survivors per 100 patients compared with TRISS, with its confidence interval

**Table 30: Additional survivors per 100 patients as compared with TRISS**

| Population | Multidisciplinary ward care (2003)[a] | Multidisciplinary ward care (2004)[a] | Multidisciplinary ward care + TU[a] | Specialist ward care[a] | General ward care[a] |
|---|---|---|---|---|---|
| Patients ISS >8 | W = -0.5, CI = 4.8 – 5.6 (n=not reported) | W = 2.6, CI = .90 – 1.99 (n=not reported) | W = 11.2, CI = 6.2 – 16.4 (n=380) | W = 8.4 (No CI reported; n=17113[b] | W = 3.1 (No CI reported; n=55729)[b] |

*(a) W statistic and confidence intervals estimated based on plots*
*(b) Specialist ward care versus general ward care p value=<0.001 with Bonferroni correction*

## 10.4 Economic evidence

**Published literature**

No relevant economic evaluations were included.

See also the economic article selection flow chart in Appendix E.

## 10.5 Evidence statements

**Clinical**

**Multidisciplinary ward care versus general ward care**

Very low quality evidence from one cohort study comprising of 7247, 3028 and 1608participants demonstrated no clinical difference between multidisciplinary ward care and general ward care for mortality amongst all patients with ISS more than 8, and a clinical benefit of multidisciplinary ward care when compared with general ward care for mortality amongst patients with ISS more than 15 and ISS more than 24, with serious imprecision.

After adjusting for confounders, one cohort study demonstrated a clinical harm of multidisciplinary ward card when compared with general ward care for mortality in patients with ISS more than 8. This evidence could not be assessed for risk of bias or imprecision.

**Multidisciplinary ward plus trauma ward care versus general ward care**

Very low quality evidence from one cohort study comprising of 56109 participants demonstrated a clinical harm associated with multidisciplinary ward care plus trauma ward compared with general ward care for mortality for all patient, with no serious imprecision.

Very low quality evidence from one cohort study comprising of 5949 and 2725 participants demonstrated a clinical benefit of multidisciplinary ward care plus trauma ward care when compared with general ward care for mortality amongst patients with ISS more than 15 and ISS more than 24, with serious or no serious imprecision.

After adjusting for confounders, one cohort study demonstrated a clinical benefit of multidisciplinary ward care plus trauma ward care compared with general ward care for mortality in patients with ISS more than 8. This data could not be assessed for risk of bias or imprecision.

**Multidisciplinary ward versus specialist ward care**

Very low quality evidence from one cohort study comprising of 17493, 5198 and 2921 participants demonstrated no clinical difference between multidisciplinary ward care compared with specialist ward care for mortality amongst all major trauma patients, and a clinical benefit for multidisciplinary ward care when compared with specialist ward care for mortality amongst patients with ISS more than 15 and ISS more than 24, with serious imprecision.

After adjusting for confounders, one cohort study comprising of participants demonstrated a clinical harm of multidisciplinary ward care compared with specialist ward care for mortality in patients with ISS more than 8. This data could not be assessed for risk of bias or imprecision.

**Multidisciplinary ward plus trauma ward versus specialist ward**

Very low quality evidence from one cohort study comprising of 864, 334, and 217 participants demonstrated no clinical difference between multidisciplinary ward care plus trauma ward compared with specialist ward care for mortality amongst all major trauma patients, and a clinical benefit for multidisciplinary ward care plus trauma ward when compared with specialist ward care for mortality amongst patients with ISS more than 15 and ISS more than 24, with serious and no serious imprecision.

After adjusting for confounders, one cohort study comprising of participants demonstrated a clinical benefit of multidisciplinary ward care plus trauma ward compared with specialist ward care for mortality in patients with ISS more than 8. This data could not be assessed for risk of bias or imprecision.

**Multidisciplinary ward versus multidisciplinary ward plus trauma ward**

Very low quality evidence from one cohort study comprising of 2000 participants demonstrated no clinical difference between multidisciplinary ward care compared with multidisciplinary ward care plus trauma ward for critical care length of stay for patients with ISS more than 15 and ISS more than 24, with no serious imprecision.

Very low quality evidence from one cohort study comprising of 2000 participants demonstrated a clinically important longer overall hospital length of stay for multidisciplinary ward care compared with multidisciplinary ward care plus trauma ward for patients with ISS more than 15 and ISS more than 24, with no serious imprecision.

After adjusting for confounders, one cohort study comprising of 2000 participants demonstrated a clinical harm of multidisciplinary ward care compared with multidisciplinary ward care plus trauma ward for mortality in patients with ISS more than 8. This data could not be assessed for risk of bias or imprecision.

**Specialist ward versus general ward care**

Very low quality evidence from one cohort study comprising of72842, 10801 and 5410 participants demonstrated no clinical difference between specialist ward care and general ward care for all major trauma patients and patients with ISS more than 15, and a clinical benefit of specialist ward care when compared with general ward care for mortality amongst patients with ISS more than 24, with no serious or serious imprecision.

After adjusting for confounders, one cohort study comprising of participants demonstrated a clinical benefit of specialist ward care compared with general ward care for mortality in patients with ISS more than 8. This data could not be assessed for risk of bias or imprecision.

**Economic**

No relevant economic evaluations were identified.

## 10.6 Recommendations and link to evidence

| | |
|---|---|
| **Recommendations** | **Recommendations for hospital trust boards, senior managers and commissioners**<br><br>**23. Hospital major trauma services should have responsibility and authority for the governance of all major trauma care in hospital.**<br><br>**24. Provide a dedicated major trauma service for patients with major trauma that consists of:**<br>• **a dedicated trauma ward for patients with multisystem injuries**<br>• **a designated consultant available to contact 24 hours a day, 7 days a week who has responsibility and authority for the** |

| | |
|---|---|
| | **hospital trauma service and leads the multidisciplinary team care**<br>• **acute specialist trauma rehabilitation services**<br>• **acute specialist services for the paediatric and elderly populations**<br>• **a named member of clinical staff (a key worker, often a senior nurse) assigned at each stage of the care pathway who coordinates the patient's care.** |
| Description of current UK services | Major trauma patients frequently require more than one specialist's input in their management. Currently in the UK, a patient may receive care on different wards, dependency settings and hospitals; with transfer or shared care between MTCs, TUs, DGHs and community and specialist units. Under this arrangement, there is some concern that patients may experience a lack of continuity of care, which may lead to suboptimal outcomes for the patient. To address these concerns, the care of major trauma patients in some MTCs is supervised by a trauma coordinator, who has responsibility for coordinating patient care across multiple specialities and settings. This role is evaluated in chapter 11 as part of the continuity of care in a trauma service. |
| Relative values of different outcomes | The GDG identified mortality, health-related quality of life, length of hospital stay, time to definitive treatment, readmission to ICU and hospital, unscheduled re-operation, and patient and carer experience as critical outcomes for the evaluation of multidisciplinary team management. Evidence was retrieved for mortality, and hospital and critical care length of stay. |
| Trade-off between clinical benefits and harms | Two studies were found comparing multidisciplinary ward care with general ward care. One study compared multidisciplinary ward care with specialist ward care and with multidisciplinary ward care with a dedicated trauma ward. One study compared multidisciplinary ward care with a dedicated trauma ward with general ward care and specialist ward care. One study compared general ward care and specialist ward care. Overall, multidisciplinary ward care when supplemented with a dedicated trauma ward emerged as the dominant intervention, with lower rates of mortality and reduced overall hospital length of stay.<br><br>The GDG used the clinical evidence and their experience to recommend that all major trauma patients requiring multi-system care should be treated by a dedicated trauma service. The GDG used the detail of the interventions used in the clinical evidence and consensus opinion to recommend specific responsibilities and facilities that should be present in the trauma service. The GDG noted that one of the benefits of a trauma ward is that this prevents patients from 'falling through the cracks'; that is where patients receive delayed treatment due to delayed awareness and response of specialist staff based elsewhere. In particular, the GDG noted the benefit of nursing staff working on trauma wards who, by working consistently with trauma patients, develop highly specialist expertise in all aspects of care required by trauma patients. This not only includes the medical aspects of patients' care, but also more broader issues, such as managing psychological distress and comorbid mental health difficulties, and managing discharge arrangements.<br><br>There was no evidence comparing multidisciplinary ward care with other ward care models for children. The GDG believed that children with major trauma would also benefit from treatment on a trauma ward, and so decided to include all trauma patients in the recommendation. |
| Trade-off between net health benefits and | No economic evidence was found on the multidisciplinary management of trauma patients. The GDG believe that currently in the MTC, some models of |

| | |
|---|---|
| resource use | multidisciplinary care have already been introduced; therefore, this recommendation does not represent a huge change in practice. The GDG thought no significant increase in resources would be required to set up a dedicated trauma service with the requirements described in the recommendation as healthcare staff would not need to increase but only arranged differently. However, it was agreed that it may be difficult for some hospitals to create a trauma ward covering all specialties on one site and this could have significant cost implication.<br><br>The clinical evidence showed that multidisciplinary ward care when supplemented with a dedicated trauma ward decreased both mortality and overall hospital length of stay. For this reason, even if an increase in staff time was required to set up this model of care, it was the GDG's opinion that this increase in resources would be offset by the reduced length of stay. In particular, length of time spent in more costly higher dependency settings may be reduced through timely transfer of care. In addition, the provision of multidisciplinary care would reduce delays in providing the appropriate treatment which may be caused by the lack of awareness of specialist staff based elsewhere. Increasing awareness of treatment required by trauma patients would lead to health gain and less resource use (for example, from complications due to treatment delays). Some cost savings could also be generated by having all staff on the same ward which would reduce the amount of time healthcare staff move between wards to visit patients.<br><br>The GDG chose to include both adults and children in the recommendation. However, the GDG noted that the number of children who require this service is likely to be small. |
| Quality of evidence | Two retrospective cohort studies were identified. One study (Davenport) did not provide any description of specialist ward care or general ward care, although, the GDG felt that the structure of these models of care is well known. One study was a UK study and one was in Norway. All of the outcomes were graded as Very low quality.<br><br>Both papers reported significant differences in key confounding factors at baseline, although, no baseline information was provided for one comparison (multidisciplinary ward care vs. multidisciplinary ward care plus TU) in Davenport. For all mortality outcomes, both papers attempted to account for confounding factors by using TRISS methodology to calculate the number of deaths in each group that would be expected given patients' age, RTS, ISS and GCS (*check both) on admission, and comparing this with the observed mortality in each group. This is commonly used in trauma research as a method for adjusting for differences in the risk of mortality in treatment groups. However, the method does not directly compare interventions. Also, it is unclear how accurate TRISS methodology is at accurately predicting mortality for patients included in the two studies. It was not possible to assess the overall risk of bias and imprecision for these outcomes. |
| Barriers to implementation | If a hospital didn't have a multidisciplinary trauma ward established this would involve reorganisation of care and redeployment of nursing staff. This model of care could have implications for the role of the trauma coordinator (see chapter 11). |
| Other considerations | The GDG felt that governance is an integral component of providing a trauma service emphasised that governance within a trauma ward should include performance improvement, audit and protocols of care. |

| | |
|---|---|
| | The GDG discussed who could act as a trauma consultant on the trauma ward. The GDG noted that a sub-speciality consultant may not require specific training to become a trauma consultant, but rather this role may represent a sub-speciality consultant who has extensive experience of trauma. |

# 11 Continuity of care: the trauma coordinator role

## 11.1 Introduction

Trauma coordinators are currently seen to play a key role in the case management of trauma patients. They provide a link to ensure good communication and support to the patient and between disciplines, timely discharge and transfer, liaise with post discharge services (for example, housing and social services) and generally act as an advocate for patients throughout the patient journey. Their role is seen to be of particular importance where the care of the patient spans multiple specialities.

The trauma coordinator role is also about communication and support, providing relevant information to the patient, families and carers, with regular updates regarding management in a timely and appropriate manner. Patient outcomes may also be improved by timely access to appropriate care through improved coordination and communication between multidisciplinary staff which can be overseen by trauma coordinators. Length of hospital stay may also be reduced through timely discharge and communication with onward support services. Furthermore, length of time spent in more costly higher dependency settings may be reduced through timely transfer of care.

Trauma coordinators often support audit, service improvement, patient documentation and transfer of information within trauma networks and they are viewed as a potential means to implement these service interventions.

The aim of this review is to evaluate the added benefits (if any) the trauma coordinators bring to the trauma patient.

## 11.2 Review question: What trauma coordination approach is the most clinically and cost effective?

For full details see review protocol in Appendix C.

**Table 31: PICO characteristics of review question**

| | |
|---|---|
| **Population** | People who have suspected major trauma and use trauma healthcare services. |
| **Intervention** | Trauma service which involves the trauma coordinator in the care of people who have suspected major trauma. |
| **Comparison** | Trauma service which does not involve the trauma coordinator in the care of people who have suspected major trauma. |
| **Outcomes** | Critical:<br>• Mortality<br>• Heath-related quality of life (immediate and long term)<br>• Ongoing consequential morbidity<br>Important:<br>• Metrics of continuity of care<br>  ○ Length of stay (LOS [total across transfers, MTC])<br>  ○ Adverse incident report severity (red, amber, green)<br>• Time in acute setting<br>• Number of procedures<br>• Time to rehab prescription<br>• ICU LOS<br>• Impact of traumatic event on concurrent morbidities |

| | |
|---|---|
| | • Patient and carer satisfaction<br>• Staff satisfaction |
| **Study design** | RCTs or observational |

## 11.3 Clinical evidence

Seven studies were included in the review[14,14;14,16;24,24;27,27; 22,22; 44,44;45,45], methodological details of which are summarised in Table 32 below. Evidence from these studies is summarised in the clinical evidence summary below (Table 33). Please also see the study selection flow chart in Appendix D, study evidence tables in Appendix G, forest plots in Appendix I, GRADE tables in Appendix H and excluded studies list in Appendix J.

Two papers based on the same RCT met the inclusion criteria specified in the protocol for this review and were merged. A further five retrospective cohort studies were also included

**Table 32: Summary of studies included in the review**

| Study | Intervention and comparison | Population | Outcomes | Comments |
|---|---|---|---|---|
| Curtis 2002[14,14] | Trauma Case Management (TCM) 5 days a week versus no TCM | n=476<br>Study population with ISS<16 and age 15-69 years (inclusive) | • Total Hospital LOS<br>• Ongoing consequential morbidity | • Study conducted in Australia<br>• Population not necessarily Major Trauma<br>• 5 month cohort study |
| Curtis 2006 [14,16] | TCM 7 days a week versus no TCM | n=1541<br><br>Average overall ISS=9 in both groups and age 15-69 years (inclusive) | • Mortality<br>• Number of procedures<br>• Total Hospital LOS<br>• Ongoing consequential morbidity<br>• Time to rehab prescription | • Study conducted in Australia<br>• Population not necessarily Major Trauma<br>• 5 month cohort study |
| Fanta 2006[22,22,44] | Paediatric Trauma Nurse Practitioners (PNP) working weekdays only versus physician led care (RES) | n=76<br><br>Paediatric population aged between 2 months and 17 years. Average ISS 4.39 (PNP) and 6.60 (RES) | • Total Hospital LOS<br>• Ongoing consequential morbidity<br>• Patient and carer satisfaction<br>• Healthcare Staff satisfaction | • Study conducted in the USA<br>• Serious Indirectness due to low ISS value in both groups<br>• Randomised survey study over 8 month period |
| Haan 2007[24,24] | Certified Nurse Practitioners (CRNP's) working weekdays versus physician led care (Control) | n=14,040<br><br>ISS score>14 in both groups | • Mortality<br>• Number of procedures<br>• Total Hospital LOS<br>• Time in acute settings | • Study conducted in the USA<br>• Average ISS >14 so no indirectness<br>• 24 month Cohort study |
| Spisso 1990[45,45] | Nurse Practitioners (NPs) working 40 hour week (pre-NP) | n=2615 | • Ongoing consequential morbidity | • Study conducted in the USA |

| Study | Intervention and comparison | Population | Outcomes | Comments |
|---|---|---|---|---|
| | versus physician led care (Post-NP) | ISS>13 in both groups. However uncertain if the same population used for all outcomes for example, discharge summaries | • Number of procedures<br>• Total Hospital LOS<br>• Patient and carer satisfaction<br>• Healthcare Staff satisfaction | • Average ISS >13, however may be indirectness<br>• 12 month Cohort study |
| Jarrett 2009[27,27] | Nurse Practitioner impact on LOS versus LOS values in National Trauma Databank (NTDB) | Population divided into subgroups by ISS score ranges<br>No further details provided | • Total Hospital LOS | • Study conducted in the USA<br>• 5 year retrospective study |

**Table 33: Clinical evidence summary table: Effectiveness of trauma coordinators**

| Outcome | Number of studies (number of participants) | Imprecision | GRADE rating | Absolute difference (field versus ED) | Control event rate (per 1000) | Control event rate for continuous outcomes |
|---|---|---|---|---|---|---|
| Mortality | 1 (n=1541) | Very serious | VERY LOW | 0 more per 1000 (from 17 fewer to 28 more) | 48 | - |
| Number of people receiving Allied Health Intervention - Occupational Therapy | 1 (n=1541) | Serious | VERY LOW | 59 more per 1000 (from 13 more to 116 more) | 270 | - |
| Number of people receiving Allied Health Intervention - Physiotherapy | 1 (n=1541) | Serious | VERY LOW | 99 more per 1000 (from 45 more to 158 more) | 450 | - |
| Number of people receiving Allied Health Intervention – Social Work | 1 (n=1541) | Serious | VERY LOW | 48 more per 1000 (from 0 more to 103 more) | 321 | - |
| Patients receiving Allied Health Intervention | 1 (n=476) | No serious imprecision | VERY LOW | 363 more per 1000 (from 238 more to 526 more) | 220 | - |
| Number of Unplanned ICU visits | 1 (n=1541) | Serious | VERY LOW | 10 fewer per 1000 (from 15 fewer to 3 more) | 18 | - |
| Documentation in patient records - Completeness of description of procedures in discharge summaries | 1 (n=420) | Serious | VERY LOW | 221 more per 1000 (from 148 more to 310 more) | 738 | - |

| Outcome | Number of studies (number of participants) | Imprecision | GRADE rating | Absolute difference (field versus ED) | Control event rate (per 1000) | Control event rate for continuous outcomes |
|---|---|---|---|---|---|---|
| Documentation in patient records - Completeness of events of hospitalisation in discharge summaries | 1 (n=420) | Serious | VERY LOW | 194 more per 1000 (from 120 more to 277 more) | 748 | - |
| Documentation in patient records - Completeness of description of injuries in discharge summaries | 1 (n=420) | Serious | VERY LOW | 194 more per 1000 (from 124 more to 272 more) | 776 | - |
| Documentation in patient records - Completeness of discharge teaching in discharge summaries | 1 (n=420) | No serious imprecision | VERY LOW | 288 more per 1000 (from 199 more to 384 more) | 686 | - |
| Documentation in patient records - Completeness of plan for follow-up care in discharge summaries | 1 (n420) | No serious imprecision | VERY LOW | 285 more per 1000 (from 202 more to 382 more) | 695 | - |
| Documentation in patient records - Compliance with obtaining inter-disciplinary consultations when indicated in inpatient records | 1 (n=420) | Serious | VERY LOW | 234 more per 1000 (from 149 more to 326 more | 710 | - |
| Number of | 1 | Very serious | VERY LOW | 4 more per 1000 | 60 | - |

| Outcome | Number of studies (number of participants) | Imprecision | GRADE rating | Absolute difference (field versus ED) | Control event rate (per 1000) | Control event rate for continuous outcomes |
|---|---|---|---|---|---|---|
| occurrences of complications - Overall Complication Rate | (n=476) | | | (from 30 fewer to 77 more) | | |
| Number of occurrences of complications - Number of occurrences of Respiratory Failure | 1 (n=1541) | Serious | VERY LOW | 13 fewer per 1000 (from 22 fewer to 4 more) | 33 | - |
| Number of occurrences of complications - Number of occurrences of Coagulopathy | 1 (n=1541) | Very serious | VERY LOW | 7 fewer per 1000 (from 17 fewer to 13 more) | 29 | - |
| Number of occurrences of complications - Number of occurrences of Deep Vein Thrombosis (DVT) | 1 (n=1541) | Very serious | VERY LOW | 8 fewer per 1000 (from 9 fewer to 2 more) | 9 | - |
| Number of procedures | 1 (n=1541) | No serious imprecision | VERY LOW | 85 fewer per 1000 (from 37 fewer to 128 fewer) | 609 | - |
| Missed Injury Detect | 1 N=(476) | No serious imprecision | VERY LOW | 48 fewer per 1000 (from 25 fewer to 53 fewer) | 54 | - |
| Number of missed injuries | 1 (n=1541) | Very serious | VERY LOW | 3 fewer per 1000 (from 18 fewer to 20 | 41 | - |

| Outcome | Number of studies (number of participants) | Imprecision | GRADE rating | Absolute difference (field versus ED) | Control event rate (per 1000) | Control event rate for continuous outcomes |
|---|---|---|---|---|---|---|
| | | | | more) | | |
| Hospital LOS | 1<br>(n=76) | No serious imprecision | VERY LOW | MD 0.28 lower (0.5 to 0.06 lower) | - | 1.31 days |

**Narrative review of results not suitable for analysis in GRADE**

**Trauma Coordinator versus no trauma Coordinator**

**Deaths per 100 admissions**

Haan 2007[24,24] reported a reduction in the deaths per 100 admissions in the Trauma Coordinator group (CRNP) group compared with the control group. This was reported to be 4.2 in the CRNP group and 4.7 in the control group.

**Total hospital LOS**

Haan 2007[24,24] reported both the Average LOS and the LOS for patients admitted for greater than 24 hours to be higher in the CRNP than in the control group. The Average LOS was 8.2 in the CRNP group compared with 7.5 in the control group. No standard deviations or p values were reported.

Spisso 1990[45,45] reported a reduction in the trauma patient hospital LOS by an average of 1.05 days (from 8.10 days in the pre-NP group to 7.05 in the NP group). No standard deviations or p values were reported.

Curtis 2002[14,14] reported Median LOS data along with corresponding p values, subcategorised into overall LOS values, LOS values for patients with ISS 8-15 and LOS data for patients over the age of 50 years. These are given below in Table 34:

**Table 34: Median Hospital LOS**

| Outcome | TCM Group | Control | p value |
|---|---|---|---|
| Overall LOS value (days) | 3 | 4 | 0.606 |
| LOS ISS 8-15( days) | 3 | 5 | 0.712 |
| LOS age >50 years (days) | 4 | 6 | 0.084 |

Curtis 2006[14,16] reported the median LOS to be unchanged in both the TCM and control groups in the age groups of 15 years and age 15-44 years. The data for all the groups as well as the overall value for LOS are shown below in Table 35:

**Table 35: Median Hospital LOS**

| Age Group (years) | TCM Group | Control | p value |
|---|---|---|---|
| Age 15 | 2 | 2 | 0.05 |
| Age 15-44 | 4 | 4 | 0.753 |
| Age 45-64 | 5 | 7 | 0.353 |
| Age>64 | 10 | 9 | 0.243 |
| Overall | 5 | 4 | 0.423 |

Jarrett 2009[27,27] reported the LOS data for Charleston Area Medical Centre (CAMC) for three different years (from 2001-2006) by dividing the patients in two subgroups of ISS ranges. LOS data was reported separately for patient with ISS scores ranging from 16-24 and 25-74 for the years 2001, 2004 and 2006 respectively. The total number of patients and the number of patients in each arm were not reported at all in this low quality study. The results reported are shown below:

**Table 36: Hospital LOS for patients with specific ISS ranges**

| ISS score | Average LOS 2001 | Average LOS 2004 | Average LOS 2006 |
|---|---|---|---|

| ISS score | Average LOS 2001 | Average LOS 2004 | Average LOS 2006 |
|---|---|---|---|
| ISS range 16-24 | 8.7 | 8.7 | 7.1 |
| ISS range 25-74 | 14.7 | 11.6 | 13.8 |

Also reported in the study was LOS data for the trauma centre (CAMC) compared against LOS data held in a national trauma database. The benchmark utilised by the CAMC to measure LOS is the 'National Trauma Data Bank (NTDB)'. It is not clear if the data held in the NTDB database is representative of data for LOS in MTC's functioning without trauma co-ordinators and is therefore a valid as our control group (no trauma co-ordinator). The results show a reduction in LOS for the trauma centre compared with the national database in the subgroup of patients with ISS 16-24. The results are reported are as below in Table 37:

**Table 37: Comparison of trauma centre LOS with National Trauma Database**

| ISS score | CAMC LOS (2001-2006) | NTDB LOS (2001-2006) |
|---|---|---|
| ISS range 16-24 | 8.22 | 8.5 |
| ISS range 25-74 | 13.4 | 13.3 |

**Number of hours that MTC was on bypass**

Haan 2007[24,24] also reported that the number of hours the trauma centre was unable to accept new admissions (bypass status) was much lower in the CRNP group (3.5 hours) compared with 10 hours in the control group

**Unexpected readmissions per 100 discharges**

Curtis 2002[14,14] reported a reduction in both the unexpected readmissions per 100 live discharges as well as unexpected readmission to the ICU per 100 ICU discharges in the CRNP group compared with the control group. The values are given below in Table 38:

**Table 38: Unexpected readmissions**

| Parameter | CRNP Group | Control Group |
|---|---|---|
| Unexpected readmissions per 100 live discharges | 1.1 | 3.2 |
| Unexpected readmission to the ICU per 100 ICU discharges | 3.3 | 7.7 |

**Days to allied health intervention**

Curtis 2006[14,16] reported a reduction in median days to Allied Health intervention in the TCM group compared with the control except in the case of Social Work where the days to intervention remained the same as shown below in Table 39:

**Table 39: Median days to allied health intervention**

| Allied Health Group | TCM Group | Control Group | p value |
|---|---|---|---|
| Physiotherapy | 1.5 | 1.9 | 0.036 |
| Occupational Therapy | 3.5 | 5 | 0.004 |
| Social Work | 3 | 3 | 0.445 |

Curtis 2002[14,14] also reported a reduction in the days to Allied Health Intervention from 3.25 days in the control group to 2.71 days in the TCM group with a reported p value of 0.625.

### Healthcare staff satisfaction

Spisso 1990[45,45] evaluated the role of the NP using a standard evaluation tool by a sample of randomly chosen registered nurse hospital staff. Of the 30 nurses surveyed, the proportion shown below felt that the NP role was very effective in the following areas:

**Table 40: Healthcare staff satisfaction**

| How effective is the role in: | Very effective | |
|---|---|---|
| Discharging patients | 93% | 28/30 |
| Interaction with patients and family on plan of care | 97% | 29/30 |
| Performing extended role procedures | 60% | 18/30 |
| Interacting with RN staff and providing liaison with physicians | 97% | 29/30 |

### Parent and carer satisfaction

Fanta 2006[22,22] asked caregivers (any parent or guardian of a child included in the study) to complete a family satisfaction survey. The Survey addressed the technical and interpersonal skills, information provision, and availability of the PNP or RES groups. Responses to the 14 questions on the overall parent satisfaction questionnaire were coded from 1-5, higher scores indicating greater satisfaction. These are shown below. Mann-Whitney U test was used to compare scores for individual questions.

**Table 41: Parent and carer satisfaction**

| Satisfaction of care | PNP Group rating | RES Group rating |
|---|---|---|
| Knowledge and experience of child's illness | 4.17 | 4.21 |
| Treat and medical follow-up | 4.33 | 4.28 |
| Attention to child's physical problems | 4.44 | 4.24 |
| Willingness to listen to concerns | 4.61 | 4.34 |
| Comfort and support given to child | 4.56 | 4.45 |
| Information given about child's injury | 4.67 | 4.34 |
| Information given about child's medical tests | 4.50 | 4.14 |
| Information given about child's treatment | 4.56 | 4.17 |
| Frequency of visits | 4.39 | 4.00 |
| Time devoted to visits | 4.3 | 4.17 |
| Follow-up | 4.0 | 4.00 |
| Control of Pain | 4.39 | 4.29 |

### Staff satisfaction

This outcome is reported in a separate paper (Shebesta 2006[44,44]) that has been merged with Fanta 2006[22,22] and measures nursing staff satisfaction with the care provided by a Paediatric Nurse Practitioner (PNP). If child was hospitalised for more than one day, a randomisation table was used to choose a nurse who would be asked to fill out a survey to have one nurse survey per patient.

The survey measured the nurse's perception of the child's care and of the child's primary health provider before discharge from the hospital or after transfer to another surgical/medical service .It addressed the technical and interpersonal skills, information provision and the availability of the PNP or Resident Clinician. The nurse was asked to rate the satisfaction of each element to the patient care they received from the PNP or Resident Clinician on a 5 point scale; higher scores indicating greater satisfaction. Mann-Whitney U test was used to compare scores for individual questions and the standard deviations are given in brackets.

**Table 42: Staff satisfaction**

| Satisfaction of care | PNP Rating Mean Score (SD) | RES Rating Mean Score (SD) |
|---|---|---|
| Knowledge and experience of the child's illness | 4.26 (0.682) | 3.45 (0.833) |
| Treat and medical follow-up | 4.23 (0.617) | 3.52 (0.755) |
| Attention to the child's physical problems | 4.26 (0.815) | 55 (0.938) |
| Comfort and support given to the child | 4.19 (0.703) | 3.29 (0.938) |
| Information given about the child's injury | 4.16 (0.820) | .97 (1.07) |
| Information given about the child's medical tests | 3.93 (0.740) | 2.91 (1.13) |
| Information given about the child's treatment | 16 (0.860) | 4. 3.09 (1.08) |
| Frequency of visit/consultation | 4.25 (0.928) | 3.06 (0.914) |
| Time devoted to visit/consultation | 4.19 (0.749) | 3.16 (0.820) |
| Management of child's pain | 4.10 (0.481) | 3.61 (0.747) |
| Response time to pages/questions | 4.43 (0.626) | 3.40 (1.03) |

## 11.4 Economic evidence

### Published literature

No relevant economic evaluations were identified.

