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Outcomes in Rural vs Urban Centre Treated Adult Trauma Patients: A Systematic Review

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Abstract

Introduction: With increased pressure on trauma systems, deciding whether to treat patients in rural or urban centres is crucial, yet outcomes are rarely compared. This systematic review aimed to assess outcomes in adult trauma patients treated in these settings.

Methodology: The study was conducted using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Cochrane Library, EMBASE, Medline (PubMed), and CINAHL were searched for relevant English-language articles from 2014 to November 2024. Paediatric and single centre studies were excluded. Two reviewers independently screened articles and provided quality analysis of the results.

Results: From 495 screened articles, 5 high-quality studies met inclusion criteria: two from Canada and one each from Australia, USA, and Norway. All studies assessed mortality and showed inpatient mortality rates had minimal variation between rural and urban centres. 60% of studies reviewed lengths of stay (LOS), which were 1-3 days longer in urban centres. 40% looked at ICU admission rates, which were 3–15% higher in urban centres. Intensive Care Unit (ICU) LOS was reviewed by only 20% of studies and shown to be 2.2 days more in urban centres.

Conclusions: This systematic review comparing trauma outcomes between rural and urban centres found no significant difference in inpatient mortality rates, likely resulting from appropriate transfer processes in these matured trauma systems. Longer LOS, ICU LOS and higher ICU admissions rates in urban centres may reflect the treatment of more severely injured patients.

Keywords: Trauma; Injury; Urban; Rural; Outcomes; Mortality; Morbidity; Systematic review

Introduction

A fundamental question for all healthcare professionals involved in the care of trauma patients, is whether or not to transfer them. This is often the case in rural centres with limited resources to care for patients if they are severely injured. Now while there is ample research on the outcomes of transferred vs non-transferred patients, there is a paucity of research on trauma patient outcomes related to treatment location; specifically rural vs urban centres [1]. Some research has suggested trauma centres with increased volume have better outcomes, in regards to survival, post severe injury [2,3]. This would thus lead to the impression that trauma patient mortality is lower in larger urban centres. However, not all such patients are presenting to, staying at,

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or being transferred to larger urban trauma centres, and rural hospital trauma outcomes warrant review and comparison.

Such outcome measurements and comparisons are often good glimpses into how well trauma systems function and how to improve them. This is crucial to assess given the increased pressure on trauma systems in the world as a result of aging populations and the evolution of transportation to facilitate transfers [4]. This is compounded by rising healthcare costs overall. Furthermore, trauma care is overall underfunded, despite the high socioeconomic impact and disease burden. The effect of such underfunding of trauma systems means they are underprepared for mass trauma incidents, provide worse outcomes, and are not ready for the challenges of the future [5,6]. Thus a review of outcomes between treatment locations for patients may provide greater insight into more appropriate resource allocation between rural and urban centres for trauma care.

The purpose of the systematic review was to examine and summarise the currently available comparisons made between outcomes in rural and urban centre treated trauma patients.

Methods

Search strategy

The study was guided and reported using the recommended reference framework of the 2020 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. No formally registered review protocol was used. The databases searched included Cochrane Library, EMBASE, Medline (PubMed), and the Cumulative Index to Nursing and Allied Health Literature "CINAHL" were searched up to 15th of November 2024. Search queries included synonyms, keywords, and MeSH terms for "treatment outcome", "postoperative outcomes", "mortality", "morbidity", "length of stay", "rural centres", "urban centres", "'trauma", and "injuries and wounds."

Study Identification and Screening:

Inclusion criteria for study selection were: English-language articles; studies published between November 2014 to November 2024 to ensure the currency of data and results; adult patients (≥16 years old), studies that included quantitative outcomes, studies that had data comparing both rural and urban patients treatment outcomes.

Exclusion criteria: Studies with animals or paediatric patients (<16 years old), single-centre studies; studies that were not peer-reviewed; studies focussing on only one specific type of trauma; studies that did not specify treatment location of patients; and studies with data from pre-2000.

