The Effect of Interhospital Transfer Time on Mortality in Severe Trauma Patients

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ABSTRACT

Trauma is a time-sensitive condition, with improved outcomes traditionally believed to occur when definitive care is deliveredpatients receive definitive care within the first 60 minutes, known as the "golden hour." In Thailand, many severely injured patients initially receive treatment at rural hospitals before being transferred to trauma centers. This study aimed to assess how interhospital transfer time affects mortality rates among patients with severe trauma.

METHODS

We conducted a retrospective cohort study using records from the Khon Kaen Trauma Center, Thailand, from January 2022 to December 2022. Severe trauma patients (Injury Severity Score [ISS] > 15) who were transferred from rural hospitals were identified. Transfer time from rural hospital to trauma center was the main exposure. The primary outcome was overall and 24-hour mortality.

RESULTS

Among 776 severe trauma patients, those in the delayed transfer group had significantly lower overall mortality (12.92% vs. 22.61%, p = 0.002) and 24-hour mortality (5.26% vs. 10.73%, p = 0.012) than patients in the optimal transfer group. Delayed transfer was associated with higher Revised Trauma Score (RTS) and greater distance from the trauma center. In multivariable analysis, lower Trauma and Injury Severity Score (TRISS) and road traffic injury were independently associated with increased 24-hour mortality. Longer transfer time was associated with decreased 24-hour mortality, although this association was borderline significant (adjusted risk ratio [RR] 0.89; 95% confidence interval [CI], 0.79–1.00; p = 0.052).

CONCLUSION

Delayed transfer time was associated with lower mortality, suggesting that greater physiological patient stability and prolonged initial care at rural hospitals may reduce immediate mortality risk. These findings indicate that not all trauma patients benefit equally from rapid transfer and highlight the importance of assessing patient stability and transfer timing to optimize outcomes.

KEYWORDS

interfacility transfer, multiple trauma, mortality

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บทคัดย่อ

การบาดเจ็บทางศัลยศาสตร์อุบัติเหตุเป็นภาวะที่ต้องได้รับการดูแลอย่างเร่งด่วน โดยมีแนวคิดที่ยอมรับกันมานานว่าผลลัพธ์จะดีขึ้นหากได้รับการรักษาที่สมบูรณ์ภายใน 60 นาทีแรก ซึ่งเรียกว่า “Golden hour” ในประเทศไทย ผู้ป่วยบาดเจ็บรุนแรงจำนวนมากได้รับการรักษาเบื้องต้นที่โรงพยาบาลชุมชนก่อนถูกส่งต่อไปยังศูนย์ศัลยกรรมอุบัติเหตุ งานวิจัยนี้มีวัตถุประสงค์เพื่อประเมินผลของระยะเวลาในการส่งต่อระหว่างโรงพยาบาลต่ออัตราการเสียชีวิตในผู้ป่วยบาดเจ็บรุนแรง

วิธีการศึกษา

การศึกษานี้เป็นการศึกษาแบบ retrospective cohort study โดยใช้ข้อมูลจากศูนย์บาดเจ็บจังหวัดขอนแก่น ระหว่างเดือนมกราคมถึงธันวาคม พ.ศ. 2565 เก็บข้อมูลในผู้ป่วยบาดเจ็บรุนแรง (Injury Severity Score [ISS] > 15) ที่ถูกส่งต่อจากโรงพยาบาลชุมชน ระยะเวลาในการส่งต่อจากโรงพยาบาลชนบทถึงศูนย์ศัลยกรรมอุบัติเหตุเป็นตัวแปรหลัก ผลลัพธ์หลักคืออัตราการเสียชีวิตโดยรวมและภายใน 24 ชั่วโมง

ผลการศึกษา

จากผู้ป่วยบาดเจ็บรุนแรงจำนวน 776 ราย พบว่ากลุ่มที่มีการส่งต่อล่าช้ามีอัตราการเสียชีวิตโดยรวมต่ำกว่าอย่างมีนัยสำคัญ (12.92% เทียบกับ 22.61%, p = 0.002) และอัตราการเสียชีวิตภายใน 24 ชั่วโมงต่ำกว่า (5.26% เทียบกับ 10.73%, p = 0.012) เมื่อเทียบกับกลุ่มที่ส่งต่อในเวลาที่เหมาะสม การส่งต่อล่าช้ามีความสัมพันธ์กับคะแนน Revised Trauma Score (RTS) ที่สูงกว่าและระยะทางการส่งต่อที่มากกว่า ในการวิเคราะห์พหุปัจจัย พบว่าคะแนน Trauma and Injury Severity Score (TRISS) ที่ต่ำและการบาดเจ็บจากอุบัติเหตุทางถนนมีความสัมพันธ์อย่างอิสระกับการเสียชีวิตภายใน 24 ชั่วโมง ระยะเวลาส่งต่อที่นานขึ้นมีความสัมพันธ์กับการเสียชีวิตภายใน 24 ชั่วโมงที่ลดลง แม้ว่าความสัมพันธ์นี้จะมีนัยสำคัญเพียงเล็กน้อย (adjusted risk ratio [RR] 0.89; 95% confidence interval [CI], 0.79–1.00; p = 0.052)