See also the economic article selection flow chart in Appendix E.

### Unit costs

The cost of a trauma coordinator is equal to the cost of a band 6 or 7 Nurse specialist, which is £51 and £42 per hour, respectively, excluding qualification.[13] The number of professionals required to cover the trauma coordinator role for each TU could be around 3 if the coordinator has to be available 24/7.

## 11.5 Evidence statements

### Clinical

Very low quality evidence from one cohort study comprising 1541 participants demonstrated no clinical difference between trauma coordinator care compared with usual care for mortality, with very serious imprecision.

Very low quality evidence from one cohort study comprising 1541 participants demonstrated a clinical benefit with trauma coordinator care compared with usual care for number of people receiving allied health intervention-occupational therapy, with serious imprecision.

Very low quality evidence from one cohort study comprising 1541 participants demonstrated a clinical benefit with trauma coordinator care compared with usual care for number of people receiving allied health intervention-physiotherapy, with serious imprecision.

Very low quality evidence from one cohort study comprising 476 participants demonstrated a clinical benefit with trauma coordinator care compared with usual care for number of people receiving allied health intervention, with no serious imprecision.

Very low quality evidence from one cohort study comprising 1541 participants demonstrated no clinical difference between trauma coordinator care compared with usual care for number of unplanned ICU visits, with serious imprecision.

Very low quality evidence from one cohort study comprising 420 participants demonstrated a clinical benefit with trauma coordinator care compared with usual care for documentation in patient records-completeness description of procedures in discharge summaries, with serious imprecision.

Very low quality evidence from one cohort study comprising 420 participants demonstrated a clinical benefit with trauma coordinator care compared with usual care for documentation in patient records-completeness of description of procedures in discharge summaries, with serious imprecision.

Very low quality evidence from one cohort study comprising 420 participants demonstrated a clinical benefit with trauma coordinator care compared with usual care for documentation in patient records-completeness of events of hospitalisation in discharge summaries , with serious imprecision.

Very low quality evidence from one cohort study comprising 420 participants demonstrated a clinical benefit with trauma coordinator care compared with usual care for documentation in patient records-completeness of description of injuries in discharge summaries, with serious imprecision.

Very low quality evidence from one cohort study comprising 420 participants demonstrated a clinical benefit with trauma coordinator care compared with usual care for documentation in patient records-completeness of discharge teaching in discharge summaries , with no serious imprecision.

Very low quality evidence from one cohort study comprising 420 participants demonstrated a clinical benefit with trauma coordinator care compared with usual care for documentation in patient records-completeness of plan for follow-up care discharge summaries , with no serious imprecision.

Very low quality evidence from one cohort study comprising 420 participants demonstrated a clinical benefit with trauma coordinator care compared with usual care for documentation in patient records-compliant with obtaining inter-disciplinary consultations when indicated in inpatient records , with serious imprecision.

Very low quality evidence from one cohort study comprising 476 participants demonstrated no clinical difference with trauma coordinator care compared with usual care for number of occurrences of complications-overall complication rate, with very serious imprecision.

Very low quality evidence from one cohort study comprising 1541 participants demonstrated no clinical difference between trauma coordinator care compared with usual care for number of occurrences of complications-number of occurrences of respiratory failure , with serious imprecision.

Very low quality evidence from one cohort study comprising 1541 participants demonstrated no clinical difference between trauma coordinator care compared with usual care for number of occurrences of complications-number of occurrences of respiratory failure , with serious imprecision

Very low quality evidence from one cohort study comprising 1541 participants demonstrated no clinical difference between trauma coordinator care compared with usual care for number of occurrences of complications-number of occurrences of coagulopathy , with very serious imprecision.

Very low quality evidence from one cohort study comprising 1541 participants demonstrated no clinical difference between trauma coordinator care compared with usual care for number of occurrences of complications-number of occurrences of deep vein thrombosis(DVT) , with very serious imprecision

Very low quality evidence from one cohort study comprising 1541 participants demonstrated a clinical benefit with trauma coordinator care compared with usual care for number of procedures, with no serious imprecision.

Very low quality evidence from one cohort study comprising 476 participants demonstrated a clinical benefit with trauma coordinator care compared with usual care for missed injury detect, with no serious imprecision.

Very low quality evidence from one cohort study comprising 1541 participants demonstrated no clinical difference between trauma coordinator care compared with usual care for number of missed injuries , with very serious imprecision

Very low quality evidence from one randomised controlled trial comprising 76 participants demonstrated a clinical benefit with trauma coordinator care compared with usual care for hospital length of stay, with no serious imprecision.

**Economic**

No relevant economic evaluations were identified.

## 11.6 Recommendations and link to evidence

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| | **Recommendation for senior managers and key workers in major trauma centres**<br><br>**25. The key worker should:**<br>• **act as a single point of contact for patients, family members and carers, and the healthcare professionals involved in their care**<br>• **provide information on how the hospital and the trauma system works (major trauma centres, trauma units and teams)**<br>• **attend ward rounds and ensure that all action plans from the ward round are carried out in a timely manner**<br>• **provide patient advocacy**<br>• **ensure that there is a management plan and identify any conflicts**<br>• **organise ongoing care including discharge planning, transfers and rehabilitation.** |
| Description of current UK services | MTCs often employ one or more trauma coordinators; they are usually senior nurses with experience of trauma care. There are fewer trauma coordinators employed in TUs and the lower volume of patients may mean that the coordinator role is combined with another role.<br><br>Care of a patient with trauma is usually complex, multifaceted and involves many disciplines. The role of the trauma co-ordinator is to 'join up' the services that are involved in the care of a patient with trauma. However there is no one definition or job description of a trauma coordinator and the functions vary considerably between hospitals. Some features of the role will depend on the trauma service within the hospital and the needs of the patient. A patient on a single speciality ward will need a different service to one on a multispecialty trauma ward. The role may include administrative functions, liaising across the hospital departments and specialities, liaising with other hospitals and rehabilitation facilities, patient documentation and transfer of information, |

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| | and patient and carer information and support. In some hospitals there are clinical case manager roles that fulfil the same service. |
| Relative values of different outcomes | The following outcomes were identified as critical: mortality, heath-related quality of life (immediate and long term) and on-going consequential morbidity. The following outcomes were identified as important: metrics of continuity of care (including length of stay [total across transfers, MTC] and adverse incident report severity [red, amber, green]), time in acute setting, number of procedures, time to rehabilitation prescription, ICU length of stay, impact of traumatic event on concurrent morbidities, patient and carer satisfaction, staff satisfaction.<br><br>No evidence was reported for health-related quality of life, time to rehabilitation prescription and impact of traumatic event on concurrent morbidities. |
| Trade-off between clinical benefits and harms | **Children**<br>The evidence for the implementation of a trauma co-ordinator in children was sparse but indicated benefit for patient, carer and staff satisfaction compared to usual care but no difference for hospital length of stay.<br><br>**Adults**<br>The evidence showed more benefit for the implementation of a trauma co-ordinator compared to usual care in reducing; hospital length of stay, number of unplanned hospital admissions, number of procedures, the number of unexpected readmissions, completeness of documentation and in the number of hours the trauma centre was unable to accept new admissions. There were improvements in the number of patients receiving allied health professional interventions, the number of days to referral and staff satisfaction.<br>Equivocal evidence was reported for mortality rates, number of complications and no benefit was found for the number of missed injuries<br><br>The GDG noted the role of the trauma coordinator was different across the studies and it was difficult to identify what elements of the role contributed to the successful outcomes reported. The GDG concluded that the role has clear benefits for the patient, staff and the organisation. The GDG also noted that the trauma coordinator role in the older papers may have been fulfilling functions that improvements in trauma care have now made redundant. However they agreed that where a patient is receiving care from several places or specialities the role will still pay an important role in ensuring continuity of care. The GDG noted these key functions are predominantly around communication, ensuring that the patient management is joined up across different areas of care and the patient and their relatives are kept informed.<br><br>As the role of the trauma coordinator is tailored to the hospital the GDG decided not to make a recommendation about the need for a trauma coordinator but to make one that emphasised the importance of the patient having all aspects of their care coordinated. The recommendation here focuses on the key components of the role and the GDG noted the need for a key worker for each patient at every part of their journey to provide the key communication and advocacy roles.<br>Key worker is used in the recommendation as a generic title rather than trauma coordinator to avoid misconceptions that it is a specific job that is being recommended rather than critical elements of the role. As noted this role can use different titles, such as clinical case manager, depending on the location. |

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| | **The key worker**<br>A key worker could be based on a multi-specialty trauma ward or work across several wards.<br><br>The central role of the keyworker is to coordinate the patient pathway and to act a single point of contact for clinicians, patients and carers. This is especially important in trauma where patients may undergo a number of tests and interventions in a very short space time, transfer between hospitals and within departments in a single hospital, be under the care of a number of different health professionals and experience long-term sequelae of their injuries. Communication is the pivotal point of the role and the trauma keyworker liaises with medical and nursing staff, and other departments, such as theatre, X-Ray, laboratories and other specialist departments.<br><br>A patient may require input from a multitude of interrelated surgical and medical specialties, diagnostic tests, therapeutic interventions, and allied health services. The keyworker ensures that the myriad of details of care are neither forgotten nor duplicated.<br><br>The trauma keyworker offers support, advice and information to patients and their relatives/carers. They key act as a patient advocate, providing a voice for patients and families to help them successfully navigate the treatment and recovery process.<br><br>Major trauma patients may be transferred back to their local TU,to other specialist services, for example, rehabilitation or from the major trauma service. The trauma keyworker will be responsible for coordinating these transfers. |
| Trade-off between net health benefits and resource use | The majority of MTCs already employ a trauma coordinator; however, this recommendation could have some economic implications for TUs, where a specific trauma coordinator role is less common. Trauma coordinators could save resources as they ensure appropriate care is delivered to patients who do not require hospital admission. Some clinical evidence showed a reduced number of operative procedures, fewer readmissions to ICU, and shorter hospital length of stay associated with the presence of a trauma coordinator. The cost of a trauma coordinator is equal to the cost of a band 6 or 7 Nurse specialist, which is £51 and £42 per hour, respectively, excluding qualification.[13] The number of professionals required to cover the trauma coordinator role for each TU could be around 3 if the coordinator has to be available 24/7. The GDG advised that some administrative support may be required to ensure the case manager works effectively in all aspects of this role.<br><br>It was the GDG opinion that this role could be combined with other roles, for example, it can be shared with an existing orthopaedic trauma practitioner role in some units, and it would not require any additional staff member but it would mainly entail changing the role of the existing staff.<br><br>Considering the unlikely or negligible additional cost for this role and the potential cost savings that it could generate, as shown by the clinical evidence, the GDG concluded that having a nominated case manager for every trauma patient is cost effective.<br><br>The trauma coordinator does not need to be available 24/7, but the GDG felt most beneficial to be provided 7 days/week. Although, this may show benefit |

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| | only when NHS moves to 7/day working.<br><br>**The key worker**<br>The role of the key worker is not a distinct new role and as such should involve limited extra costs; the costs here are around the initial reorganisation of services to set up a single ward for patient with major trauma. |
| Quality of evidence | The evidence in the paediatric population was Low quality and was also considered indirect as the mean ISS score was 4.49 to 6.60.<br><br>The evidence for the retrospective cohort studies in the adult population was graded as Very low quality. |
| Barriers to implementation | A recent survey of UK trauma coordinators identified resources as a potential barrier to being able to carry out their job effectively, for example, the availability of trauma nurses and clerical staff. In some hospitals a trauma coordinator is not available 24 hours/7 days a week. (Crouch et al., 2015).<br><br>The barriers to providing this service are similar and require the availability of trauma nurses to be able to successfully under take this role. It also requires the time to successfully fulfil the demands of the role. |

# 12 Documentation and transfer of information

## 12.1 Introduction

The transfer of information and documentation during handover between staff from the pre-hospital setting to the emergency department (ED) and onwards from the ED to other departments is essential to achieve a continuity of safe, effective, individualised and patient care. If relevant information required to proceed with care is not available in a timely manner, onward care may be compromised, delayed or inappropriate decisions made regarding onward management.

The GDG sought to identify the best way of achieving the efficient transfer of high quality clinical information in acute pre- and hospital settings.

## 12.2 Review question: What are the barriers to the transfer of information and documentation from a) pre-hospital to the ED b) from the ED to surgery, other departments?

For full details see review protocol in Appendix C.

**Table 43: PICO characteristics of review question**

| | |
|---|---|
| **Objective** | Documentation and transfer of information is assumed to improve quality of care. If relevant information required to proceed with care is not available in a timely manner, onward care may be delayed or inappropriate decisions regarding onward management may be made. |
| **Population and setting** | Trauma service staff in both pre-hospital and hospital settings. |
| **Review strategy** | Meta-synthesis of overarching themes as identified by the available qualitative evidence |

## 12.3 Clinical evidence

### Methods

Qualitative studies exploring trauma service staff's perceptions and experiences of the transfer of information and documentation from pre-hospital to the ED and/or from the ED to other departments; exploring both facilitators and barriers to efficient information flow were searched for.

Three qualitative studies were included in the review [31,38,46] these are summarised in Table 44 below. Key findings from these studies are detailed in the evidence summary below (Table 45). See also the study selection flow chart in Appendix D, study evidence tables in Appendix G, and excluded studies list in Appendix J.

Interpretations and explanations from the original studies were synthesised to gain an insight into themes present across the body of evidence as a whole. The main concepts found in each individual study which were relevant to our review question were drawn together to inform understanding of overarching themes.

Two of the included studies explore the perceptions and experiences of paramedics and hospital receiving staff of handing over critically ill patients from the ambulance to the ED [38,46]. The third study included investigates the communication during handover of critically ill patients from ED to intensive care unit by nursing staff of both departments[31]. While none of the studies specifically

focuses on documentation required for handover of patients with major trauma, the findings highlight barriers and facilitators of documentation and effective information transfer that may be relevant to any critically ill trauma patient. A narrative summary of the evidence synthesis is provided in section 12.5.

**Table 44: Summary of studies included in the review**

| Study | Methods used | Population | Research aim | Comments |
|---|---|---|---|---|
| McFetridge 2007[31] | Multi-method design combining semi-structured individual and focus group interviews with documentation review. | ED and Intensive Care Unit (ICU) nurses (n=20) from two major acute hospitals in Northern Ireland | To explore the communication between ED and ICU nursing staff during transfer of critically ill patients. | Patient population may not be directly applicable (not specified if the 'critically ill' patients presented with trauma). |
| Owen 2009[38] | Grounded theory approach using semi-structured individual interviews with open-ended probing questions to elicit participants' perceptions of handover. | Paramedics (n=19), registered nurses (n=15), and doctors (n=16) from two ambulance services and two EDs across two states of Australia | To investigate perceptions by paramedics and hospital receiving staff about what enables and constrains handover in ED. | Patient population may not be directly applicable (not specified trauma). |
| Suserud 2003[46] | Qualitative interviews exploring further in depth the written description of a fatal case. Description derived from phenomenological life world portrayal to evaluate the experiences as they have been lived. | Ambulance nurses (n=6) with between three and fourteen years' experience of pre-hospital emergency care were interviewed in three ambulance stations in western Sweden | To investigate the experiences of ambulance nurses reporting on and handing over patients to staff of emergency receiving units. | Patient population may not be directly applicable (not specified trauma). Very limited description of analysis method. Themes more descriptive than evaluative. |

**Evidence**

Three main themes emerged from the evidence synthesis: 1) Lack of structure to handover/fragmentation, 2) Communication, and 3) Role of each staff and personal factors. These are explained in detail in Table 45.

**Evidence summary**

**Table 45: Summary of evidence by themes on pre-hospital and hospital staff's experiences and perceptions of patient handover**

| Study design and sample | | Themes and findings | Quality assessment | | |
|---|---|---|---|---|---|
| **No of studies** | **Design** | | **Criteria** | **Rating** | **Overall** |
| Theme 1: Lack of structure to handover/fragmentation | | | | | |
| 3 | interviews | Patient handover was recognised as integral process in the continuity of care for the critically ill patient. But no standardised policy/framework existed regarding the key information and documentation that should be passed on from the pre-hospital to the ED staff or from the ED to the ICU staff. Consequently, handover was described as lacking consistency and structure. Lack of structure also meant that information got more and more fragmented and changed with each handover, that is, 'Chinese whispers'.<br>Development of handover documentation for pre-hospital to ED, and for ED to ICU transfers was recommended detailing the type and order of information to be transferred. | Limitations of evidence | No limitations | MODERATE |
| | | | Coherence of findings | Coherent | |
| | | | Applicability of evidence | Applicable | |
| | | | Theme saturation/sufficiency | Saturated | |
| Theme 2: Communication | | | | | |
| 3 | interviews | Chaotic environment with many distractions and many people. Competing demands of attending to patients' critical care needs whilst handing over information at the same time, having the potential to omit or mishear information and so negatively impact on continuing care of the critically ill patient (patient safety).<br>Paramedics and ED receiving staff were lacking common language; difficulty to convey in words what the scene looked like and the 'body has been through' by the time the patient arrives at ED.<br>Receiving staff were trying to gain as much information from as many sources as possible (for example, medical, nursing staff). | Limitations of evidence | No limitations | MODERATE |
| | | | Coherence of findings | | |
| | | | Applicability of evidence | Applicable | |
| | | | Theme saturation/sufficiency | Saturated | |

| Study design and sample | | Themes and findings | Quality assessment | | |
|---|---|---|---|---|---|
| **No of studies** | **Design** | | **Criteria** | **Rating** | **Overall** |
| | | [*Links to Theme 3: Roles of staff*] | | | |
| Theme 3: Role of each staff and personal factors | | | | | |
| 3 | interviews | Not always clear who to actually handover the patient information to. Lack of clear leadership.<br>(In-)experience and attitude of staff can contribute to (in-)effectiveness of the handover process (for example, knowing what questions to ask, what information to share). Lack of awareness of each other's' roles was highlighted as a barrier.<br>'Senders' felt a loss of control in the management of the patient when handing over in the busy environment and at this stage, some staff (that is, ED nurses transferring patients to ICU) felt 'sidelined'.<br>Insistence by hospital receiving staff for ambulance staff to make diagnosis in unclear cases, if wrong, can cause delays to patient care and are difficult to rectify.<br>Education on each other's roles to foster understanding of each other's tasks and objectives and to improve communication is required. This may increase team efficiency too.<br>Making uninterrupted time for handovers between staff was suggested.<br>[*Links to Theme 1: Lack of structure and Theme 2: Communication*] | Limitations of evidence<br>Coherence of findings<br>Applicability of evidence<br>Theme saturation/sufficiency | No limitations<br>Coherent<br>Applicable<br>Saturated | MODERATE |

## 12.4 Economic evidence

**Published literature**

No relevant economic evaluations were identified.

See also the economic article selection flow chart in Appendix E.

## 12.5 Evidence statements

**Clinical**

Three qualitative studies suggested the following barriers and facilitators for the efficient transfer of high quality information when responsibility of care for trauma patients was transferred between staff in acute pre- and hospital settings:

**Lack of structure to handover or fragmentation**

Moderate quality evidence from all three studies suggested that patient handover forms a vital part in the continuity of care for the critically ill patient but highlighted that no standardised policy or framework existed detailing the type of information and documentation that needed to be transferred from the pre-hospital to the ED staff or from the ED to the ICU staff. As a result, handover lacked consistency and structure with information becoming more and more fragmented with each handover. The evidence recommended that handover documentation for pre-hospital to ED, and for ED to ICU transfers was developed specifying the type and order of information that needed to be passed on.

**Communication**

Moderate quality evidence from all three studies suggested that the competing demands of attending to patients' critical care needs whilst simultaneously handing over information can easily result in omitting or mishearing information, and as such may negatively impact on patient safety. The evidence further identified that receiving staff were trying to gain as much information from as many sources as possible (for example, medical, nursing staff), but also that paramedics and ED receiving staff were lacking common language to communicate what the patient had been through by the time of arrival at ED.

**Role of each staff and personal factors**

Moderate quality evidence from all three studies identified that lack of clear leadership, not knowing who to handover the patient information to, unawareness of each other's roles, as well as (in) experience and attitude of staff formed barriers to effective handover. The evidence further suggested that making uninterrupted time for handovers between staff, and providing education on each other's roles to foster understanding and improve communication was required. This may also increase team efficiency.

**Economic**

No relevant economic evaluations were identified.

## 12.6 Recommendations and link to evidence

**Recommendations**

**Documentation**

**Recommendations for ambulance and hospital trust boards, senior managers and commissioners within a trauma network**

**26. Ensure that pre-hospital documentation is standardised within a trauma network, for example using the Royal College of Physicians' Professional guidance on the structure and content of ambulance records.**

**27. Ensure that hospital documentation is standardised within a trauma network and there are systems that allow healthcare professionals access to all relevant and current clinical data at different points in the care pathway. This could be by using compatible electronic medical records such as a picture archiving and communication system (PACS) and an image exchange portal.**

These recommendations were developed and supported by the evidence review addressing the scope area,' patient documentation and transfer of information.' and the scope areas, 'documentation of clinical assessments and management (including pre-hospital and hospital)' in each of the four clinical guidelines:

- Complex fractures: assessment and management of complex fractures (including pelvic fractures and open fractures of limbs)
- Fractures: diagnosis, management and follow up of fractures (excluding head and hip, pelvis, open and spinal)
- Major trauma: assessment and management of airway, breathing and ventilation, circulation, haemorrhage and temperature control.
- Spinal injury assessment: assessment and imaging, and early management for spinal injury (spinal column or spinal cord injury) and ,' patient documentation and transfer of information' in the Major trauma services guidance scope area.

The chapters on documentation in these guidelines should be read in conjunction with this chapter.

**Developing the recommendations**

Documentation recommendations were developed across the trauma guidelines by all the individual GDGs. Each GDG was asked to define a clinical question to address the scope area that was specific and important to the population in their scope. Evidence reviews were completed for all the guidelines and the separate GDGs reviewed the evidence and drafted recommendations.

The overall guideline population of patients with major trauma meant that similarities and duplication between the draft recommendations were inevitable. The recommendations were taken to Project Executive Team (PET) for coherence and consistency checking. The PET also had the advantage of identifying gaps in separate guidelines that had been addressed in another guideline. The PET agreed on a core set of draft recommendations that encompassed the separate guideline recommendations. These recommendations are a key set of principles that underline best practice in

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| | documenting and communicating the management of a patient with major trauma.<br><br>Where recommendations were specific to the guideline these were kept separate for publication in that guideline. For example, the spinal injury guideline has documentation recommendations on documenting the secondary survey results and using the ASIA chart.<br><br>The core set of recommendations and were taken back to each of the separate GDGs for review and agreement. The GDGs had access to the reviews underpinning the recommendations.<br><br>The recommendations listed in this guidance are service guidance with direction for organisations responsible for commissioning services. The recommendations for clinical staff are listed in the clinical guidelines.<br><br>The LETR in this chapter summarises the decision making of the service delivery GDG. |
| Description of current UK services and issues | Throughout the UK there is variability both in what information is recorded and transferred, as well as variability in how this is done. For example, pre-hospital information may be recorded electronically or by hand. Where recorded electronically, systems may allow for records to be printed or electronically transferred when reaching the hospital. However, hospital trauma records are not always electronic and even where records are electronically held; these may not be compatible with other units within the hospital or within the trauma network. |
| Relative values of different outcomes | If barriers to ensure appropriate documentation and information transfer were removed, then patient outcomes would improve.<br>In particular, the GDG wished to prioritise removal of any barriers that led to:<br>• a poorly structured handover<br>• incompatibility and prevention of information transfer across the whole care pathway and trauma system<br>• miscommunication between different clinical professionals<br>• lost documents<br><br>Any service delivery barriers relating to these outcomes were identified. |
| Trade-off between clinical benefits and harms | Three qualitative studies were included in the review**.** Two of the included studies explored the perceptions and experiences of paramedics and hospital receiving staff or handing over critically ill patients from the ambulance to the ED. The third study included investigated the communication during handover of critically ill patients from the ED to intensive care unit by nursing staff of both departments. While none of the studies specifically focused on documentation required for handover of patients with major trauma, the GDG felt confirmed that the findings highlight barriers and facilitators of documentation and effective information transfer were relevant to any critically ill trauma patient.<br><br>Three themes were identified:<br>Patient handover was recognised as an integral process in the continuity of care for the critically ill patient. But no standardised policy/framework existed regarding the key information and documentation that should be passed on from the pre-hospital to the ED staff or from the ED to the intensive care unit staff. Consequently, handover was described as lacking consistency and structure. Lack of structure also meant that information got more and more |

fragmented and changed with each handover, that is, 'Chinese whispers'.

Communication poses a particular challenge to comprehensive documentation. The environment may be chaotic with many distractions and many people. There are competing demands in terms of attending to patients' critical care needs whilst handing over information at the same time. Paramedics and ED receiving staff may be lacking a common language leading to difficulty conveying in words what the scene looked like and the 'body has been through'.

The role of staff was the third theme identified. It was not always clear who to actually handover the patient information to which may be due to a lack of clear leadership. Inexperience and the attitude of staff can contribute to an ineffective handover process (for example, knowing what questions to ask, what information to share). Lack of awareness of each other's roles was highlighted as a barrier.

'Senders' felt a loss of control in the management of the patient when handing over in the busy environment and at this stage some staff (that is, ED nurses transferring patients to intensive care units) felt 'sidelined'. Some hospital receiving staff 'pressured' ambulance staff to make diagnosis in unclear cases, which if wrong, can cause delays to patient care and are difficult to rectify.

**Pre-hospital documentation and handover**

The GDG expressed the desire for handover documentations for pre-hospital to ED, and for ED to transfers to other departments to be developed and standardised, detailing the type and order of information to be transferred. They suggested pre-hospital information to be reported in the pre-hospital report form. See chapter 7 on pre-alert for the pre-hospital handover.

**Handover within a hospital**

The GDG expressed concerns that shift changes of staff could result in very brief information transfer at handover. It was also raised whether there should be separate handovers between doctors and nurses. It was noted that people interpret the same information differently; the most informed person may be the person who started the care pathway with the patient.

Departments and services within trauma networks (that is, ambulance/pre-hospital, ED, intensive care unit) need to have compatible systems.

Electronic systems may facilitate the transfer of information.

**Communication with primary care, patients and carers**

Some patients may not be able to assimilate information about their condition, for example, they may be unconscious, in pain or lacking capacity due to a head injury. It is therefore important that this information is in a written format so that it can be read by the patient at a time when they are able to assimilate the information. If appropriate, this information also needs to be made available to carers so that they are informed about the person's condition. However, patient confidentiality must be respected. The written information should not replace face-to-face communication. It is important that the written synopsis should be updated and communicated when circumstances change, for example, when a diagnosis or management plan changes, or if the patient is transferred to another service. The information synopsis could include: main diagnosis, pertinent physical findings, results of procedures and laboratory tests, discharge medications with reasons for any

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|---|---|
| | changes to the previous medication regimen, details of follow-up arrangements made, information given to the patient and family, test results pending at discharge, specific follow-up needs and anticipated recovery time. |
| Trade-off between net health benefits and resource use | No economic studies were identified specifically on the cost associated with removing the barriers to transfer of information or documentation.<br><br>There are potential costs associated with staff training and the development, purchasing and maintenance of electronic systems and software.<br><br>Some costs may be offset by decreased workloads due to computerisation of manual records and reduced clinical costs of adverse events due to improved safety.<br><br>It was also noted that uniformity of the documentation process and protocol, through an economy of scale, could be less expensive for the NHS than implementation of disparate systems.<br><br>Overall, the GDG believed that the recommendations made would not have a significant cost impact in comparison to current practice as they are not prescriptive in how exactly documentation systems are implemented. In due course, changes to documentation structures across all acute care pathways may mean that roll out of electronic systems become more cost effective as they increase in their economy of scale and scope (that is, assisting people using the same service but with conditions other than trauma) |
| Quality of evidence | The quality of the body of the qualitative evidence for all three themes was Moderate. This was primarily due to applicability reasons as the patient population was not specified as trauma. |
| Other considerations | The GDG agreed on the following consensus recommendations on the general principles of documentation and the transfer of information for a patient with major trauma injuries:<br>• integrated systems across trauma networks<br>• standardised documentation<br>• minimum data sets<br>• clear line of responsibility for documentation<br><br>These recommendations were supported by evidence reviews reported in the Major Trauma guideline.<br><br>All these recommendations also facilitate the accurate and complete collection of research and audit data.<br><br>The GDG were keen to emphasise the importance of Safeguarding and the need for accurate documentation. The GDG noted these recommendations in the NICE CG176 Head injury.<br>1.2.16 Ambulance crews should be trained in the safeguarding of children and vulnerable adults and should document and verbally inform emergency department staff of any safeguarding concerns. [2003, amended 2014]<br><br>1.3.11 A clinician with training in safeguarding should be involved in the initial assessment of any patient with a head injury presenting to the emergency department. If there are any concerns identified, document these and follow local safeguarding procedures appropriate to the patient's age. [2003, amended 2014] |

**Use of images from the incident site**

The GDG wanted to comment on the use of images in the pre-hospital setting. The GDG agreed that these images can be initially distracting to the receiving hospital team; a verbal description followed by the written documentation was perceived as of more value. This could include descriptors such as type of injury (penetrating or blunt), mechanism of injury (especially in team response) and environmental aspects (how cold, trapped at scene, other timings involved with description of incident and of aspects of delivery of care).

