In response to an enquiry from the National Planning Forum

What is the evidence for the clinical and cost effectiveness of major trauma centres as the core component of a trauma service, compared with standard care for adults with major trauma?

What is a scoping report?
Scoping reports ascertain the quantity and quality of the published clinical and cost-effectiveness evidence on health technologies under consideration by decision makers within NHSScotland. They also serve to clarify definitions related to the research question(s) on that topic. They are intended to provide an overview of the evidence base, including gaps and uncertainties, and inform decisions on the feasibility of producing an evidence review product on the topic. Scoping reports are undertaken in an approximately 1-month period. They are based upon a high-level literature search and selection of the best evidence that Healthcare Improvement Scotland could identify within the time available. The reports are subject to peer review. Scoping reports do not make recommendations for NHSScotland. Further information on scoping reports is available at www.healthcareimprovementscotland.org

Key definitions

Major trauma: any injury or multiple injuries with an Injury Severity Score (ISS) \( \geq 15 \), or that could result in permanent disability or death (examples include serious head injuries, serious injuries resulting from road accidents, severe gunshot wounds).

Major trauma centre (MTC): a multispecialty hospital optimised for the provision of trauma care that provides all the major specialist services relevant to the care of major trauma on a single site (equivalent to a Level I trauma centre in the United States of America (USA)).

Trauma system: an organised approach to the delivery of trauma care services within a defined geographical region, involving collaboration between all providers of care (including pre-hospital services, hospitals and rehabilitation services).

Background

Incidence and management of major trauma in Scotland

The Scottish Trauma Audit Group (STAG) recorded 5,045 patients admitted to hospital in 2011 as a result of trauma, of whom 761 were classified as major trauma (ISS \( \geq 16 \))\(^1\). These data include patients aged \( \geq 13 \) years (although fewer than 3% were under 20 years of age) admitted to 20 participating hospitals for at least 3 days or who died as a direct result of trauma (three or five eligible hospitals did not submit data (the exact number is unclear in the report))\(^1\). The proportion of trauma cases classified as major trauma was similar in urban (15%) and rural (18%) areas\(^1\).

Thirty hospitals across NHSScotland have accident and emergency (A&E) units that accept trauma patients delivered by the Scottish Ambulance Service (SAS)\(^2\). Patients are generally taken to the nearest hospital with an emergency department\(^2\). There is currently no formal infrastructure for major trauma care in Scotland. However, two regions have local protocols to determine when the SAS should bypass certain A&E units\(^2\). None of the 30 hospitals currently meet the requirements for a major trauma centre or a trauma unit as defined by the NHS (England) Clinical Advisory Group Report on regional networks for major trauma\(^2,3\).

The STAG 2011 audit of trauma care in Scotland showed that the majority of the major trauma patients, 89% (677/761), arrived by ambulance, 4% (30/761) by air, and the remaining 7% (53/761) were self-presentation\(^1\). The proportion of major trauma patients transferred from the initial receiving hospital to another STAG hospital or to a specialist regional centre was 37% (279/761), comprising 20% transferred directly from the emergency department and 17% after leaving the emergency department\(^1\).
Of the 761 major trauma patients admitted to the participating STAG hospitals, 634 survived (83%) (survival to discharge, or beyond, was not stated in the report)\(^1\). Data collection by STAG has been intermittent, having stopped in 2002: comparison between the 2011 data and the 1992–2002 datasets showed an increase in survival of major trauma patients from 75% to 83% (absolute difference=8%; 95% confidence interval (CI) 5% to 11%; p<0.05)\(^1\).

**Trauma system development in the UK**

The management of major trauma in England has undergone significant change with the commissioning of regional trauma systems\(^4\). The London trauma system, which was the first to be established, began operating in April 2010 and comprises four trauma networks\(^5\). Each network has an MTC linked with a number of local trauma units. The MTC provides care for the most seriously injured patients, with the trauma units caring for the less seriously injured\(^5\). Roll out of other regional trauma networks centred on designated MTCs across England began in April 2012\(^6\). Trauma systems have not yet been implemented in Scotland, Wales or Northern Ireland\(^4\).

The National Audit Office (NAO) (England) stated that the costs of major trauma are not fully understood, and there is no national tariff to underpin the commissioning of services\(^7\). It estimated that there were at least 20,000 major trauma cases (5,400 deaths) per year in England in 2007, and that major trauma costs the NHS (England) between £0.3 and £0.4 billion a year in immediate treatment. Further, the cost of subsequent hospital treatment, rehabilitation, home care support and informal care costs are not known. The NAO estimated the annual lost economic output as a result of major trauma at £3.3–3.7 billion\(^7\).

