Jurnal Saintika Medika
Jurnal Ilmu Kesehatan dan Kedokteran Keluarga
Faculty of Medicine UMM

Vol. 22 No.1 June 2026
p-ISSN : 0216-759X e-ISSN : 2614-X476X
http://ejournal.umm.ac.id/index.php/sainmed

Emergency Department Length of Stay Prior to Surgery in Head Injury Patients

Suryanto Eko Agung Nugroho[1], Tita Hariyanti[2], Taufiq Abdullah[1], Yuddy Imowanto[1], Dewi Puspitasari[1]

[1]Departement of Emergency Medicine, Saiful Anwar General Hospital, Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia.
[2]Master Program In Hospital Management, Faculty of Medicine, Universitas Brawijaya, Indonesia.

Corresponding Author : Dewi Puspitasari

Email : dewipuspitasari@student.ub.ac.id

Received : Apr 02th2026. Revised : Apr 27th2026. Published: Jun 06th2026.

DOI : 10.22219/sm.Vol22.SMUMM1.44440

ABSTRACT

Preoperative delays in traumatic brain injury (TBI) significantly increase morbidity and mortality. While general emergency department (ED) crowding is well-documented, specific bottlenecks bridging ED admission to neurosurgical intervention remain underexplored. This study identifies primary determinants prolonging ED length of stay (LOS) for preoperative TBI patients, offering a novel perspective on systemic versus clinical delays. This retrospective cohort study evaluated 102 head injury patients requiring emergency surgery at Dr. Saiful Anwar Hospital from January 2024 to June 2025. Mean ED LOS was 575.5 minutes (≈9.6 hours). Multivariate linear regression showed that prolonged boarding time and extended diagnostic durations were primary predictors of increased LOS ($P < 0.05$). Conversely, clinical factors like triage priority and staffing ratios did not significantly influence stay duration ($P > 0.05$). Notably, boarding time was the most dominant factor, accounting for 40.6% of LOS variance ($R^2 = 0.406$). These findings indicate that systemic operational inefficiencies in preoperative waiting and diagnostic workflows are more critical drivers of delay than patient acuity. Consequently, hospital management should prioritize optimizing inter-departmental coordination and emergency surgical pathways to improve outcomes for head injury patients.

Keywords : boarding time; diagnostic duration; emergency department; head injury; length of stay.

INTRODUCTION

Traumatic brain injury (TBI) is defined as a neurological disruption resulting from external mechanical forces, often leading to multifaceted physical and cognitive deficits (Abidin *et al.*, 2023). The Centers for Disease Control and Prevention characterize TBI as a functional brain disturbance triggered by percussive impacts or penetrating trauma to the cranium (Capizzi et al., 2020). In the Indonesian context, the Basic Health Research highlighted a significant burden of head injuries, with road traffic accidents—particularly those involving motorcycles—accounting for over 70% of reported cases (Kementerian Kesehatan Republik Indonesia, 2022).

The prognosis of neurosurgical emergencies is inherently time-dependent, with systemic delays in access to surgical intervention closely associated with higher morbidity and mortality (Lepercq *et al.*, 2023) (American College of Surgeons, 2024). Effective management in the emergency department (ED) is essential for early stabilization and accurate triage of critically ill patients, highlighting its central role in optimizing care delivery and strengthening critical care systems (Giri *et al.*, 2022).

Evidence suggests that patients with traumatic brain injury (TBI) who undergo surgical intervention within the "golden window" after admission have a significantly lower risk of mortality compared to those receiving delayed treatment. Therefore, reducing delays in the transition from the ED to the operating room remains a critical priority in emergency care (Mehmood *et al.*, 2021). Furthermore, delayed control of intracranial pressure may aggravate secondary brain injury and is associated with poorer clinical outcomes (Papa and Goldberg, 2018).

Additionally, a study conducted in Malang reported that higher levels of knowledge and positive attitudes toward personal protective equipment (PPE) were associated with improved compliance, which plays an important role in reducing the risk of injury (Vika *et al.*, 2024).