# 13 Trauma audit

## 13.1 Introduction

The UK currently has a national audit of trauma services in place, and entry to this audit is already linked to best practice tariff. However, the incentive for data collection is mainly focused on clinical observations, timing and staffing in the acute phase for patients who at some point are treated at a major trauma centre (MTC). The Trauma Audit & Research Network (TARN) is an established national clinical audit for trauma care across England, Wales and the Republic of Ireland. TARN has been supporting trauma receiving trusts for over twenty years by providing each NHS trust with analysis of process, case mix adjusted outcome analysis and comparisons of trauma care. The data collected follows the patient pathway from incident through to discharge from hospital and focuses on key observations, interventions, investigations and attendants treating the injured patient. TARNlet was established in 2000 to record data on children under 16 yrs. There are strict entry criteria, meaning that information regarding low risk patients suspected of major trauma is not routinely collected on a national basis. Furthermore, data is not collected for longer term outcomes after the acute phase. There is no validated system of looking at functional outcome, despite acknowledgement that return to normal activities and productivity is an important outcome.

Whilst routine clinical observation and data collection is recognised to be important, there is less certainty on how audit could be best used to inform future improvements in service performance and whether additional data would be beneficial. It is unknown how individual providers may supplement information captured by national audit through local audit systems. It is recognised that whilst national systems are important for benchmarking, local systems are critical in data collection and implementing local system improvement

## 13.2 Review question: Is audit and feedback effective for improving health provider performance and healthcare outcomes?

For full details see review protocol in Appendix C.

**Table 46: PICO characteristics of review question**

| | |
|---|---|
| **Population** | Adults and children with suspected trauma |
| **Intervention(s)** | Audit and feedback (alone)<br>Audit and feedback as the core/essential feature of a multifaceted intervention |
| **Comparison(s)** | Standard care |
| **Outcomes** | Critical:<br>Compliance with desired practice<br>Patient outcomes |
| **Study design** | RCTs or observational |

## 13.3 Review question: What features are needed in a national audit system to ensure that audit improves service performance as measured by patient outcomes?

For full details see review protocol in Appendix C.

**Table 47: PICO characteristics of review question**

| | |
|---|---|
| **Population and setting** | Any population and setting involving national audit |
| **Objective** | To determine how national audit systems could improve performance by identifying which type of information is critical to collect. |
| **Context** | The review hopes to assist recommendations regarding how national audit systems could be used to inform performance improvement and future decision making regarding trauma services. |
| **Review strategy** | Meta-synthesis of qualitative research: Thematic analysis - information synthesised into themes and sub-themes. Results presented diagrammatically and as narrative. |

## 13.4 Clinical evidence

No studies were identified to answer the question of whether audit and feedback improves health provider performance or patient outcomes.

Three studies[11]; [40]; [41] reported on different aspects on national audit which may improve patient outcomes.

**Table 48: Summary of studies included in the review**

| Study | Design | Population (n) | Research aim | Comments and study quality |
|---|---|---|---|---|
| Cornish 2011[11] | This was a prospective e-survey on colorectal surgeons' attitudes towards and opinions of the NBOCAP, within trusts in the UK. A questionnaire was emailed to members of the Association of Coloproctology of Great Britain and Ireland (ACPGBI). | Of the 171 trusts contacted by email, 66% of trusts (n=117) had at least 1 consultant respond. Of the 117 trusts that responded, 60 (51.2%) had submitted data to the NBOCAP. A total of 549 consultants received the questionnaire, and 159 (29.0%) consultants responded. Fifty-one per cent (n=60) of the trusts had submitted data to the NBOCAP. | The National Bowel Cancer Audit Project (NBOCAP) collects data from hospitals in the UK and aims to improve surgical outcomes and quality of care for patients. The aims of this study were to understand why trusts were/were not participating in the NBOCAP and how to improve the quality of data collected and feedback. | Directness of evidence: MODERATE<br>National UK audit<br>Not trauma population |
| Racy 2014[40] | A telephone survey | 26 MTCs in England. The mean number of TARN data collectors was two per centre, ranging from one to five. Data had been collected and uploaded to the TARN registry for a mean of five years, | To identify how data was collected at a local level, what software and methods were used and what resources were allocated to collect and upload trauma data to the TARN. | Directness of evidence: HIGH<br>National UK audit<br>Trauma population |

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|---|---|---|---|---|
| | | ranging from one to twelve. | | |
| Rudd 2001[41] | A national audit of organisational structure and retrospective case note audit, repeated within 18 months. Separate postal questionnaires were used to identify the types of change made between the first and second round and to compare the representativeness of the samples. | 157 trusts (64% of eligible trusts in England, Wales, and Northern Ireland) participated in both rounds. Participants—5589 consecutive patients admitted with stroke between 1 January 1998 and 31 March 1998 (up to 40 per trust) and 5375 patients admitted between 1 August 1999 and 31 October 1999 (up to 40 per trust). | To describe the standards of care for stroke patients in England, Wales and Northern Ireland and to determine the power of national audit, coupled with an active dissemination strategy to effect change | Directness of evidence: MODERATE<br>National UK audit<br>Not trauma population |

**Evidence synthesis**

**Table 49: Summary of evidence: Themes derived from the evidence**

| No. of studies | Design Sample | Themes | Quality assessment | |
|---|---|---|---|---|
| How data is recorded | | | | |
| 1 | Telephone survey | • The majority of hospitals (n=11) used Microsoft Excel as a local database. Seven used dedicated commercial software. Only three responders were able to state whether the software they used was high level architecture compatible (whether it can interact with other systems irrespective of platform). | Low quality – methodological limitations could not be assessed due to insufficient reporting | Direct UK trauma population. |
| Reasons for submitting data | | | | |
| 1 | Survey | • To compare a units' data with national data<br>• to improves outcomes<br>• to generation of information for use at a local level | Very low quality – methodological limitations could not be assessed due to insufficient reporting | Indirect population: Colorectal surgeons attitudes and opinions of the NBOCAP. |
| Reasons for non-submission | | | | |
| 1 | Survey | • Lack of technical support<br>• lack of funding<br>• lack of dedicated audit time<br>• resources for audit are very poor or poor<br>*[link to reasons for barriers for entering data theme]* | Very low quality – methodological limitations could not be assessed due to insufficient reporting | Indirect population: Colorectal surgeons attitudes and opinions of the NBOCAP. |
| Barriers to entering data | | | | |
| 1 | Telephone survey | • When uploading data to TARN, the data for each patient is entered manually into an online form.<br>• Data already input into existing databases has to be entered again, requiring time and a dedicated member of staff, as well as resulting in the duplication of data.<br>• Creating an automatic upload to TARN would require the data into the local | Low quality – methodological limitations could not be assessed due to insufficient reporting | Direct UK trauma population. |

| No. of studies | Design Sample | Themes | Quality assessment | |
|---|---|---|---|---|
| | | database to be correctly entered and coded. Failure to do so would result in inaccurate and misleading data or an administrator would have to check the data for accuracy.<br>• Some data may be left out and may have to be added later.<br>• Data not meeting the inclusion criteria for TARN would have to be filtered out.<br>*[link to reasons for non-submission theme]* | | |
| Factors rated likely to influence future data submissions | | | | |
| 1 | Survey | • Health Care Commission mandating audit<br>• credit in annual health check<br>• pressure from patients/patient groups<br>• pressure from professional bodies<br>• peers becoming involved<br>• fully integrated online data submission<br>• online reporting to allow up to date feedback for individual units | Very low quality – methodological limitations could not be assessed due to insufficient reporting | Indirect population: Colorectal surgeon's attitudes and opinions of the NBOCAP. |
| Features of national audit | | | | |
| 1 | Survey | • Audit report should identify individual trust results | Very low quality – methodological limitations could not be assessed due to insufficient reporting | Indirect population: Colorectal surgeon's attitudes and opinions of the NBOCAP. |
| Feedback of audit results | | | | |
| 1 | Postal questionnaire | • Trusts indicated that the confidential report detailing their performance against the national benchmark was valuable.<br>• Similarly, feedback from the 17 regional workshops between the audit rounds suggested that they were a stimulating arena for sharing ideas on good practice at a local level.<br>• We cannot prove that change would not have occurred with feedback of results alone, but we believe that regional workshops were an important additional factor in giving local clinicians new ideas for change and the confidence to promote those ideas. | Very low quality – methodological limitations could not be assessed due to insufficient reporting | UK setting but indirect population: Stroke patients describing standards of care from the National Stroke Audit. |

## 13.5 Economic evidence

### Published literature

No relevant economic evaluations were identified.

See also the economic article selection flow chart in Appendix E.

## 13.6 Evidence statements

### Clinical

Three low to very low quality qualitative studies (one in a directly applicable population and two in an indirect population) reported the following themes:

- How data is recorded, specifically what software was used to record information
- reasons for submitting data, for example to improve patient outcomes
- reasons for non-submission of data and barriers to entering data, for example lack of technical support and time
- factors rated likely to influence future data submission, for example pressure from patients groups and professional bodies and if fully integrated online data submission becomes available
- features of national audit, for example the ability to identify individual trust results
- feedback of audit results, for example the value of confidential feedback of individual trust results and the opportunity for shared learning

### Economic

No relevant economic evaluations were identified.

## 13.7 Recommendations and link to evidence

**Recommendations for ambulance and hospital trust boards, medical directors, senior managers and commissioners**

28. **Ensure that there is a major trauma audit programme to evaluate systems, services and processes as part of the major trauma network's quality improvement programme.**

29. **Ensure that a major trauma audit programme includes:**
    - **regular review of audits undertaken locally and regionally**
    - **registration with the Trauma Audit and Research Network (TARN)**
    - **accurate and complete data submission to TARN**
    - **quarterly review of TARN reports.**

30. **A national trauma audit system should collect and analyse data to enable providers of major trauma services to review their local, regional and national major trauma performance.**

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| Description of current UK services | The UK currently has a national audit of trauma services in place (TARN), and entry to this audit is already linked to best practice tariff for MTCs. MTC's can obtain best practice tariff payments for their patients if they meet certain criteria. The best practice tariff is made up of two levels of payment differentiated by the ISS of the patient. For each patient with an ISS more than 8 there is an extra payment of £1500 if the:<br>1. patient is assessed and if needed given a rehabilitation prescription within 48 hours of admission<br>2. TARN data is submitted within 25 days of acute care discharge or death<br>plus if<br>3. Any non-emergency transfer in occurs within 48 hours<br>and<br>4. If the patient required blood transfusion tranexamic acid (TXA) is given within 3 hours of injury.<br>The patient has to meet a minimum of 2 maximum of 4 of these indicators for the payment.<br>For each patient with an ISS more than 15 there is an extra payment of £1500 if the:<br>1. Consultant sees the patient within 5 minutes of arrival<br>2. Head CT within 30 minutes if GCS<13 and head injury (nice head injury guidance).<br>These payments incentivize MTCs and support the costs of TARN data collection. TUs do not receive the best practice tariff even if they meet the criteria above. All TUs are members of TARN but do not have the same resource support to collect and submit TARN data.<br><br>The incentive for data collection is mainly focused on clinical observations, timing and staffing in the acute phase for patients who at some point are treated at a MTC. There are strict entry criteria, meaning that information regarding low-risk patients suspected of major trauma is not routinely collected on a national basis. Furthermore, data is not collected for longer term outcomes after the acute phase. There is no validated system of looking at functional outcome, despite acknowledgement that return to normal activities and productivity is an important outcome.<br><br>Whilst routine clinical observation and data collection is recognised to be important, there is less certainty on how audit could be best used to inform future improvements in service performance and whether additional data would be beneficial. It could be argued that performance improvement, peer review system, audit and governance are an integral part of a national audit system. |
| Relative values of different outcomes | Improving patient outcomes and service provider performance were identified as important outcomes. |
| Trade-off between clinical benefits and harms | Three qualitative studies were identified that reported on different features of national audit systems. Studies reported on how they submit data, and reasons for submission and non-submission (including barriers). Features of national audit and how feedback should be provided were also highlighted. Data was submitted to national audit to improve performance and to compare results with other service providers. Reasons for the non-submission of data included lack of resources (time, finances and technical support). The study on the TARN highlighted several barriers to submission, including manual data entry and duplication of data entry (data is entered locally and nationally). However, an automatic upload to TARN may lead to inaccurate and misleading data.<br><br>The GDG emphasised the importance of participation in local and national |

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| | audit in order to improve standards of care and to highlight areas for future research. The key aim of national trauma audit is to encourage best practice within the emergency care setting and support this by monitoring standards recommended by NICE and professional bodies. The GDG supported the existing current national trauma audit programme, TARN and TARNlet, which produces both national and local data on adult and paediatric trauma services respectively. Regular review of audit data is important in order to report national trends, monitor the effectiveness of interventions, to identify audit outliers and to compare the performance of local services with national performance indicators. |
| Trade-off between net health benefits and resource use | No economic evaluations on the cost effectiveness of audit were identified to inform this review. There was no quantitative evidence retrieved by this review to assist the cost effectiveness evaluation of audit. The below discussion is based on GDG consensus and discussion papers identified in the economic search. Despite the potential running costs involved with national audits, the GDG were aware of the fact that a national audit is already in place and therefore the set up costs would be minimal. They also concluded that benefits such as improved standards of care justify the running costs.<br><br>Consideration was given to the resources involved (above and beyond usual care) in the implementation of audit, such as the collecting data, recording data and storing data, quality assurance of data (inclusive of ensuring completeness and accuracy), general governance and administration of the audit and the training costs of staff members involved. The benefit of national audit is that many of these services and costs can be centralised.<br><br>Consideration was also given to other means by which patient outcomes may be improved through data collection such as publicly available data, for example, the use of HES data or financial monitoring data (such as, NHS reference costs) or information from health-related R&D studies funded from the NHS budget. However, these alternatives lack comprehensiveness and the cross-comparability that a national audit could provide.<br><br>Generally, audits and registries are likely to have high, up front, one-off costs in their set up and design, but could have minimal on-going running costs (dependent on their design, roles, responsibilities and pay of staff involved in audit and software use). Where audit or registries are linked into pre-existing systems of data collection required for clinical monitoring, marginal cost to clinical care may be minimal.<br>Running costs will depend on the size of the data collection exercise, as well as the duration and frequency of follow-up. One discussion paper commented that costs may range from £45,000 (including set up and management) of a small audit limited to 18 months collection to an excess of £2.8 million annual expenditure of a large national registry. [48,49] Importantly, the cost of audit is often borne by the participating hospital and generally not well reported. [48,49]. The implementation costs to train staff to use a pre-existing trauma audit system for one provider have been estimated to be in the region of £6000, with on-going running costs not reported .[25,25].<br><br>Formal networks and membership schemes may help individual providers to lower the cost of audit, whilst allowing for more meaningful cross setting comparison. Membership to a national audit for a hospital trust is likely to fall within the range of £3000 to £9000, to include:<br>• Training days for staff to learn how to enter data<br>• Four full-time analysts for ad hoc bespoke reports |

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| | • One university data storage facility<br>• Online web hosting of data base<br>• Governance of dataset<br><br>However, it is important to also think about the unreported cost of the provider which membership fees generally do not account for. This includes time of a staff member sufficiently skilled to enter data accurately (that is, a band 6) who, dependent on the number of trauma patients seen, could work from 1 day a week to full time in the entry of data. Further staff time may be spent on quality assurance and advice on coding, as well as IT and HR time in support. Additional clinical staff time is required to record the observations in the field.<br><br>Registries and audits benefit from economies of scale and could be viewed as having the properties of a public good. Although the collection of high quality information data may be costly, the cost of making this data available to additional users is often low and sometimes close to zero. Scale economies arise because unit costs fall as more consumers use the data product[9,10]. The more inclusive the audit or registry system in terms of their population and the more accessible the information is that they collect, the lower the cost per patient is likely to be and the wider benefit they are likely to bring [9,10].<br><br>Computerised systems of documentation and automatic upload may increase the upfront cost of implementing an audit. Software costs and maintenance could be in the region of tens of thousands of pounds per provider. However, ensuring software compatibility could be done centrally. This upfront investment may be offset by reduced manual labour of data entry and may provide additional benefit in assisting accessibility of timely data and feedback to providers.<br><br>A key barrier to obtaining longer term outcomes was the cost of follow up. Whilst it was recognised that collection of long term follow-up data was key in linking service change to improved patient outcomes, it was not clear whether the benefit of this data would outweigh the costs involved in its collection. For this reason, the GDG wished to formulate a research recommendation. |
| Quality of evidence | The study on TARN was rated as High quality with respect to the directness of the applicability of evidence. The other two papers were rated as Moderate quality as they were not on patients with trauma. Methodological limitations could not be assessed due to poor reporting of methods and data analysis. |
| Barriers to implementation | MTCs are provided with financial incentives to submit data to TARN, this is not currently the case with TUs.<br>Conducting audit is resource intensive and dedicated staff are required to obtain and enter data<br>Staff time and resources have to be allocated to review feedback from audit and change management in response to the findings |
| Other considerations | The GDG noted that TARN is actively seeking to reduce the burden of data collection for trusts with tools that will actively pull data from the electronic patient data. This will require minimal additional input from trust audit staff, in line with HQIP objectives (HQIP National Clinical Audit for Specialist Rehabilitation following Major Trauma).<br><br>Audit systems are designed with a cycle of continuous service improvement and bench marking as a primary objective. Audits are not primarily designed to inform specific primary clinical or operational research objectives. None the less, registries and audit data are often looked at as potential data sources for |

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| | retrospective studies, especially where primary research may be not be feasible (that is, due to high costs, ethical implications).<br><br>Whilst it would be impossible to anticipate the needs of every specific research project regarding trauma care and analysis of information to inform future recommendations; there are some considerations which may inform audit design to maximise the potential benefit for health service research. Implications for research outlined within the NICE trauma suite of guidance highlight some information gaps and features of an audit which could assist primary research within policy research timeframes. These include, but are not limited to:<br>• Accessibility and ease of processing data for bespoke analysis<br>• Ability to record or link to other databases that record long term outcomes.<br>• Ability to link to information regarding the service configuration of the providers<br>• Recording of a quality of life measure (that is, the EQ5D)<br>• Discussion with methodologists to identify and record factors which could act as instrumental variables in future research (such as, distance from injury to provider).<br>• Consideration of recording prognostic and diagnostic criteria which are commonly used within the field to inform clinical or service decisions.<br>• Identification or estimation and recording of critical time points, which in turn could assist with survival analysis.<br>• Specification of why a clinical activity was undertaken and for which indication<br>• Inclusivity of all of the relevant population (that is, inclusive of the more common but lower risk groups) across all of the patient journey from time of injury (that is inclusive of pre-hospital information for all, including the very severe in whom mortality occurred en route to hospital). This will greatly assist determination of the clinical progression or deterioration in relation to service intervention.<br>• Additional outcomes (over and above mortality) should be recorded in order audit to be more useful for example morbidity, quality of life (for example, EQ5D), Glasgow Outcome Scale, return to 'normal' activities up to two years post discharge.<br>• However, follow-up post-discharge is extremely time consuming.<br>• It is important to differentiate between audit and research. Audit cannot enable conclusions to be drawn with respect to their trauma care or trauma experience.<br>• Audit should encompass NICE trauma guideline information.<br>• Trauma governance feeds into Trust governance (this is usually quarterly) including review of TARN performance.<br>• IT should support the bulk upload of data to TARN or another national audit system but this does take up a huge amount of resources and often involves double data entry. |

# 14 Paediatric trauma training

## 14.1 Introduction

Paediatric trauma patients are triaged and referred to an emergency department (ED) according to local service configurations. In the most part, major trauma centres (MTCs) will treat adults and children, however, there are also five trauma centres which exclusively treat children (and are concentrated in the midlands). Secondary transfer for children suspected of a trauma is common place, not least as approximately 25% will self-present at a local emergency department (ED).

While there is advanced paediatric life support courses there are no known gold standard training courses for paediatric trauma care. Paediatric major trauma is rare and healthcare professionals often describe their feelings of uncertainty and anxiety when faced with a severely injured child.

The objective of this review is to determine what training (if any) in paediatric trauma care should routinely be implemented, whilst considering whether training programmes are viable given the low volumes of paediatric trauma cases the majority of healthcare providers experience. The GDG asked in particular what aspects (type and frequency) of paediatric training for trauma improve outcomes for providers which experience high volumes of adult trauma and experience of trauma in children.

## 14.2 Review question: What aspects (type and frequency) of paediatric training for trauma improve outcomes for providers which experience high volumes of adult trauma and experience of trauma in children?

For full details see review protocol in Appendix C.

**Table 50: PICO characteristics of review question**

| | |
|---|---|
| **Population** | Children (aged 0 to 16 years) |
| **Interventions** | • Paediatric Advanced Life Support (PALS)<br>• Assistant Life Support Technician<br>• No training<br>• standard care<br>• Adult trauma specialists with APLS basic paediatric training<br>• Adult trauma specialists + paediatric in-service training<br>• Paediatric trauma specialists<br>• General paediatrics training + trauma in-service training |
| **Comparison** | All interventions will be compared with each other, unless otherwise stated |
| **Outcomes** | Critical:<br>• Mortality<br>• Quality of life<br>• Time to intervention<br>• Important:<br>• Length of stay<br>• Hospitalisation<br>• Time to diagnosis<br>• Time to transfer |

| | |
|---|---|
| | • Skill delivery<br>• Skill retention<br>• Other clinical outcomes |
| **Study design** | RCTs or observational |

## 14.3 Clinical evidence

We searched for randomised and non-randomised studies comparing different paediatric training methods on clinical and clinician outcomes. One retrospective cohort study was included in the review.[3] Evidence from this study is summarised in the GRADE clinical evidence summary below (Table 52). Please also see the study selection flow chart in Appendix D, study evidence tables in Appendix G, forest plots in Appendix I, GRADE tables in Appendix H and excluded studies list in Appendix J.

**Table 51: Summary of studies included in the review**

| Study | Intervention and comparison | Population/ Setting | Outcomes | Comments |
|---|---|---|---|---|
| Baker 2009[3] | Paediatric training - PALS. PALS- trained EMS caregivers with PALs certification<br><br>Paediatric training - standard care<br><br>N=183 | Population: Paediatric patients requiring acute resuscitation and activation of the critical care and trauma response teams upon arrival to ED; all resuscitations initiated by Emergency medical services (EMS) personnel<br><br>Setting: Regional paediatric trauma referral centre for a 20 county area in Southwestern Ohio, USA | Mortality<br>Successful intubation<br>Successful intravenous (IV) or intraosseous (IO) access<br>intravenous (IV) or intraosseous (IO) | Only 47% had experienced trauma, and so this was regarded as indirect evidence. Although the groups differed at baseline for age, response time, whether the event had occurred in an urban or rural location, whether trauma had occurred, whether intubation was required and whether in IV or IO access was indicated, adjustments were made to outcomes for these in a multivariable analysis. |

**Table 52: Clinical evidence summary: PALS versus no PALS training**

| Outcome | Number of studies (no. of participants) | Imprecision | GRADE rating | Relative Risk | Control event rate (per 1000) | Control event rate for continuous outcomes |
|---|---|---|---|---|---|---|
| Mortality | 1 (n=183) | Very serious | VERY LOW | OR 0.7 (0.3 to 1.63) | - | - |
| Successful intubation in those requiring it | 1 (n=104) | serious | VERY LOW | OR 4.4 (1.2 to 16.13) | - | - |
| Successful IV/IO access in those for whom it was attempted | 1 (n=134) | None | VERY LOW | OR 17.4 (2.5 to 121.11) | - | - |

## 14.4 Economic evidence

**Published literature**

No relevant economic evaluations were included.

See also the economic article selection flow chart in Appendix E.

## 14.5 Evidence statements

**Clinical**

Very low quality evidence from one cohort study comprising 184 participants showed that PALS training led to a clinical benefit in terms of mortality compared with no PALS training, with very serious imprecision.

Very low quality evidence from one cohort study comprising 104 participants showed that PALS training led to a clinical benefit in terms of successful intubation compared with no PALS training, with serious imprecision.

Very low quality evidence from one cohort study comprising 134 participants showed that PALS training led to a clinical benefit in terms of successful IV/IO access compared with no PALS training, with no serious imprecision.

**Economic**

No relevant economic evaluations were identified.

## 14.6 Recommendations and link to evidence

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|---|---|
| **Recommendations** | **Recommendation for ambulance and hospital trust boards, medical directors and senior managers**<br><br>**31. Provide education and training courses for healthcare professionals who deliver care to children (under 16s) with major trauma that include the following components:**<br>• **safeguarding**<br>• **taking into account the radiation risk of CT to children when discussing imaging for them**<br>• **the importance of the major trauma team, the roles of team members and the team leader, and working effectively in a major trauma team**<br>• **managing the distress families and carers may experience and breaking bad news**<br>• **the importance of clinical audit and case review.** |
| Description of current UK services | There are only a small number of MTCs specialising in paediatric trauma. Routine training for adult trauma already occurs as part of advanced trauma life support training; however, there is no specific training course for paediatrics. Paediatric trauma is rare and healthcare professional report feeling unprepared in this situation. |

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| Relative values of different outcomes | Critical outcomes were mortality, quality of life, length of stay, hospitalisation, any other clinically relevant outcomes and time to diagnosis, intervention or transfer. Important outcomes were clinician skill delivery and retention.<br><br>No evidence was reported for quality of life, length of stay, hospitalisation, time to diagnosis, intervention or transfer, or clinician skill delivery and retention. |
| Trade-off between clinical benefits and harms | Evidence only existed for PALS versus no PALS training. This showed clear benefits from PALS with respect to successful intubation and successful intravenous or intraosseous access. There was no difference in mortality.<br><br>The generalisability of the evidence to all scenarios within the UK is questionable. The evidence is from settings where staff are routinely treating paediatric patients. There is no clear evidence that this effect is sustainable in a different setting where the occurrence of paediatric critical care is low. This would be more in keeping with the average UK emergency department.<br><br>The GDG considered there was benefit in training all emergency department staff given that approximately 25% of injured children arrive as walk-ins and are not necessarily triaged to a MTCs by pre-hospital staff. Generalist emergency department staff need to be prepared for this. However, it is unlikely that any one emergency department provider will treat more than one or two paediatric cases per year. The GDG emphasised the importance of the application of any paediatric trauma training to practice frequently. Skills are unlikely to be maintained if the volume of paediatric trauma patients is low. The lack of evidence combined with the reasons mentioned previously, led the GDG to make recommendations on specific aspects of training instead of a specific training course.<br><br>The purpose of the trauma team is to provide advanced simultaneous care from relevant multidisciplinary specialists to the seriously injured paediatric trauma patient, their actions being coordinated by a team leader. Well-functioning trauma teams improve patient outcomes and communication skills amongst team members are particularly important.<br><br>Health professionals treating paediatric trauma patients need to be well informed about radiation risks associated with X-ray and CT (see recommendation on full body CT). They must also be able to communicate the risks and benefits on assessment and interventions to carers.<br><br>Managing distressed relatives and carers is particularly important in paediatric trauma. The importance is often under emphasised and specific training is often not provided. The GDG noted that the siblings of the child with major trauma should not be ignored when communicating with the family.<br><br>At every stage of the trauma pathway, the importance of safeguarding children is paramount. The GDG were keen to emphasise the importance of Safeguarding. The GDG noted that there are recommendations in the NICE CG176 Head injury that refer to safeguarding training for ambulance crews and clinicians.<br><br>Audit should be integrated into all trauma services (see recommendations on audit). The GDG emphasised that audit and care review are an essential in order to improve service and patient outcomes, especially in services where the volume of paediatric trauma is low. Audit describes the nature of injuries occurring; inform the future configuration of services; and provide data on the outcome for individual hospitals measured against others within the system. |

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| Trade-off between net health benefits and resource use | No economic evidence was included for this review.<br><br>Key costs include those to implement the course and staff time invested in training; which may be offset by the potential reduction in costs of adverse events (avoided with training) and costs of secondary transfer required due to unavailability of paediatric skills within the initial treating centre.<br><br>Overall investment in training represents a sunk cost. The more children a trained healthcare professional attends, potentially the larger the clinical benefit and consequently the more cost effective the training becomes.<br><br>A pertinent issue to whether training is cost effective is where and to whom children present. Another issue is how long the effect size of training is maintained and whether a recurring training session (and cost) needs to be considered.<br><br>Trauma paediatric cases are relatively rare, with approximately 1:30 child to adult trauma cases. Such ratios will be specific to local contexts and existing infrastructure, and thus, training may be most cost-effective if matched to local need. Unfortunately, without evidence of effect for outcomes, such as skill maintenance or its relation to volume of cases seen, useful estimates of cost effectiveness cannot be derived.<br><br>It remains unclear whether resources would be better invested in training paediatricians on the specifics of trauma paediatric care, over and above, training trauma specialists in paediatric trauma care. Likewise, there is no evidence to inform whether investment into training local non-designated trauma staff is cost effective in the likelihood such staff will not see the volumes of patients required to maintain those skills. |
| Quality of evidence | The non-randomised study used an appropriate multivariable analysis to adjust for plausible confounders, with an acceptable number of events per variable. The key confounder of injury severity was not used in the analysis, but the need for intubation and intravenous/intraosseous access could be regarded as reasonable proxy variables. Attrition bias was present but poorly reported and so potential bias must be assumed. Indirectness resulting from only 47% having trauma and imprecision for two of the outcomes makes the quality of this evidence very low overall. |
| Barriers to implementation | The low number of exposures to paediatric cases per year for the average emergency department provider was felt to be a problem, as even annual training cannot make up for a lack of practical experience. That is, “You can’t train experience”. It was therefore suggested that it was important to foster a habit of sharing relevant ideas and experience between peers. |
| Other considerations | The GDG felt that making a recommendation about educating providers on trauma in paediatrics was appropriate, but that because of the low number of paediatric cases it might be more cost-effective to adapt existing courses rather than design a completely new one.<br><br>In 2000, TARNLET, the paediatric (0 - 15 years) component of the Trauma Audit and Research Network was established. |

# 15 Information and support

## 15.1 Introduction

The NICE guideline on 'Patient Experience' (CG138) has established that adults and their carers and families require information about their diagnosis, prognosis and treatment. Appropriate and timely information empowers people giving a sense of control and reducing psychological stress. Information is required from the very early stages of assessment and treatment. There is variation in the content and in the way people with major trauma and their families and carers receive information

In the hours following major trauma people may be disorientated, distressed and coming to terms with multiple injuries. In these frightening circumstances, it is important that an injured person is given the information they need from the very early stages of assessment and treatment to feel safe and reassured. The major trauma GDG explored this question.

