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Analysis of the application value and safety of the in-hospital emergency mode in tertiary medical institutions for the treatment of severe trauma

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ABSTRACT

Background: Severe trauma is a major cause of death and disability and requires rapid, coordinated management. Traditional emergency care is often fragmented across departments, which may delay critical interventions. This study evaluated the effectiveness of the Trauma Center emergency model, an integrated multidisciplinary system with standardized protocols, compared with conventional care in patients with severe trauma.

Methods: This non-randomized time-series study included 100 patients with severe trauma admitted to Zigong Fourth People's Hospital from January to December 2025. Severe trauma was defined as a Shock Index >0.8. Patients were assigned chronologically to a control group receiving traditional emergency care and a study group managed under the Trauma Center model, with 50 patients in each group. Outcomes included time to intravenous access, emergency department processing time, complication rate, and rescue success rate.

Results: Compared with the control group, the Trauma Center group had significantly shorter time to intravenous access (12.17 ± 3.43 vs. 19.79 ± 5.88 min; mean difference 7.62 min, 95% CI 5.71-9.53; p-value < 0.001) and shorter emergency department processing time (78.32 ± 25.42 vs. 103.54 ± 39.27 min; mean difference 25.22 min, 95% CI 11.89-38.55; P < 0.001). The complication rate was lower (14.0% vs. 40.0%; p-value = 0.004), while rescue success was higher (92.0% vs. 80.0%; p-value = 0.003).

Conclusion: Implementation of the Trauma Center emergency model in severe trauma care significantly reduces critical time intervals, lowers complication rates, and improves rescue success.

Keywords: Clinical application, safety, severe trauma, trauma center emergency model, treatment outcomes.
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INTRODUCTION

The acceleration of societal modernization has been accompanied by a substantial burden of severe trauma, which remains a leading cause of death and disability worldwide.[1] Epidemiological data consistently show that injuries claim millions of lives annually and account for a major share of premature mortality and disability, with a disproportionate impact on younger populations.[2] Beyond the immediate loss of life, severe trauma is associated with substantial long-term disability and imposes a considerable social and economic burden on patients, families, and healthcare systems.[3,4] This escalating crisis underscores an urgent public health imperative to refine and strengthen trauma systems of care to reduce preventable death and disability.

The clinical management of severe trauma is critically time-sensitive, with mortality classically described in a trimodal distribution.[5] While the first peak of death occurs within minutes of injury due to unsurvivable injuries, the second peak occurs within hours and represents a crucial opportunity for intervention. During this period, deaths from potentially reversible conditions, particularly hemorrhage and other severe but treatable injuries, may be prevented with prompt definitive care.[5,6] Timely and systematic intervention during this phase can reduce mortality, making it a critical window for trauma resuscitation.[7–9] Despite this knowledge, significant clinical gaps persist. Outcomes for severely injured patients vary widely and are influenced by the efficiency, organization, and maturity of the receiving hospital's trauma response system.[3,8,10] Previous studies have shown that optimizing in-hospital trauma pathways and implementing organized trauma systems are associated with improved survival and faster delivery of key interventions for severely injured patients.[8–10] However, the comparative effectiveness of different emergency care models, particularly the specialized Trauma Center approach, in addressing this early preventable mortality still requires further rigorous investigation. Consequently, this study aims to evaluate the application value and safety of the Trauma Center emergency model in the treatment of severe trauma.

METHODS

Study Design and Population.

This study employed a non-randomized, time series design to compare two emergency care models for severe trauma. The research was conducted at Zigong Fourth People's Hospital from January to December 2025. Patients with suspected severe trauma presenting to the Emergency Department and Trauma Center were screened using a Shock Index (SI) > 0.8 as the primary criterion. A total of 100 patients meeting the criteria for severe trauma were enrolled and assigned to either the study group (admitted July–December 2025, n=50) or the control group (admitted January-June 2025, n=50) based on chronological order of admission.