At the national level, the standard maximum length of stay in the emergency department (ED LOS) in Indonesia is 8 hours (480 minutes), as stipulated in the national minimum service standards (Kementerian Kesehatan Republik Indonesia, 2008). However, several hospitals have translated these benchmarks into more stringent institutional standard operating procedures (SOPs) and quality indicators. At Dr. Saiful Anwar General Hospital (RSSA), an internal memorandum specifies that the total ED length of stay must not exceed 6 hours (360 minutes), with boarding time limited to 5 hours (300 minutes). Despite this, Emergency department crowding generally leads to decreased operational performance (Ahmed et al., 2026).Previous literature has categorized these delays into patient-related factors, such as financial or consent issues, clinical complexity, and hospital-centric variables including resource availability and staffing dynamics(Shikder, Jahan and Hossain, 2023). Current research at tertiary centers in East Java has identified boarding time as a critical correlate of ED LOS (Imowanto *et al.*, 2025).

However, a significant research gap remains. Most previous studies have focused broadly on general ED overcrowding and non-operative patient boarding (Khamis *et al.*, 2025). There is a lack of specific investigation isolating the exact determinants that prolong the interval between ED admission and transfer to the operating theater specifically for severe TBI cohorts. The urgency of this research lies in the highly time-dependent nature of TBI interventions; delayed access to the operating room directly resolves into fatal outcomes (Shakir *et al.*, 2024).

This study provides a novel perspective by explicitly contrasting clinical acuity against systemic operational factors (boarding and diagnostic times) within a high-volume tertiary referral hospital. By determining these specific throughput barriers, this research aims to resolve the critical problem of

delayed emergency neurosurgery, offering a data-driven foundation essential for targeted clinical pathway redesign right now.

METHODS

This research utilized an analytical observational approach with a retrospective cohort design. Data were extracted from the emergency department (ED) registry at RSUD Dr. Saiful Anwar (RSSA) Malang, spanning the period from January 2024 to June 2025. A total of 102 patients were enrolled using a total sampling methodology.

The inclusion criteria encompassed head injury patients admitted via the ED who were clinically indicated for emergency neurosurgery and had completed at least one ancillary diagnostic procedure (radiological or laboratory). Conversely, patients were excluded if they died prior to surgical intervention, refused treatment, left against medical advice (LAMA), or possessed incomplete medical records.

The primary dependent variable was ED Length of Stay (LOS), defined as the chronological interval from initial registration to the patient's transfer to the operating theater. Independent variables were categorized as follows: Arrival time (Shift 1 vs. Shift 2), total patient volume per shift, nurse-to-patient ratios, triage severity according to the Patient Acuity Category Scale (PACS), diagnostic test duration (the interval for the most time-consuming diagnostic test), and boarding time (the duration from anaesthesiology consultation to surgical transfer). Data processing was conducted using SPSS version 25. Bivariate analysis was performed using Independent Samples T-Tests for categorical predictors and Pearson correlation for continuous variables. Factors demonstrating a p-value < 0.25 in the bivariate stage were subsequently entered into a multiple linear regression model to identify independent determinants of LOS. The significance threshold was established at $\alpha = 0.05$.

Ethical approval was obtained from the Institutional Review Board of Dr. Saiful Anwar General Hospital (Approval No: 400/159/K.3/102.7/2025). All data were fully anonymized prior to analysis by removing personal identifiers, including patient names and medical record numbers, and replacing them with unique study codes. Data were stored in a secure, password-protected database accessible only to the research team.

RESULTS AND DISCUSSION

The study cohort was predominantly male (74.51%), with a significant majority categorized as Priority 1 (68.63%) based on triage. Traffic accidents were identified as the primary mechanism of injury, accounting for 83.33% of cases. These incidents frequently resulted in mixed intracranial hemorrhages (30.39%), followed by non-hemorrhagic injuries (29.41%) and epidural hematomas

(22.55%). The surgical interventions performed mainly consisted of wound debridement (55.88%) and decompressive trephination or other decompressive surgeries (44.12%).

Table 1. Demographic Characteristics of Head Injury Patients (n = 102)

Variable	Category	Frequency (n)	Percentage %
Sex	Male	76	74.51
	Female	26	25.49
Triage	P1	70	68.63
	P2	32	31.37
Diagnosis	EDH	23	22.55
	ICH	4	3.92
	Mixed	31	30.39
	SAH	8	7.84
	SDH	6	5.88
	Non-hemorrhagic	30	29.41
Mechanism of Injury	Traffic accident	85	83.33
	Non-traffic	17	16.67

The mean ED LOS was recorded at 575.50 minutes (SD = 223.67), a duration that significantly exceeds both the national guideline of 480 minutes and the RSSA internal benchmark of 360 minutes. The average diagnostic test duration was 140.04 minutes, while the mean boarding time reached 285.47 minutes.