Patients and carers may find themselves having to seek out the information themselves, and information that is available may not be in a format suitable for easy consumption in what can be a confusing and angst-ridden setting. Hospital trusts which provide trauma services may have to consider new ways of working and incorporating access to electronic patient information and telemedicine systems to provide adequate support for major trauma patients and their families and carers. The service delivery GDG sought to investigate some of the ways in which information and support could best be provided to the population who receive care from major trauma services.

This chapter describes, through a combination of consensus opinion from this GDG and synthesis of findings from qualitative studies from the Major Trauma guidance the:

- specific thoughts and feelings of people who have experienced major trauma injuries
- ways in which information and support could best be provided to the population who receive care from major trauma services.

## 15.2 Review question: How should information and support be provided to families and carers?

For full details see review protocol in Appendix C.

**Table 53: PICO characteristics of the service delivery review question**

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|---|---|
| **Population and setting** | Families and carers of people with suspected or confirmed traumatic injury and who use trauma services. |
| **Objective** | To determine how information and support should be provided to families and carers of people with major trauma |
| **Context** | For example:<br>• telemedicine<br>• leaflets<br>• designated person<br>• trauma nurse coordinator |
| **Review strategy** | Meta-synthesis of qualitative research: Thematic analysis - information synthesised into themes and sub-themes. Results presented diagrammatically and as narrative. |

The review question in the Major Trauma clinical Guideline was ,'what information and support do people with major trauma and their families and carers want in-hospital and on discharge from ED?' (see Major Trauma Clinical Guideline chapter 16).

## 15.3 Clinical evidence

We searched for qualitative studies exploring perceptions of how information and support should be provided to families and carers of people who have received care provided by major trauma services. No relevant studies were identified

## 15.4 Economic evidence

**Published literature**

A search specific to this topic was not undertaken, as economic evaluations are unlikely to comment on how interventions address specific support needs.

## 15.5 Evidence statements

**Clinical**

No clinical evidence was identified

**Economic**

No relevant economic evaluations were identified.

## 15.6 Recommendations and link to evidence

| | |
|---|---|
| | **The NICE guideline on major trauma contains recommendations for healthcare professionals on information and support.**<br><br>**Recommendation for ambulance and hospital trust boards, senior managers and commissioners**<br><br>**32. Establish a protocol for providing information and support to patients, family members and carers.**<br><br>**Recommendations for healthcare professionals providing information to people with major trauma in the emergency department**<br><br>**Providing support**<br><br>**33. The trauma team structure should include a clear point of contact for providing information to patients, family members and carers.**<br><br>**Support for children and vulnerable adults**<br><br>**34. Allocate a dedicated member of staff to contact the next of kin and provide support for unaccompanied children and vulnerable adults.**<br><br>**Providing information** |

35. **Document all key communications with patients, family members and carers about the management plan.**

36. **For patients who are being transferred from an emergency department to another centre, provide verbal and written information that includes:**
    - **the reason for the transfer**
    - **the location of the receiving centre and the patient's destination within the receiving centre**
    - **the name and contact details of the person who was responsible for the patient's care at the initial hospital**

These recommendations were developed and supported by the evidence reviews addressing the scope area, ' provision of information and support for families and carers ' and' Information and support needs of patients and their families and carers when appropriate' in each of the four clinical guidelines:

- Complex fractures: assessment and management of complex fractures (including pelvic fractures and open fractures of limbs)
- Fractures: diagnosis, management and follow up of fractures (excluding head and hip, pelvis, open and spinal)
- Major trauma: assessment and management of airway, breathing and ventilation, circulation, haemorrhage and temperature control.
- Spinal injury assessment: assessment and imaging, and early management for spinal injury (spinal column or spinal cord injury)

The chapters on information and support in these guidelines should be read in conjunction with this chapter.

**Developing the recommendations**

Information and support recommendations were developed across the trauma guidelines suite by all the individual GDGs. Each GDG was asked to define a clinical question to address the scope area that was specific and important to the population in their scope. Evidence reviews were completed for all the guidelines and the separate GDGs reviewed the evidence and drafted recommendations.

The overall guideline population of patients with major trauma meant that similarities and duplication between the draft recommendations were inevitable. The recommendations were taken to Project Executive Team (PET) for coherence and consistency checking. The PET also had the advantage of identifying gaps in the separate guidelines that had been addressed in another guideline. The PET agreed on a core set of draft recommendations that encompassed the meaning from the separate recommendations. These recommendations are a key set of principles that underline best practice in providing information and support to a patient with traumatic injuries. and their families and/or carers

Where there were recommendations that were specific to the guideline these were kept separate for publication in that guideline. For example, the spinal injury guideline has a recommendation highlighting the importance of eye contact with a person with suspected spinal injury to avoid movement of their neck.

The core set of recommendations and were taken back to each of the separate

| | |
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| | GDGs for review and agreement. The GDGs had access to the reviews underpinning the recommendations.<br><br>The recommendations listed here are directed at organisations responsible for commissioning. The recommendations for healthcare professionals are listed in the clinical guidelines.<br><br>The LETR in this chapter summarises the decision making of the service delivery GDG |
| Description of current UK services | Currently, how information is communicated to primary care physicians, patients and carers varies considerable. In many services, information is sent to the primary care physician when the patient is discharged. However, relatives and friends often visit the primary care physician asking for information about the injury whilst the patient is still in hospital. The information sent to the primary care physician may not be a format that is suitable for the patient and carers, for example, computer-generated discharge summaries. |
| Relative values of different outcomes | A qualitative review was conducted to explore how information should be provided and who should provide this information. No evidence was identified. |
| Trade-off between clinical benefits and harms | Some patients may not be able to assimilate information about their condition, for example, they may be unconscious, in pain or lacking capacity due to a head injury. It is therefore important that this information is in a written format so that it can be read by the patient at a time when they are able to assimilate the information. If appropriate, this information also needs to be made available to carers so that they are informed about the person's condition. The written information should not replace face–to-face communication. It is important that the written synopsis should be updated and communicated when circumstances change, for example, when a diagnosis or management plan changes, or if the patient is transferred to another service. The information synopsis could include: main diagnosis, pertinent physical findings, results of procedures and laboratory tests, discharge medications with reasons for any changes to the previous medication regimen, details of follow-up arrangements made, information given to the patient and family, test results pending at discharge, specific follow-up needs and anticipated recovery time.<br><br>The GDG noted that patients and carers often do not understand why they have been transported to a major trauma centre, bypassing the trauma unit, which may be a long distance from home.<br><br>There are unlikely to be clinical harms from offering information and support. Poor information transfer and discontinuity has been shown to be associated with lower quality of care on follow-up, as well as adverse clinical outcomes. Clinical benefits may also include an increased sense of control over the person's own life, a greater ability to make appropriate self-management decisions and reduced anxiety. |
| Trade-off between net health benefits and resource use | No economic studies were identified specifically on the cost associated with different ways to provide information and support to patients and carers. The role of the key worker is not a distinct new role and as such should involve limited extra costs; the costs here are around the initial reorganisation of services to set up a single ward for patient with major trauma.<br><br>Overall, the GDG believed that the recommendations made would not have a significant cost impact and having standardised protocols for providing |

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| | information and support would make this process more efficient in the long term.<br><br>Also providing information effectively would lead to better health outcomes for the patients, such as increased sense of control over the person's own life, a greater ability to make appropriate self-management decisions and reduced anxiety. |
| Quality of evidence | No evidence was identified. |
| Barriers to implementation | Currently, information is not often communicated to primary care within 24 hours of admission. In order to implement this, services may wish to consider electronic transfer of information or enabling primary care physician access to information stored on hospital systems. One role of the trauma coordinator should be ensuring that the information is communicated and updated. |
| Other considerations | Please also refer to the NICE guidelines on 'Care of the dying adult' (due to be published December 2015), 'End of life care for infants, children and young people' (due to be published 2016) and Improving supportive and palliative care in adults (update) (due to be published January 2018) |

# 16 Rehabilitation

## 16.1 Introduction

After the recovery from the initial trauma many patients will need input from rehabilitation services. Rehabilitation is delivered by specialist multi-disciplinary teams with support from the trauma specialists while needed. A significant number of patients will have more complex needs requiring more prolonged input from a multidisciplinary team with expertise, and a smaller group will need more prolonged specialist rehabilitation (in- or out-patient). The Trauma Clinical Advisory Group advised that every patient with ISS≥9 in either a Major Trauma Centre or a Trauma unit should have their needs for rehabilitation assessed, and that a rehabilitation prescription (RP) should be provided for all patients with rehabilitation needs. The RP is used to document the rehabilitation needs of severely and identify how they will be addressed. The question asked here is why early rehabilitation is not implemented following an assessment.

## 16.2 Review question: What are the barriers to providing early rehabilitation following early rehabilitation assessment? What are the implications for service delivery?

For full details see review protocol in Appendix C.

**Table 54: PICO characteristics of review question**

| | |
|---|---|
| **Population** | People who have suspected major trauma and use trauma healthcare services.<br><br>Indirect populations to be included if no evidence: Traumatic brain injury and spinal injury |
| **Intervention(s)** | Early rehabilitation (physiotherapy, occupational therapy, speech, mental health) following early rehabilitation assessment (within 72 hours)<br><br>NOTE: If there is limited evidence on early rehabilitation assessment we will include papers that look at barriers to providing rehabilitation following assessment even if the assessment is not early |
| **Outcomes** | These will be the barriers identified in the papers for example:<br>Inadequate assessment<br>Staff resources<br>Patients factors (severity of illness, pain/discomfort)<br><br>Implications for service delivery of the barriers identified |
| **Study design** | Qualitative |

## 16.3 Clinical evidence

No relevant studies were identified

## 16.4 Economic evidence

**Published literature**

No relevant economic evaluations were identified.

See also the economic article selection flow chart in Appendix E.

## 16.5 Evidence statements

### Clinical

No clinical evidence identified.

### Economic

No relevant economic evaluations were identified.

## 16.6 Recommendations and link to evidence

| Recommendations | **Research recommendation: What are the barriers to people with major trauma receiving early rehabilitation after rehabilitation assessment? What changes to services are needed to overcome these barriers?** |
|---|---|
| Description of current UK services | The availability of early rehabilitation varies considerably across the UK due to a number of factors, including local service configuration and the type of rehabilitation required for example neurological or orthopaedic, inpatient or outpatient. It is a requirement of the Best Practice Tariff to complete a rehabilitation prescription (RP) to document the rehabilitation needs of severely injured patients (ISS score ≥9) and identify how they will be addressed. The RP should be initiated within 2 calendar days of admission to the trauma service. |
| Relative values of different outcomes | A qualitative review was undertaken to identify the barriers to providing early rehabilitation following early rehabilitation assessment and to identify the service delivery implications of the removal of these barriers. No evidence was identified. |
| Trade-off between clinical benefits and harms | The lack of effective early rehabilitation after major trauma has been identified as one of the major factors underlying the poor outcome seen after major trauma in the UK. There are many potential barriers to providing early rehabilitation following early rehabilitation assessment, for example, including staff being unsure of the benefits of early rehabilitation, lack of trained staff ,lack of an integrated care pathway and a low priority given to rehabilitation compared to acute services.<br><br>Rehabilitation is an intrinsic part of recovery and the GDG felt strongly that the paucity of evidence should be emphasised. As such they made a research recommendation to focus research on identifying what barriers existed in the UK NHS system to delivering rehabilitation effectively.<br><br>The GDG noted that the clinical and cost effectiveness of early rehabilitation needs to be established but this was not within the scope of this guideline. |
| Trade-off between net health benefits and resource use | The GDG were unsure of what barriers existed in the UK NHS system and therefore could not establish the costs associated with the removal of these barriers. For this reason they made a research recommendation. The GDG noted that the clinical and cost effectiveness of early rehabilitation needs to be established but this was not within the scope of this guideline. |
| Quality of evidence | No evidence was identified. |
| Barriers to implementation | Research recommendation |

| | |
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| Other considerations | The GDG emphasised that rehabilitation should start as soon as possible, and that waiting is inappropriate. Delayed rehabilitation may result in:<br>• an inappropriate use of other resources. Whilst waiting for rehabilitation a person may well be occupying space in another setting that is equally in demand.<br>• The development of 'complications' while waiting for example physical problems such as skin pressure ulcers, joint contracture and psychological complications such as depression, apathy and anger<br>The rehabilitation services that exist across the UK are highly variable for example with respect to the proportion of patients selected for inpatient care and the availability of home, outpatient and residential services. Barriers to providing early rehabilitation need to be identified in all services proving rehabilitation. The GDG noted that patients may need to be referred for on-going pain management but this was outside of the scope of this guideline<br>• The GDG made a research recommendation: What are the barriers to providing early rehabilitation following early rehabilitation assessment? What are the implications for service delivery? |

# 17 Access to services and the skills required to deliver the service

## 17.1 Introduction

The organisation of trauma services in the UK remains topical and there are continuing controversies regarding the optimum system of delivering trauma services within the present resource. The optimal management of a person with major trauma and potentially life threatening injuries needs to have the right staff, with the right skills, in the right place at the right time. The NICE clinical guideline Head injury (CG 176) has made a significant contribution to improving the way people with head injury are managed. The development of these NICE guidelines on different aspects of trauma care (Complex Fractures; Fractures; Major Trauma; Spinal injuries assessment and Major Trauma Services) will significantly add to this contribution further improving and standardising the delivery of trauma care and services across the UK.

This chapter summarises the services and skills recommended in this service delivery guidance and across the following clinical guidelines:

- Complex fractures: assessment and management of complex fractures (including pelvic fractures and open fractures of limbs)
- Major trauma: assessment and management of airway, breathing and ventilation, circulation, haemorrhage and temperature control.
- Spinal injury assessment: assessment and imaging, and early management for spinal injury (spinal column or spinal cord injury)

To further explore the impact of the clinical recommendations on trauma services, we aimed to develop a service systems model evaluating different service configurations. A number of scope areas across the trauma clinical guidelines have a direct impact on trauma service system configuration and it was anticipated these areas would populate the systems model. These areas include; pre hospital choice of intervention (and therefore staffing required), hospital intervention (and therefore dictating where a patient should go) and timing in which a given intervention should be given. Exploring different service configurations would enable the GDG to have insight into the relationships between areas of practice and support them to recommend the optimal services across the patient pathway and not in isolation.

This chapter will be presented in three sections:

- The service delivery implications of the recommendations in this guidance and the complex fractures, spinal injuries assessment and major trauma, clinical guidelines.
- Additional reviews undertaken based on the service delivery impact:
  - Airway management
  - Timing of interventional radiology for people with major trauma and haemorrhage
- The service systems model.

# 17.2 Service delivery implications

## 17.2.1 Overview of methods

**First stage: Identification of the recommendations with service delivery implications across the guidelines**

The recommendations made in the Complex fractures, Spinal injury assessment, Major Trauma, and Major Trauma services guidance were reviewed by the GDG to identify those with an impact on services through:

- timing – the timing an intervention should be given
- destination of the patient – triaging decisions, initial destination or secondary transfer
- availability of a service – the routine availability of an intervention
- staff skills – expertise not routinely available

See Table 55 for the recommendations that the GDG identified with these important service implications.

**Second stage: Prioritising specific service delivery areas for further work**

When making any recommendation, clinical effectiveness is weighed up against the cost and resource implications of an intervention, with the assumption that access to interventions and expertise is in line with current practice and service specifications. The following factors were considered when assessing the recommendations identified in Table 55:

- Economies of scope or scale may mean that overall clinical benefit of an intervention may be under or over estimated.
- Resource and cost involved in implementing a service to ensure uniform access may be sufficiently high when this is taken into account that the clinical net benefit no longer outweighs the net cost of the intervention.
- Local factors within a given health economy could highly influence what health strategies or interventions may be appropriate or most cost effective.
- Social values and context (i.e. requirement for equity of access, equity of health outcome, maximisation of patient satisfaction, promotion of local decision making and empowerment) were as important in determining optimal service configuration and guidance as the need to consider maximisation of population health under a budget constraint.
- Training and education

Where the GDG thought that a clinical recommendation was significantly outside of current practice and service specifications, the clinical and cost effectiveness evidence informing that recommendation was revisited and additional review questions were developed regarding access issues. As a result the GDGs identified the recommendations below to potentially have large service implications, and prioritised these areas for further work to support the clinical recommendations (see Table 56):

- Airway management in the pre-hospital setting, in particular access to expertise in RSI
- Access to imaging, in particular access to timely CT within trauma units and MRI more generally
- Access to interventions which control for bleeding, in particular interventional radiology
- Access to interventions that may require orthopaedic and plastic surgery expertise

Although the other recommendations in Table 55 had been identified as having an impact on services the GDG considered that the access to the interventions and expertise was either in line or feasible within current practice and service specifications.

### 17.2.2 Summary of recommendations identified to have service implications

**Table 55: Relevant NICE guidelines and recommendations with potential service implications**

| Guideline | Recommendation | Main implication for access to the service |
|---|---|---|
| Major trauma | The GDG rationale for recommending the service is described in the relevant LETR in the guidelines | |
| Airway | Use drug-assisted rapid sequence induction (RSI) of anaesthesia and intubation as the definitive method of securing the airway in patients with major trauma who cannot maintain their airway and/or ventilation. .<br><br>If RSI fails, use basic airway manoeuvres and adjuncts and/or a supraglottic device until a surgical airway or assisted tracheal placement is performed.<br><br>Aim to perform RSI as soon as possible and within 45 minutes of the initial call to the emergency services, preferably at the scene of the incident.<br><br>If RSI cannot be performed at the scene :<br>• consider using a supraglottic device if the patient's airway reflexes are absent<br>• use basic airway manoeuvres and adjuncts if the patient's airway reflexes are present or supraglottic device placement is not possible.<br>• transport the patient to a major trauma centre for RSI provided the journey time is 60 minutes or less<br>• only divert to a trauma unit for RSI before onward transfer if a patient on airway cannot be maintained of the journey time to a major trauma centre is more than 60 minutes. | Staff skills to deliver RSI. Only trained physicians and trained paramedics as part of a physician led team can deliver RSI.<br><br>Timing of appropriate staff that can deliver RSI. Staff trained to deliver RSI may not be initially present at the scene and there will therefore be a delay in waiting for them to arrive. |
| Chest trauma (pre-hospital) | Consider using eFAST (extended focused assessment with sonography for trauma) to augment clinical assessment only if a specialist team equipped with ultrasound is immediately available and onward transfer will not be delayed. | Availability of ultrasound<br><br>Staff skills to perform ultrasound<br><br>Ultrasound machines may be |

| Guideline | Recommendation | Main implication for access to the service |
|---|---|---|
| | | less available in current practice than for example X-ray, and training may be required |
| Chest trauma (pre-hospital) | Only perform chest decompression in a patient with suspected tension pneumothorax if there is haemodynamic instability or severe respiratory compromise.<br><br>Use open thoracostomy instead of needle decompression if the expertise is available, followed by a chest drain via the thoracostomy in patients who are breathing spontaneously. | Staff skills to perform decompression techniques<br><br>Paramedics are trained to perform needle decompression but only trained physicians can perform an open thoracostomy |
| Chest trauma (in hospital) | Perform chest decompression using open thoracostomy followed by a chest drain in patients with tension pneumothorax. | Staff skills to perform decompression<br><br>Only trained physicians can perform an open thoracostomy and insert a chest drain |
| Chest trauma (in hospital) | In patients with tension pneumothorax, perform chest decompression before imaging only if they have either haemodynamic instability or severe respiratory compromise.<br><br>Imaging to assess chest trauma<br><br>Consider immediate chest X-ray and/or eFAST (extended focused assessment with sonography for trauma) as part of the primary survey to assess chest trauma in adults (16 or over) with severe respiratory compromise.<br><br>Consider immediate CT for adults (16 or over) with suspected chest trauma without severe respiratory compromise who are responding to resuscitation or whose haemodynamic status is normal.<br><br>Consider chest X-ray and/or ultrasound for first-line imaging to assess chest trauma in children. | Availability of X-ray, ultrasound and CT.<br><br>Timing to imaging<br><br>Either the equipment or personnel to perform these may not be immediately available. |

| Guideline | Recommendation | Main implication for access to the service |
|---|---|---|
| | Do not routinely use CT for first-line imaging to assess chest trauma in children (under 16s). | |
| Anticoagulation reversal | Consult a haematologist immediately for advice on adults (16 or over) who have active bleeding and need reversal of any anticoagulant agent other than a vitamin K antagonist.<br><br>Consult a haematologist immediately for advice on children (under 16s) with major trauma who have active bleeding and may need reversal of any anticoagulant agent. | Availability of a haematologist |
| Circulatory access | For circulatory access in patients with major trauma in pre-hospital settings:<br>• use peripheral intravenous access **or**<br>• if peripheral intravenous access fails, consider intra-osseous access.<br><br>For circulatory access in children with major trauma, consider intra-osseous access as first-line access if peripheral access is anticipated to be difficult.<br><br>For circulatory access in patients with major trauma in hospital settings:<br>• use peripheral intravenous access **or**<br>• if peripheral intravenous access fails, consider intra-osseous access. | Staff skills to provide circulatory access<br><br>Central venous access requires significant skill and training and can only be performed by a physician |
| Haemorrhage protocols | For patients with active bleeding, start with a fixed-ratio protocol for blood components and change to a protocol guided by laboratory coagulation results at the earliest opportunity. | Availability of laboratory services |
| Fluid replacement | In pre-hospital settings only use crystalloids to replace fluid volume in patients with active bleeding if blood components are not available.<br><br>In hospital settings do not use crystalloids for patients with active bleeding (see the section on resuscitation in the NICE guideline 'intravenous fluid therapy in adults in hospital' for advice on tetrastarches)<br><br>For adults (16 or over) use a ratio of 1 part plasma to 1 unit of red blood cells, and base the volume on the child's weight.<br><br>For children (under 16s) use a ratio of 1 part plasma to 1 part red blood cells, and base the volume on | Availability of blood and plasma. These products are not routinely carried by UK paramedics |

| Guideline | Recommendation | Main implication for access to the service |
|---|---|---|
| | the child's weight. | |
| Haemorrhage control | Limit diagnostic imaging (such as chest and pelvis X-rays or FAST [focused assessment with sonography for trauma]) to the minimum needed to direct intervention in patients with suspected haemorrhage and haemodynamic instability who are not responding to volume resuscitation.<br><br>Be aware that a negative FAST does not exclude intraperitoneal or retroperitoneal haemorrhage.<br><br>Consider immediate CT for patients with suspected haemorrhage if they are responding to resuscitation or if their haemodynamic status is normal. | Availability of X-ray, Fast scan and CT<br><br>Timing of imaging<br>Either the equipment or personnel to perform these may not be immediately available. |
| Whole-body CT | Use whole-body CT (consisting of a vertex-to-toes scanogram followed by a CT from vertex to mid-thigh) in adults (16 or over) with blunt major trauma and suspected multiple injuries. Patients should not be repositioned during whole-body CT. | Availability of CT<br><br>Timing of imaging<br><br>Either the equipment or personnel to perform CT may not be immediately available. |
| Damage control surgery | Use damage control surgery in patients with haemodynamic instability who are not responding to volume resuscitation.<br><br>Consider definitive surgery in patients with haemodynamic instability who are responding to volume resuscitation.<br><br>Use definitive surgery in patients whose haemodynamic status is normal. | Availability and timing of surgery<br><br>Either the equipment or personnel to perform surgery may not be immediately available. |
| Interventional radiology | Use interventional radiology techniques in patients with active arterial pelvic haemorrhage unless immediate open surgery is needed to control bleeding from other injuries.<br><br>Consider interventional radiology techniques in patients with solid-organ (spleen, liver or kidney) arterial haemorrhage.<br><br>Consider a joint interventional radiology and surgery strategy for arterial haemorrhage that extends to | Availability and timing of interventional radiology<br><br>Availability and timing of surgery<br><br>Either the equipment or personnel to perform these may |

| Guideline | Recommendation | Main implication for access to the service |
|---|---|---|
| | surgically inaccessible regions.<br><br>Use an endovascular stent graft in patients with blunt thoracic aortic injury. | not be immediately available. |
| Documentation<br><br>Transfer of information | A senior nurse or trauma team leader in the emergency department should receive the pre-alert information and determine the level of trauma team response according to agreed and written local guidelines. | Availability of a senior nurse /trauma team leader |
| Documentation | One member of the trauma team should be designated to record all team findings and interventions as they occur (take 'contemporaneous notes').<br><br>The trauma team leader should be responsible for checking the information recorded to ensure it is complete. | Availability of an individual to be responsible for documentation |
| Information and support | The trauma team structure should include a clear point of contact for providing information to the patients, family members and carers. | Availability of a dedicated person to provide support and information to the patient, their families and carers. |
| Information and support | Allocate a dedicated member of staff to contact the next of kin and provide support for unaccompanied children and vulnerable adults. | Availability of a dedicated person |
| Spinal injury | The GDG rationale for recommending the service is described in the relevant LETR in the guidelines | |
| Immobilisation | At all stages of the assessment:<br>• protect the person's cervical spine with manual in-line spinal immobilisation, particularly during any airway intervention, **and**<br>• avoid moving the remainder of the spine.<br><br>Carry out full in-line spinal immobilisation if any of the factors in recommendation 3 are present or if this assessment cannot be done.<br><br>Carry out or maintain full in-line spinal immobilisation un the emergency department if any of the factors in recommendation 3 are present or if this assessment cannot be done. | Skills and the staff to carry out manual and full in-line spinal immobilisation. Staff need to be trained and also a number of staff are required. |

| Guideline | Recommendation | Main implication for access to the service |
|---|---|---|
| | | |
| Assessment | Assess whether the person has a high- or low-risk factor for cervical spine injury using the Canadian C-spine rule as follows:<br>• the person is at high-risk factor if they have at least one of the following high-risk factors:<br>– age 65 years or older<br>– dangerous mechanism of injury (fall from a height of greater than 1 metre or 5 steps, axial load to the head – for example diving, high-speed motor vehicle collision, rollover motor accident, ejection from a motor vehicle, accident involving motorised recreational vehicles, bicycle collision,horse riding accidents)<br>– paraesthesia in the upper or lower limbs<br>• the person is at low-risk factor if they have at least one of the following low-risk factors:<br>– involved in a minor simple rear-end motor vehicle collision<br>– not comfortable in a sitting position<br>– not been ambulatory at any time since the injury<br>– midline cervical spine tenderness<br>– delayed onset of neck pain.<br>• the person remains at low risk if they are:<br>– is unable to actively rotate their neck 45 degrees to the left and right (the range of the neck can only be assessed safely if the person is at low risk and there are no high risk factors). | Skills to use the Canadian C-spine rule |
| Immediate destination | Transport people with suspected acute traumatic spinal cord injury (with or without column injury), with full in-line spinal immobilisation, to a major trauma centre irrespective of transfer time, unless the person needs an immediate lifesaving intervention.<br><br>Ensure that time spent at the scene is limited to giving life-saving interventions.<br><br>Transport adults with suspected spinal column injury without suspected acute spinal cord injury, with full in-line spinal immobilisation, to the nearest trauma unit, unless there are pre-hospital triage indications to transport them directly to a major trauma centre.<br><br>Transport children with suspected spinal column injury (with or without spinal cord injury) to a major | Destination and time to destination. Transporting patients to major trauma centres may involve long distances. |

| Guideline | Recommendation | Main implication for access to the service |
|---|---|---|
| | trauma centre. | |
| Spinal - imaging | Imaging for spinal injury should be performed urgently and the images should be interpreted immediately by a healthcare professional with training skills in this area.<br><br>**Suspected cervical spine cord or column injury**<br>**Children (under 16 years)**<br>Perform MRI for children (under 16s) if there is a strong suspicion of :<br>– cervical spine injury as indicated by Canadian C-spine rule and by clinical assessment or<br>– cervical spinal column injury as indicated by clinical assessment or abnormal neurological signs or symptoms, or both.<br><br>Consider plain X-rays in children (under 16s) who do not fulfil the criteria for MRI in recommendation 37 but clinical suspicion remains after repeated clinical assessment.<br><br>Discuss the findings of the plain X-rays with a consultant radiologist and perform further imaging if needed.<br><br>For imaging in children (under 16s) with head injury and suspected cervical spine injury, follow the recommendations in section 1.5 of the NICE guideline on head injury.<br><br>**Adults**<br>Perform CT in adults (16 or over) if:<br>– imagine for cervical spine injury is indicated by the Canadian C-spine rule or<br>– there is a strong suspicion of thoracic or lumbosacral spine injury associated with abnormal neurological signs or symptoms.<br><br>**Suspected thoracic or lumbosacral injury**<br>*Suspected column injury only*<br>Perform an X-ray as the first-line investigation for people with a suspected spinal column injury without | Availability and timing of :<br>Radiologist<br>Consultant radiologist<br>MRI<br>CT<br>X-ray |