Duplicated studies were first identified and reduced to one copy. Two reviewers (A.K. and Y.H.) independently screened the studies to reduce bias. This was done using the aforementioned inclusion and exclusion criteria, first based on titles, then abstracts, and finally on the full retrieved articles. Discrepancies and disagreements were resolved with consensus or by a third reviewer if required (R.N.).

Data Extraction:

A predetermined data extraction form was used to extract data from eligible articles, which were reviewed simultaneously and independently from two reviewers (A.K. and Y.H.). The following data were extracted for each study: title of the article, name of the first author, year of publication, country/region of study, language, study period, study design, age range, location of centres of treatment, outcomes, statistical analysis, and main findings. Outcomes for which data were sought included mortality, specifically inpatient mortality; length of hospital stay (LOS), Intensive Care Unit (ICU) admission rates, ICU LOS. Discussion through reviewers and team consensus resolved any disagreement. The authors of the included studies were not contacted for additional data. A meta-analysis of data was not conducted.

Quality Review:

Two independent reviewers (A.K. and Y.H.) performed the quality assessment of eligible full articles, along with an evaluation of the risk of bias, using a modified Newcastle-Ottawa Quality Assessment Scale for case-control studies and cohort studies as appropriate [7].

Results

The search of databases identified a total of 495 articles. 24 duplicate articles were removed. 471 articles were screened by title and 256 were deemed irrelevant. Abstracts screening for 215 articles were screened and 142 were excluded. Thus, 73 full articles were assessed for eligibility. After inclusion and exclusion criteria were applied, 5 articles were identified for inclusion in this review [8-12]. A full PRISMA flowchart of study selection can be seen in figure 1.

Of the included articles, two were from Canada (n=2) [9,11] and one each from Australia (n=1) [8], USA (n=1) [10], and Norway (n=1) [12]. All included studies were retrospective cohort studies (n=5) and all were in the English language (n=5), although one study was also written concurrently in French (n=1) [11].

All included studies assessed inpatient mortality (n=5) and showed inpatient mortality rates had minimal variation between rural and urban centres. 60% of studies reviewed LOS (n=3) [10-12] with a median stay of 1-3 days longer in urban centres. 40% looked at ICU admission rates (n=2) [10,11], which were on average 3-15% higher in urban centres. ICU LOS was reviewed by only 20% of studies (n=1) [10] which showed a median 2.2 days increased ICU LOS in urban centres.

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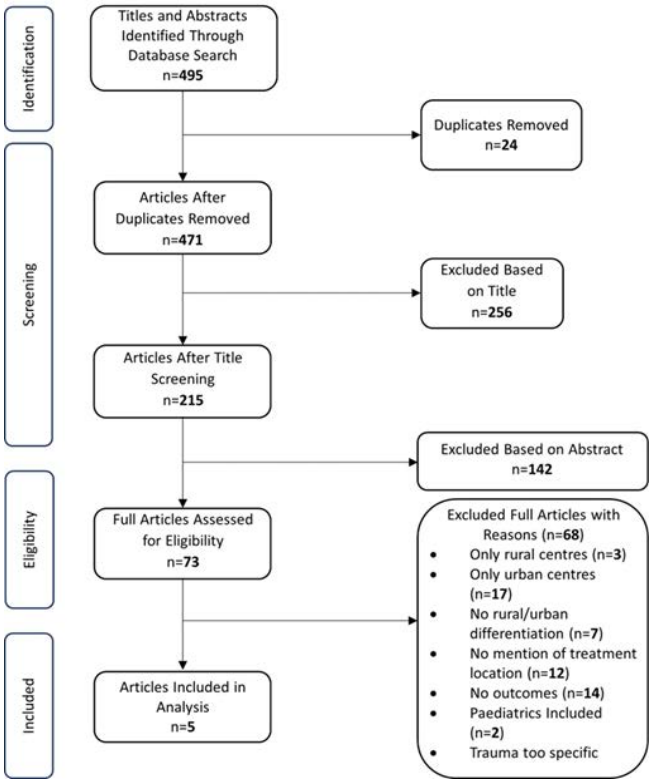

Figure 1: Flowchart of study identification and screening.