Inclusion criteria were: age ≥4 years, Shock Index >0.8, and time from injury to hospital admission <24 hours. Exclusion criteria included: cardiac arrest or clinical death upon admission, severe traumatic brain injury precluding shock index assessment, pregnancy or lactation, severe underlying diseases affecting prognosis (end-stage renal disease, advanced malignancy), and incomplete data or loss to follow-up. Baseline characteristics were comparable between groups. The study group (25 males, 25 females; mean age 56.13±3.57 years) had injury causes including falls (12 cases), traffic accidents (19), blunt force trauma (11), crush injuries (7), and burns (1). The control group (25 males, 25 females; mean age 54.70±3.49 years) presented with falls (13), traffic accidents (14), blunt force trauma (10), crush injuries (7), and burns (6). No statistically significant differences were observed in demographic or clinical characteristics between groups (p-value>0.05). All patients or their families provided informed consent, and the study received approval from the hospital's Medical Ethics Committee.

Study Variables and Procedures

Control Group (Traditional Emergency Model): Patients received care under the conventional consultation-based system, characterized by sequential processing: emergency department evaluation, specialist consultations arranged individually, multiple patient transfers, and verbal handovers between pre-hospital and in-hospital teams. Management focused on basic life support, including airway maintenance, artificial respiration, and external chest compressions. Study Group (Trauma Center Emergency Model): Patients were managed through an integrated multidisciplinary approach with the following components:

Trauma Team Organization: A dedicated trauma team was established, led by an experienced senior physician, incorporating pre-hospital emergency services, emergency medicine, neurosurgery, general surgery, orthopedics, critical care, and diagnostic departments. All team members completed standardized severe trauma training. Three distinct nursing roles were designated: a primary nurse (N2 level or above) managing airway, assessment, and coordination; an associate primary nurse (N1 level) responsible for vascular access, monitoring, and anti-shock therapy; and a liaison nurse (N0 level) handling supplies, blood products, and green channel coordination.

Protocol Implementation: Upon arrival, triage nurses conducted an initial assessment and activated the primary nurse, who initiated the trauma response and green channel. The assembled trauma team performed rapid focused assessment (airway, breathing, circulation, consciousness), with simultaneous shock management, bleeding control, and diagnostic procedures. Individualized treatment plans were formulated following diagnosis confirmation, with streamlined transfer pathways to the operating room or intensive care unit as indicated.

Activation and Operational Protocols: Activation followed explicit physiological criteria (systolic blood pressure <90 mmHg, Glasgow Coma Scale ≤13, penetrating injury, high-energy mechanism), with flexibility for clinical judgment. A two-tier on-call system ensured 24/7 coverage, with attending physicians available within 15 minutes. Priority access to computed tomography and operating rooms was secured through protocol-based coordination, including designated "green channel priority" surgical capacity. Dynamic staffing allocation ensured at least two dedicated nurses per trauma resuscitation. Quality control included monthly multidisciplinary case reviews and quarterly department-level process evaluations.

Outcome Measures

The primary outcome was time to intravenous access establishment, with secondary outcomes being emergency department processing time, total complication rate, and rescue success rate. Complications encompassed neurological injury, shock, and extensive tissue necrosis, assessed within 24 hours of admission. The total complication rate was calculated as (number of cases with complications / total cases) × 100%. Rescue success was defined as recovery of spontaneous heartbeat, normalization of skin color, pupil constriction, restoration of spontaneous breathing, and regained consciousness. The rescue success rate or resuscitation after arrest was calculated as (number of successful rescues / total cases) × 100%.

Statistical Analysis

Data were analyzed using SPSS statistical software. Measurement data were expressed as mean ± standard deviation (SD) with intergroup comparisons using independent samples t-tests. Count data were expressed as frequencies (n) and percentages (%) with intergroup comparisons using χ^2 tests. Statistical significance was set at p-value<0.05.