| Guideline | Recommendation | Main implication for access to the service |
|---|---|---|
| | abnormal neurological signs or symptoms in the thoracic or lumbosacral regions (T1–L3).<br><br>Perform CT if the X-ray is abnormal or there are clinical signs or symptoms of a spinal column injury.<br><br>If a new spinal column fracture is confirmed, image the rest of the spinal column.<br><br>*Suspected column and cord injury in children*<br>Perform MRI for children (under 16s) if there is a strong suspicion of:<br>– cervical spinal cord injury as indicated by the Canadian C-spine rule and by clinical assessment or<br>– cervical spinal column injury as indicated by clinical assessment or abnormal neurological signs or symptoms, or both.<br><br>Consider plain X-rays in children (under 16s) who do not fulfil the criteria for MRI in recommendation 37 but clinical suspicion remains after repeated clinical assessment.<br><br>Discuss the findings of the plain X-rays with a consultant radiologist and perform further imaging if needed.<br><br>*Suspected column and cord injury in adults*<br>Perform CT in adults (16 or over) if:<br>– imaging for cervical spine injury is indicated by the Canadian C-Spine rule or<br>– there is a strong suspicion of thoracic or lumbosacral spinal injury associated with abnormal neurological signs or symptoms. | |
| Whole body CT | See major trauma recommendation above | |
| Liaison with tertiary services | For people in a trauma unit who have a spinal cord injury, the trauma team leader should immediately contact the specialist neurosurgical or spinal surgeon on call in the trauma unit or nearest major trauma centre. | Availability of specialist neurosurgical/spinal surgeon |

| Guideline | Recommendation | Main implication for access to the service |
|---|---|---|
| | For people in a major trauma centre who have a spinal cord injury, the trauma team leader should immediately contact the specialist neurosurgical or spinal surgeon on call.<br><br>For people who have a spinal cord injury, the specialist neurosurgical or spinal surgeon at the major trauma centre should contact the local spinal cord injury centre consultant within 4 hours of diagnosis. | |
| Liaison with tertiary services | All people who have a spinal cord injury should have a lifetime of personalised care that is guided by a spinal cord injury centre. | Availability of specialist neurosurgical/spinal surgeon<br>Availability of local SCIC consultant |
| Information and support | See major trauma recommendation above | |
| Documentation | See major trauma recommendation above | |
| Complex fracture | The GDG rationale for recommending the service is described in the relevant LETR in the guidelines | |
| Open fracture | In the pre-hospital setting, administer prophylactic intravenous antibiotics within 1 hour of injury to people with open fractures without delaying transport to hospital. | Availability of antibiotics<br>Timing<br>Antibiotics are not routinely given in the pre-hospital setting. |
| Open fracture | Transport people with suspected open fractures:<br>• directly to a major trauma centre or specialist centre for orthoplastic care if a long bone, hindfoot or midfoot are involved, or<br>• to the nearest trauma unit or emergency department if the suspected fracture is in the hand, wrist or toes, unless there are pre-hospital triage indications for direct transport to a major trauma centre.<br><br>Transport people with suspected pelvic fractures:<br>– to the nearest hospital if suspected pelvic fracture is the only pre-hospital triage indications<br>– directly to the major trauma centre if they also have other pre-hospital triage indications for major trauma. | Destination and time to destination<br>Transporting patients to major trauma centres may involve long distances. |
| Pelvic fractures | Immediately transfer people with haemodynamic instability from pelvic or acetabular fractures to a major trauma centre for definitive treatment of active bleeding. | Destination and time to destination<br>Transporting patients to major |

| Guideline | Recommendation | Main implication for access to the service |
|---|---|---|
| | Transfer people with pelvic or acetabular fractures needing specialist pelvic reconstruction to a major trauma centre or specialist centre within 24 hours of injury.<br><br>Immediately transfer people with a failed closed reduction of a native hip joint to a specialist centre if there is insufficient expertise for open reduction at the receiving hospital. | trauma centres may involve long distances. |
| Vascular injury | Perform immediate surgical exploration if hard signs of vascular injury persist after any necessary restoration of limb alignment and joint reduction.<br><br>In people with a devascularised limb following long bone fracture, use a vascular shunt as the first surgical intervention before skeletal stabilisation and definitive vascular reconstruction. | Availability of surgery<br>Timing |
| Whole-body CT | See Major trauma recommendation | |
| Pelvic fracture | Use CT for first-line imaging in adults (over 16s) with suspected high-energy pelvic fractures.<br><br>For first-line imaging in children (under 16s) with suspected high-energy pelvic fractures:<br>• use CT rather than X-ray when CT of the abdomen or pelvis is already indicated for assessing other injuries<br>• consider CT rather than X-ray when CT of the abdomen or pelvis is not indicated for assessing other injuries.<br><br>Use clinical judgement to limit CT to the body areas where assessment is needed. | Availability of CT<br><br>Timing of imaging<br>Either the personnel or equipment may not be available immediately |
| Pelvic haemorrhage | See the major trauma recommendation | |
| Pelvic binder | For people with suspected pelvic fractures and pelvic binders, remove the pelvic binder as soon as possible if<br>• there is no pelvic fracture or<br>• a pelvic fracture is identified as mechanically stable or<br>• the binder is not controlling the mechanical stability of the fracture or<br>• there is no further bleeding or coagulation is normal<br>Remove all pelvic binders within 24 hours of application. | Availability of a pelvic surgeon |
| Open fractures | Surgery to achieve debridement, fixation and cover of open fractures of the long bone, hindfoot or | Availability and timing of |

| Guideline | Recommendation | Main implication for access to the service |
|---|---|---|
| | modfoot should be performed concurrently by consultants in orthopaedic and plastic surgery (a combined orthoplastic approach).<br><br>Perform debridement:<br>• immediately for highly contaminated open fractures<br>• within 12 hours of injury for high-energy open fractures (likely Gustilo–Anderson classification type IIIA or type IIIB) that are not highly contaminated<br>• within 24 hours of injury for all other open fractures.<br><br>Perform fixation and definitive soft tissue cover:<br>• at the same time as debridement if the next orthoplastic list allows this within the time to debridement recommended in recommendation 14, or<br>• within 72 hours of injury if definitive soft tissue cover cannot be performed at the time of debridement.<br><br>When internal fixation is used, perform definitive soft tissue cover at the same time. | orthopaedic and plastic surgeons at the same time |
| Open fractures | Consider negative pressure wound therapy after debridement if immediate definitive soft tissue cover has not been performed. | Availability of negative pressure wound therapy |
| Pilon fractures | Management in adults (skeletally mature)<br><br>Create a definitive management plan and perform initial surgery (temporary or definitive) within 24 hours of injury in adults (skeletally mature) with displaced pilon fractures.<br><br>If a definitive management plan and initial surgery cannot be performed at the receiving hospital within 24 hours of injury, transfer adults (skeletally mature) with displaced pilon fractures to a specialist centre (ideally this would be emergency department to emergency department transfer to avoid delay).<br><br>Immediately transfer adults (skeletally mature) with displaced pilon fractures to an orthoplastic centre | Availability and timing of surgery |

| Guideline | Recommendation | Main implication for access to the service |
|---|---|---|
| | if there are wound complications.<br><br>Management in children (skeletally immature)<br><br>Create a definitive management plan involving a children's orthopaedic trauma specialist within 24 hours of diagnosis in children (skeletally immature) with intra-articular distal tibia fractures.<br><br>If a definitive management plan and surgery cannot be performed at the receiving hospital, transfer children (skeletally immature) with intra-articular distal tibia fractures to a centre with a children's orthopaedic trauma specialist (ideally this would be emergency department to emergency department transfer to avoid delay). | |
| Documentation | See the major trauma recommendation | |
| Open wounds | All trusts receiving patients with open fractures must have information governance policies in place that enable staff to take and use photographs of open fracture wounds for clinical decision-making 24 hours a day. Protocols must also cover the handling and storage of photographic images of open fracture wounds.<br><br>Consider photographing open fracture wounds when they are first exposed for clinical care before debridement and at other key stages of management.<br><br>Keep any photographs of open fracture wounds in the patient's records. | Availability of equipment/software to photograph and enable appropriate handling of photographs |
| Information and support | See the major trauma recommendation | |
| Service delivery | | |
| Airway management | Ensure that drug-assisted rapid sequence induction of anaesthesia and intubation (RSI) is available for patients with major trauma who cannot maintain their airway and/or ventilation, and be aware that RSI should:<br>– be performed as soon as possible and within 45 minutes of the initial call to the emergency services.<br>– preferably be provided at the scene of the incident and not by diverting to a trauma unit. | Staff skills to deliver RSI<br><br>Timing within 30 minutes of 999 call<br><br>Destination |

| Guideline | Recommendation | Main implication for access to the service |
|---|---|---|
| Control of haemorrhage | Ensure that interventional radiology and definitive open surgery are equally and immediately available for haemorrhage control in all patients with active bleeding. | Availability of immediate availability of interventional radiology |
| Triage | Support practitioners using the major trauma triage tool with immediate clinical advice from the ambulance control centre. | Staff skills in the ambulance control centre |
| | Be aware that the optimal destination for patients with major trauma is usually a major trauma centre. In some locations or circumstances intermediate care in a trauma unit might be needed for urgent treatment, in line with agreed practice within the regional trauma network. | Destination<br><br>Capacity at the major trauma centre |
| | Divert to the nearest trauma unit if a patient with major trauma needs a life-saving intervention, such as drug-assisted rapid sequence induction of anaesthesia and intubation, that cannot be delivered by the pre-hospital team. | Destination<br><br>Capacity at the trauma unit to provide immediate lifesaving interventions |
| Pre alert<br>Trauma teams | See Major Trauma recommendations on documentation<br>Consider a tiered team response to receive patients in major trauma centres. This may include:<br>• a standard multispecialty trauma team or<br>• a standard multispecialty trauma team plus specialist involvement (for example, code red for major haemorrhage) and mobilisation of supporting departments and services such as transfusion, interventional radiology and surgery.<br><br>Have a paediatric trauma team available immediately for children with major trauma. | Availability of specialists for the trauma team |
| Multidisciplinary team management | Provide a dedicated major trauma service for patients with major trauma that consists of:<br>• a dedicated trauma ward for patients with multisystem injuries<br>• facilities to deliver specialist management for patients with comorbidities and acute medical needs<br>• a designated consultant available to contact 24 hours a day, 7 days a week who has responsibility and authority for the hospital trauma service and leads the multidisciplinary team care<br>• a named member of clinical staff (a key worker, often a senior nurse) assigned at each stage of the care pathway who coordinates the patient's care. | Feasibility of a trauma ward<br><br>Availability of a designated consultant 24 hours/7 days a week<br><br>Feasibility of a key worker |

| Guideline | Recommendation | Main implication for access to the service |
|---|---|---|
| Transfer between emergency departments | Ensure that patients with major trauma who need critical interventions at a major trauma centre leave the sending emergency department within 30 minutes of the decision to transfer. | Availability of team to transfer and the timing within 30 minutes |
| Information and support | Establish a protocol for providing information and support to patients, family members and carers.<br>See also the major trauma recommendations above | |
| Documentation | Ensure that pre-hospital documentation is standardised within a trauma network, for example using the Royal College of Physicians' Professional guidance on the structure and content of ambulance records. | Availability of bidirectional information systems – electronic medical records |
| | Ensure that hospital documentation is standardised within a trauma network and there are systems that allow clinicians access to all relevant and current clinical data at different points in the care pathway. This could be by compatible electronic medical records such as a picture archiving and communication system (PACS) and an image exchange portal. | Electronic systems have not been implemented nationally |
| Audit | Ensure that there is a major trauma audit programme to evaluate systems, services and processes as part of the major trauma network's quality improvement programme. | Resources to register and submit complete data to TARN |
| | Ensure that a major trauma audit programme includes:<br>• regular review of audits undertaken locally and regionally<br>• registration with the Trauma Audit and Research Network (TARN)<br>• accurate and complete data submission to TARN<br>• quarterly review of TARN reports. | |
| | A national trauma audit system should collect and analyse data to enable providers of major trauma services to review their local, regional and national trauma performance. | |

**Table 56: Recommendations prioritised for further service delivery exploration**

| Recommendation | Reason for prioritisation | Further work |
|---|---|---|
| Airway management in the pre-hospital setting, in particular access to expertise in RSI of | Pre-hospital services may or may not have the capability to ensure access to expertise in RSI of anaesthesia and | The airway management review and the service delivery GDG recommendation is reported in section 17.3.1. |

| Recommendation | Reason for prioritisation | Further work |
|---|---|---|
| anaesthesia and intubation | intubation | This recommendation was also identified as a key area to populate the service systems model and this is explained in section 17.4 |
| Access to interventions which control for bleeding, in particular interventional radiology | To ensure a standard of timely access to interventional radiology services, for the life threatening and rapidly deteriorating population that would benefit from these services. | The interventional radiology review and the service delivery GDG recommendation is reported in section 17.3.2.<br>This recommendation was also identified as a key area to populate the service systems model and this is explained in section 17.4 |
| Access to imaging, in particular access to timely CT within trauma units and MRI more generally | Availability of immediate imaging, in particular CT and MRI.<br>The capacity of hospitals to provide this for all the major trauma population.<br><br>MRI for children with spinal cord injury was not prioritised. The spinal injuries GDG and service delivery GDG acknowledged the potential service issues of the availability of MRI scanners, however the benefits to this small population outweighed the disadvantages (see NICE Spinal injury assessment guideline CG XXX chapter 10 for the detailed discussion). | Access to imaging, in particular access to timely CT was addressed in the Major Trauma and Spinal injuries assessment guidelines (see Major Trauma CG XXX chapters 9, section 11.2 and 11.3; Spinal Injuries assessment CG XXX chapter 9).<br>The Major trauma guideline aimed to identify if early imaging is clinically and cost effective in a suspected major haemorrhage population. The Spinal injury assessment guideline aimed to identify the most appropriate imaging to detect a spinal injury. |
| Access to interventions that may require orthopaedic and plastic surgery expertise | The feasibility of concurrent orthopaedic and plastic surgery approach. | Access to interventions that may require concurrent orthopaedic and plastic surgery expertise was addressed in the Complex Fractures Guideline (see Complex fractures CG XXX section 6.6).The Complex fractures guideline aimed to evaluate the timing of initial debridement of open fractures and open fracture debridement with orthopaedic surgeon and plastic surgeon. |

# 17.3 Additional Reviews undertaken based on the service delivery impact

## 17.3.1 Airway management

### 17.3.1.1 Introduction

In the UK the available airway management options depend on the skills and expertise of the attending pre-hospital health practitioners. The major trauma clinical guideline recommended drug-assisted as the definitive method of securing an airway (see recommendations 1-4 on airway management). There is variation in the delivery of Rapid sequence Induction (RSI) of anaesthesia and intubation due to the availability of skilled teams to deliver the intervention and the aim of this review was to determine the optimal timing for major trauma patients. This review included surgical airway as this is the only alternative airway when intubation is impossible, this technique also requires a skilled team to deliver the procedure and as such there are potential delays to access.

### 17.3.1.2 Review question: What is the optimal timing of intubation or surgical airway?

For full details see review protocol in Appendix C.

**Table 57: PICO characteristics of review question**

| | |
|---|---|
| **Population** | Children, young people and adults with major trauma that require airway management |
| **Intervention(s)** | Intubation<br>surgical airway/assisted endotracheal placement |
| **Comparison(s)** | Comparison of the intervention at different time points (as identified by the literature) to a maximum of 24 hours |
| **Outcomes** | Critical:<br>• Mortality up to 12 months<br>• Health-related quality of life<br>• Functional outcomes (validated scales)<br>• Important:<br>• Length of hospital stay<br>• Number of procedures<br>• Adverse events |
| **Study design** | RCTs or observational |

### 17.3.1.3 Clinical evidence

One study was included in the review[4,5]. The population was people with severe traumatic brain injury (TBI), the GDG agreed that evidence from this population is directly relevant to the major trauma population and often these people have other injuries. The study is summarised in Table 58 below. Evidence from this study is summarised in the clinical evidence summary below (Table 59). The study also narratively reported the number of cardiac arrests. This data was not included as from the details provided; they were unrelated to the intervention. See also the study selection flow chart in Appendix D, study evidence tables in Appendix G, forest plots in Appendix I, GRADE tables in Appendix H and excluded studies list in Appendix J. Studies were excluded if they did not provided details of the type of intervention or the interventions were delivered in a method not comparable to UK practice. No evidence was identified for surgical airway.

**Table 58: Summary of studies included in the review**

| Study | Intervention and comparison | Population | Outcomes | Comments |
|---|---|---|---|---|
| RCT | | | | |
| Bernard 2010[4,5] | Pre-hospital intervention: Rapid sequence induction (RSI); n=160<br>Hospital intervention: RSI; n=152 | Patients assessed by paramedics as having: evidence of head trauma, Glasgow Coma Score ≤9, age ≥15 years and intact airway reflexes. Exclusions: Within 10 minutes of a designated trauma hospital, no intravenous access, allergy to any RSI drugs or transport planned by medical helicopter. Patients taken to trauma centres. Australia | Mortality<br>Glasgow Outcomes Scale<br>Craniotomy<br>Length of stay | RCT. Time at scene pre-hospital 35 (SD 12) vs. ED 23 (10) minutes p<0.0005 |

**Table 59: Clinical evidence summary table: Pre-hospital versus ED RSI**

| Outcome | Number of studies (number of participants) | Imprecision | GRADE rating | Absolute difference (Pre-hospital versus ED) | Control event rate (per 1000) | Control event rate for continuous outcomes |
|---|---|---|---|---|---|---|
| Mortality - ED | 1 (n=312) | Very serious | LOW | 14 more per 1000 (from 38 fewer to 116 more) | 92 | - |
| Mortality - In hospital | 1 (n=312) | Serious | MODERATE | 29 fewer per 1000 (from 119 fewer to 45 more) | 362 | - |
| Mortality - 6 months[1] | 1 (n=299) | Serious | MODERATE | 50 fewer per 1000 (from 139 fewer to 70 more)[a] | 387 | - |
| Glasgow Outcome Scale extended 5-8 - All patients | 1 (n=299) | Serious | MODERATE | 114 more per 1000 (from 0 more to 264 more) | 394 | - |
| Glasgow Outcome Scale extended 5-8 - Initial Glasgow Coma Scale 5-9 | 1 (n=154) | Serious | MODERATE | 88 more per 1000 (from 61 fewer to 293 more) | 466 | - |
| Craniotomy within 6 hours of ED arrival | 1 (n=312) | Very serious | LOW | 46 more per 1000 (from 40 fewer to 175 more) | 211 | - |

*(a) No extra deaths record but patients lost to follow-up*

**Narrative review**

**Table 60: Length of stay**

| Outcome | Field (Median, IQR) | ED (Median, IQR) | P |
|---|---|---|---|
| ICU length of stay (hours) | 107 (32-240) | 103 (36-261) | p=0.74 |
| Hospital length of stay (days) | 11 (5-19) | 11 (3.5-21) | p=0.75 |

### 17.3.1.4 Economic evidence

**Published literature**

No relevant economic evaluations were identified.

**New cost-effectiveness analysis**

This area was prioritised for new cost-effectiveness analysis. However the model could not be developed. Details are provided below in section 17.4 and in Appendix M.

### 17.3.1.5 Evidence statements

**Clinical**

Low quality evidence from 1 RCT comprising 312 participants showed that pre-hospital compared with ED RSI of anaesthesia and intubation was associated with a clinically higher mortality rate (in the ED), with very serious imprecision

Moderate quality evidence from 1 RCT comprising 312 participants showed that pre-hospital compared with ED RSI of anaesthesia and intubation was associated with a clinically lower mortality rate (at hospital discharge), with serious imprecision

Low quality evidence from 1 RCT comprising 299 participants showed that pre-hospital compared with ED RSI of anaesthesia and intubation was associated with a clinically lower mortality rate (at 6 months), with serious imprecision

Moderate quality evidence from 1 RCT comprising 299 and 154 participants showed that pre-hospital RSI of anaesthesia and intubation was clinically beneficial compared with ED RSI of anaesthesia and intubation in terms of the proportion of patients with a Glasgow Outcome Scale extended 5–8 (all patients and patients with an initial Glasgow Coma Scale 5–9), with serious imprecision

Low quality evidence from 1 RCT comprising 312 participants showed that pre-hospital compared with ED RSI of anaesthesia and intubation was associated with a clinically higher craniotomy rate within 6 hours of ED arrival, with very serious imprecision

**Economic**

No relevant economic evaluations were identified.

### 17.3.1.6 Recommendations and link to evidence

| | |
|---|---|
| **Recommendations** | **Access to drug-assisted rapid sequence induction (RSI) of anaesthesia and intubation.**<br><br>**The major trauma GDG recommended RSI as the definitive method of securing an airway (cross refer to the MT recommendations 1-4)**<br><br>**Recommendation for ambulance and hospital trust boards, medical directors, and senior managers**<br><br>**37. Ensure that drug-assisted rapid sequence induction of anaesthesia and intubation (RSI) is available for patients with major trauma who cannot maintain their airway and/or ventilation, and be aware that RSI should:**<br>• **be performed as soon as possible and within 45 minutes of the initial call to the emergency services and**<br>• **preferably be provided at the scene of the incident and not by diverting to a trauma unit.**<br><br>**(For more information see the section on airway management in pre-hospital and hospital settings in the NICE guideline on 'Major trauma'.)** |
| | The recommendations on airway management were identified as key areas to evaluate in the,' Access to Services' scope area. See Major Trauma guideline chapter 6 for details on the development of the airway management clinical recommendations. |
| Description of current UK services | In the UK the available airway management options depend on the skills and expertise of the attending pre-hospital health practitioners.<br>Currently, only physicians (anaesthetists or advanced pre-hospital doctors) and paramedics trained in the technique as part of a physician led team can perform RSI of anaesthesia and intubation. If such a team aren't available and a person's airway or ventilation is not secure despite basic airways manoeuvres and adjuncts and/or a supraglottic device, the patient will be transported to the nearest emergency department (ED) for the airway to be secured. The nearest ED may be situated within a trauma unit and the patient will be transported there instead of being transported direct to the major trauma centre. This can result in delays in definitive treatment.<br>This practice and decision to the destination varies across the UK and depends upon the availability of a suitably trained team to deliver RSI of anaesthesia and intubation and local policies that take into account clinical and geographical factors e.g., time to trauma unit versus major trauma centre.<br><br>The major trauma clinical guideline recommended drug-assisted RSI as the definitive method of securing an airway |
| Relative values of different outcomes | The GDG identified mortality at 12-months, health-related quality of life, length of hospital stay, number of procedures, adverse events and Glasgow Outcome Scale as critical outcomes for evaluating the timing of intubation or surgical airway. Evidence was identified for mortality, Glasgow Outcomes Scale, craniotomy, and length of stay. |
| Trade-off between clinical .benefits and harms | One RCT in adults with TBI was included that compared pre-hospital with emergency room RSI of anaesthesia and intubation. Compared with RSI |

conducted in the ED, pre-hospital RSI was associated with a clinically important higher rate of mortality in the emergency room, but with very serious imprecision. Compared with RSI conducted in the ED, pre-hospital RSI was associated with a clinically important lower rate of mortality at discharge and at 6 months, but with serious imprecision. A clinically important higher proportion of patients with a Glasgow Outcome Scale of five to eight was reported in the pre-hospital patients but with serious imprecision (all patients and patients with an initial Glasgow Coma Scale of five to nine). Pre-hospital RSI of anaesthesia and intubation was associated with a clinically higher proportion of patients undergoing craniotomy but with very serious imprecision. There was no difference in ICU or hospital length of stay.

The GDG noted that although this evidence is from a specific TBI population the principles and consequences of requiring an immediate airway intervention were the same in any patient with traumatic injuries. If an airway is not secure and ventilation is inadequate then people with major injuries will not be adequately oxygenated and be at risk of death or disability.

The results are equivocal with higher mortality rates for RSI of anaesthesia and intubation in the pre-hospital setting in the immediate time period after injury but lower rates at six months or at discharge. This could be explained by the severity of the patient's injuries, with the most severely ill patients benefiting from all the speciality input a hospital setting provides. In addition the functional outcomes are better (Glasgow Outcome Scale) in patients that had RSI in the pre- hospital setting. This may be attributed to quicker and better oxygenation from the time of injury.

The evidence while not conclusive suggests that for patients with severe injuries pre-hospital RSI of anaesthesia and intubation improves mortality rates and functional outcome justifying the additional time spent at the scene in this population.

The study included in the review did not compare the competency of different types of practitioners performing RSI of anaesthesia and intubation in the same location but instead compared pre-hospital (performed by paramedics) with hospital intervention. The GDG decided not to comment on who should deliver the intervention other than it should be someone trained in the technique.

The GDG discussed the evidence and concluded that performing RSI of anaesthesia and intubation at the scene reduces the risk of aspiration and the secondary consequences of inadequate ventilation and offers greater protection to the airway than, for example, a supraglottic device (complications including failure to provide adequate airway or ventilation, precipitating vomiting and aspiration, and patient intolerance). The consensus of the GDG was that RSI of anaesthesia and intubation should be delivered within 45 minutes of the 999 call. This is the best method of securing an airway and allows the patient to be safely transported to a MTC for definitive care

This requires a paramedic without the expertise to deliver the intervention to rapidly identify that RSI is indicated, and not wait for more basic airway management techniques to fail before calling for the skilled team. It is important to note that the paramedic is maintaining the airway with the most appropriate technique until the team arrives. 45 minutes was chosen as the GDG felt that this is a reasonable length of time a patient can be managed

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| | adequately using either a supraglottic device or more basic airway adjuncts before RSI can be delivered. Beyond 45 minutes, the probability of survival and a better functional outcomes was thought to be increased by diverting the patient to the nearest trauma unit to have RSI than waiting longer at the scene. If RSI of anaesthesia and intubation cannot be delivered within 45 minutes of the 999 call, the GDG felt that the potential benefits of RSI would be outweighed by the increased time spent at scene waiting for a competent physician or team to arrive. Additional delay could be life threatening in time critical situations involving major trauma patients where they may have multiple injuries.<br>The GDG did note that there could be circumstances where waiting for a team to deliver RSI is not in the best interests if the patient where an airway can be secured by another means for a short journey to the MTC. For example if the MTC is a 5 minute journey ( where there is immediate access to RSI) then waiting up to 45 minutes for a team at the scene to deliver the intervention is not sensible. |
| Trade-off between net health benefits and resource use | No published economic evidence was identified to inform this question.<br>RSI and drug-assisted tracheal intubation have the highest unit costs (£32.80) of all the pre-hospital airway management methods (see Major Trauma review of airway techniques). The differential in unit cost for the devices is likely to expand once staff costs are added, in that the cheapest interventions also require the least competence to undertake, whereas RSI and drug-assisted tracheal intubation needs higher skill and expertise to deliver.<br><br>The key issue is that a competent person needs to be present on scene to deliver RSI of anaesthesia and intubation. Only trained doctors hold this competency and are only on scene when an enhanced critical care team or individual doctors (e.g. BASICS) are. Dispatch of such teams is dependent on the triaging decision of the 999 call handler and/or the first attendants on scene. Over triage at the dispatch stage or a recommendation in favour of making RSI of anaesthesia and intubation available whenever an airway may need to be maintained, could lead to highly qualified and costly staff members being displaced from other beneficial duties and increase the overall cost of the strategy substantially. The cost-effectiveness in part will depend on who is trained to undertake RSI, and also the extent other indirect populations (such as those with acute medical emergencies) may also benefit from having expertise in RSI routinely available on scene.<br><br>Alternatively, skilled staff may be called to scene to provide RSI. Currently, pre-hospital teams will consider; whether the patient is triage positive for an MTC and the time criticality of the patients other injuries, the time to reach the nearest provider, whether the nearest health provider is a TU or MTC, and whether travel time to the nearest provider is more or less time than waiting for expertise to come to scene. Although potentially a less expensive model, waiting on scene and calling out expertise only where necessary, is only likely to be clinically and cost effective if the on scene triage is accurate, the wait for expertise to arrive is quick, and there is high benefit in transport direct to an MTC.<br><br>Patients can also currently be taken to a trauma unit, if nearer than a major trauma centre, if basic airway adjuncts or a supraglottic device have failed to secure the airway and to provide adequate ventilation, in order for RSI to be performed, and then a secondary transfer would be needed to take the patient on to a major trauma centre. If RSI can be undertaken at the roadside, this negates the need to take the patient to the trauma unit, and could therefore reduce delays in receiving treatment, from the onward transfer that would have taken place if the ambulance diverted to the trauma unit. |

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| | Because so many of the costs and benefits accrued from RSI of anaesthesia and intubation depend on economies of scale (i.e. the more patients needing RSI of anaesthesia and intubation on scene, the less down time of the attending specialist staff) and economies of scope (i.e. the ability of the attending staff to clinically manage other aspects of the trauma beside the airway), and these economies depend on local circumstance, the most cost effective option may differ according to local circumstance. Further, demography, geography, density of service provider and configuration will also play a role. For example, the high density of MTCs within a small regional area within London will mean a lower proportion of patients will be further away from an MTC than a TU and travel time to any provider is less, than for example, the experience in more rural isolated areas. If the value of maximising population health gain by not exceeding the £20,000 per QALY threshold is upheld, this may mean different healthcare provision (and potential health gain) according to local circumstance.<br><br>There are several factors which will impact on whether the incremental benefit of early RSI (pre-hospital) would justify the incremental cost. There was Insufficient data to allow accurate modelling, the factors which would inform such a model are outlined below.<br><br>Many of the factors which inform the likely cost (and opportunity loss) of employing a certain strategy are dictated by local circumstance and epidemiology. For example:<br>• The incidence of different types of injury, in particular the incidence of needing an RSI as well as sustaining another time critical injury which may only be managed appropriately at an MTC.<br>• The probability that a patient will sustain an injury closer to an appropriate facility versus an inappropriate facility to manage their airway and treat their other injuries in a timely fashion.<br><br>Other factors are informed by local staffing arrangements and availability:<br>• The extent of "down time" that the staff will incur waiting for a call out (may depend on shift, rota and call out arrangements, as well as local epidemiology of trauma and acute medical emergencies).<br>• The type, grade and pay scale required to ensure the level of competency to undertake RSI of anaesthesia and intubation<br><br>Moreover, cost and cost effectiveness of roadside RSI will depend on clinical effectiveness of not only the management of the airway, but also the impact that delay has on the clinical status of the patient who has a patent airway, and the impact of delay on the effectiveness of downstream management. For example:<br>• The likelihood and extent of adverse events associated with RSI<br>• The likelihood and extent of deterioration in clinical status (that is, due to other injuries such as blood loss) waiting at the scene for staff with the appropriate skills<br>• The likelihood and extent that onward treatment options are complicated due to a delay (due to waiting at the scene or due to transfer)<br><br>Other considerations also include:<br>• Accuracy of dispatch triage, and on scene triage<br>• The extent of beneficial impact that skilled staff on scene may also have on the number and type of adverse events which accrue due to clinical |

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| | management not associated with the airway. Improved triage and medical decision making may also need to be taken into account<br>• Cost of transfer and/or retrieval of patients between TU's and MTC's.<br><br>The clinical review identified a study which showed a clinically important reduction in mortality from pre-hospital RSI. Failure to provide an adequate airway can result in disability or death. Other benefits of intubation include the administration of anaesthesia and effective ventilation (for example, in patients with significant chest injuries). The GDG felt this strategy would be more cost effective than the use of other airway management strategies. Although RSI does have side effects, it was felt that diverting to a TU would delay access to downstream services and specialist care available at an MTC, which could also be detrimental to the patient.<br><br>It was GDG consensus, that RSI of anaesthesia and intubation is the gold standard in airway management (see MT airway LETR), and where possible according to local service provision, should be implemented within a timely manner and without diverting to a trauma unit. After 45 minutes, it was felt that the benefits of RSI of anaesthesia and intubation would be outweighed by the additional delay on scene (where the delay is caused by waiting for a physician to perform this procedure).<br><br>This recommendation is likely to be a change a practice. Firstly because traditional teaching involves a tendency towards beginning with the least invasive airway device (bag and mask) and increasing the complexity of the interventions until the patient's airway is secure. The aim of this recommendation however is to encourage beginning with RSI (if the skills are available) as this would be the definitive method of securing the airway and the most appropriate in major trauma patients who cannot maintain their own airway. Secondly, with regards to the time aspect in the recommendation, there are many factors to consider when evaluating the cost effectiveness of providing RSI on scene, and these are likely to be determined by local circumstance. It is important to note the population requiring RSI is likely to be small as the trauma population is small to begin with. There are, however, other populations that may benefit from RSI resources such as cardiac arrest patients. Therefore, having healthcare professionals trained in RSI may have a positive impact on other populations as well. This recommendation is also likely to have a cost impact as resourcing of staff capable of undertaking RSI will be an issue. |
| Quality of evidence | The included RCT has no serious methodological limitations. Outcomes were downgraded for imprecision and ranged from Low to Moderate. The study was considered to be directly applicable to UK practice even though the pre-hospital intervention was delivered by paramedics compared to pre-hospital physicians in the UK. |
| Barriers to implementation | There are two key barriers to implementing the provision of RSI of anaesthesia and intubation as soon as possible and within 45 minutes of the 999 call. Firstly, the availability of pre-hospital health practitioners who are skilled and competent to perform RSI of anaesthesia and intubation varies across the UK. At the moment paramedics, who are most likely to be in first attendance, are not able to perform RSI of anaesthesia and intubation in the UK unless they are part of a physician led team. This is due to the small number of patients who will require RSI of anaesthesia and intubation pre-hospital and the need to perform the procedure regularly in order to maintain competence. Currently in the UK, RSI of anaesthesia and intubation is delivered by registrars or |

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| | consultants, usually from anaesthesia or emergency medicine or by trained paramedics supervised by a trained physician. This means that a smaller number of specialised clinicians will be required to attend patients pre-hospital where a need for RSI of anaesthesia and intubation is identified. This may involve clinicians travelling to the accident site or meeting the ambulance en route to the MTC. The time it will take for clinicians trained in RSI of anaesthesia and intubation to reach the patient will depend on the number of clinicians available and the transport mechanism available e.g., land or helicopter.<br><br>Secondly, geographical features (e.g. urban versus rural) will also influence the time it will take to respond to a 999 call and for clinicians who are able to perform RSI of anaesthesia and intubation to reach patients pre-hospital. |
| Other considerations | The GDG identified no considerations specific to children. |

### 17.3.2 Timing of interventional radiology for people with major trauma and haemorrhage

#### 17.3.2.1 Introduction

Interventional radiology (IR) techniques may be used to achieve haemostasis in people with active haemorrhage. The use of IR may increase the number of patients who are successfully managed non-operatively or may act as a bridge to definitive surgery in initially unstable patients. See the Major Trauma clinical Guideline recommendations on Interventional radiology.