Quality assessment of the included studies showed all studies were of high quality (n=5) with 80% of the studies (n=4) having the top scale score of 9. This was primarily due to the studies being retrospective cohort studies of well-established databases. The one study with (n=1) [10] a score of 7 lost points in two areas. a) the exposed cohort of patients was not representative of the general trauma population as this particular study examined only patients aged ≥65; and b) there was no explicit confirmation that outcomes (mortality, LOS, etc) were not present at the start of the study. Quality assessment of articles can be seen summarised in table 1.

Discussion

This study aimed to summarise the currently available comparisons made between outcomes in rural and urban centre-treated trauma patients. While previous studies had assessed the effects of interhospital transfers and geographical location of injury, none has specifically assessed the outcomes based on the first treatment centre a patient is brought to [1,14]. While the former two would provide valuable insights on the appropriateness of transfers and the rates/severity of injuries in various geographical locations respectively, this study aimed to provide a closer snapshot of the current outcomes between treatment locations for patients. This in theory would provide greater insight into more appropriate resource allocation between rural and urban centres for trauma care, as well as providing confidence in the decision to keep patients in centres of treatment without transfer.

Modified Ottawa-Newcastle Scale Quality Assessment Scale: Cohort Studies

Domain	Criteria	Points	Scoring Details	Studies (By Author)				
				Dinh	Fleet	Maxwell	Moore	Ulleberg
Selection (Max 4)	Representativeness of the Exposed Cohort	1	1: Exposed cohort (rural patients) is truly/somewhat representative of the general trauma population. 0: Narrow or unrepresentative group.	1	1	0	1	1
	Selection of the Non-Exposed Cohort	1	1: Non-exposed cohort (urban patients) is from the same population as the exposed cohort. 0: Non-comparable or distinct population.	1	1	1	1	1
	Ascertainment of Exposure	1	1: Clearly defined rural vs. urban classification based on established criteria. 0: Poorly defined or ambiguous classification.	1	1	1	1	1
	Outcome Not Present at Start of Study	1	1: Explicit confirmation that no outcomes (e.g., mortality, ICU LOS) were present at baseline. 0: Unclear or no confirmation of outcome absence.	1	1	0	1	1
Comparability (Max 2)	Comparability of Cohorts (Design/Analysis)	2	2: Controlled for ≥2 confounders (e.g., age, injury severity, comorbidities). 1: Controlled for 1 confounder. 0: No confounder control.	2	2	2	2	2
Outcome (Max 3)	Assessment of Outcomes	1	1: Outcomes (e.g., mortality, LOS) clearly defined and consistently applied. 0: Ambiguous or subjective outcome measures.	1	1	1	1	1
	Length of Follow-Up Adequate for Outcomes	1	1: Sufficient follow-up to observe outcomes (e.g., hospital discharge, mortality during stay). 0: Inadequate or unspecified follow-up period.	1	1	1	1	1
	Adequacy of Follow-Up	1	1: Follow-up complete for ≥80% of participants or proper handling of lost-to-follow-up. 0: Incomplete or poorly documented follow-up.	1	1	1	1	1
Total Score				9	9	7	9	9
Scoring Guide								
Quality	Score Range							
High Quality	7–9							
Moderate Quality	5–6							
Low Quality	<5							

Table 1: Modified Ottawa-Newcastle Quality Assessment Scale.