Table 2. Descriptive Statistics of Emergency Department Operational Time Intervals and Workload Indicators

Variable	Minimum	Maximum	Mean	SD
ED LOS (minutes)	188.00	1395.68	575.50	223.67
Diagnostic duration (minutes)	65.95	511.35	140.04	75.32
Boarding time (minutes)	105.70	866.88	285.47	152.66
Patients per shift	13	40	21.76	4.92
Nurse-to-patient ratio	0.23	0.69	0.40	0.09

Our bivariate analysis revealed that clinical workload indicators—specifically patient volume per shift ($p = 0.764$) and nursing ratios ($p = 0.608$)—did not exert a statistically significant impact on LOS. Similarly, arrival shifts ($p = 0.780$) and triage priority ($p = 0.800$) demonstrated no significant association with throughput delays. These findings suggest that the existing service capacity and

parallel processing protocols at RSSA are sufficiently robust to manage fluctuating workloads without compromising the speed of preoperative care.

Table 3. Bivariate Analysis of Demographic, Clinical, and Operational Variables Associated with Emergency Department Length of Stay

Variable	Effect Size (t / r)	p-value
Arrival time	−0.280	0.780
Triage severity	−0.254	0.800
Patients per shift	−0.030	0.764
Nurse-to-patient ratio	0.051	0.608
Diagnostic duration	0.254	0.010*
Boarding time	0.637	<0.001*

*Categorical variables were analyzed using the independent *t*-test, and continuous variables using Pearson correlation, effect sizes are reported as *t* or *r* values, $p < 0.05$ was considered statistically significant

However, multivariate analysis identified boarding time as the most potent predictor, explaining 40.6% of the variance in LOS ($R^2 = 0.406$, $p < 0.001$). This indicates that nearly half of the delay occurs after the surgical decision is finalized, likely stemming from systemic bottlenecks such as limited operating room availability or anesthesiology scheduling constraints. Diagnostic duration also emerged as a significant secondary factor ($p = 0.010$), reflecting the time-intensive nature of emergency CT imaging and laboratory turnaround in complex trauma cases. These results align with recent international studies reporting that prolonged diagnostic processes and boarding intervals remain the primary drivers of ED overcrowding (Janke et al., 2026;(Oskvarek *et al.*, 2026)