RESULTS

Comparison of Intravenous Access Time and Emergency Department Processing Time Between the Two Groups.

The time required to establish intravenous access and the emergency department processing time were both significantly shorter in the study group compared to the control group, with the differences being statistically significant ($P < 0.05$) (Table 1). Compared with the control group, the study group demonstrated a significantly shorter time to establish intravenous access, with a mean difference of 7.62 minutes (95% CI: 5.71 to 9.53; p-value < 0.001). Additionally, the emergency department processing time was also significantly reduced in the study group,

with a mean reduction of 25.22 minutes (95% CI: 11.89 to 38.55, p-value<0.001) (Table 1).

Comparison of Complication Rates and Rescue Success Rates Between the Two Groups.

The overall complication rate in the study group was significantly lower than that in the control group, while the rescue success rate was significantly higher. Both differences were statistically significant (p-value<0.05) (Table 2).

Table 1. Comparison of Intravenous Access Time and Emergency Department Processing Time Between the Two Groups

Variable	Control (n = 50)	Study (n = 50)	Mean Difference (95% CI)	p-value
Time to Establish Intravenous Access (min)	19.79 ± 5.88	12.17 ± 3.43	7.62 (5.71 – 9.53)	<0.001*
Emergency Department Processing Time (min)	103.54 ± 39.27	78.32 ± 25.42	25.22 (11.89 – 38.55)	<0.001*

*Statistically significant at p-value<0.05 based on an independent t-test.

Table 2. Comparison of Overall Complication Rates and Rescue Success Rates Between the Two Groups

Variable	Control (n = 50)	Study (n = 50)	p-value
Neurological Injury, n (%)	11 (22.0)	5 (10.0)	0.109
Shock, n (%)	4 (8.0)	1 (2.0)	0.350*
Extensive Tissue Necrosis, n (%)	5 (10.0)	1 (2.0)	0.197*
Total Complications, n (%)	20 (40.0)	7 (14.0)	0.004*
Rescue Success, n (%)	40 (80.0)	46 (92.0)	0.148

*Statistically significant at p-value<0.05 based on Fisher's exact test.

DISCUSSION

The Trauma Center model represents a shift from traditional consultant-led emergency care toward an integrated, multidisciplinary system that brings key surgical and diagnostic services into the emergency care pathway. This model is intended to provide timely, comprehensive, and systematic assessment and treatment for patients with severe trauma, while standardizing care pathways and improving outcomes.[11,12] In the present study, implementation of this model at Zigong Fourth People's Hospital was associated with shorter times to intravenous access and emergency department processing, lower complication rates, and higher rescue success than conventional care, supporting the value of the Trauma Center approach in the Chinese healthcare setting.

The reduction in time-based indicators observed in our study is consistent with previous evidence on trauma system optimization. Georgiou and Lockey showed that effective hospital trauma teams improve the timeliness of resuscitation, imaging, and transfer to definitive care by enabling simultaneous specialist input rather than sequential consultation.[11] Murphy et al. also found that simulation-based multidisciplinary trauma team training reduced time to critical operations, while Nonis et al. reported shorter emergency department length of stay and faster progression to definitive management after trauma team activation.[13,14] These findings suggest that the efficiency of the Trauma Center model mainly arises from parallel task execution, predefined role allocation, and anticipatory resource mobilization, which likely also explains the shorter emergency department processing time in our cohort.[11,12]

The higher rescue success rate in our study, 92% versus 80% in the control group, is likewise in line with the established evidence supporting trauma center effectiveness. MacKenzie et al. reported lower mortality in patients treated at trauma centers than at non-trauma centers, especially among those with more severe injury, and Celso et al. showed that trauma system implementation was associated with a 15% reduction in mortality risk.[8,15] More recent studies from China reported similar benefits, including lower in-hospital mortality and shorter times to computed tomography, transfusion, and emergency surgery after trauma center establishment or new in-hospital trauma care models.[9,12] The larger reduction in complications observed in our study may reflect the relatively unstructured baseline care in the control group, since greater gains are often seen when hospitals move from less organized trauma care to formalized systems rather than when already mature systems undergo incremental refinement.[10,12]