In its recent consideration for a national trauma service in Scotland, the Royal College of Surgeons of Edinburgh (RCSE) Trauma Working Group concluded that the benefits of regionalised trauma care could also be attained in Scotland, although the precise configuration of a trauma system for Scotland requires further research\(^8\).

**The following questions were scoped:**

1. **What evidence is there that adults with major trauma have better outcomes if**

2. **What is the evidence for the cost effectiveness of trauma centres, as the core component of a trauma service, compared with standard care for adults with major trauma?**

**Literature search**

A systematic search of the secondary literature was carried out between 20/02/2013 and 26/02/2013 to identify systematic reviews, health technology assessments (HTAs) and other evidence-based reports. In addition, Medline, Medline in process, Embase, Cinahl and Web of Science were searched for systematic reviews.

Key websites were searched for guidelines, policy documents, clinical summaries, and economic studies. Websites of organisations related to this topic, e.g. Scottish Audit Trauma Group, American College of Surgeons Committee on Trauma, were also searched.

Concepts used in all searches included: major trauma centre, level 1 trauma centre, trauma service, trauma system, and trauma care organisation. Results were limited to English language. No date limit was applied. A full list of resources searched and terms used are available on request.

An enquiry was circulated to all ListServ members of the International Network of Agencies for Health Technology Assessment (INAHTA), which has 53 member agencies in 29 countries worldwide, to identify relevant completed or ongoing assessments not identified by the literature search.

**Evidence base**

<table>
<thead>
<tr>
<th>Publication type</th>
<th>Number of publications</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systematic reviews</td>
<td>3</td>
<td>9-11</td>
</tr>
<tr>
<td>Meta-analysis</td>
<td>2</td>
<td>10,11</td>
</tr>
<tr>
<td>Other reviews(^1)</td>
<td>2</td>
<td>12,13</td>
</tr>
<tr>
<td>Reports</td>
<td>2</td>
<td>8,14</td>
</tr>
<tr>
<td>Cost-effectiveness analysis</td>
<td>3</td>
<td>15-17</td>
</tr>
</tbody>
</table>

\(^1\) Given the paucity of evidence from systematic reviews, these reviews, although not systematic reviews, describe how they were conducted and provide additional ‘best available’ information.
Communications through INAHTA failed to identify any completed or ongoing HTAs.

Findings

1. What evidence is there that adults with major trauma have better outcomes if cared for in a major trauma centre, as the core component of a trauma service, compared with standard care?

Mortality

The scoping search identified two published systematic reviews on the effects of trauma centres/systems on patient mortality, with one reporting a meta-analysis. Neither of the reviews were up to date (literature searched to 1998 and 2004, respectively).

A systematic review of studies published to May 1998 provided a narrative overview (in three separate articles) of the effects of trauma centres/systems on patient outcomes reported in population-based, panel review (expert consensus) and registry comparison studies conducted in the USA and Canada. The evidence base at that time was found to comprise weak evidence (Class III: quasi-experimental studies that use existing databases, registries or rely on case series data) and to rely on hospital deaths as the primary indicator of effectiveness. There was some evidence from panel studies that treatment at a trauma centre may be associated with fewer preventable deaths among the seriously injured compared with treatment at a non-trauma centre. Registry studies provided some evidence of a reduction in the risk of death comparing trauma system outcomes with norms from the Major Trauma Outcome Study (a retrospective descriptive study of injury severity and outcome coordinated through the American College of Surgeons). Population-based studies provided evidence of improved survival among seriously injured patients after a trauma system, or some component of a trauma system, was established.

A subsequent systematic review of population-based studies conducted in North America identified 14 published studies (1992–2004) of mortality among severely injured patients treated at a trauma centre following the establishment of a trauma system. Nine studies used a before-and-after design and five compared outcomes between trauma centre and non-trauma centre sites (variously within state, inter-state, inter-regional and across countries). All were considered as Class III evidence. Eight studies reported improved mortality, three reported worse mortality and three found no statistically significant difference. Six studies that reported sufficient data to calculate an effect size (odds ratio (OR)) were included in a meta-analysis: five were before-and-after studies and one compared trauma system with non-trauma system across states. The meta-analysis showed a borderline statistically significant reduction in mortality in favour of trauma systems (OR=0.881; 95% CI 0.778 to 0.998; p value not reported). The authors also reported a ‘quality-weighted’ pooled OR of 0.85 on which their conclusion of a 15% reduction in mortality in favour of the presence of a trauma system appears to be based (CIs were not reported). A number of methodological shortcomings warrant cautious interpretation of this meta-analysis.