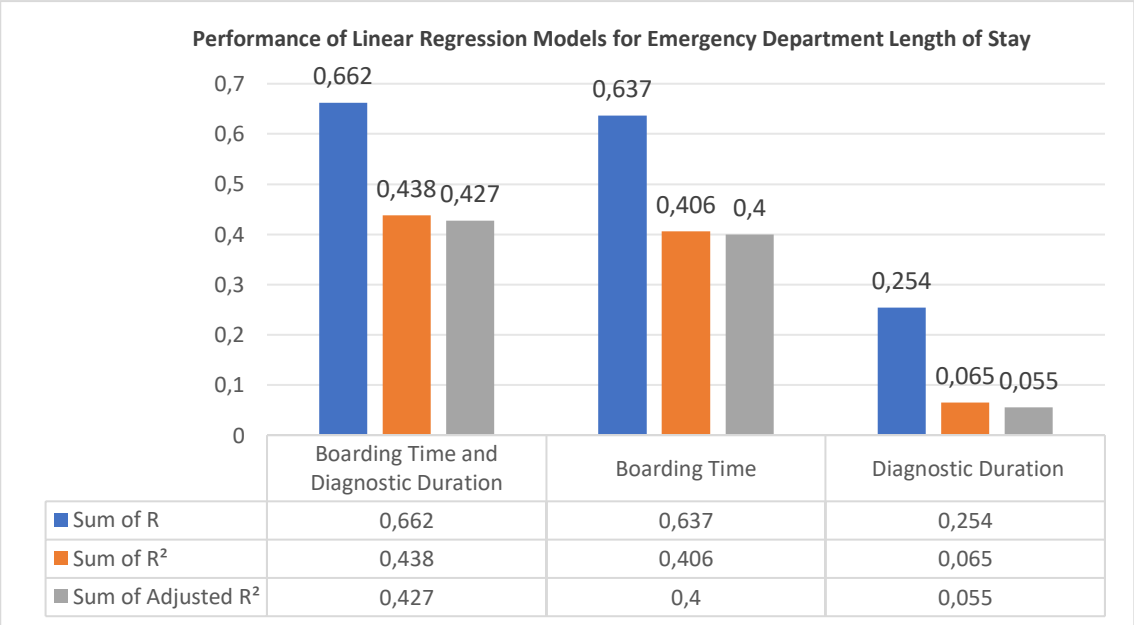

Figure 1. Performance of Linear Regression Models for Emergency Department Length of Stay

The observed average ED LOS of 575.50 minutes (~9.6 hours) markedly exceeds the national target of 480 minutes and the internal RSSA benchmark of 360 minutes. The absence of a significant association between arrival time and ED LOS in this study contrasts with earlier reports suggesting increased delays during nighttime admissions. However, recent evidence indicates that delays in TBI management are predominantly driven by intrahospital and systemic factors rather than temporal variations in patient presentation. A global meta-analysis demonstrated that intrahospital delays—such as imaging, surgical preparation, and inter-unit coordination—constitute the primary contributors to prolonged care timelines . Furthermore, studies in the Asia-Pacific region highlight that the quality and organization of early care pathways play a more critical role than timing alone (Shakir *et al.*, 2024) . This finding may therefore reflect the capacity of tertiary care centers, such as RSSA, to maintain consistent 24-hour diagnostic and surgical readiness, minimizing time-of-day disparities.

Furthermore, triage severity (P1 vs. P2) did not significantly alter the duration of stay, with mean values of 571.68 and 583.87 minutes, respectively. While triage protocols effectively prioritize initial clinical assessment, the standardized nature of preoperative requirements creates a uniform processing time for all surgical candidates. These results corroborate recent findings noting that while physician-led triage improves general ED outcomes, it may not inherently accelerate specific surgical trajectories once the initial stabilization is complete (Imowanto *et al.*, 2025)

The analysis revealed that ED crowding, measured by patient volume per shift, had no significant impact on LOS ($r = -0.030$, $p = 0.764$). This finding suggests that the parallel processing capacity at RSSA may effectively mitigate the impact of high patient volume on patient flow and surgical pathways. Although prolonged ED LOS has been associated with adverse clinical outcomes the absence of such an association in this study may reflect efficient operational systems and interdepartmental coordination (Lauque *et al.*, 2022). Furthermore, adequate staffing levels, as indicated by the nurse-to-patient ratio, appeared sufficient to manage TBI cases without causing delays, consistent with current recommendations from the Emergency Nurses Association (Emergency Nurses Association, 2021)

Diagnostic test duration showed a significant positive correlation with LOS ($r = 0.254$, $p = 0.010$). Although the mean duration of 140.04 minutes meets the national laboratory standard, it notably exceeds the internal RSSA goal of 60 minutes for CT imaging. This highlights a critical area for workflow streamlining, as prolonged diagnostic intervals are known contributors to ED stagnation globally (Savioli et al., 2022; Vrijsen et al., 2022; Payne et al., 2023).

However, boarding time emerged as the most dominant determinant of LOS, accounting for 40.6% of its variance ($R^2 = 0.406$, $p < 0.001$). The mean interval of 285.47 minutes suggests that nearly half of the patient's ED stay occurs while awaiting transfer post-surgical decision. This supports recent global evidence identifying boarding as the absolute primary driver of ED

overcrowding (Haas *et al.*, 2023; Samadian *et al.*, 2026). Consequently, the findings suggest that systemic factors—specifically operating theater availability and inter-departmental scheduling—exert more influence on throughput than individual clinical characteristics.

Several factors contribute to delays in traumatic brain injury (TBI) care across both prehospital and in-hospital settings (Shakir *et al.*, 2023) . Effective reduction of hospital length of stay requires a comprehensive, patient-centered strategy that integrates standardized care pathways—including enhanced recovery after surgery (ERAS) protocols—with efficient discharge planning and well-coordinated multidisciplinary management. Crucially, these approaches must retain the flexibility to adapt to individual patient characteristics and emerging clinical evidence, thereby optimizing both healthcare efficiency and quality of outcomes (Hirani et al., 2025).