Mortality

All included studies assessed inpatient mortality, finding minimal differences between rural and urban centres. These results challenge the often-held perception that urban centres, typically equipped with greater resources and specialised expertise, inherently yield better survival outcomes for trauma patients. Instead, they suggest that rural centres, despite their limitations, can deliver comparable care, particularly in terms of life-saving measures. This may be attributed to several factors, including the stabilisation protocols followed in rural settings, adherence to evidence-based guidelines, and the growing integration of telemedicine, or better retrieval and transfer networks [8].

However, these findings must be interpreted with caution. The studies did not account for the potential impact of pre-hospital care or the time taken for patients to reach either rural or urban centres, which are critical factors influencing mortality, particularly in neurotrauma and penetrating trauma [15]. Additionally, the relatively short duration of inpatient stays reported across studies raises questions about

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long-term survival and functional outcomes, which remain underexplored in these studies. The mechanism of trauma was not studied as a confounding factor either. Although less frequent than blunt trauma, penetrating trauma is associated with significantly higher prehospital and ED mortality, hence not accounting for this may skew results as urban patients experience higher rates of penetrating trauma compared to rural patients [16,17].

Length of Stay (LOS)

Three studies evaluated LOS, reporting a slightly longer median duration of 1-3 days in urban centres compared to rural centres. This difference could be attributed to several factors, including the availability of specialised services, the complexity of cases handled, and differences in discharge practices. Urban centres often cater to more complex trauma cases with studies showing higher median ISS, lower GCS scores when compared to their rural counterparts. Rural trauma patients are also more likely to die on scene meaning a hospital admission may not even take place [18,19]. Such complex, comorbid, or severely injured patients require multidisciplinary management, advanced imaging, and subspecialty consultations, potentially prolonging hospital stays. Conversely, rural centres may prioritize early transfer to higher-level care facilities or discharge to community-based care, reducing LOS.

It is known that while rural patients often have older ages and higher rates of injury and hospitalisation associated with it when compared to their urban counterparts, this cohort also has higher rates of transfer to larger trauma centres. This older injured demographic may take longer to be transferred back to rural centres, becoming “stuck” in urban centres and further lengthening LOS in such places [13,19]. On the other hand, rural centres might discharge patients earlier due to limited bed capacity or fewer support services for extended inpatient care. These variations underscore the need for standardisation of discharge criteria and follow-up care across settings to ensure equitable patient outcomes.

ICU Admission Rates and Length of Stay

ICU admission rates were higher in urban centres, ranging from 3% to 15% above those in rural settings. This finding aligns with the expectation that urban trauma centres, with their advanced facilities and staffing, are better equipped to manage critically injured patients. The higher ICU admission rates may also reflect the more severe nature of cases typically managed in urban centres or a lower threshold for ICU admission due to resource availability [18].

Interestingly, only one study examined ICU LOS, reporting a median increase of 2.2 days in urban centres. This may indicate more intensive or prolonged care for patients in urban settings, possibly due to the complexity of injuries or complications requiring advanced interventions. However, the limited data on ICU metrics restricts broader generalisations. Future research should explore ICU outcomes more comprehensively, including factors such as mechanical ventilation duration, complications, and resource utilisation, to better understand differences in care delivery and outcomes between rural and urban centres.

It should be noted that unplanned transfers to urban ICUs may help explain some of the results in this paper, as studies have found unplanned ICU admissions to be associated with increased rates of major abdominal surgery and need for mechanical ventilation, expectedly impacting overall hospital LOS [20].

Implications for Trauma System Design

The findings of this review have important implications for trauma system design and resource allocation. The comparable mortality outcomes between rural and urban centres suggest that rural facilities are capable of managing a significant proportion of trauma cases effectively. This highlights the importance of supporting rural centres with adequate resources, training, and infrastructure to maintain and improve care quality.

At the same time, the slightly longer LOS and higher ICU admission rates in urban centres underscore the critical role these facilities play in managing complex trauma cases. This reinforces the need for efficient triage and transfer protocols to ensure that patients requiring advanced care reach urban centres promptly, while those with less severe injuries can be managed locally. Strengthening communication and collaboration between rural and urban centres is essential to optimise patient outcomes and resource utilisation.