However, there is frequently a delay in receiving interventional radiology, compared with open surgical techniques. The aim of this review was to determine the optimal timing of IR for major trauma patients.

#### 17.3.2.2 Review question: What is the optimal timing of interventional radiology?

For full details see review protocol in Appendix C.

**Table 61: PICO characteristics of review question**

| | |
|---|---|
| **Population** | Children, young people and adults who have experienced a traumatic incident and require interventional radiology |
| **Objective** | Interventional radiology techniques |
| **Intervention** | IR at different time points, as identified by the literature, to a maximum of 24 hours. |
| **Comparison** | A comparison of the above |
| **Outcomes** | Critical:<br>• Mortality<br>• Health-related quality of life<br>• Amputation (for vascular compromise)<br>• Important:<br>• Length of hospital stay<br>• Number of procedures<br>• Adverse events |
| **Study design** | RCTs or observational |

#### 17.3.2.3 Clinical evidence

No RCTs were identified relevant to this review. Two retrospective cohort studies[26,43] were included in the review, these are summarised in Table 62 below. Evidence from these studies is summarised in

the clinical evidence summary below (Table 63 and Table 64). See also the study selection flow chart in Appendix D, study evidence tables in Appendix G, forest plots in Appendix I, GRADE tables in Appendix H and excluded studies list in Appendix J.

The Schwartz paper compared the outcomes of IR performed during normal working hours with procedures performed during out of hours (that is, evenings and weekends). The GDG felt that this study was relevant for inclusion in this review as both groups received surgery by the same healthcare professionals, with the main key difference between the two groups being the time before surgery.

On consideration of the Howell paper, the GDG suggested that the high proportion of patients with penetrating injuries in the sample (53.85%) was much greater than the proportion of patients with penetrating injuries treated in the UK. Furthermore, the GDG suggested that a level I and level II trauma centre in this study were both similar to the service provided by a MTC in the UK. As a consequence, the GDG felt that the analysis in this paper combining patients treated in level I and level II trauma centres and stratifying by mechanism of injury (blunt versus penetrating injury) was the most relevant analysis for this review.

A key limitation of these studies is that patient records did not specify the length of time between the time of injury and admission to hospital. As a consequence, the time of intervention is from admission and not from time of injury, and it is unclear whether the groups differed in the length of time spent prior to admission.

**Table 62: Summary of studies included in the review**

| Study | Intervention and comparison | Population | Outcomes | Comments |
|---|---|---|---|---|
| Howell 2010[26] | Rapid IR (<1 hour of admission)<br>vs. delayed IR (1-3 hours following admission) | Young people and adults (age >15 years) identified through the National Trauma Data Bank (version 7.1) between 2002-2006. Systolic BP <90 mmHg on arrival, and who underwent procedures for arterial vessel occlusion <3 hours from trauma admission. Patients transferred directly to the treating centre only. Median ISS score=17 (IQR 9-29).<br>n=665 | In-hospital mortality | Retrospective review of patient records. Analysis stratified by mechanism of injury (blunt versus penetrating injury). Multivariate logistic regression accounting for the following confounders: age, sex, injury severity score (ISS), emergency department systolic BP, Glasgow coma scale (GCS), head/neck abbreviated injury score(AIS), scene intubation status, and trauma centre designation (level I vs. level II) |
| Schwartz 2014[42] | IR during regular working hours (median time from admission to IR=193 minutes [137 – 275])<br>vs. IR during evenings and weekends (median time from admission to | Adult trauma patients identified through the institution's Trauma Registry of the American College of Surgeons database admitted between 2008–2011 with a severe pelvic injury (pelvis AIS score ≥3) who received at least 1 unit of blood product, | 30-day mortality | Retrospective review of patient records. Multivariate logistic regression accounting for the following covariates: age, injury severity, shock and tachycardia. Level 1 trauma centre. IR |

| Study | Intervention and comparison | Population | Outcomes | Comments |
|---|---|---|---|---|
| | IR=301 minutes (211-389) | and had documentation of haemorrhagic shock (defined as base deficit >5, transfusion of RBCs in the ED, and faculty documentation of shock in patient notes). Median ISS=27-29. n=191 | | procedures performed by a specialist team. Time to IR is shorter in normal working hours as staff are present performing elective procedures and the equipment is more readily available. Risk of survival bias (29% of the daytime group and 62% of the out of hours group died without undergoing IR). |

**Table 63: Clinical evidence summary: Rapid (less than 1 hour) versus delayed (1-3 hours) interventional radiology**

| Outcome | Number of studies (no. of participants) | Imprecision | GRADE rating | Absolute difference (IR <1 hour vs. IR 1-3 hours) | Rapid IR mortality | Delayed IR mortality |
|---|---|---|---|---|---|---|
| In hospital mortality (blunt trauma) | 1 (n=293) | Serious | VERY LOW | OR (95% CI)=2.6 (1.2-5.7); p=.012 | - | - |
| In hospital mortality (penetrating trauma) | 1 (n=342) | Serious | VERY LOW | OR (95% CI)=2.9 (1.2-7.3); p=.023a | - | - |

**Table 64: Clinical evidence summary: Work day (median 193=minutes) versus out of hours (median=301 minutes) interventional radiology**

| Outcome | Number of studies (number of participants) | Imprecision | GRADE rating | Absolute difference (IR work day vs. IR out of hours) | Work day mortality (n=32) | Out of hours mortality (n=56) |
|---|---|---|---|---|---|---|
| 30-day mortality [a] | 1 (n=88) | Serious | VERY LOW | OR=1.94 CI as reported in the paper=(1.051–4.967) | 21 | 32 |

*(a) No forest plot is provided for this outcome as figures reported in the paper are inconsistent with our analysis*

#### 17.3.2.4 Economic evidence

**Published literature**

No relevant economic evaluations were identified.

**New cost-effectiveness analysis**

This area was prioritised for new cost-effectiveness analysis. However the economic modelling could not be developed. Details are provided below in section 17.4 and in Appendix M.

#### 17.3.2.5 Evidence statements

**Clinical**

Very low quality evidence from two cohort studies comprising of 88, 293 and 342 participants demonstrated a clinical harm of delayed IR for mortality in patients with severe pelvic injury and in patients with blunt and penetrating injuries who require procedures for arterial vessel occlusion, with serious imprecision.

**Economic**

#### 17.3.2.6 Recommendations and link to evidence

| | |
|---|---|
| **Recommendations** | **Access to Interventional radiology**<br><br>**The major trauma and complex fractures GDG recommended interventional radiology techniques as the optimal treatment for patients with active arterial pelvic haemorrhage unless other injuries indicated open surgery (cross refer to the major trauma (1.6.14) and complex fractures (1.2.16) recommendations).**<br><br>**Recommendation for hospital trust boards, medical directors, and senior managers**<br><br>**38. Ensure that interventional radiology and definitive open surgery are equally and immediately available for haemorrhage control in all patients with active bleeding. (For more information see the section on interventional radiology in the NICE guideline 'Major trauma' and the section on controlling pelvic haemorrhage in the NICE guideline 'Fractures (complex)').** |
| | The recommendations on IR in the Major Trauma and complex fractures clinical guideline were identified as key areas to evaluate in the Major Trauma service delivery guidance scope area,' Access to Services'. See Major Trauma Clinical Guideline chapter 11 and Complex fractures clinical guideline chapter 7.8 for details on the development of the IR clinical recommendation. |
| Description of current UK services | Currently, IR techniques are available in MTCs at any time; 7 days a week and over a 24 hour period. However, there is generally a delay of 60 minutes in |

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| | receiving the intervention, due to the amount of time needed to prepare the IR suite and equipment. Outside of working hours, specialist clinicians needed to perform the procedure are not always on site, and therefore there may be a delay while waiting for clinicians to attend. In most MTCs the IR suite is separate from the surgical suite, however, practice is evolving with hybrid theatre suites where IR and surgery can take place in the same suite is becoming more common. The delay in receiving IR is in contrast to the time patients may wait for definitive surgical techniques, which are usually available in MTCs within 30 minutes. IR is not always available in TUs.<br>The Major Trauma clinical guideline recommendations recommend the use of IR techniques and access to the services it was identified as an important area to include in the systems model. |
| Relative values of different outcomes | The GDG identified mortality, health-related quality of life, length of hospital stay, number of procedures, adverse events, and amputation as critical outcomes in evaluating the impact of delays to interventional radiology. |
| Trade-off between clinical benefits and harms | This review specifically addressed the timing of IR and the implications of any delay in accessing the procedure.<br><br>Two studies in adults were included in the review; one study comparing IR (procedures for arterial vessel occlusion) conducted <1 hour versus IR performed within 1-3 hours; and one study comparing IR (for patients with severe pelvic injury) conducted during regular working hours (mean time to procedure = 3.2 hours) with IR conducted out of regular working hours (mean time to procedure = 5 hours).<br><br>After controlling for key confounders, both studies indicated a large increase in the risk of mortality associated with delays to interventional radiology. This increase was apparent for both time comparisons, suggesting that the risk of mortality may increase for each hour of delay to IR. The GDG noted that this effect was demonstrated for both patients with blunt and penetrating injuries. As both studies excluded patients who died while awaiting IR, and these patients were more likely to be in the delayed group, the GDG suggested that the effect of delay on mortality in these studies may actually be under-estimated.<br><br>No other outcomes were reported in either study. No other outcomes were reported in either study. The GDG discussed their clinical experience and agreed that IR has advantages over open surgery for some patients (for example, those without any other injury). They described the advantages as including, less invasive surgery, a shorter recovery period and stay in hospital. For these patients IR should be available as an alternative to surgery and with the equivalent access. In addition to this the GDG felt that the evidence on mortality was clear enough to make a strong recommendation that IR be available within the same timeframe as other surgical procedures for all patients with major trauma and not to a specific patient group.<br><br>The GDG noted that this recommendation will only be applicable to a small number (approximately 5-10%) of trauma patients; however these patients are a high risk group with a significant risk of mortality and in some the surgical alternative will be high risk or complicated. As a consequence, the GDG felt that the increased resource required to provide early IR will be justified by the expected significant reduction in mortality and morbidity. |
| Trade-off between net health benefits and resource use | No economic evidence was identified to inform this question.<br>Being able to undertake IR earlier involves earlier involvement and availability of staff. Setting up the IR suite can be time consuming. In a time critical |

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| | situation, earlier intervention would be assumed to lead to less mortality, and the clinical evidence identified corroborates this, although being of low quality and having limitations.<br><br>The location of injury and distance to a hospital with IR facilities is an important consideration. However, IR's being available in all TUs is unfeasible and unlikely to be cost effective given the large cost outlay in terms of equipment and staff needed for implementation and the small number of patients, within an already small trauma population, who would be candidates for/benefit from IR. The recommendation makes it clear that a patient with major trauma and possible haemorrhage should be taken to a MTC where access to IR is available. TUs have access to clinicians that perform damage control surgery, therefore, if pre-hospital staff consider that a patient may not survive the potential 45 minute journey to a MTC where IR is available, then patients could be stabilised with damage control surgery at a TU and transferred into a MTC for interventional radiology.<br><br>For MTCs, interventional radiologists are required to be on call within 30 minutes if they are needed. Undertaking IR sooner will require the staff to be present sooner, which could imply needing staff in house rather than on call, which could be more costly. However given the small population likely to require these services, having the appropriate staff available full time may not be efficient or cost effective, thus a potential pre-alert system was discussed, or training other staff to prepare the IR suite.<br>The GDG felt that timely access to IR is generally available in MTC's, but a recommendation stating that this standard should be the same as the access to definitive surgical techniques would help to standardise and reinforce timely access. |
| Quality of evidence | All of the evidence was from retrospective cohort studies at very high risk of bias. This was mainly because of the availability of accurate timing data (time to IR did not include time spent pre-hospital) and because of potential differences between the populations and care compared. However, the GDG felt that the data was consistent with their clinical experience, and given the risk of survival bias also present in the studies, felt confident in making a strong recommendation for early interventional radiology. |
| Barriers to implementation | The GDG noted that the provision of IR at an equivalent timeframe to open surgical techniques would require a change in practice. This is primarily because the staff required to perform the intervention are not ordinarily immediately available outside of normal working hours. The GDG suggested that rather than provide for interventional radiologists to be available over a 24-hour period, due to the low number of patients who may require this intervention, services may instead train other healthcare professionals (for example on call radiographer and theatre staff) to prepare the IR suite and equipment. Services may also wish to consider the implementation of an early warning system, to alert on call staff of the need to attend earlier in the patient journey. This may involve IR being incorporated in services' haemorrhage protocols. With such adjustments, the GDG did not expect that implementing this recommendation would have significant cost implications. |
| Other considerations | The GDG identified no considerations specific to children |

## 17.4 Trauma service systems model

In any area of healthcare, the assessment or intervention a person receives is connected directly or indirectly with the rest of the clinical pathway, and in turn each clinical pathway is part of a complex service system. With this in mind it is important to consider the impact assessments and

interventions, and in particular the timing of these, have on each other within the clinical pathways when making recommendations.

To support the GDG in understanding the impact of recommendations within the pathway, we aimed to develop a service systems model evaluating different service configurations. An understanding of different configurations would potentially allow draft recommendations from the clinical guidelines to be further developed to shape a coherent and connected clinical pathway. The process taken to achieve this is briefly described below. For full details of the approach to the systems model see Appendix M.

### 17.4.1 Conceptual modelling

Through processes of iterative refinement we sought to simplify the service system by assessing the strength of association between different components of the system and identify which, if any, of the components could be evaluated as distinct entities using traditional NICE methodologies of systematic review. The remaining components were considered as candidate topics which could benefit from exploration through systems modelling.

Conceptual modelling was the formal technique used to prioritise the problems to be addressed in the systems model and is an emerging and increasingly used technique to conceptualise service topics into a form that can be modelled. *A conceptual model is a graphical or model representation of the real world. It* is "the abstraction and representation of complex phenomena of interest in some readily expressible form, such that the individual stakeholders' understanding of the parts of the actual system, and mathematical representation of the system, may be shared, questioned, tested and ultimately agreed".[47] In other words, it is the process of deciding how to simplify the real world problem, in terms of what aspects to include and exclude, into a form which can be modelled and tested. The process itself aims to use the knowledge of the stakeholders involved in the system to describe the objectives, inputs, outputs, content, assumptions and simplifications of the model.[29]

In the context of guideline development, conceptual modelling is used to explore and share knowledge between the technical team and the GDG experts with the aim to:

- establish breadth and complexity of problem
- enable simplification of the problem
- agree aim of the evidence review
- prioritise aspects which would benefit most from research and data synthesis
- agree scope of question and define the problem
- define objectives of the evidence review

The stages undertaken by the GDG in various conceptual modelling exercises to provide a framework of evaluation for the trauma services guidance and potential for system modelling is briefly described below.

**First stage: identifying the clinical pathways within the system**

The first stage to evaluating a service system and the potential impact of different configurations is to fully explore its boundaries, the key clinical pathways of the patients inclusive of the place of the interventions within that pathway and their overall impact.

To initiate this, GDG members mapped out where the service delivery scope topic areas would be placed within a figurative pathway. The initial map and pathway designed contained extensive detail regarding clinical interventions (i.e. the placement of drips which then may later result in the need for movement between hospital clinical settings for their eventual removal) or precise clinical indication for movement between settings within the hospital (i.e. reasons for movement between

ITU and HDU). The GDG then identified the important clinical interventions within the pathway. As the refinement process continued, such detail was removed to work with a more concise framework.

**Second stage: identifying boundaries and excluding unsuitable topics from the quantitative systems modelling.**

From this primary mapping activity it became clear that there were several areas of the major trauma services scope which could not be easily placed within a fixed service pathway when looking at services at a network system level. This was because these areas were either:

- indicative of cross cutting themes and standards which should be considered throughout the pathway (for example, multidisciplinary team working, patient information and carer support, documentation),
- distinct interventions that would have an impact across the pathway (addition of trauma coordinators),
- areas that could be evaluated outside a systems approach (i.e. rehabilitation assessment)
- or interventions which would operate and impact on a national scale over and above a regional or network level (i.e. audit).

At an early stage of guideline development, these topics were identified as unsuitable candidates to be informed by quantitative systems modelling and would benefit from a distinct systematic evidence review

**Third stage: identifying associations between clinical activities, direct outcomes and indirect (proxy) outcomes.**

The primary mapping activity also allowed exploration of what aspects of the scope topic areas could be seen as service interventions which impact on outcomes (i.e. triage tools impacting on the flow of patients to different settings) and which topic areas could be described as an interim outcome which could later impact on other areas of the system (i.e. travel times may be a product of the triaging decision, but within their own right would have an impact on clinical outcome and or the triaging decision itself).

**Fourth stage: identifying the key clinical activities and outcomes to be evaluated to assist decision making and form recommendations to improve trauma services.**

At this point, areas of the scope were highlighted on the map and the relative importance of evaluating key clinical activities was explored and defined. For example, the GDG identified the use of ambulance triage tools as having greater importance and uncertainty of value to the overall service configuration than dispatch triage tools.

The map showed potential logic pathways between activities and outcomes. Each arrow showing an association was briefly discussed and questioned, in particular whether the magnitude of association could be safely assumed or whether data or further analysis was required to explore the magnitude of effect or association further. For example, the cost of a consultant could be directly calculated using the number of hours worked and the cost per hour based on salary and on cost. However, further analysis on how service interventions may impact on the number of hours worked was important in order to evaluate overall cost instead of relying on assumptions

The activity was also used to identify areas which may not have been initially identified as key areas to formulate guidance on, but nonetheless were critical to inform and support the recommendations. For example, despite the map showing that a key outcome/aim of the pre-hospital service interventions was the extent they reduced time to appropriate treatment in hospital, this outcome was not in the scope of the guideline and therefore we did not look for any data on how, or the extent, delay to appropriate treatment in hospital would impact on patient outcomes. It was clear that to be able to evaluate and form recommendations around the service interventions

highlighted by stakeholders in the scope (notably those pre-hospital), information and evidence about optimal timing of specific interventions for trauma patients (e.g. airway management and access to interventional radiology for haemorrhage control), and how different pre-hospital service configurations can impact these, was critical to consider.

**Fifth stage: Drafting the systems model objectives and related protocols to inform critical parameters.**

The systems model objectives were drawn up to identify key changes in the system the GDG wished to explore and under which constraints.

The main purpose of the model was to explore the extent of delay to definitive treatment when using different pre hospital triage interventions, and using pre-hospital information in different ways (see Appendix M section 2.3 for a comprehensive description of the model objectives). Then protocols for the systematic reviews were drawn up to identify evidence on the outcomes, effectiveness, and the resource use that was key to informing the model and in turn the recommendations. Protocols were drawn up for the application of triage tools, pre-alert, trauma team response, access to airway management, access to interventional radiology for haemorrhage control. It was anticipated that recommendations for these scope areas would be informed by the model. In addition, protocols on access to other interventions important to people with major trauma (including neurosurgery) were made to populate the model with additional data ,but recommendations would not be made on the service based on these additional reviews.

**Sixth stage: Identification and evaluation of the evidence to inform recommendations**

According to the protocols, clinical and economic evidence was searched for and evaluated for applicability and quality using the methods outlined in the methods chapter. Full details of the included studies are available in the respective guidance chapters, and also summarised In Appendix M.

No fully applicable economic evidence was retrieved on the system under evaluation in the model objectives or for any individual clinical review protocol. Where possible therefore, it was thought to be important to scale up the systems model to explore cost effectiveness of given service configurations or changes.

### 17.4.2 Introduction to topics considered to benefit from systems modelling.

There are various strategies which aim to ensure that a person with traumatic injury receives the right services in a timely way. From the conceptual mapping discussion, developers felt the following scope topic areas may benefit from being explored via systems model:

- Application of triage tools
- Pre-alert
- Tiered trauma teams

It was noted that travel times, skills and expertise of pre-hospital staff, quality of transfer and staffing arrangements within hospital (on call and outreach) may influence or be influenced by the above key areas.

### 17.4.3 System model objectives

The most important objective of the modelling activity was to link service changes and recommendations to the key patient outcomes of survival and quality of life, through the determination of how a service change altered the extent of delay to definitive treatment (inclusive of appropriate discharge with no intervention).

### 17.4.4 Approach to the modelling

It was anticipated that a patient-level time-to-event simulation model would be the most appropriate to evaluate the service and was due to be built in simul8. This was due to:

- the patient heterogeneity within the patient population and the importance of the specific type of injuries sustained and patient characteristics in the triaging decision algorithms and also on the potential for deterioration;
- the availability of a UK individual patient level dataset to inform the model and to draw patients from, mirroring UK demography and epidemiology exactly;
- the importance of measuring time to events within the model;
- the ability to scale the model up to look at issues of limited resources or capacity if required at a later stage of development.

Initially review protocols were drafted to ensure broad consideration of data for modelling purposes; however it soon became clear that evidence base was too limited to inform a systems model.

It was thought that TARN could provide the patient-level data to which a retrospective triaging decision could be applied; in addition, mortality could be obtained based on patient index group, and correct and incorrect destination of transport. This was not the case and the option of conducting the economic analysis based on TARN data was considered unfeasible. See Appendix xx for detail on the use of TARN data in this guidance and in the Major Trauma and Complex fracture Clinical Guidelines.

A simplified model focusing only on triaging tools was considered, however this was concluded to be unfeasible as well due to the lack of evidence on comparative accuracy of tools in the adult population.

### 17.4.5 Discussion

The feasibility of making evidence informed recommendations regarding trauma services through quantitative systems modelling was explored. However the evidence base is extremely limited in this area to fully understand the relationships between clinical activities and outcomes considered important in evaluation of the service. Foremost, no published high quality evidence was identified regarding the accuracy of ambulance triage tools in the adult population, except those pertaining to variants of the ASCOT tool. Therefore we had no information on a comparator to this one tool and even a more simplified version of the economic model could not be developed.

Within a patient level simulation model, an alternative to modelling with published accuracy data would be to retrospectively apply the different pre hospital decision tools to a sample of UK patients with suspected trauma. Individual patient characteristics, as recorded by TARN, could feed into a decision rule indicated by the triage tools criteria or algorithm, and a triaging decision calculated by the model. Retrospectively, clinicians could determine whether the triage decision informed by the tool was correct or not, and respective sequences of events and outcomes applied.

At the time of writing we learnt that similar work is underway to understand the value of UK ambulance triage tools. However, even if we were to use the retrospective analysis of TARN data of triage decisions, the analysis would be limited by the use of proxy clinical indicators. In particular it would be difficult to look at many of the factors of interest on the triage decision, such as the influence of local service provision, time from injury to local provider or to MTC, the use of clinical judgement (or not), which are not described within TARN for the purposes of audit.

Further, even with accuracy of triage information, the link to clinical outcomes would be tenuous given the paucity of data on the impact of delay to intervention on clinical outcomes and of data on deterioration of different time critical injuries.

We had envisioned that we would need to look toward audit data for treatment effect on clinical outcomes, given that studies looking at delay to intervention were unlikely to be forthcoming. However, primary analysis undertaken for the Major Trauma guideline to estimate treatment effect of delay to intervention for people with suspected bleeding highlighted very serious limitations in use of regression to address bias when using this data source to inform treatment effect.

### 17.4.6 Conclusions

The original model planned for this guideline could not be conducted due to the lack of data to inform the most important parameters of the model, including the accuracy of the triaging tools currently used in practice. For this reason the recommendations for the following scope areas (application of triage tools, pre-alert, trauma team response, access to airway management, access to interventional radiology for haemorrhage control) anticipated to be supported by the model were made using the evidence identified and using the GDG expert opinion. The GDG decided not to recommend any specific triage tool but to make a research recommendation for this instead. These have already been reported in this and previous chapters in this guidance.