CONCLUSION

Boarding intervals and diagnostic turnaround times are the primary determinants of ED length of stay for head injury patients requiring emergency neurosurgery at RSUD Dr. Saiful Anwar. Among these factors, boarding time emerged as the most dominant contributor, accounting for 40.6% of the total variance in LOS. Conversely, clinical acuity—such as triage priority—and operational workload indicators, including patient volume and staffing ratios, did not demonstrate a significant influence on the duration of stay. These results emphasize that systemic operational pathways, rather than patient-related clinical characteristics or resource density, are the critical drivers of ED throughput efficiency.

To improve clinical outcomes and reduce preoperative delays, hospital management should prioritize strategic interventions focused on optimizing operating room scheduling for emergency cases, enhancing inter-departmental communication protocols, and streamlining diagnostic workflows.

Despite these clear findings, this study has several limitations. The retrospective, single-center design may limit the generalizability of the findings to institutions with different trauma care resource profiles. Furthermore, over 50% of the variance in LOS remains unexplained, suggesting the presence of unmeasured confounding variables such as delays in obtaining informed consent, blood product availability, and specialist consultation intervals. Therefore, future research should prioritize multicenter prospective studies to validate these findings and explore unmeasured variables. Additionally, interventional studies focusing on the impact of streamlined boarding protocols on actual patient mortality and neurological functional outcomes are highly recommended.

REFERENCES

Abidin, Z. *et al.* (2023) *Mortalitas Pasien Cedera Kepala Berat Berdasarkan Nilai Mean Arterial Pressure di RSUD Ulin Banjarmasin Januari 2018-Oktober 2021 Mortality Severe Head Injury Patients Based on Mean Arterial Pressure at Ulin Hospital Banjarmasin Since Januari 2018-Oktober 2021*.

Ahmed, A.E. *et al.* (2026) "Clinical and Operational Effects of Emergency Department Crowding: A Systematic Review," *Cureus* [Preprint]. Available at: https://doi.org/10.7759/cureus.100560.

American College of Surgeons. Best Practices Guidelines The Management of Traumatic Brain Injury. 2024.

Capizzi, A., Woo, J. and Verduzco-Gutierrez, M. (2020) "Traumatic Brain Injury: An Overview of Epidemiology, Pathophysiology, and Medical Management," *Medical Clinics of North America*. W.B. Saunders, pp. 213–238. Available at: https://doi.org/10.1016/j.mcna.2019.11.001.

Emergency Nurses Association (2021) *Staffing and productivity in the emergency department: Position statement*. Des Plaines, IL: Emergency Nurses Association.

Giri, S. *et al.* (2022) "Characteristics and outcomes of patients triaged as critically ill in the emergency department of a tertiary care hospital in Bhutan," *International Journal of Emergency Medicine*, 15(1). Available at: https://doi.org/10.1186/s12245-022-00468-8.

Haas, R. *et al.* (2023) "Emergency Department Overcrowding: An Environmental Scan of Contributing Factors and a Summary of Systematic Review Evidence on Interventions," *Canadian Journal of Health Technologies*, 3(11). Available at: https://doi.org/10.51731/cjht.2023.786.

Hirani, R. *et al.* (2025) "Strategies to Reduce Hospital Length of Stay: Evidence and Challenges," *Medicina*, 61(5), p. 922. Available at: https://doi.org/10.3390/medicina61050922.

Imowanto, Y. *et al.* (2025) "FACTORS CORRELATED WITH THE LENGTH OF STAY OF PATIENTS IN THE EMERGENCY DEPARTMENT OF HOSPITAL A, EAST JAVA." Available at: https://doi.org/10.32539/JKK.V12i1.480.

Janke, A.T., Melnick, E.R. and Venkatesh, A.K. (2022) "Hospital Occupancy and Emergency Department Boarding During the COVID-19 Pandemic," *JAMA Network Open*, 5(9), p. e2233964. Available at: https://doi.org/10.1001/jamanetworkopen.2022.33964.

Kementerian Kesehatan Republik Indonesia. (2008) *Keputusan Menteri Kesehatan Republik Indonesia Nomor 129/Menkes/SK/II/2008 tentang Standar Pelayanan Minimal Rumah Sakit*. Jakarta: Kementerian Kesehatan Republik Indonesia.