Limitations of the Review Process

This study suffered from several limitations in the overall systematic review process utilised.

- The review included only English-language studies, potentially excluding relevant articles published in other languages. This introduces a risk of language bias, which could skew the findings by omitting diverse perspectives or regional data.
- By excluding non-peer-reviewed studies, including grey literature, data from conference proceedings, government reports, or ongoing research may have been overlooked. These sources might provide unique insights, especially in underrepresented regions or contexts.
- The review was restricted to studies published between 2014 and 2024 and excluded data from before 2000. While this approach ensured contemporary relevance, it may have excluded historical trends or long-term comparisons that could provide a broader understanding of trauma outcomes.

- Another weakness of this paper was that all included papers were from nations considered developed. This reduces the generalisability of results to the developing world which often experience a difference in outcomes with younger trauma systems [21].
- Single-centre studies were excluded, which might have omitted valuable granular data specific to certain rural or urban centres. These studies often provide in-depth insights into localised practices and outcomes. It should be noted however, that due to the vast difference in trauma systems worldwide, comparison between single-centre studies would be fraught with confounding factors affecting results.
- The review focused exclusively on adult patients (≥16 years old), thereby excluding paediatric trauma patients, primarily due to the unique characteristics of this population. This limits the generalisability of the findings, as paediatric trauma care often differs significantly from adult care due to anatomical, physiological, and developmental differences.
- All included studies were retrospective cohort studies, which are inherently susceptible to selection bias and confounding. However, it must be noted that running a Randomised Control Trial to better assess outcomes would have severe ethical implications and is likely impractical.
- The review did not conduct a meta-analysis of the data. While this approach preserved the integrity of individual studies, it also limited the ability to provide a quantitative synthesis of findings and stronger statistical conclusions. This could be considered as an option in future review of this work by the authors.
- Despite efforts to reduce bias through dual independent reviews, implicit biases of the reviewers may have influenced study selection, data extraction, or quality assessment. The consensus process for resolving discrepancies could also have influenced study inclusion decisions.
- The review exclusively examined quantitative outcomes and did not include qualitative studies. This may have excluded insights into other important outcomes that include patient experiences, healthcare provider perspectives, or system-level challenges in rural and urban trauma care.

Gaps and Future Research Directions

This review highlights several areas for future research to address existing gaps and enhance the understanding of trauma outcomes in rural and urban settings:

- Studies should examine long-term survival, functional recovery, and quality of life in trauma patients to provide a more comprehensive assessment of care effectiveness in different settings.
- A Norwegian study looking at assessing the associations between prehospital time and urban-remote disparities in the functional outcomes of trauma found every minute of increased total pre-hospital time was linked to an increased likelihood of moderate disability in children and adults [22]. Research is needed to explore the impact of pre-hospital care, including transport times, emergency medical services availability, and initial stabilisation, between rural and urban trauma outcomes
- Expanding the scope of research to include paediatric patients and specific trauma types (e.g., traumatic brain injuries, burns) will provide a more nuanced understanding of care needs and outcomes.
- Evaluating the cost-effectiveness of trauma care in rural versus urban centres will help inform resource allocation and policy decisions. Research could also further explore the impact of resource distribution and funding disparities on trauma care quality and outcomes, particularly in underfunded rural settings.
- Developing standardised definitions of rural and urban settings, as well as consistent outcome measures, will improve the comparability and reliability of future studies.

Conclusion

This systematic review provides an important overview of trauma outcomes in rural and urban centres, highlighting both similarities and differences in care delivery and outcomes. The findings underscore the need for continued investment in rural trauma care infrastructure and resources while maintaining the advanced capabilities of urban centres. By addressing the limitations of current evidence and focusing on areas for future research, healthcare systems can better meet the challenges of trauma care in diverse settings, ultimately improving outcomes for all patients.

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Conflict of interest

All authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as potential conflicts of interest.

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