สรุปผล

การส่งต่อล่าช้ามีความสัมพันธ์กับอัตราการเสียชีวิตที่ต่ำกว่า ซึ่งอาจสะท้อนถึงความมั่นคงทางสรีรวิทยาของผู้ป่วยและการดูแลเบื้องต้นที่ยาวนานขึ้นในโรงพยาบาลชุมชนที่ช่วยลดความเสี่ยงการเสียชีวิตทันที ผลการศึกษานี้ชี้ให้เห็นว่าผู้ป่วยบาดเจ็บไม่ได้รับประโยชน์จากการส่งต่ออย่างรวดเร็วเท่าเทียมกัน และเน้นความสำคัญของการประเมินอาการของผู้ป่วยและการตัดสินใจในระยะเวลาส่งต่อเพื่อให้ได้ผลลัพธ์ที่ดีที่สุด

คำสำคัญ

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BACKGROUND

Road traffic injury is the eighth leading cause of death worldwide across all age groups and is the leading cause of death among children and young adults aged 5–29 years.(1) The global burden remains unacceptably high, with approximately 1.35 million deaths from road traffic injuries each year.(1)

Total prehospital time has been reported to be independently associated with increased all-cause in-hospital mortality among trauma patients.(2) The concept of the “golden hour” emerged from the belief that trauma patients have better outcomes if definitive care is provided within 60 minutes of injury. However, there is limited scientific evidence to support this concept (3).

Several studies have focused on specific trauma subgroups. In Canada, rapid transport of patients with traumatic acute subdural hematomas has been associated with decreased mortality (4).

Similarly, another study reported that severe morbidity and mortality were three times higher in patients who underwent surgery more than 4 hours after injury (5).

In Thailand, many trauma patients receive initial resuscitation and stabilization at rural hospitals before being transferred to trauma centers. However, there are few studies examining the association between interhospital transfer time from rural hospitals to trauma centers and mortality among patients with severe trauma in Thailand.

Evidence from other settings has been mixed. A study from Pakistan found no significant association between in-hospital mortality and transfer delays longer than 1 hour.(6) A systematic review of prehospital transfer strategies concluded that current evidence does not definitively clarify the effect of direct transport to a trauma center compared with initial transport to a non–trauma center hospital for stabilization first.(7)

In 2021, registry data from Khon Kaen Hospital indicated that the average transfer time from rural hospitals to Khon Kaen Hospital was approximately 4 hours. Building on findings from Virginia, which suggested that morbidity was three times greater in patients undergoing surgery after 4 hours from onset of injury (5). We aimed to investigate whether transfer times longer than 4 hours are associated with mortality in severe trauma patients. We therefore conducted a study to determine the effect of interhospital transfer time on mortality in severe trauma patients, defining delayed transfer time as more than 4 hours from arrival at the primary hospital to arrival at Khon Kaen Hospital.

METHODS

Study design

We conducted a retrospective cohort study by reviewing medical records and trauma registry data from Khon Kaen Hospital and the Khon Kaen Trauma Center, Thailand, between January 2022 and December 2022. We used recorded data to identify transfer times from rural hospitals to the trauma center and to determine mortality as the primary outcome. The study was approved by the institutional ethics committee.

Study patients

We included medical records of severe trauma patients, defined as those with an ISS greater than 15, calculated at the time of arrival at Khon Kaen Hospital. Only patients referred from rural hospitals in Khon Kaen province were eligible. We excluded patients whose records lacked transfer time data from the rural hospital to Khon Kaen Hospital, as well as patients referred from districts outside Khon Kaen province or from other provinces.

Exposure

The exposure of interest was interhospital transfer time, defined as the time interval from patient arrival at a rural hospital to arrival at Khon Kaen Hospital. A delayed transfer time was defined as a transfer duration more than 4 hours. Patients were categorized into two groups: delayed transfer (> 4 hours) and optimal transfer (≤ 4 hours).