Kementerian Kesehatan Republik Indonesia. (2022) *Keputusan Menteri Kesehatan Republik Indonesia Nomor HK.01.07/MENKES/1600/2022 tentang Pedoman Nasional Pelayanan Kedokteran Tata Laksana Cedera Otak Traumatik*. Jakarta: Kementerian Kesehatan Republik Indonesia

Khamis, M.M. *et al.* (2025) "Effect of Emergency Department Boarding on ICU Length of Stay and In-Hospital Mortality; A Retrospective Cohort Study," *Archives of Academic Emergency Medicine*, 13(1). Available at: https://doi.org/10.22037/aaemj.v13i1.2604.

Lauque, D. *et al.* (2022) "Length-of-Stay in the Emergency Department and In-Hospital Mortality: A Systematic Review and Meta-Analysis," *Journal of Clinical Medicine*, 12(1), p. 32. Available at: https://doi.org/10.3390/jcm12010032.

Lepercq, D. *et al.* (2023) "Association of Organizational Pathways with the Delay of Emergency Surgery," *JAMA Network Open*, 6(4). Available at: https://doi.org/10.1001/jamanetworkopen.2023.8145.

Mehmood, A. *et al.* (2021) "Delays in emergency department intervention for patients with traumatic brain injury in Uganda," *Trauma Surgery and Acute Care Open*, 6(1). Available at: https://doi.org/10.1136/tsaco-2021-000674.

Oskvarek, J.J. *et al.* (2026) "Emergency Department Crowding in the Modern Era: A Systematic Review (2018–2025)," *Clinical and Experimental Emergency Medicine* [Preprint]. Available at: https://doi.org/10.15441/ceem.25.172.

Papa, L. and Goldberg, S.A. (2018) 'Head trauma', in Walls, R.M. (ed.) *Rosen's Emergency Medicine: Concepts and Clinical Practice*. 9th edn. Philadelphia: Elsevier, pp. 301–328

Payne, K. *et al.* (2023) "Factors that contribute to patient length of stay in the emergency department: A time in motion observational study," *Australasian Emergency Care*, 26(4), pp. 321–325. Available at: https://doi.org/10.1016/j.auec.2023.04.002.

Samadian, K.D. *et al.* (2026) "A Cross-Sectional Study on the Impact of Emergency Department Boarding and Crowding on Emergency Department Observation Unit Patient Populations.," *Journal of the American College of Emergency Physicians open*, 7(3), p. 100363. Available at: https://doi.org/10.1016/j.acepjo.2026.100363.

Savioli, G. *et al.* (2022) "Emergency Department Overcrowding: Understanding the Factors to Find Corresponding Solutions," *Journal of Personalized Medicine*. MDPI. Available at: https://doi.org/10.3390/jpm12020279.

Shakir, M. *et al.* (2023) "Factors Delaying the Continuum of Care for the Management of Traumatic Brain Injury in Low- and Middle-Income Countries: A Systematic Review," *World Neurosurgery*. Elsevier Inc., pp. 169-193.e3. Available at: https://doi.org/10.1016/j.wneu.2023.09.007.

Shakir, M. *et al.* (2024) "Temporal Delays in the Management of Traumatic Brain Injury: A Comparative Meta-Analysis of Global Literature," *World Neurosurgery*, 188, pp. 185-198.e10. Available at: https://doi.org/10.1016/j.wneu.2024.05.064.

Shikder, Md.K.U., Jahan, A. and Hossain, S. (2023) "Study of factors associated with waiting time for patients undergoing emergency surgery," *Scholars Journal of Applied Medical Sciences*, 11(08), pp. 1399–1404. Available at: https://doi.org/10.36347/sjams.2023.v11i08.003.

Vika, T.S.K. *et al.* (2024) "Knowledge and Attitudes regarding Compliance with the Use of Personal Protective Equipment for Motor Vehicle Test Workers at the Malang Regency Transportation Service," *Saintika Medika*, 20(1), pp. 54–64. Available at: https://doi.org/10.22219/sm.vol20.smumm1.32691.

Vrijsen, B.E.L. *et al.* (2022) "Shorter laboratory turnaround time is associated with shorter emergency department length of stay: a retrospective cohort study," *BMC Emergency Medicine*, 22(1), p. 207. Available at: https://doi.org/10.1186/s12873-022-00763-w.