A systematic review and meta-analysis comparing outcome of severely injured patients treated in trauma centers following the establishment of trauma systems


CRD summary
This review assessed the effectiveness of trauma systems for the treatment of severely injured patients. A 15% reduction in mortality was found in favour of the establishment of trauma systems. However, concerns about the robustness of the analyses used in both the review and the original studies suggest that the findings should be interpreted with caution.

Authors' objectives
To assess if the establishment of a trauma system improves outcomes for severely injured patients undergoing treatment in trauma centres.

Searching
MEDLINE, PubMed and CINAHL were searched from 1966 to August 2004; the search terms were reported. The reference lists of retrieved articles were checked for further studies. The searches were limited to studies carried out in North America and reported in English. For inclusion in the meta-analysis, a study had to be published in a peer-reviewed journal.

Study selection
Study designs of evaluations included in the review
Any population-based concurrent comparative study (centre-, regional- or state-based) and before-and-after studies were eligible for inclusion. Studies using expert panels or national injury registries were excluded from the review. Only studies using a logistic regression analysis were eligible for inclusion in the meta-analysis.

Specific interventions included in the review
The intervention of interest was the establishment of a trauma system; trauma systems were not explicitly defined in the paper. Studies that included any of the following comparisons were eligible for inclusion: pre- versus post-intervention; concurrent trauma centre versus non-trauma hospital; or regional or state comparison of a trauma system versus a non-trauma system.

Participants included in the review
Studies of participants suffering from severe trauma were eligible for inclusion. The participants included in the review came from various different states within the USA and Canada. Only one study reported the age range of the participants (age over 65 years). However, one study excluded participants younger than 16 or older than 79 years, while another excluded hip fracture patients older than 60 years. Six studies included all trauma injuries, two included all injuries, and one included blunt trauma patients only. The remaining studies included one or more of the following specific types of injuries: motor vehicle crash injuries; head injury; penetrating trauma; spleen or liver injury; chest injury; pelvic fracture; femur or tibia fracture; burns; skull fracture; vascular injury; and spinal cord injury. Five studies excluded injuries below a defined injury severity score (ISS). This was usually a score of 15, but one study used a cut-off of 9 and another used 16. Eleven of the studies also excluded patients on an individual study basis.

Outcomes assessed in the review
Any study that assessed some measure of trauma system performance was eligible for inclusion. The studies included in the review reported either mortality or survival data.

How were decisions on the relevance of primary studies made?
The authors did not state how the papers were selected for the review, or how many reviewers performed the selection.
Assessment of study quality
The validity of the studies was assessed using the following criteria: study objectives defined; outcome measures defined; inclusion and exclusion criteria defined; all trauma patients included; baseline comparability of the study groups and participant injuries (both within 20%); any baseline differences accounted for in the analysis; and methods of analysis described. A maximum score of 5 points was awarded for each criterion. A total score of 8 to 23 was considered poor quality, 24 to 27 average quality, 28 to 30 good quality, and 31 to 40 excellent quality. The authors did not state how many reviewers performed the validity assessment.

Data extraction
The authors did not state how the data were extracted for the review, or how many reviewers performed the data extraction.

The participant inclusion/exclusion criteria, type of analysis used and any adjustments made to control for potential confounders were reported. Survival and mortality data were presented as percentages with p-values, odds ratios (OR) with 95% confidence intervals (CIs), or relative risk (RR) ratios with 95% CIs. However, only studies that had sufficient data to calculate an OR with 95% CIs were eligible for inclusion in the meta-analysis. The data were presented as either crude data or data adjusted for participant or setting characteristics.

Methods of synthesis
How were the studies combined?
The studies were combined in a narrative summary. Studies meeting the criteria for inclusion in the meta-analysis were combined by outcome using both a fixed-effect model and a random-effects model. Pooled ORs with 95% CIs were reported.

How were differences between studies investigated?
Differences were discussed in the narrative summary and evident from the data tables. In addition, statistical heterogeneity in the meta-analysis was assessed using the Q statistic. Differences in study quality were assessed graphically by plotting the quality assessment score against the individual crude ORs for each study. A quality-adjusted OR was also calculated for each study by multiplying the quality score and the OR. The sum of all of the quality-adjusted ORs was then divided by the sum of the quality scores for all of the studies, to determine the overall quality-adjusted OR.