Outcomes

The primary outcome was mortality, including overall in-hospital mortality and 24-hour mortality after arrival at the trauma center. Mortality was identified by reviewing medical records and, when necessary, cross-checking with the Civil Registration database.

Secondary outcomes included admission to the intensive care unit (ICU), length of ICU stay (days), length of hospital stay (days), and use of mechanical ventilation.

Data collection

We collected patient characteristics and clinical data, including age and sex, Abbreviated Injury Scale (AIS) and ISS, RTS, TRISS, mechanism of injury, circumstance of injury, vital signs on arrival, Glasgow Coma Scale (GCS) and GCS motor (M) score, incident location distance from the trauma center (km), predicted transfer time from incident location to trauma center (vehicle transfer time calculated using Google Maps)(9), actual interhospital transfer time, operative interventions performed (10). Data were extracted from medical records and the trauma registry using a standardized data collection form.

Statistical analysis

We compared baseline characteristics between the delayed transfer and optimal transfer groups. Categorical variables were summarized as frequencies and percentages and compared using Fisher's exact test. Normally distributed continuous variables were described as mean ± standard deviation (SD) and compared using the independent t-test.

Non-normally distributed continuous variables were presented as median and interquartile range (IQR) and compared using the Mann–Whitney U test.

A p-value < 0.05 was considered statistically significant. Statistical uncertainty was expressed using two-sided 95% confidence intervals (CIs). All analyses were performed using STATA, version 16 (StataCorp. 2019. Stata Statistical Software: Release 16. College Station, TX: StataCorp LLC).

We also used univariable and multivariable risk ratios (RRs) to compare outcomes and identify prognostic factors associated with delayed transfer time and with 24-hour mortality.

RESULTS

From January 2022 to December 2022, a total of 8,474 patients were admitted to the trauma units (trauma ward and trauma ICU) of Khon Kaen Hospital. Of these, 7,281 patients were excluded because they had an ISS ≤ 15, 352 patients were not referred from rural hospitals, and 65 patients were referred from outside Khon Kaen province.

A total of, 776 patients met the inclusion criteria. Among these, 209 patients (26.9%) were categorized into the delayed transfer group (transfer time > 4 hours) and 522 patients (67.3%) into the optimal transfer group (transfer time ≤ 4 hours). The median time to arrival was 5.9 hours for the delayed group and 2.43 hours for the optimal group ($p < 0.001$).

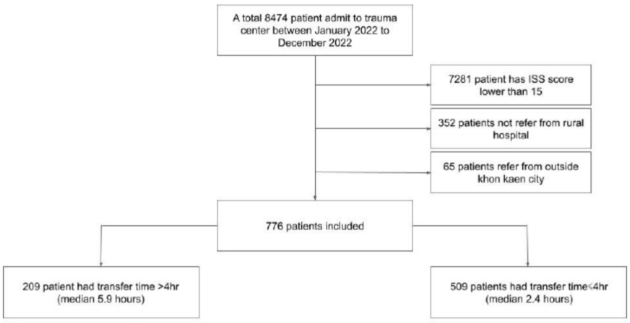

Figure 1. The study patients flow chart.

There were no significant differences between the groups in terms of age, sex, or initial vital signs. The mean age was 43.23 ± 20.95 years in the delayed group and 44.38 ± 19.35 years in the optimal group (p = 0.468). Male patients accounted for 72.25% of the delayed group and 76.44% of the optimal group (p = 0.479). Pulse rate (94.55 ± 22.02 vs. 94.88 ± 26.27 beats/min, p = 0.873), systolic blood pressure (132.90 ± 27.80 vs. 129.83 ± 33.29 mmHg, p = 0.243), and diastolic blood pressure (82.18 ± 17.80 vs. 80.33 ± 21.94 mmHg, p = 0.282) were similar between groups. The proportion of patients undergoing operative intervention did not differ significantly (37.50% vs. 43.76%, p = 0.130).

The mechanism of injury was predominantly blunt trauma in both groups (98.05% vs. 97.06%, p = 0.324). However, road traffic injury as the circumstance of injury was more frequent in the optimal transfer group (72.55% vs. 65.07%, p = 0.029). Regarding severity scores, the mean ISS was slightly lower in the delayed transfer group, with borderline significance (20.11 ± 5.11 vs. 20.92 ± 5.02, p = 0.050). The delayed transfer group had significantly higher TRISS (0.89 ± 0.19 vs. 0.79 ± 0.27, p < 0.001) and higher RTS (6.92 ± 1.56 vs. 6.05 ± 1.96, p < 0.001), indicating better physiological status and higher predicted probability of survival.