A more recent systematic review of 36 observational studies (1986–2011) evaluated the effect of inter-hospital transfer on trauma patient outcomes, comparing direct transport to a trauma centre with secondary transfer from an outlying hospital. The studies included predominantly moderate to major trauma patients, overall representing a heterogenous set of study populations (three were restricted to paediatrics). The countries, in which the studies were conducted, were not explicitly reported (from their authors and/or titles, about two-thirds appear to have been conducted in North America, six in Europe and six elsewhere). Most were retrospective studies and all had a medium to high risk of bias. Meta-analysis of 34 studies showed no statistically significant difference in in-hospital/30-day mortality between direct transport and secondary transfer (OR=1.06; 95% CI 0.90 to 1.25; p=0.63), with substantial heterogeneity (I²=82%, indicating that 82% of the variation among studies was not due to chance). Subgroup analysis restricted to the eight studies conducted in rural settings also showed no significant difference. The authors advised caution in interpreting their meta-analysis results given the high level of heterogeneity across studies, which precluded drawing definitive conclusions on the impact of inter-hospital transfer on mortality after major trauma.
The Medical Care Research Unit (MCRU) at Sheffield conducted an unpublished rapid review in 2008 on reorganising trauma care as it was then being considered by some Primary Care Trusts in England. Due to time constraints, it was not carried out using methods that would be expected of a systematic review and is included here for information, given the paucity of relevant secondary evidence identified. It summarised evidence around the potential reconfiguration of trauma services so that patients meeting the criteria for specialist care would be identified as far as possible by the ambulance service and taken to an appropriate specialist hospital, bypassing non-specialist hospitals. It had a particular interest in the evidence for serious orthopaedic trauma but considered studies pertaining to all serious trauma. The review reported the reduction in mortality findings from the aforementioned systematic reviews in favour of treatment at a trauma centre following the establishment of a trauma system. It found ‘little evidence’ that direct transport to a designated trauma receiving hospital resulted in better mortality outcomes than transfer from the nearest casualty receiving hospital to a specialist centre, noting that more recent and better quality evidence suggested that outcomes were similar. This question was subsequently addressed in the aforementioned systematic review.

The RCSE Trauma Working Group report on trauma care in Scotland reported the meta-analysis findings of a reduction in mortality in favour of treatment at a trauma centre following the establishment of a trauma system. It also cited four other primary studies but did not report using systematic methods to review the literature.

**Morbidity and functional outcomes**

The scoping search did not identify any published secondary evidence on morbidity or functional outcomes in relation to major trauma centre care compared with usual care.

The systematic review of effects of inter-hospital transfer on trauma patient outcomes identified studies that reported on complications, of which two reported significantly more complications among secondary transfer patients compared with direct admissions.

The MCRU rapid review on trauma service reorganisation reported finding an ‘almost complete lack’ of studies reporting on morbidity outcomes.

A published review of current (2011) practice across international trauma registries found that, of the 18 registries identified, only one, the Victoria State Trauma Registry (VSTR) in Australia, routinely collected follow-up functional outcome data.

The RCSE Trauma Working Group report on trauma care in Scotland cited three primary studies reporting on functional outcomes but did not report using systematic methods to review the literature.

**Service impact outcomes**

The scoping search did not identify any published secondary evidence on service impact outcomes in relation to major trauma centre care compared with usual care.

The systematic review of effects of inter-hospital transfer on trauma patient outcomes identified 19 studies that reported on hospital length of stay, of which most did not adjust for potential confounders and overall the results were inconsistent.

The MCRU rapid review considered the effects of trauma service reorganisation on wider processes of care (such as on the emergency department, other services, staff training, other emergency and immediate care providers, and patient travel, transport and satisfaction) but cited sparse supporting evidence for its conclusions, such that the extent to which they were evidence-based was unclear.

The review of current (2011) practice across international trauma registries found that most collected data on length of stay but did not elucidate what were the other ‘large amounts of quality indicators’ collected.

**Volume–outcome relationship**

The scoping search did not identify any published secondary evidence on the effect of volume on outcomes in relation to major trauma centre care.

Despite a limited search, the MCRU rapid review found a ‘moderately large’ literature on the effect of volume on outcomes (mainly mortality) in serious trauma, but noted that studies rarely
distinguished the impact of volume from the impact of differences in services and facilities\textsuperscript{13}. It also noted that nearly all of the literature was from North America, which, the authors argued, was problematic for generalising to the UK because of the large differences in trauma volumes. Whether similar reductions in mortality could be achieved at the much lower serious trauma volumes seen in the UK was unknown\textsuperscript{13}.

The RCSE Trauma Working Group report\textsuperscript{8} cited the RCS of England interim guidance for commissioners of regional trauma systems that states there is a recognised volume–outcome relationship in major trauma care, and that an MTC should see at least 400 major trauma patients each year\textsuperscript{21}. Conversely, the NHS (England) Confederation report on implementing trauma systems\textsuperscript{14} asserted that despite evidence to the contrary in the USA, other USA studies and UK Trauma Audit and Research Network (TARN) data failed to demonstrate a significant correlation between high volume and outcomes\textsuperscript{22}. Neither of these reports reported using systematic methods to review the literature.