## 17.5 Access to services and skills

### 17.5.1 Recommendations and link to evidence: access to services

| Recommendations | **Recommendation for ambulance and hospital trust boards, senior managers and commissioners**<br><br>**There are other national documents that are relevant to the Major Trauma services including: Regional Networks for Major Trauma NHS Clinical Advisory Groups Report (2010), The NHS standard contract for Major trauma services.**<br><br>**39. Ensure that people with major trauma have access to services that can provide the interventions recommended in this guideline and in the NICE guidelines on non-complex fractures, complex fractures, major trauma and spinal injury. See Table 55 and Table 56 for the recommendations for pre-hospital and hospital management of major trauma that might have particular implications for service delivery.** |
|---|---|
| Trade off between clinical benefits and harms | Across the following guidelines (complex fractures, non-complex fractures, spinal injuries assessment, major trauma, major trauma services) the GDGs considered the clinical and cost effectiveness of the recommendations as part of the decision making. All the recommendations were considered to be appropriate, cost effective and in the best interests of the patient with trauma.<br>In the case of major trauma and in particular when a condition is life threatening it is vital that the access to the services and interventions recommended are available at all times; 24 hours a day, 7 days a week.<br><br>The trade-off between net health benefits and resource use, quality of evidence, barriers to implementation are outlined in the linking evidence to recommendation tables for each of the recommendations in the guidelines.<br>See Table 55 for a list of the relevant recommendations from each guideline. |

### 17.5.2 Recommendations and link to evidence: skills required to deliver care for people with major trauma

| Recommendations | **Recommendations for ambulance and hospital trust boards, medical directors and senior managers within trauma networks**<br><br>**40. Ensure that each healthcare professional within the trauma service has the training and skills to deliver, safely and effectively, the interventions they are required to give, in line with the NICE guidelines on non-complex fractures, complex fractures, major trauma and spinal injury.**<br><br>**41. Enable each healthcare professional who delivers care to patients with major trauma to have up-to-date training in the interventions they are required to give.** |
|---|---|
| Trade-off between clinical benefits and harms | Across the following guidelines (complex fractures, non-complex fractures, spinal injuries assessment, major trauma, major trauma services) the GDGs considered the clinical and cost effectiveness of the recommendations as part of the decision making. All the recommendations were considered to be appropriate, cost effective and in the best interests of the patient with trauma.<br>In the case of major trauma and in particular when a condition is life threatening it is vital that the access to the services and interventions recommended are available at all times; 24 hours a day, 7 days a week.<br>The trade-off between net health benefits and resource use, quality of evidence, barriers to implementation are outlined in the linking evidence to recommendation tables for each of the recommendations in the guidelines.<br>See Table 55 for a list of the relevant recommendations from each guideline.<br><br>In order to deliver care safely and effectively the recommendations in the following guidelines (complex fractures, non-complex fractures, spinal injuries assessment, major trauma, major trauma services) healthcare practitioners and professionals need to be trained and up to date in the interventions.<br><br>The GDG emphasised the need for Trust boards to support their staff through providing time to attend training and access to training courses.<br>See chapter 14 on paediatric trauma training for further detail on the principles and importance of training practitioners and healthcare professionals to deliver interventions to people with major trauma. |

# 18 Acronyms and abbreviations

| Acronym or abbreviation | Description |
|---|---|
| ABPI | Ankle brachial pressure index |
| ADL | Activities of daily living |
| AIS | Abbreviated Injury Scale |
| ASIA score | American Spinal Injury Association Impairment score |
| ATLS | Advanced Trauma Life Support |
| CI | Confidence interval |
| CC | Comparative costing |
| CCA | Cost-consequences analysis |
| CEA | Cost-effectiveness analysis |
| CNS | Central nervous system |
| CT | Computed tomography |
| CUA | Cost-utility analysis |
| DASH Score | The Disabilities of the Arm, Shoulder and Hand Score |
| DVT/PE | Deep vein thrombosis and pulmonary embolism. |
| eFAST | Extended Focused Assessment with Sonography for Trauma |
| EMAS | East Midlands Ambulance Service |
| FAST | Focused assessment with sonography for trauma |
| GCS | Glasgow coma scale |
| GOS | Glasgow outcome scale |
| INR | International normalised ratio |
| IO | Intraosseous |
| IR | Interventional radiology |
| IV | Intravenous |
| ISS | Injury Severity Score |
| JRCALC | Joint Royal Colleges Ambulance Liaison Committee |
| KED | Kendrick Extrication Device |
| MDCT | Multi-detector computed tomography |
| MDT | Multidisciplinary team |
| MRI | Magnetic resonance imaging |
| MTC | Major Trauma Centre |
| NEXUS | National Emergency X Radiography Utilization Study |
| NNT | Number needed to treat |
| NPV | Negative predictive value |
| NSAIDS | Non-steroidal anti-inflammatory drugs |
| ORIF | Open reduction and internal fixation |
| PACS | Picture Archiving and Communications Systems |
| PCC | Prothrombin complex concentrate |
| PPV | Positive predictive value |
| QALY | Quality-adjusted life year |
| RCT | Randomised controlled trial |
| RSI | Rapid Sequence Induction of anaesthesia and intubation |

| Acronym or abbreviation | Description |
|---|---|
| TARN | The Trauma Audit & Research Network |
| TU | Trauma unit |
| UTI | Urinary tract infection |
| VKA | Vitamin K antagonist |
| VTE | Venous thrombosis embolism |

# 19 Glossary

| Term | Definition |
|---|---|
| Abbreviated Injury Scale (AIS) | Injuries are ranked on a scale of 1 to 6, with 1 being minor, 5 severe and 6 an unsurvivable injury. This represents the 'threat to life' associated with an injury and is not meant to represent a comprehensive measure of severity. |
| Abstract | Summary of a study, which may be published alone or as an introduction to a full scientific paper. |
| Active Bleeding | Also known as or related to haemorrhage and loss of blood. It describes on going bleeding . |
| Activities of daily living (ADL) | Routine activities carried out for personal hygiene and health (including bathing, dressing, feeding) and for operating a household. |
| Acute | A stage of injury or stroke starting at the onset of symptoms. The opposite of chronic. |
| Advanced Trauma Life Support (ATLS) | A training program for medical professionals in the management of acute trauma cases, developed by the American College of Surgeons. |
| Algorithm (in guidelines) | A flow chart of the clinical decision pathway described in the guideline, where decision points are represented with boxes, linked with arrows. |
| Allocation concealment | The process used to prevent advance knowledge of group assignment in a RCT. The allocation process should be impervious to any influence by the individual making the allocation, by being administered by someone who is not responsible for recruiting participants. |
| Ambulation | Walking with braces and/or crutches. |
| American Spinal Injury Association Impairment (ASIA) Score | A system to describe spinal cord injury and help determine future rehabilitation and recovery needs. It is based on a patient's ability to feel sensation at multiple points on the body and also tests motor function. Ideally, it's first given within 72 hours after the initial injury. Scored from A-E; A means complete injury; E means complete recovery. |
| Angiography | Radiography of blood or lymph vessels, carried out after introduction of a radiopaque substance. |
| Angular deformity | Deformity of limbs by angulation at joints or in the bones themselves. |
| Ankle brachial pressure index (ABPI) | The ratio of the blood pressure in the lower legs to the blood pressure in the arms. It is used for decision-making in leg ulcer assessment. |
| Antero-lateral | Directed from the front towards the side. |
| Antero-posterior | Directed from the front towards the back. |
| Anticoagulation | The process of hindering the clotting of blood. |
| Antifibrinolytic agent | Pharmacological agents that inhibit the activation of plasminogen to plasmin, prevent the break-up of fibrin and maintain clot stability. They are used to prevent excessive bleeding. |
| Applicability | The degree to which the results of an observation, study or review are likely to hold true in a particular clinical practice setting. |
| Arm (of a clinical study) | Sub-section of individuals within a study who receive one particular intervention, for example placebo arm |
| Arterial injury | An injury following a traumatic injury which results in a laceration, contusion, puncture, or crush injury to an artery. |
| Arterial shunts | An artificial passageway introduced through a surgical procedure that allows blood to flow from through the arteries. |
| Aspiration event | The event of food or drink entering the airway. |
| Association | Statistical relationship between two or more events, characteristics or other variables. The relationship may or may not be causal. |

| Term | Definition |
|---|---|
| Attrition bias | Bias resulting from the loss of data from analysis. Loss of data from analysis causes bias by disrupting baseline equivalence and also because data from people who drop out are often systematically different from data collected from those who don't drop out. Loss of such data therefore distorts the apparent response of a group to a treatment. For example, those who drop out from a treatment may be the worst responders and so if these are not included in the analysis this may make a treatment look better than it really is. Attrition bias may be reduced by following an intention to treat approach (see 'intention to treat'). |
| Avascular necrosis | Avascular necrosis is cellular death of bone components due to interruption of the blood supply. |
| Baseline | The initial set of measurements at the beginning of a study (after run-in period where applicable), which may be important in demonstrating how much selection bias is present. They may also be compared with subsequent results in certain study designs. |
| Basic airway manoeuvres | A set of medical procedures performed in order to prevent airway obstruction and thus ensuring an open pathway. Manoeuvres include encouraging the victim to cough, back blows and abdominal thrusts. |
| Before-and-after study | A study that investigates the effects of an intervention by measuring particular characteristics of a population both before and after taking the intervention, and assessing any change that occurs. Because there is no control group, this approach is subject to considerable bias (see control group).<br>'Before and after study' is sometimes also used to denote historical cohort studies that compare two groups separated in time, often before and after the initiation of a new treatment strategy. In such cases the control group is the group treated earlier. |
| Bias | Systematic (as opposed to random) deviation of the results of a study from the 'true' results that is caused by the way the study is designed or conducted. |
| Blinding | Keeping the study participants, caregivers, and outcome assessors unaware which interventions the participants have been allocated in a study. |
| Blunt trauma | A traumatic injury caused by the application of mechanical force to the body by a blunt force, object or instrument or an injury in which the body strikes a surface such as a wall or the ground, in which the skin was not penetrated. |
| Canadian C-Spine Rules | Selective guidelines developed in Canada for the ordering of cervical spine imaging following acute trauma. |
| Carer (caregiver) | Someone other than a health professional who is involved in caring for a person with a medical condition. |
| Case-control study | Comparative observational study in which the investigator selects individuals who have experienced a health-related event (cases) and others who have not (controls), and then collects data to determine relative prior exposure to a possible cause. |
| Case-series | Report of a number of cases of a given disease, usually covering the course of the disease and the response to treatment. There is no comparison (control) group of patients. See 'before and after ' study. |
| Central nervous system (CNS) | The brain and spinal cord. |
| Cervical | High-level nervous structure of the spinal cord responsible for controlling the neck muscles, diaphragm, shoulders, wrists, triceps and fingers. |
| Cervical collar | A cervical collar (also neck brace) is an orthopaedic medical device used to support a patient's neck and head. |

| Term | Definition |
|---|---|
| Charlson comorbidity index | A comorbidity index which predicts the ten-year mortality for a patient who may have a range of comorbid conditions. The score is helpful in deciding how aggressively to treat a condition. |
| Chest decompression | A medical procedure to remove air from the pleural cavity and treat tension pneumothorax injuries. A cannula is inserted and advanced in the chest until air is aspirated. The manoeuver effectively converts a tension pneumothorax into a simple pneumothorax. |
| Chronic spinal cord injury | The stage of spinal cord injury where there is no longer continuing damage or recovery. |
| Clinical efficacy | The extent to which an intervention produces an overall health benefit when studied under controlled research conditions. |
| Clinical effectiveness | The extent to which an intervention produces an overall health benefit in routine clinical practice. |
| Clinician | A healthcare professional providing direct patient care, such as a doctor, nurse or physiotherapist. |
| Coagulopathy | Coagulopathy is a condition in which the blood's ability to clot (coagulate) is impaired. It can be caused as a result of on-going cycles of dilution and consumption of coagulation factors, hypothermia and acidosis following traumatic incidents. |
| Cochrane Review | The Cochrane Library consists of a regularly updated collection of evidence-based medicine databases including the Cochrane Database of Systematic Reviews (reviews of randomised controlled trials prepared by the Cochrane Collaboration). |
| Cohort study | A sample (or cohort) of individuals without a chosen outcome event (such as a disease) are defined on the basis of presence or absence of exposure to one or more suspected risk factors or interventions. The effects of these risk factors or interventions on chosen outcomes are then evaluated at later follow up.<br>Prospective cohort studies are managed by the researchers in real time. This allows the measurement of appropriate potential confounding variables at baseline. Retrospective cohort studies are based on databases that were collected prospectively, often for another purpose, but which are used retrospectively (that is, not in real time) by a researcher. This approach often means that appropriate confounding variables may not have been collected |
| Comorbidity | One or more additional disorders (other than that being studied or treated) in an individual. |
| Comparability | Similarity of the groups in characteristics likely to affect the study results (such as health status or age). |
| Comparative costing (CC) | A type of analysis where costs are compared without the consideration of health benefits |
| Compartment syndrome | A condition that occurs when the amount of swelling and/or bleeding in a muscle compartment causes pressure that is greater than the capillary pressure and results in tissue ischemia and potential tissue necrosis. |
| Complete injury | Generally, a spinal cord injury that cuts off all sensory and motor function below the lesion site. |
| Computed tomography (CT) scan | A scan which produces images of a cross sectional plane of the body. The scan is produced by computer synthesis of X-ray images taken in many different directions in a given plane. |
| Comminuted fracture | A fracture in which the bone shatters into three or more pieces. |
| Compound Fracture | A fracture in which broken bone fragments lacerate soft tissue and protrude through an open wound in the skin. This term is synonymous with ‘open |

| Term | Definition |
|---|---|
| | fracture'. See open fracture |
| Conceptual mapping | Activity which involves diagrammatically representing the relationships between different areas and the interactions between interventions and outcomes. |
| Conceptual modelling | Activity in which the participants' understanding of the decision problem is represented in a mathematical model which can be discussed and agreed by the participants. |
| Concordance | This is a recent term whose meaning has changed. It was initially applied to the consultation process in which doctor and patient agree therapeutic decisions that incorporate their respective views, but now includes patient support in medicine taking as well as prescribing communication. Concordance reflects social values but does not address medicine-taking and may not lead to improved adherence. |
| Concussion | Reversible paralysis following brain trauma, usually involving loss of consciousness and/or a transient state of confusion. |
| Confidence interval (CI) | A range of values for an unknown population parameter with a stated 'confidence' (conventionally 95%) that it contains the true value. The interval is calculated from sample data, and straddles the sample estimate. The 'confidence' value means that if the method used to calculate the interval is repeated many times, then that proportion of intervals will actually contain the true value. |
| Confounding | In a study, confounding occurs when the effect of an intervention (or risk factor) on an outcome is distorted as a result of one or more additional variables that are able to influence the outcome, and that also have an association with the intervention (or risk factor). Association with the intervention (or risk factor) generally means an imbalance in the confounder across intervention (or risk factor) groups. For example, a sample of coffee drinkers may be observed to have more heart disease than a sample of non-coffee drinkers. If the coffee drinker sample are much older than the non-coffee drinker sample, then differing age may explain the outcome rather than coffee consumption, assuming greater age increases heart disease risk. |
| Consensus methods | Techniques that aim to reach an agreement on a particular issue. Consensus methods may be used when there is a lack of strong evidence on a particular topic. |
| Constant-Murley shoulder Outcome Score | A commonly used outcome measure for assessing the outcomes of the treatment of shoulder disorders. |
| Control group | A group of people in a study who do not receive the treatment or test being studied. Instead, they may receive the standard treatment (sometimes called 'usual care') or a dummy treatment (placebo). The results for the control group are compared with those for a group receiving the treatment being tested.<br>Without a control group it is impossible to know the extent to which a change in outcome in the intervention group is due to the treatment effect or to intervening effects such as the placebo effect , practice effect or natural history effect. However if a control group has very similar characteristics to the treatment group then it can be assumed that it will be exposed to very similar intervening effects. Therefore taking the difference between group outcomes (or the ratio if the outcome is bivariate) allows the intervening effects to largely cancel out, leaving only the differential between-group treatment effect. |
| Cosmesis | The surgical correction of a disfiguring physical defect. |
| Cost benefit analysis | A type of economic evaluation where both costs and benefits of healthcare |

| Term | Definition |
|---|---|
| | treatment are measured in the same monetary units. If benefits exceed costs, the evaluation would recommend providing the treatment. |
| Cost-consequences analysis (CCA) | A type of economic evaluation where various health outcomes are reported in addition to cost for each intervention, but there is no overall measure of health gain. |
| Cost-effectiveness analysis (CEA) | An economic study design in which consequences of different interventions are measured using a single outcome, usually in 'natural' units (For example, life-years gained, deaths avoided, heart attacks avoided, cases detected). Alternative interventions are then compared in terms of cost per unit of effectiveness. |
| Cost-effectiveness model | An explicit mathematical framework, which is used to represent clinical decision problems and incorporate evidence from a variety of sources in order to estimate the costs and health outcomes. |
| Cost-utility analysis (CUA) | A form of cost-effectiveness analysis in which the units of effectiveness are quality-adjusted life-years (QALYs). |
| Credible Interval | The Bayesian equivalent of a confidence interval. |
| Crush injury | An injury by an object that causes compression of the limb or body. |
| Cryoprecipitate | A source of fibrinogen, vital to blood clotting. |
| Damage control surgery | A technique of surgery for critically ill patients involving other sub-specialty services in addition to the trauma surgeon. This technique places emphasis on preventing the "lethal triad", rather than correcting the anatomy. The patient will be stabilised before definitive treatment. |
| Debridement | The whole process of opening up of a wound, or pathological area (for example, bone infection), together with the surgical excision of all avascular, contaminated, infected, or other undesirable tissue. |
| Decision analysis | An explicit quantitative approach to decision making under uncertainty, based on evidence from research. This evidence is translated into probabilities, and then into diagrams or decision trees which direct the clinician through a succession of possible scenarios, actions and outcomes. |
| Deep infection | Deep incisional surgical site infections must meet the following three criteria:<br>• Occur within 30 days of procedure (or one year in the case of implants)<br>• are related to the procedure<br>• involve deep soft tissues, such as the fascia and muscles.<br><br>In addition, at least one of the following criteria must be met:<br>• Purulent drainage from the incision but not from the organ/space of the surgical site.<br>• A deep incision spontaneously dehisces or is deliberately opened by a surgeon when the patient has at least one of the following signs or symptoms - fever (>38°C), localised pain or tenderness - unless the culture is negative.<br>• An abscess or other evidence of infection involving the incision is found on direct examination or by histopathologic or radiological examination.<br>• Diagnosis of a deep incisional SSI by a surgeon or attending physician. |
| Definitive closure | The final surgical closing of a wound by suture or staple. |
| Definitive cover | Final closure of the open fracture wound, using a local flap of skin, or skin grafted from another part of the body. |
| Definitive (internal or external) fixation | The final surgical implantation of internal or external metalwork for the purposes of repairing a bone and fixing it into place. |
| Definitive haemorrhage | A surgical procedure to completely stop bleeding following trauma. |

| Term | Definition |
|---|---|
| control | |
| Definitive treatment | A final treatment, which may conclude prior preparatory stages, which aims to achieve a specific therapeutic effect. |
| Delayed bone healing | A fracture that takes longer to heal than expected. |
| Detection bias | Bias relating to the way in which data is collected. The most common cause of detection bias results from failure to blind outcome assessors. If outcome assessors know the group allocation of a participant this may influence the way that the measurement is carried out. |
| Diagnostic RCT | A randomised controlled trial that compares outcomes from groups allocated to two or more different forms of diagnostic assessment. Diagnostic RCTs are a pragmatic way of assessing how well diagnostic tests affect outcome through their ability to determine appropriate management of patients. In contrast to diagnostic accuracy studies, they can encompass issues like the duration or comfort of a test, which may be important considerations in the decision concerning which diagnostic test should be used. |
| The Disabilities of the Arm, Shoulder and Hand (DASH) Score | A patient reported questionnaire to inform on functional capacity of the arm. |
| Disability rating index | A patient reported clinical tool for assessing physical disability, mainly intended for clinical settings. |
| Discounting | Costs and perhaps benefits incurred today have a higher value than costs and benefits occurring in the future. Discounting health benefits reflects individual preference for benefits to be experienced in the present rather than the future. Discounting costs reflects individual preference for costs to be experienced in the future rather than the present. |
| Discrete Event Simulation | A type of model (also known as time-to-event model) based on patient-level simulation where 'time to event' is the key parameter as opposed to 'probability of event occurring' like in a Markov model. |
| Dislocation | Displacement of one or more bones at a joint. |
| Dominance | An intervention is said to be dominated if there is an alternative intervention that is both less costly and more effective. |
| Drop-out | A participant who withdraws from a trial before the end. |
| Dynamic fluoroscopy | Imaging technique which uses an X-ray tube and a fluoroscopic screen with an image intensifier to create a real-time image of moving objects. |
| Economic evaluation | Comparative analysis of alternative health strategies (interventions or programmes) in terms of both their costs and consequences. |
| Effect (as in effect measure, treatment effect, estimate of effect, effect size) | The observed association between interventions and outcomes or a statistic to summarise the strength of the observed association. |
| Effectiveness | See 'Clinical effectiveness'. |
| Efficacy | See 'Clinical efficacy'. |
| Embolization | Therapeutic introduction of a substance into a blood vessel in order to occlude it and prevent active bleeding following trauma. |
| Emergent phenomena | A stage in recovery from general anaesthesia that includes a return to spontaneous breathing, voluntary swallowing and normal consciousness. |
| Epidemiological study | The study of a disease within a population, defining its incidence and prevalence and examining the roles of external influences (For example, infection, diet) and interventions. |
| EQ-5D (EuroQol-5D) | A standardise instrument used to measure a health outcome. It provides a single index value for health status and measures quality of life |

| Term | Definition |
|---|---|
| Evidence | Information on which a decision or guidance is based. Evidence is obtained from a range of sources including randomised controlled trials, observational studies, expert opinion (of clinical professionals and/or patients). |
| Exclusion criteria (literature review) | Explicit standards used to decide which studies should be excluded from consideration as potential sources of evidence. |
| Exclusion criteria (clinical study) | Criteria that define who is not eligible to participate in a clinical study. |
| Extended dominance | If Option A is both more clinically effective than Option B and has a lower cost per unit of effect, when both are compared with a do-nothing alternative then Option A is said to have extended dominance over Option B. Option A is therefore more efficient and should be preferred, other things remaining equal. |
| Extended Focused Assessment with Sonography for Trauma (eFAST) | Extends the viewing area of FAST to include other assessments . It is often used to image the thorax. |
| External fixation | External fixation involves the placement of pins or screws into the bone on both sides of the fracture. The pins are then secured together outside the skin with clamps and rods, forming an external frame. |
| Extrapolation | In data analysis, predicting the value of a parameter outside the range of observed values. |
| Fascia iliaca compartment block | Fascia iliaca block is a low-tech alternative to a femoral nerve or a lumbar plexus block. The mechanism behind this block is that the femoral and lateral femoral cutaneous nerves lie under the iliacus fascia. |
| Fasciotomy | The surgical division the investing fascial wall of an osseo-fascial muscle compartment, usually to release pathologically high intra-compartmental pressure. |
| Fibrinolysis | A process within the body that prevents blood clots that occur naturally from growing and causing problems. |
| Focused assessment with sonography for trauma (FAST) | A rapid bedside ultrasound (see definition) examination performed as a screening test for blood around the heart (pericardial effusion) or abdominal organs (hemoperitoneum) after trauma. |
| Flap failure | When a mass of tissue used for grafting, only partially removed so that it retains its own blood supply during transfer to another site, does not fully re-vascularise. |
| Follow-up | Observation over a period of time of an individual, group or initially defined population whose appropriate characteristics have been assessed in order to observe changes in health status or health-related variables. |
| Frankel classification | Precursor to ASIA scoring system to assess spinal function. |
| Fresh frozen plasma | The remaining serum of human blood that is frozen after the cellular component has been removed for blood transfusion |
| Full-body computed tomography (CT)/whole-body CT | A CT scan from the head to below the hips with a form of X-ray imaging that produces cross-sectional images. |
| Generalisability | The extent to which the results of a study based on measurement in a particular patient population and/or a specific context hold true for another population and/or in a different context. In this instance, this is the degree to which the guideline recommendation is applicable across both geographical and contextual settings. For example, guidelines that suggest substituting one form of labour for another should acknowledge that these costs might vary across the country. |
| Glasgow coma scale (GCS) | A rating scale devised to assess the level of consciousness following brain |

| Term | Definition |
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| | damage. The scale assesses eye, verbal and motor responses. The GCS grades on a scale of 1–15, the lower score indicating the greater neurologic impairment. |
| Glasgow outcome scale (GOS) | A system for classifying the outcome of persons who survive. The scale has eight outcome categories and relates to functional independence and not residual deficits. |
| Gold standard | See 'Reference standard' |
| Gustilo Anderson Grade | The Gustilo Anderson Grade open fracture classification system comprises:<br>Type I: clean wound smaller than 1 cm in diameter, appears clean, simple fracture pattern, no skin crushing.<br>Type II: a laceration larger than 1 cm but without significant soft-tissue crushing, including no flaps, degloving, or contusion. Fracture pattern may be more complex.<br>Type III: an open segmental fracture or a single fracture with extensive soft-tissue injury. Also included are injuries older than 8 hours. Type III injuries are subdivided into three types:<br>Type IIIA: adequate soft-tissue coverage of the fracture despite high-energy trauma or extensive laceration or skin flaps.<br>Type IIIB: inadequate soft-tissue coverage with periosteal stripping. Soft-tissue reconstruction is necessary.<br>Type IIIC: any open fracture that is associated with vascular injury that requires repair. |
| Haematoma block | An analgesic technique used to allow painless manipulation of fractures avoiding the need for full anaesthesia. |
| Haemodynamic instability | Patients who are non-responders or transient responders to intravenous fluid therapy. |
| Haemodynamically unstable | A patient requiring frequent interventions to maintain Heart Rate, Blood Pressure, or oxygenation. |
| Haemodynamic status | The status of blood flow in the circulation, the sum result of cardiac output and blood pressure. Stable haemodynamic status occurs when the circulatory supply of oxygen maintains organ perfusion. |
| Harms | Adverse effects of an intervention. |
| Health economics | The study of the allocation of scarce resources among alternative healthcare treatments. Health economists are concerned with both increasing the average level of health in the population and improving the distribution of health. |
| Health-related quality of life (HRQoL) | A combination of an individual's physical, mental and social well-being; not merely the absence of disease. |
| Heterogeneity | The term (or 'lack of homogeneity') is used in meta-analyses and systematic reviews when the results or estimates of effects of treatment from separate studies seem to be very different. This can be in terms of the different size of treatment effects or even to the extent that some studies indicate beneficial treatment effects and others suggest adverse treatment effects. Such results may occur as a result of differences between studies in terms of the patient populations, outcome measures, definition of variables or duration of follow-up, although there is also a small probability they may due to random sampling error. |
| High-energy fracture | A fracture resulting from a direct impact of sufficient energy to cause disruption of bone in anyone regardless of their health or comorbidities. Examples are a motor vehicle accident, a high-height fall, or an industrial accident. |

| Term | Definition |
|---|---|
| Image intensifier | A medical device that converts X-rays into visible light at higher intensity than fluorescent screens do. |
| Immobilised | The process of holding a joint or bone in place with a splint, cast or brace. This is done to prevent an injured area from moving while it heals. |
| Imprecision | Results are imprecise when they have wide confidence intervals around the estimate of effect. This may be partly due to studies including relatively few patients. It also arises as a result of high intrinsic variability in continuous outcome, or a low event rate. |
| Inclusion criteria (literature review) | Explicit criteria used to decide which studies should be considered as potential sources of evidence. |
| Incomplete injury | If a person with a spinal cord injury has either some sensation and/or some movement below the level of their spinal cord lesion, their injury is said to be incomplete |
| Incontinence | Loss of control of bowel or bladder. |
| Incremental analysis | The analysis of additional costs and additional clinical outcomes with different interventions. |
| Incremental cost | The mean cost per patient associated with an intervention minus the mean cost per patient associated with a comparator intervention. |
| Incremental cost effectiveness ratio (ICER) | The difference in the mean costs in the population of interest divided by the differences in the mean outcomes in the population of interest for one treatment compared with another. |
| Incremental net benefit (INB) | The value (usually in monetary terms) of an intervention net of its cost compared with a comparator intervention. The INB can be calculated for a given cost-effectiveness (willingness to pay) threshold. If the threshold is £20,000 per QALY gained then the INB is calculated as: (£20,000 x QALYs gained) – Incremental cost. |
| Indirectness | The available evidence is different to the review question being addressed, in terms of the population, intervention, comparison or outcome. |
| Initial surgery | A patient's first surgical intervention after injury |
| Injury Severity Score (ISS) | A clinical scale from 1 to 75 (higher score being more serious) which can classify patients following a traumatic incident. Those scoring above 15 are defined as having suffered from major trauma. ISS of 9-15 have moderately severe trauma. |
| International normalised ratio (INR) | A laboratory test measure of blood coagulation based on prothrombin time. |
| Intention to treat analysis (ITT) | A strategy for analysing data from a randomised controlled trial. All participants' data are analysed in the arm to which they were allocated, regardless of whether participants received (or completed) the intervention given to that arm or not. Intention-to-treat analysis reflects real-world adherence to the protocol and also prevents bias caused by the loss of participants' data from analysis. (see attrition bias) |
| Intervention | Healthcare action intended to benefit the patient, for example, drug treatment, surgical procedure, psychological therapy. |
| Interventional radiology (IR) | Defined by the British Society for Interventional Radiology (IR) it refers to a range of techniques which rely on the use radiological image guidance (X-ray fluoroscopy, ultrasound, computed tomography [CT] or magnetic resonance imaging [MRI]) to precisely target therapy. Most IR treatments are minimally invasive alternatives to open and laparoscopic (keyhole) surgery. |
| Intramedullary fixation | A surgical technique in which a metal nail provides stability to the bone. |

| Term | Definition |
|---|---|
| Intraoperative | The period of time during a surgical procedure. |
| Intraosseous (IO) access | The process of injecting directly into the marrow of a bone to provide a non-collapsible entry point into the systemic venous system |
| Intraperitoneal | Intraperitoneal means within or administered through the peritoneum. The peritoneum is a thin, transparent membrane that lines the walls of the abdominal (peritoneal) cavity and contains and encloses the abdominal organs, such as the stomach and intestines |
| Intravenous | A drug, nutrient solution, or other substance administered into a vein. |
| Intubation | Insertion of a tube into the trachea for purposes of anaesthesia, airway maintenance and lung ventilation. |
| Ischaemic damage | Damage caused to tissue or an organ due to insufficient supply of blood to an organ. |
| Kappa statistic | A statistical measure of inter-rater agreement that assesses the probability that the agreement occurred by chance. |
| Kendrick Extrication Device (KED) | A device used for extricating and immobilizing patients from auto accidents and other confined spaces. |
| Laparotomy | A surgical procedure to open the abdomen for diagnosis or in preparation for surgery. |
| Length of stay | The total number of days a participant stays in hospital. |
| Lesion | Site of injury or wound to the spinal cord. |
| Licence | See 'Product licence'. |
| Life-years gained | Mean average years of life gained per person as a result of the intervention compared with an alternative intervention. |
| Likelihood ratio | The likelihood ratio combines information about the sensitivity and specificity. It tells you how much a positive or negative result changes the likelihood that a patient would have the disease. The likelihood ratio of a positive test result (LR+) is sensitivity divided by 1- specificity. |
| Limb salvage | A surgical procedure to maintain a limb following a traumatic incident. |
| Log roll | Method of turning a patient without twisting the spine. |
| Long-term care | Residential care in a home that may include skilled nursing care and help with everyday activities. This includes nursing homes and residential homes. |
| Loss to follow-up | Loss to follow up is usually caused by failure of participants to attend for follow-up outcome assessments, though it can also occur if researchers exclude participants from a study for non-compliance (see 'intention to treat'). Loss to follow up may cause bias if the reason for non-attendance could have affected outcomes. For example, if non-attendance at follow-up is due to the treatment having made the condition worse, then such harm from the treatment is not captured during follow up and thus analysis, making the treatment seem better than it really is. |
| Low energy fracture | A fracture resulting from mechanical forces that would not ordinarily lead to the bone to fracture, for example, a fall from a standing height. Low-energy fractures may be more common in individuals with bone fragility (e.g. individuals with osteoporosis) |
| Lumbar | Lower-level area of the spine, lying below the thoracic spine and above the sacral spine. Lumbar nerves are responsible for innervation of the abdomen, parts of the perineum and most of the lower limbs. |
| Magnetic resonance imaging (MRI) | A medical imaging technique used for medical diagnosis, staging of disease and for follow-up without exposure to ionizing radiation. MRI scanners use magnetic fields and radio waves to form images of the body. |
| Major haemorrhage | Loss of more than one blood volume within 24 hours (around 70 mL/kg, |