Neurological status also differed significantly between groups. The mean GCS was higher in the delayed group (12.67 ± 3.85 vs. 10.74 ± 4.58, p < 0.001), as was the GCS motor score (5.41 ± 1.30 vs. 4.91 ± 1.66, p < 0.001).

Patients in the delayed transfer group were located farther from the trauma center, with a greater mean distance from the trauma center (63.47 ± 28.44 km vs. 53.16 ± 24.84 km, p < 0.001) and longer predicted vehicle transfer time (66.76 ± 23.27 vs. 59.28 ± 19.90 minutes, p < 0.001). All finding are summarized in Table 1.

Table 1
Characteristics of patients

Characteristic	Delayed transfer n=209	Optimal transfer n=522	p-Value
Age, years (mean±SD)	43.23 ± 20.95	44.38 ± 19.35	0.468
Male sex, n (%)	72.25	76.44	0.479
ISS (mean±SD)	20.11 ± 5.11	20.92 ± 5.02	0.050
TRISS (mean±SD)	0.89 ± 0.19	0.79 ± 0.27	<0.001
RTS (mean±SD)	6.92 ± 1.56	6.05 ± 1.96	<0.001
Blunt mechanism, n (%)	98.05	97.06	0.324
Road traffic injury, n (%)	65.07	72.55	0.029
Vital signs			
Pulse rate, bpm (mean±SD)	94.55 ± 22.02	94.88 ± 26.27	0.873
SBP, mmHg (mean±SD)	132.90 ± 27.80	129.83 ± 33.29	0.243
DBP, mmHg (mean±SD)	82.18 ± 17.80	80.33 ± 21.94	0.282
GCS (mean±SD)	12.67 ± 3.85	10.74 ± 4.58	<0.001
Best motor response (mean±SD)	5.41± 1.30	4.91 ± 1.66	<0.001
Distance from TC, km (mean±SD)	63.47 ± 28.44	53.s16 ± 24.84	<0.001
Predicted vehicle transfer time, min (mean±SD)	66.76 ± 23.27	59.28 ± 19.90	<0.001
Time to arrival, hours [median, IQR]	5.9 [4.7, 9.05]	2.4 [1.8, 3.1]	<0.001
Operative intervention, n (%)	37.5%	43.76%	0.130

SD = standard deviation; ISS = injury severity score; TRISS = trauma injury severity score; RTS = revised trauma score; bpm = beats per minute; SBP = systolic blood pressure; DBP = diastolic blood pressure; GCS = Glasgow coma scale; TC = trauma center; km = kilometers, min = minute; IQR = interquartile range

The delayed transfer group had significantly lower overall in-hospital mortality compared with the optimal transfer group (12.92% vs. 22.61%, p = 0.002). Similarly, 24-hour mortality was lower in the delayed group (5.26% vs. 10.73%, p = 0.012). Secondary outcomes also differed between the groups. ICU admission was less frequent in the delayed transfer group (24.50% vs. 42.99%, p < 0.001), and the use of mechanical ventilation was lower (43.0% vs. 61.1%, p < 0.001). There were no statistically significant differences in the length of ICU stay (median 5 days [IQR 2–10.5] vs. 5 days [IQR 3–11], p = 0.358) or in the length of hospital stay (median 5 days [IQR 3–11] vs. 6 days [IQR 3–13], p = 0.336) between the delayed and optimal transfer groups. All finding are summarized in Table 2.

Table 2
Outcomes of the treatment

Outcomes of patient	Delayed transfer	Optimal transfer	p-value
Primary outcome, %			
Overall	12.92	22.61	0.002
24-hour	5.26	10.73	0.012
Secondary outcome, %			
ICU admission	24.50	42.99	<0.001
ICULOS, days [median, IQR]	5 [2, 10.5]	5 [3, 11]	0.358
LOS, days [median, IQR]	5 [3, 11]	6 [3, 13]	0.336
Mechanical ventilation used, %	43	61.1	<0.001

ICU = intensive care unit; ICULOS = ICU length of stay; IQR = interquartile range; LOS = length of stay

In crude analysis, higher RTS, higher TRISS, higher GCS and GCS motor scores, road traffic injury, and greater distance from the trauma center were associated with delayed transfer time (> 4 hours). In multivariable analysis, only RTS and distance from the trauma center remained significantly associated with delayed transfer. Higher RTS was associated with an increased likelihood of delayed transfer (adjusted RR 1.53; 95% CI, 1.09–2.15; p = 0.013). Greater distance from the trauma center also remained a significant predictor of delayed transfer (adjusted RR 1.01; 95% CI, 1.00–1.01; p = 1.016, as reported).