Results of the review
Fourteen studies (n more than 507,899) including three state, two regional and three level one pre-test post-test studies, and one national, three state and two regional comparisons of different interventions (trauma systems versus non-trauma systems or centres), were included in the review. Six studies (number of patients unclear) including two state, one regional and two level one pre-test post-test studies, and one state comparison of different interventions, were included in the meta-analysis.

The authors did not report the individual quality scores for those studies not included in the meta-analysis. However, quality scores for the six studies included in the meta-analysis ranged from 18 (poor) to 33 (excellent). Overall, one study was rated as poor quality, two were average, two were good, and one was excellent. The graph of quality score versus OR suggested that the higher the study quality the more likely the studies were to approach the line of no effect (i.e. OR=1); the poorest quality study showed the greatest increase in survival rate.

Overall findings (14 studies).
Survival odds were in favour of trauma systems in eight of the fourteen included studies, as compared with normal hospital care. However, the odds of survival were worse for trauma system groups in three comparative studies. There were no significant differences between trauma systems and normal hospital care in the three remaining studies.

Meta-analysis (6 studies).
Two studies showed statistically significant survival ORs in favour of trauma systems, while a further also showed favourable survival ORs but the findings were non-significant. Overall, the pooled survival OR was 0.93 (95% CI: 0.87, 1.00) when using a fixed-effect model and 0.88 (95% CI: 0.78, 1.00) when using a random-effects model. Significant statistical heterogeneity was reported (Q=12.286, d.f.=5, p=0.031). The quality-adjusted OR was 0.85 in favour of greater survival with the use of trauma systems.

**Authors' conclusions**
A 15% reduction in mortality was found in favour of the establishment of trauma systems. However, an ongoing outcome analysis is required to ensure that measures effectively capture true outcome performance and so optimise patient care.

**CRD commentary**
This review was based on a clear research question, although the authors did not report details of the inclusion criteria for outcome measures and those for the intervention were not clearly described. The literature searches were limited to electronic databases and reference lists, and there were no specific attempts to locate unpublished data. Since only studies published in peer-reviewed journals were eligible for inclusion in the meta-analysis, the review findings may be open to publication bias. The authors also only included North American studies published in English, which seems reasonable given the topic focus, although this may restrict the generalisability of the findings. In terms of review methods, the authors provided very little detail on how studies were selected for inclusion in the review and how many authors were involved in the quality assessment and data extraction processes; this makes it difficult to comment on whether appropriate steps were taken to reduce the risk of bias and error. The authors did, however, discuss their findings in the context of study quality. The quality-adjusted plot of ORs suggest that the poorer the quality of the study the more likely it is to show a greater beneficial effect in favour of trauma systems.

The authors also considered the degree of homogeneity between studies and this limited the number of studies included in the meta-analysis. Despite these attempts, the meta-analysis showed evidence of statistically significant heterogeneity and the authors therefore carried out both random-effects and fixed-effect analyses. However, the level of heterogeneity detected in both analyses is of concern. The authors commented that the included studies often failed to account for potential confounding factors in their analyses, which may also have affected the robustness of the findings. Taking all these concerns into consideration, the authors' reported effect sizes should be interpreted with caution but their recommendations for further research appear reasonable.

**Implications of the review for practice and research**
Practice: The authors did not state that there should be a concerted effort to direct severely injured patients to trauma centres.

Research: The authors stated that the effectiveness of trauma centres and trauma systems should be continuously monitored as systems evolve over time. The outcome measures used should also evolve to ensure that they focus on achieving optimal patient care. Particular areas for investigation include process issues such as complication rates, delays in treatment and the treatment of co-morbidities. Future studies should also use functional return as a measure of the impact of severe injury and ensure that they account for physiological effects, using multivariate analysis to control for differences in patients and injuries.

**Bibliographic details**

**Indexing Status**
Subject indexing assigned by NLM
Record Status
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.