| Term | Definition |
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| | >5 litres in a 70 kg adult), a 50% of total blood volume lost in less than 3 hours, or bleeding in excess of 150 mL/minute. |
| Major Trauma Centre (MTC) | A specialist hospital responsible for the care of major trauma patients across the region. It is a specialist hospital responsible for the care of the most severely injured patients involved in major trauma. It provides 24/7 emergency access to consultant-delivered care for a wide range of specialist clinical services and expertise.<br>It is optimised for the definitive care of injured patients. In particular, it has an active, effective trauma Quality Improvement programme. It also provides a managed transition to rehabilitation and the community.<br>It takes responsibility for the care of all patients with Major Trauma in the area covered by the Network. It also supports the Quality Improvement programmes of other hospitals in its Network.<br>It provides all the major specialist services relevant to the care of major trauma, that is, general, emergency medicine, vascular, orthopaedic, plastic, spinal, maxillofacial, cardiothoracic and neurological surgery and interventional radiology, along with appropriate supporting services, such as critical care.<br>The Royal College of Surgeons cite research advising that such centres should admit a minimum of 250 critically injured patients per year |
| Major Trauma | Major trauma is defined a potentially life threatening injury or injuries with the potential to cause the loss of a major limb. |
| Major Trauma Network | A collaboration between the providers commissioned to deliver trauma care services in a geographical area. A trauma network includes all providers of trauma care: pre-hospital services, other hospitals receiving acute trauma admissions (Trauma Units), and rehabilitation services. The trauma network has appropriate links to the social care and the voluntary/community sector. While individual units retain responsibility for their clinical governance, members of the Network collaborate in a Quality Improvement programme. |
| Malunion | Consolidation of a fracture in a position of deformity. |
| Markov model | A method for estimating long-term costs and effects for recurrent or chronic conditions, based on health states and the probability of transition between them within a given time period (cycle). |
| Multi-detector computed tomography (MDCT) scan | A form of computed tomography (CT) technology for diagnostic imaging. In MDCT, a two-dimensional array of detector elements replaces the linear array of detector elements used in typical conventional and helical CT scanners. The two-dimensional detector array permits CT scanners to acquire multiple slices or sections simultaneously and greatly increase the speed of CT image acquisition |
| Meta-analysis | A statistical technique for combining (pooling) the results of a number of studies that address the same question and report on the same outcomes to produce a summary result. The aim is to derive more precise and clear information from a large data pool. It is generally more likely to confirm or refute a hypothesis than the individual trials. |
| Methaemoglobinaemia | Methaemoglobin (MetHb) is an altered state of haemoglobin (Hb), reducing its ability to release oxygen. It can be acquired following admission of anaesthesia. |
| Minimal load bearing | Load-bearing only as much as is required to maintain the best level of independence achievable. |
| Minimal weight bearing | Weight-bearing only as much as is required to maintain the best level of independence achievable. |
| Motor function | Ability to perform functional tasks. |

| Term | Definition |
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| Motor recovery | Recovery of the strength and co-ordination of voluntary movement. |
| Multidisciplinary team (MDT) | Group of experts providing optimal management following Spinal Cord Injury. Teams can consist of Medics, Nurses, Surgical Team Physiotherapists, General Practitioner, Speech and Language Therapist. |
| Multivariable model | A statistical model for analysis of the relationship between two or more predictor (independent) variables and the outcome (dependent) variable. |
| Muscle/joint contracture | A permanent shortening of a muscle or joint. |
| Myoglobinuria | Myoglobinuria is a condition usually the result of rhabdomyolysis or muscle destruction which can be detected by the detection of myglobin in the urine. |
| National Emergency X Radiography Utilization Study (NEXUS) | Guideline detailing Low-Risk Criteria to rule-out cervical spine injury in patients following acute trauma. |
| Necrosis | The death of most or all of the cells in an organ or tissue due to disease, injury, or failure of the blood supply. |
| Neer Classification | The Neer classification of proximal humeral fractures is probably the most frequently used along with the AO classification of proximal humeral fractures.<br>The classification has been variably adapted by multiple authors into 4 main areas:<br>• One-part fracture - fracture lines involve 1-4 parts none of the parts are displaced (that is, <1 cm and <45 degrees). These undisplaced/minimally displaced fractures account for approximately 70-80% of all proximal humeral fractures and are almost always treated conservatively 6-7.<br>• Two-part fracture - fracture lines involve 2-4 parts, one part is displaced (that is, >1 cm or >45 degrees). Four possible types of two-part fractures exist (one for each part): surgical neck, greater tuberosity, anatomical neck, lesser tuberosity: uncommon<br>• Three-part fracture - fracture lines involve 3-4 parts, two parts are displaced (that is, >1 cm or >45 degrees)<br>• Four-part fracture -fracture lines involve parts, three parts are displaced (that is, >1cm or >45 degrees) with respect to the 4th. |
| Negative predictive value (NPV) [In screening/diagnostic tests:] | A measure of the usefulness of a screening/diagnostic test. It is the proportion of those with a negative test result who do not have the disease, and can be interpreted as the probability that a negative test result is correct. |
| Neuropathic/spinal cord pain | Neuropathic pain is a problem experienced following Spinal Cord Injury. A sharp pain is the result of damage to the spine and soft tissue surrounding the spine. |
| Neuroprotective agents | Medications that protect the brain and spinal cord from secondary injury caused by stroke or trauma. |
| Neurovascular compromise | Injury occurring when vessels and nerves are be disrupted or distorted by a fracture or dislocation and require urgent reduction. |
| Non-union | Non-union is failure of bone healing. A fracture is judged to be un-united if the signs of non-union are present when a sufficient time has elapsed since injury, during which the particular fracture would normally be expected to have healed by bony union. That period will vary according to age, fracture location and patho-anatomy. |
| Normotension | Fluid resuscitation with the aim of increasing systemic blood pressure to normal blood pressures. |
| No weight bearing | Not allowed to walk/stand. |
| Number needed to treat (NNT) | The number of patients that who on average must be treated to cause a single occurrence of the positive outcome of interest. |

| Term | Definition |
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| Oblique fracture | A fracture with an angled pattern. |
| Observational study | Retrospective or prospective study in which the investigator observes the natural course of events with or without control groups; for example, cohort studies and case–control studies. |
| Occlusive dressing | A dressing that seals the wound from air or bacteria |
| Odds ratio | The odds of an event is the ratio of the number of events occurring (for example, the number of people dying) to the number of non-events (for example, the number of people not dying) within a single group. Odds are distinct from risks (see risk ratio) and are therefore not strictly a measure of probability.<br>Odds are normally compared across two groups as an odds ratio (OR). For example the OR of dying in smokers compared to non-smokers would be calculated by dividing the odds of death in smokers by the odds of death in non-smokers.<br>An odds ratio of 1 would show that the odds of the event is the same for both groups. An odds ratio greater than 1 means the odds of event are greater in the first group. An odds ratio less than 1 means that the odds of the event are less likely in the first group.<br>Sometimes odds can be compared across more than 2 groups – in this case, one of the groups is chosen as the 'reference category', and the odds ratio is calculated for each group compared with the reference category. For example, to compare the odds of dying from lung cancer for non-smokers, occasional smokers and regular smokers, non-smokers could be used as the reference category. Odds ratios would be worked out for occasional smokers compared with non-smokers and for regular smokers compared with non-smokers. See also ‘relative risk’ and ‘risk ratio’. |
| Open fracture | The skin may be pierced by the bone or by a blow that breaks the skin at the time of the fracture. The bone may or may not be visible in the wound. This term is synonymous with ‘compound fracture’. |
| Open pneumothorax | When there is a pneumothorax associated with a chest wall defect, such that the pneumothorax communicates with the exterior. Usually caused by gunshot or knife wounds to chest. |
| Open reduction and internal fixation (ORIF) | A method of surgically repairing a fractured bone. Generally, this involves either the use of plates and screws or an intramedullary (IM) rod to stabilize the bone. |
| Opiates | A class of drugs that includes heroin, morphine, and codeine. |
| Opportunity cost | The loss of other health care programmes displaced by investment in or introduction of another intervention. This may be best measured by the health benefits that could have been achieved had the money been spent on the next best alternative healthcare intervention. |
| Osteomyelitis | An acute or chronic inflammatory condition affecting bone and its medullary cavity, usually the result of bacterial (occasionally viral) infection of bone. |
| Ottawa ankle rules | Ottawa ankle rules are a set of guidelines for clinicians to help decide if a patient with foot or ankle pain should be offered X-rays to diagnose a possible bone fracture. |
| Outcome | Measure of the possible results that may stem from exposure to a preventive or therapeutic intervention. Outcome measures may be intermediate endpoints or they can be final endpoints. See ‘Intermediate outcome’. |
| P-value | The probability that an observed difference could have occurred by chance, assuming that there is in fact no underlying difference between the means of the observations. If the probability is less than 1 in 20, the P value is less than 0.05; a result with a P value of less than 0.05 is conventionally considered to |

| Term | Definition |
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| | be 'statistically significant'. |
| Paralysis | Injury or disease to a person's nervous system can affect the ability to move or feel. |
| Paraplegia | Loss of function and paralysis below the cervical area of the neck; generally, the upper body retains motor and sensory function. |
| Partial weight bearing | A small amount of weight may be supported by the limb. |
| Pelvic packing | Pelvic packing is an invasive surgical procedure, used to tamponade sources of pelvic bleeding. Absorbent packs are placed within the preperitoneal and retroperitoneal spaces and must be removed, usually within 48 hours. |
| Performance bias | Bias resulting from differences in the way different groups are treated, apart from the actual treatment under investigation. This may occur if those caring for participants are not blinded to group allocation. For example, participants in the 'favoured' group may be given better care. Performance bias also relates to participant beliefs about a treatment's efficacy. For example, if a participant knows he/she is in the intervention group then they may experience a placebo effect, which might not be felt by those in a non-treatment group. |
| Perioperative | The period from admission through surgery until discharge, encompassing the pre-operative and post-operative periods. |
| Permissive hypotension | The use of restrictive fluid therapy, specifically in the trauma patient, that increases systemic blood pressure without reaching normal blood pressures. |
| Picture Archiving and Communications Systems (PACS) | PACS enables X-ray and scan images to be stored electronically and viewed on screens. |
| Pilon | The distal end of the tibia – from the French for a stump, or a pestle. Fractures of the distal tibial metaphysic caused by axial load failure are called "pilon fractures". |
| Placebo | An inactive and physically identical medication or procedure used as a comparator in controlled clinical trials. |
| Plantar aspect | Relating to the sole of the foot. |
| Platelets | Blood cells whose function (along with coagulation factors) is to stop bleeding. |
| Pneumothorax | A collection of air or gas in the pleural cavity which can cause the lung(s) to collapse. |
| Polypharmacy | The use or prescription of multiple medications. Polypharmacy is often defined as taking 5 or 10 medications at the same time/ |
| Polytrauma | Patients with associated injury (i.e. two or more severe injuries in at least two areas of the body), or with a multiple injury (i.e. two or more severe injuries in one body area). Also known as multisystem trauma. |
| Positive predictive value (PPV) | In screening/diagnostic tests: A measure of the usefulness of a screening/diagnostic test. It is the proportion of those with a positive test result who have the disease, and can be interpreted as the probability that a positive test result is correct. |
| Postoperative | Pertaining to the period after patients leave the operating theatre, following surgery. |
| Post-test probability | For diagnostic tests. The proportion of patients with that particular test result who have the target disorder |
| Post-traumatic arthritis | Post-traumatic arthritis is caused by the wearing out of a joint that has had |

| Term | Definition |
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| | any kind of physical injury. Such injuries can damage the cartilage and/or the bone, changing the mechanics of the joint and making it wear out more quickly. |
| Power (statistical) | The ability to demonstrate an association when one exists. Power is related to sample size; the larger the sample size, the greater the power and the lower the risk that a possible association could be missed. |
| Preoperative | The period before surgery commences. |
| Pressure sore | Skin breakdown due to unrelieved pressure. |
| Pre-test probability | For diagnostic tests. The proportion of people with the target disorder in the population at risk at a specific time point or time interval. Prevalence may depend on how a disorder is diagnosed. |
| Primary amputation | A primary amputation is one that is carried out immediately on admission without any attempt to salvage the limb. |
| Primary care | Healthcare delivered to patients outside hospitals. Primary care covers a range of services provided by general practitioners, nurses, dentists, pharmacists, opticians and other healthcare professionals. |
| Primary outcome | The outcome of greatest importance, usually the one in a study that the power calculation is based on. |
| Product licence | An authorisation from the MHRA to market a medicinal product. |
| Prognosis | A probable course or outcome of a disease. Prognostic factors are patient or disease characteristics that influence the course. Good prognosis is associated with low rate of undesirable outcomes; poor prognosis is associated with a high rate of undesirable outcomes. |
| Prophylactic antibiotics | The prevention of infection complications using antimicrobial therapy (most commonly antibiotics). |
| Prospective study | A study in which people are entered into the research and then followed up over a period of time with future events recorded as they happen. This contrasts with studies that are retrospective. |
| Protected load bearing | Encouraged to use limb within load limit set by clinician. |
| Protected weight bearing | Patient encouraged to walk as normal, but with the use of a walking aid. |
| Prothrombin complex concentrate (PCC) | A combination of blood clotting factors II, VII, IX and X, as well as protein C and S, prepared from fresh-frozen human blood plasma used to reverse the effects of oral anticoagulation therapy in an actively bleeding patient. |
| Publication bias | Also known as reporting bias. A bias caused by only a subset of all the relevant data being available. The publication of research can depend on the nature and direction of the study results. Studies in which an intervention is not found to be effective are sometimes not published. Because of this, systematic reviews that fail to include unpublished studies may overestimate the true effect of an intervention. In addition, a published report might present a biased set of results (e.g. only outcomes or sub-groups where a statistically significant difference was found. |
| Quadriplegia | Scientifically known as tetraplegia; paralysis affecting all four limbs. |
| Quality of life | See 'Health-related quality of life'. |
| Quality-adjusted life year (QALY) | An index of survival that is adjusted to account for the patient's quality of life during this time. QALYs have the advantage of incorporating changes in both quantity (longevity/mortality) and quality (morbidity, psychological, functional, social and other factors) of life. Used to measure benefits in cost-utility analysis. The QALYs gained are the mean QALYs associated with one treatment minus the mean QALYs associated with an alternative treatment. |
| Randomisation | Allocation of participants in a research study to two or more alternative groups using a chance procedure, such as computer-generated random |

| Term | Definition |
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| | numbers. This approach is used in an attempt to ensure there is an even distribution of characteristics across groups, which should minimise selection bias. |
| Randomised controlled trial (RCT) | A comparative study in which participants are randomly allocated to intervention and control groups and followed up to examine differences in outcomes between the groups. |
| Rapid Sequence Induction of anaesthesia and intubation (RSI) | A medical procedure prompt involving a prompt administration of general anaesthesia and subsequent intubation of the trachea. The procedure results in rapid unconsciousness (induction) and neuromuscular blockade (paralysis) and is used to maintain a patient's airway following a traumatic incident. |
| RCT | See 'Randomised controlled trial'. |
| Receiver operated characteristic (ROC) curve | A graphical method of assessing the overall accuracy of a diagnostic test at several different thresholds of the index measure. Sensitivity is plotted against 1 minus specificity. A perfect test will have a vertical line that extends from the origin to the top left point of the graph, continuing as a horizontal line to the top right portion of the graph. A good test will be somewhere close to this ideal. |
| Reduction | The replacement or realignment of a body part in normal position or restoration of a bodily condition to normal. |
| Reference standard | The test that is considered to be the best available method to establish the presence or absence of the outcome – this may not be the one that is routinely used in practice. |
| Regional nerve block | A deliberate interruption of signals traveling along a nerve, often for the purpose of pain relief |
| Rehabilitation | Set of services intended to restore maximum function -- physical, psychological, vocational and social - to a person with a disability. |
| Relative risk (RR) | Risk and probability are synonymous. The risk of an event is the ratio of the number of events occurring (for example, the number of people dying) to the total number of events and non-events (for example, the total number of people dying and staying alive) in a group. Risks are distinct from odds (see odds ratio).<br>Risks are normally compared across two groups as a relative risk, which is also known as a risk ratio (RR). For example the RR of dying in smokers compared to non-smokers would be calculated by dividing the risk of death in smokers by the risk of death in non-smokers.<br>A RR of 1 would show that the risk of the event is the same for both groups. RR ratio greater than 1 means the risk of the event are greater in the first group. A RR less than 1 means that the risk of the event are less likely in the first group.<br>Sometimes risks can be compared across more than 2 groups – in this case, one of the groups is chosen as the 'reference category', and the RR is calculated for each group compared with the reference category. For example, to compare the risk of dying from lung cancer for non-smokers, occasional smokers and regular smokers, non-smokers could be used as the reference category. RRs would be worked out for occasional smokers compared with non-smokers and for regular smokers compared with non-smokers. See also 'odds ratio'. |
| Reporting bias | See publication bias. |
| Rescue board | A robust and light construction board for placing patients on following injury. Rescue boards are particularly useful for water rescues but can be also used on land. |

| Term | Definition |
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| Resource implication | The likely impact in terms of finance, workforce or other NHS resources. |
| Respiratory compromise | An impairment of normal pulmonary gas exchange. If this leads to an arterial PaO2 of <8Kpa this signals the onset of respiratory failure. Respiratory compromise could be due to respiratory depression (see 'respiratory depression') or other causes such as fluid in the lungs. |
| Respiratory depression | Respiratory depression: Occurs when ventilation is compromised below the level required for normal gas exchange. This is related to both rate (<10 breaths per minute) and depth of breathing. This can be induced by many causes such as excessive analgesia, head injury, intoxication or cervical spine injury. |
| Restricted weight bearing (active/passive range) | Restricted to range specific to a joint. |
| Retroperitoneal | The space between the peritoneum and the posterior abdominal wall that contains especially the kidneys and associated structures, the pancreas, and part of the aorta and inferior vena cava. |
| Retrospective study | A retrospective study deals with the present/ past and does not involve studying future events. This contrasts with studies that are prospective. |
| Revascularisation | The restoration of perfusion to a body part or organ that has suffered ischemia following surgical intervention. |
| Review question | In guideline development, this term refers to the questions about treatment and care that are formulated to guide the development of evidence-based recommendations. |
| Rigid non-removable cast | A non-removable off-bearing cast which is generally made from fibreglass or plaster of Plaster of Paris. |
| Scoop stretcher | The scoop stretcher is a device used specifically for casualty lifting. It is most frequently used to lift supine patients from the ground, either due to unconsciousness or in order to maintain stability in the case of trauma, especially spinal injury. |
| Secondary amputation | An amputation that is carried out after an attempted salvage of the limb. |
| Secondary outcome | An outcome used to evaluate additional effects of the intervention deemed a priori as being less important than the primary outcomes. |
| Selection bias | A systematic bias in selecting participants for study groups, so that the groups have differences in prognosis and/or therapeutic sensitivities at baseline. Randomisation (with concealed allocation) of patients protects against this bias. In non-randomised studies a multivariable analysis helps to partially adjust for selection bias. |
| Selective imaging | An imaging method following trauma in which scanning is limited to areas suspected of having injury. Imagining can be undertaken using ultrasound, CT or X-ray. |
| Selective immobilization | Immobilization following the use of a prediction soon. |
| Sensitivity | Sensitivity or recall rate is the proportion of true positives which are correctly identified as such. For example in diagnostic testing it is the proportion of true cases that the test detects.<br>See the related term 'Specificity' |
| Sensitivity analysis | A means of representing uncertainty in the results of economic evaluations. Uncertainty may arise from missing data, imprecise estimates or methodological controversy. Sensitivity analysis also allows for exploring the generalizability of results to other settings. The analysis is repeated using different assumptions to examine the effect on the results.<br>One-way simple sensitivity analysis (univariate analysis): each parameter is varied individually in order to isolate the consequences of each parameter on |

| Term | Definition |
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| | the results of the study.<br>Multi-way simple sensitivity analysis (scenario analysis): two or more parameters are varied at the same time and the overall effect on the results is evaluated.<br>Threshold sensitivity analysis: the critical value of parameters above or below which the conclusions of the study will change are identified.<br>Probabilistic sensitivity analysis: probability distributions are assigned to the uncertain parameters and are incorporated into evaluation models based on decision analytical techniques (For example, Monte Carlo simulation). |
| Significance (statistical) | A result is deemed statistically significant if the probability of the result occurring by chance is less than 1 in 20 ($p < 0.05$). |
| Skeletal maturity | Skeletal maturity is relevant to the consideration of fractures for many reasons. The term is used frequently in the guideline. The anatomy of immature bone is different from mature bone; most obviously in the presence of growth plates, but also in the different pattern of blood supply. Immature bones break in a way different to mature bone, consequent upon the presence of growth plates and the quality of the bone itself. Immature bone tend to heal more rapidly. The initial injury or its treatment may interfere with normal bone growth.<br><br>For the whole person the skeleton is mature once all growth plates are closed. For an individual injury skeletal maturity is when the growth plates in the bones under consideration have closed. Clinical judgement is required during the transition period from immaturity to maturity as to how the bone should be regarded for clinical management purposes. |
| Skeletal stabilisation | Stabilising an unstable limb, part of limb or pelvis by a method which involves attaching something to the bone.<br><br>This can be definitive or temporary. Definitive skeletal stabilisation (also referred to as definitive skeletal fixation) will be left in situ throughout the planned healing process, and therefore is durable and precisely applied. Temporary skeletal stabilisation is replaced by a definitive solution before the healing process is complete, and so can be done more quickly, may cross joints, and may not involve such precise reduction. |
| Softcast | A lightweight splint that is removal and can be applied for immobilisation. |
| Specificity | The proportion of true negatives that a correctly identified as such. For example in diagnostic testing the specificity is the proportion of non-cases incorrectly diagnosed as cases.<br>See related term ‘Sensitivity’.<br>In terms of literature searching a highly specific search is generally narrow and aimed at picking up the key papers in a field and avoiding a wide range of papers. |
| Spinal Cord Injury (SCI) | An injury to the spinal cord interferes with messages between the brain and the body and results in paralysis and sensory loss below the level of the injury. The location at which the cord is injured and the severity of the injury determines the physical limitations the person will have. |
| Spinal shock | Often occurring soon after spinal cord injury, this is a loss of reflexes below the level of injury with associated loss of sensorimotor functions. This condition can last for several hours to days after initial injury. |
| Stakeholder | Those with an interest in the use of the guideline. Stakeholders include manufacturers, sponsors, healthcare professionals, and patient and carer groups. |

| Term | Definition |
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| Subcutaneous | An injection in which a needle is inserted just under the skin. |
| Supraglottic device | Medical device that when applied facilitates unobstructed access of respiratory gases to the glottic opening by displacing tissue and sealing off the laryngeal area. |
| Surgical site infection (SSI) | Defined as being present when pathogenic organisms multiply (SSI) in a wound giving rise to local signs and symptoms, for example heat, redness, pain and swelling, and (in more serious cases) with systemic signs of fever or a raised white blood cell count. Infection in the surgical wound may prevent healing taking place so that the wound edges separate or it may cause an abscess to form in the deeper tissues.<br>The definitions of SSI may vary between research studies but are commonly based on those described by the Centers for Disease Control and Prevention (CDC) although other valid measures have been used, for example the ASEPSIS scoring method for postoperative wound infections and some studies that have focused only on the more serious deep and organ/space infections for which less subjective measures are available. Differences in case definitions should be taken into account when comparing reported rates of SSI. |
| Surgical wound classification | *Clean* – an incision in which no inflammation is encountered in a surgical procedure, without a break in sterile technique, and during which the respiratory, alimentary and genitourinary tracts are not entered.<br>*Clean-contaminated* – an incision through which the respiratory, alimentary or genitourinary tract is entered under controlled conditions but with no contamination encountered.<br>*Contaminated* – an incision undertaken during an operation in which there is a major break in sterile technique or gross spillage from the gastrointestinal tract, or an incision in which acute, non-purulent inflammation is encountered. Open traumatic wounds that are more than 12–24 hours old also fall into this category.<br>*Dirty or infected* – an incision undertaken during an operation in which the viscera are perforated or when acute inflammation with pus is encountered during the operation (for example, emergency surgery for faecal peritonitis), and for traumatic wounds where treatment is delayed, and there is faecal contamination or devitalised tissue present. |
| Systems model | A problem-oriented representation of a complex system where parts of the system and their interactions that are relevant to the decision problem are explicitly set out. |
| Systematic review | Research that summarises the evidence on a clearly formulated question according to a pre-defined protocol using systematic and explicit methods to identify, select and appraise relevant studies, and to extract, collate and report their findings. It may or may not use statistical meta-analysis. |
| Telemedicine | Delivery of health services via remote telecommunications. This includes interactive consultative and diagnostic services. |
| Tension band | A format for orthopaedic wiring of fracture fragments either alone or with a screw or Kirschner wire to force fragments together in compression. |
| Tension pneumothorax | A tension pneumothorax occurs when intrapleural air accumulates progressively in and leads to significant impairment of respiration and/or blood circulation. It is a life threatening occurrence requiring rapid recognition and treatment is required if cardiorespiratory arrest is to be avoided. |
| Test and treat studies | See 'diagnostic RCT'. |
| Thoracic | Portion of the spinal column in the chest, between the cervical and lumbar areas. |

| Term | Definition |
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| Thoracotomy | The construction of an artificial opening through the chest wall, usually for the drainage of fluid or the release of an abnormal accumulation of air. Used to treat pneumothorax. |
| Tiered team response | Tiered trauma systems aim to better match the personnel and resources of the trauma team to the immediacy of the patients need for care |
| Time horizon | The time span over which costs and health outcomes are considered in a decision analysis or economic evaluation. |
| Tracheal intubation | A medical procedure in which a tube is placed into the windpipe (trachea), through the mouth or the nose. In most emergency situations it is placed through the mouth. |
| Transverse fracture | This type of fracture has a horizontal fracture line. |
| The Trauma Audit & Research Network (TARN) | An independent monitor of trauma care in England and Wales that is committed to making a real difference to the delivery of the care of those who are injured. They promote improvements in care through national comparative clinical audit. |
| Trauma coordinator | Typically a nurse recruited into MTCs with experience of trauma care |
| Trauma Unit (TU) | A hospital that is part of the major trauma network providing care for all except the most severe major trauma patients. When it is not possible to get to the major trauma centre within 45 minutes, or where the patient needs to be stabilised quickly, the patient is taken to the nearest hospital with a local trauma unit for immediate treatment and stabilisation before being transferred on to the major trauma centre. |
| Traumatic Brain Injury | A non-degenerative, non-congenital insult to the brain from an external mechanical force, possibly leading to permanent or temporary impairment of cognitive, physical, and psychosocial functions, with an associated diminished or altered state of consciousness. |
| Treatment allocation | Assigning a participant to a particular arm of the trial. |
| Triage | Triage is the process by which people are classified according to the type and urgency of their symptoms/condition/situation. The aim is to get someone in need to the right place at the right time to see an appropriately skilled person/team. |
| Ultrasound | Diagnostic ultrasound, also called sonography or diagnostic medical sonography, is an imaging method that uses high-frequency sound waves to produce images of structures within your body. |
| Univariate | Analysis which separately explores each variable in a data set. |
| Unrestricted load bearing | Encouraged to use limb as normal. |
| Unrestricted mobility | Encouraged to use limb as normal. |
| Unrestricted weight bearing | Encouraged to walk as normal. |
| Unstable fracture | A fracture with a tendency to displace after reduction. |
| Utility | A measure of the strength of an individual's preference for a specific health state in relation to alternative health states. The utility scale assigns numerical values on a scale from 0 (death) to 1 (optimal or 'perfect' health). Health states can be considered worse than death and thus have a negative value. |
| Vacuum mattress | A vacuum mattress is a medical device used for the immobilisation of patients, especially in the case of vertebra, pelvis or limb trauma. The atmospheric pressure enables the mattress to become rigid securing the patient. |
| Vitamin K antagonist (VKA) | A group of substances that reduce blood clotting by reducing the action of vitamin K. |

| Term | Definition |
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| Whole-Body CT | A scanogram (vertex to toes) followed by a CT scan from vertex to mid-thigh. |
| Wound photographs | A digital photograph of the wound to kept along kept as documentation with the patients note. |
| X-ray | A radiograph made by projecting X-rays through organs or structures of the body onto a photographic film. Structures that are relatively radiopaque (allow few X-rays to pass through), such as bones and cavities filled with a radiopaque contrast medium, cast a shadow on the film. Also called X-ray film. |

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