TRISS, road traffic injury, GCS, and GCS motor score were significant in crude analyses but lost significance after adjustment. Overall, the strongest predictors of delayed transfer were better physiological status (higher RTS) and increased distance from the trauma center. All finding are summarized in Table 3.

Table 3
Multivariable analysis of factors associated with Delayed transfer time

Risk factors	uRR	upper 95% CI	lower 95% CI	p-value	mRR	upper 95% CI	lower 95% CI	p-value
ISS	0.98	0.95	1.00	0.078	-			
TRISS	4.04	2.03	8.03	<0.001	0.97	0.27	3.41	0.966
RTS	1.23	1.14	1.34	<0.001	1.53	1.09	2.15	0.013
Road traffic injury	1.28	1.01	1.62	0.042	1.23	0.97	1.57	0.085
GCS	1.08	1.05	1.12	<0.001	0.96	0.84	1.10	0.626
Best motor response	1.20	1.08	1.34	0.001	0.84	0.65	1.09	0.197
Distance from TC	1.01	1.01	1.01	<0.001	1.01	1.00	1.01	0.999

uRR = univariable risk ratio; CI = confidence interval; mRR = multivariable risk ratio; ISS = injury severity score; TRISS = trauma injury severity score; RTS = revised trauma score; GCS = Glasgow coma scale; TC = trauma center

In the multivariable analysis of factors associated with 24-hour mortality, lower TRISS scores were significantly associated with higher 24-hour mortality in both crude (RR 0.02; 95% CI, 0.01–0.03; p < 0.001) and adjusted analyses (adjusted RR 0.22; 95% CI, 0.07–0.61; p = 0.004). Road traffic injury was also independently associated with higher 24-hour mortality (crude RR 1.75; 95% CI, 1.11–2.75; p = 0.015; adjusted RR 1.83; 95% CI, 1.22–2.74; p = 0.003).

Lower RTS, lower GCS, and lower GCS motor scores were significantly associated with 24-hour mortality in crude analyses, but these associations were not significant after adjustment. Longer transfer time was associated with decreased 24-hour mortality in crude analysis (RR 0.78; 95% CI, 0.67–0.90; p = 0.001). In the adjusted model, this association remained borderline significant (adjusted RR 0.89; 95% CI, 0.79–1.00; p = 0.052). All finding are summarized in Table 4.

Table 4
Multivariable analysis of factors associated with 24 hour mortality

Risk factors	uRR	upper 95% CI	lower 95% CI	p-value	mRR	upper 95% CI	lower 95% CI	p-value
ISS	1.01	0.98	1.06	0.416	-			
TRISS	0.02	0.01	0.03	<0.001	0.22	0.07	0.61	0.004
RTS	0.54	0.49	0.59	<0.001	1.00	0.80	1.26	0.950
Road traffic injury	1.75	1.11	2.75	0.015	1.83	1.22	2.74	0.003
GCS	0.68	0.61	0.76	<0.001	0.89	0.71	1.12	0.339
Best motor response	0.48	0.43	0.54	<0.001	0.73	0.52	1.03	0.080
Distance from TC	1.00	0.99	1.01	0.805	-			
predicted vehicle transfer time	1.00	0.99	1.01	0.675	-			
Time to arrival	0.78	0.67	0.90	0.001	0.89	0.79	1.00	0.052

uRR = univariable risk ratio; CI = confidence interval; mRR = multivariable risk ratio; ISS = injury severity score; TRISS = trauma injury severity score; RTS = revised trauma score; GCS = Glasgow coma scale; TC = trauma center

A subgroup analysis compared mortality rates at different transfer time thresholds (1, 2, 3, 4, 5, and 6 hours). For each cut-off, mortality was compared between an "optimal transfer window" (≤ cut-off point) and a "delayed transfer window" (> cut-off point).

As the threshold for defining delayed transfer increased, the mortality rate consistently decreased in the delayed transfer group compared with the optimal transfer group. For example, at the 2-hour threshold, mortality was 14.9% in the optimal window versus 7.54% in the delayed window (p = 0.005); at the 4-hour threshold, mortality was 10.73% versus 5.26% (p = 0.012); and at the 6-hour threshold, 10.21% versus 2.88% (p = 0.008).