2. What is the evidence on the cost effectiveness of trauma centres, as the core component of a trauma service, compared with standard care for adults with major trauma?

Three published full economic evaluations were identified, two conducted in the USA\textsuperscript{15,16} and one in Canada\textsuperscript{17}.

A recent cost-effectiveness analysis was based on 5,043 adults from the National Study on the Costs and Outcomes of Trauma (NSCOT) in the USA, a prospective cohort study of severely injured adults (Abbreviated Injury Scale (AIS) score $\geq 3$) cared for in 69 hospitals (18 trauma centres, 51 non-trauma centres) in 14 states. It estimated the cost effectiveness of treatment at a Level 1 trauma centre compared with a non-trauma centre hospital\textsuperscript{15}. The model included costs for the index hospitalisation, all transport, subsequent inpatient care, outpatient and home care. Costs (2005) were derived from multiple sources, quality of life was measured using the SF-6D, and the analysis was undertaken from a societal perspective. The incremental cost per quality-adjusted life year (QALY) gained was US$36,961 (£23,585) (note: all reported costs converted to GBP using the exchange rate as 7 February 2013)\textsuperscript{15}.

An earlier cost-effectiveness analysis conducted in the USA, based on 2001–2003 data held in a Florida hospitals administrative database, estimated an incremental cost for treatment in a trauma centre compared with a non-trauma centre at US$34,887 (£22,159) per life saved (CIs not reported)\textsuperscript{16}. The study population of ‘true trauma patients’ was defined by International Classification of Diseases (ICD-9) codes and was not restricted to adults, and the majority of trauma centres were designated level II\textsuperscript{16}.

The Canadian study, based on 484 patients (ISS$\geq 12$) treated at a single tertiary hospital trauma centre (1994–1996), estimated the incremental cost per QALY for care at the trauma centre compared with a non-trauma centre at CAN$4,303 (£2,754)\textsuperscript{17}. The study was undertaken from a hospital perspective, relied on assumptions for survival benefit and cost of care compared with a non-specialised centre, and is considerably out of date.

Summary

The scoping search identified limited published secondary evidence in relation to major trauma centre care compared with usual care. The published systematic reviews on the effects of trauma centres/systems on patient mortality show the considerable potential for bias and marked heterogeneity among the studies reviewed, and are not up to date. Consequently, the meta-analysis results need to be interpreted with caution. The authors of the recent systematic review on the effect of inter-hospital transfer on trauma patient mortality could not draw definitive conclusions because of the heterogeneity and risk of bias among the primary studies.

There appears to be scant information in the secondary literature for morbidity, functional and service impact outcomes.

Most of the primary studies included in the existing systematic reviews, identified by the scoping search and/or cited in key reports, originate from the USA, and marked variation is evident in the trauma centres and systems, comparators and selected patient populations evaluated. Consequently, much of the published literature may not be generalisable to a UK healthcare setting.
The secondary sources identified did not report sufficient detail to allow exploration of the relevance of the evidence to the Scottish setting with respect to geographic demography, transport and access factors, or levels of technology (such as telehealth and diagnostics).

There is a lack of consensus on the impact of volume on outcome, and no systematic review was identified.

The scoping search did not identify relevant cost-effectiveness evidence generalisable to the UK.

**Further work for Healthcare Improvement Scotland**

Initial scoping suggested there is unlikely to be sufficient published secondary evidence on clinical and cost effectiveness to produce an evidence note on this topic. The available published secondary literature provided only partial information to answer the questions posed.

**Equality and diversity**

Healthcare Improvement Scotland is committed to equality and diversity in respect of the nine equality groups defined by age, disability, gender reassignment, marriage and civil partnership, pregnancy and maternity, race, religion, sex, and sexual orientation. As a scoping report summarises information and does not provide recommendations a full EQIA assessment is not deemed necessary.

The scoping report process has been assessed and no adverse impact across any of these groups is expected. The completed equality and diversity checklist is available on www.healthcareimprovementscotland.org

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Dr. Howard Champion, Professor of Surgery and Senior Advisor in Trauma, Uniformed Services University of the Health Sciences, USA, independent clinical expert

Declarations of interest were sought from the clinical advisors and all peer reviewers. All contributions from peer reviewers were considered by the group. However the peer reviewers had no role in authorship or editorial control and the views expressed are those of Healthcare Improvement Scotland.

Healthcare Improvement Scotland development team:

Heather McIntosh, Author/Health Services Researcher
Paul Herbert, Information Scientist
Emma Riches, Medical Writer
Doreen Pedlar, Project Co-ordinator
Marina Tudor, Team Support Administrator
Members of the SHTG evidence review committee

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References