Some differences between our findings and prior studies should also be considered. Our study was dominated by traffic accidents and falls, whereas penetrating trauma represents a larger proportion of severe trauma in some North American studies, which may affect generalizability because blunt and penetrating injuries may benefit differently from specific trauma system components.[16] The predominance of blunt multisystem trauma in our population may have amplified the benefit of coordinated multidisciplinary assessment. In addition, the tiered nursing structure in our model, with primary, associate, and liaison nurses assigned distinct roles, appears more explicitly organized than in many Western reports. Although trauma nurse leadership has been shown to improve communication and team performance, formal nursing role differentiation is less often described, and this structured delegation may have contributed to the strong gains in time-based outcomes in

our study.[11,17] More broadly, the Chinese tertiary hospital context, characterized by high patient volumes, centralized leadership, and clearly specified nursing roles, may create favorable conditions for rapid implementation of protocolized trauma care pathways.[12,18]

This study has several limitations. The non-randomized time-series design introduces the possibility of temporal confounding, as improvements may partly reflect growing staff experience or broader trauma system maturation over time rather than the intervention alone. The single-center design limits generalizability, while the use of Shock Index > 0.8 as an inclusion criterion may not fully capture injury severity heterogeneity across different trauma types. The modest sample size prevented subgroup analyses, and variations in clinician performance, team dynamics, and communication may still have influenced outcomes. In addition, follow-up was limited to the immediate post-resuscitation period, so long-term recovery, quality of life, return to work, and cost-effectiveness could not be evaluated. Future research should therefore use multicenter designs with stronger quasi-experimental or randomized implementation approaches, including stepped-wedge cluster trials where appropriate, to better address temporal trends and improve external validity. Larger studies would allow subgroup analyses by injury mechanism, anatomical pattern, physiological severity, and patient characteristics. Longer follow-up is also needed because the impact of trauma care extends beyond early survival and includes long-term disability, functional recovery, and socioeconomic outcomes. Economic evaluation is equally important, as trauma center care may remain cost-effective despite higher initial costs. Finally, future work should examine implementation barriers and facilitators, optimize team composition and training, and evaluate new technologies such as artificial intelligence and telemedicine as potential enhancements to the Trauma Center model.

CONCLUSION

This study shows that the Trauma Center emergency model improves severe trauma management compared with conventional care, as reflected by faster intravenous access, shorter emergency department processing time, lower complication rates, and higher rescue success, all with statistical significance. These benefits likely result from multidisciplinary integration, standardized protocols, and coordinated team-based care that support rapid assessment and timely intervention during the critical post-injury period. These findings support the implementation of Trauma Center models with adaptation to local resources and case mix, strengthened by standardized training and simulation-based team rehearsal. However, because this was a single-center study, larger multicenter prospective studies are still needed to confirm generalizability, identify patient groups most likely to benefit, and guide policy efforts aimed at reducing severe trauma morbidity and mortality.

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CONFLICT OF INTEREST

All authors of this paper declare that they have no conflicts of interest.

ETHICAL CLEARANCE

This study was approved by the Medical Ethics Committee of Zigong Fourth People's Hospital. Written informed consent was obtained from all patients or their legal representatives.

AUTHOR CONTRIBUTIONS

L.Lv. contributed to study design and manuscript editing. M.F. contributed to manuscript editing and review and served as guarantor. L.Li. contributed to manuscript editing and data acquisition. P.X. contributed to manuscript editing and statistical analysis.

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ARTIFICIAL INTELLIGENCE STATEMENT

No generative artificial intelligence or AI-assisted tools were used in the writing, editing, analysis, or preparation of this manuscript. All content was developed and reviewed entirely by the authors, who take full responsibility for the final version of the manuscript.

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