Overall, these findings suggest that longer transfer times were associated with lower mortality rates in this cohort. All finding are summarized in Table 5.

Table 5
Comparative Analysis of Mortality at Varying Transfer Time Points.

Transfer time point	Mortality Rate in the Optimal Transfer	Mortality Rate in the Delayed Transfer	P-value
1 hours	20	8.94	0.151
2 hours	14.9	7.54	0.005
3 hours	13.4	4.75	0.004
4 hours	10.73	5.26	0.012
5 hours	10.56	3.47	0.004
6 hours	10.21	2.88	0.008

DISCUSSION

In this study, we evaluated the effect of interhospital transfer time on mortality among severe trauma patients, using a 4-hour threshold to define delayed transfer. Contrary to the traditional "golden hour" paradigm, our findings demonstrated that patients with delayed transfer had significantly lower overall and 24-hour mortality than those with shorter transfer times. Similar patterns were observed across multiple transfer time thresholds.

Delayed transfer was strongly associated with higher RTS and greater distance from the trauma center, suggesting that patients who were physiologically more stable and located farther away were more likely to experience longer transfer times. In contrast, patients with lower TRISS scores and road traffic injuries were at higher risk of 24-hour mortality.

Our findings differ from the classical "golden hour" hypothesis, which proposes that rapid provision of definitive trauma care within 60 minutes reduces mortality (3). Several previous studies have shown that shorter prehospital or transfer times are associated with improved outcomes in specific trauma populations.

For instance, Canadian studies reported that reducing time-to-treatment for traumatic acute subdural hematoma decreased mortality (4). Another study from Virginia demonstrated that severe morbidity and mortality were three times higher among patients who underwent surgery more than 4 hours after injury.(5) Additionally, a study from Oklahoma City suggested that severely injured patients should be transported directly to tertiary trauma centers (11).

In contrast, our study shows an association between longer interhospital transfer time and lower mortality. We believe this discrepancy may be explained by differences in patient selection and referral patterns. Patients in the optimal transfer group in our study tended to have lower TRISS scores, indicating a lower probability of survival. A lower TRISS score was a strong predictor of 24-hour mortality in both crude and adjusted analyses. These high-risk patients may have been rapidly transferred from rural hospitals due to their critical condition.

Conversely, patients in the delayed transfer group had higher RTS, indicating better physiological status and higher survival probability. Rural hospitals may have had more time to stabilize these patients before transfer, which might have contributed to improved outcomes despite longer transfer times.

Our results are partly in line with studies from Pakistan and systematic reviews suggesting that transfer time and transfer strategy do not always have a straightforward relationship with mortality and that patient condition and system factors play critical roles (6, 7).

This study has several limitations. First, its retrospective design is subject to inherent biases, including selection bias and potential misclassification of variables. Data quality depended on the accuracy and completeness of medical records and registry entries.

Second, the study was conducted at a single trauma center in Thailand, which may limit generalizability to other regions or healthcare systems with different prehospital infrastructures or referral patterns. Third, transfer times and distances were based on recorded data and predicted travel times from Google Maps, which may not perfectly reflect real transport conditions, such as traffic or weather. Finally, unmeasured confounding factors, including prehospital care quality, availability of resources at rural hospitals, and decision-making processes regarding transfer, may have influenced the observed associations.

Prospective multicenter studies are needed to confirm these findings and to explore the mechanisms by which delayed transfer, patient stability, and the quality of initial care interact to influence trauma outcomes.

CONCLUSION

Our study demonstrates that, in this setting, delayed interhospital transfer time (> 4 hours) was associated with lower overall and 24-hour mortality among severe trauma patients. Multivariable analysis identified higher RTS and greater distance from the trauma center as the strongest predictors of delayed transfer, suggesting that physiologically more stable patients and those located farther away were more likely to experience longer transfer times.

Despite longer transfer durations, these more stable patients may have benefited from prolonged initial resuscitation and stabilization at rural hospitals, thereby reducing immediate mortality risk. In contrast, patients with more severe physiological derangements or lower TRISS scores may have been prioritized for rapid transfer, contributing to higher mortality in the "optimal transfer" group. These findings suggest that rapid transfer does not uniformly benefit all trauma patients. Instead, patient stability, injury severity, distance, and the quality of initial care should be carefully considered when planning interhospital transfer. Tailored transfer strategies that account for these factors may be more effective than a uniform emphasis on minimizing transfer time alone.

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