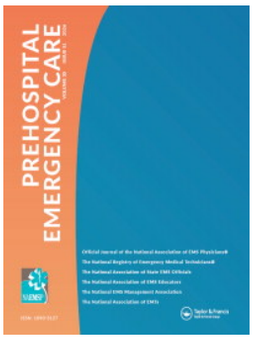

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Emergency Medical Services Time on Scene Associated with Reduced Dead-on-Arrival Status Among Pediatric Patients with Severe Traumatic Brain Injury

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ABSTRACT

Objectives: Severe traumatic brain injury (TBI) is a leading cause of mortality among the pediatric population, and the impact of emergency medical services (EMS) prehospital times on patient survival remains unclear. The objective of this study was to determine associations between EMS time-on-scene and mortality during transport (i.e., dead-on-arrival [DOA] status) among pediatric patients with severe TBI. We also sought to investigate potential effects of social determinants of health on prehospital care practices.

Methods: This was a retrospective cohort study using data from the American College of Surgeons Trauma Quality Improvement Program (2017–2022). Pediatric (<18 years old) patients with severe (Glasgow Coma Scale ≤8) TBI were included in our analyses. We constructed a hierarchical logistic regression model for associations with DOA status. Expecting a potential non-linear relationship between EMS time on scene and odds of presenting DOA, we trained a random forest model to predict survival probability as a function of time on scene and visualized the results with a locally estimated scatterplot smoothing (LOESS) plot. Secondary analyses were performed to investigate demographic associations with EMS time on scene and dispatch of a helicopter ambulance.

Results: Among 1,225 pediatric patients with severe TBI (median age, 13 years), 5.6% ($N=69$) presented with DOA status. Longer EMS time on scene was associated with decreased odds of DOA (odds ratio [OR], 0.92; 95% CI, 0.85–0.99; $p=0.025$). The LOESS plot revealed a non-linear relationship between EMS time on scene and survival probability, with EMS times associated with increasing survival up to approximately 12 min, then plateauing and subsequently decreasing. Black and Hispanic patients experienced shorter EMS scene times ($p=0.008$ and $p=0.018$, respectively), and all non-White patients had lower odds of air medical service dispatch (all $p<0.001$).

Conclusions: Longer EMS time on scene, to a certain point, was associated with lower odds of presenting DOA among pediatric patients with severe TBI, potentially due to increased stabilization measures performed on scene. These results challenge the assumption that expedited transport to a trauma center alone optimizes patient outcomes. Moreover, racial disparities in EMS scene times and ambulance dispatch type highlight a need for further research into prehospital care practices.

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Introduction

Traumatic brain injury (TBI) is one of the leading causes of death in the pediatric (<18 years old) population (1,2). In 2019 and 2020 alone, there were over 16,000 TBI-related pediatric hospitalizations and over 2,700 TBI-related pediatric deaths (1). This is of particular concern considering the impact TBIs can have on childhood development and the functional deficits that can persist as a result. Ten percent of TBIs are classified as severe based on a presenting Glasgow Coma Scale (GCS) ≤8 (3,4). Pediatric severe TBIs have been shown to drive deficits in executive function even a year after the original injury, resulting in significant disability (5–7).

Among patients who sustain a TBI, a subset experience a traumatic injury that results in mortality during transport to a trauma center, classified as dead-on-arrival (DOA) status (8). In the adult trauma population, interestingly, injury severity does not appear to be a major predictor of DOA (9–11). Rather, prior literature has demonstrated that emergency medical services (EMS) transport time and prehospital time are significant predictors of DOA status, prompting efforts to expedite care in the field and reduce transportation delays (12–15). However, there is growing evidence that other factors, including the type and quality of prehospital care provided, also influence patient mortality (16–18). This nuanced perspective has led to efforts aimed at understanding which factors and practices in prehospital care are associated with improved outcomes in patients with TBI.

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Given the significant variation in guidelines and standard of prehospital care for patients with TBI across the United States and Canada, particularly in the pediatric population, there has been no clear identification of which components are predictive of the best outcomes for these patients (19–24). Prehospital care is also influenced by social determinants of health. Prior studies have demonstrated racial and socioeconomic disparities in EMS response patterns, interventions, and transport decisions, including lower rates of advanced prehospital care and air medical service transport among non-White patients (25,26). These disparities highlight the need to examine whether social factors contribute to variation in EMS scene time and transport modality, as well.

Therefore, through a retrospective cohort study using data from the American College of Surgeons Trauma Quality Improvement Program (2017–2022), we sought to better characterize prehospital care patterns for pediatric patients with severe TBI, investigate if prehospital times were associated with DOA status, and determine whether sociodemographic factors were associated with EMS care. Specifically, we hypothesized that pediatric patients with severe TBI with longer EMS time on scene would experience decreased odds of presentation with DOA status, and racial minorities would receive shorter scene times.

Methods

Study Design and Population

This study had a retrospective cohort design. Data were obtained from the American College of Surgeons Trauma Quality Programs (TQIP) dataset, which is a national registry that receives voluntarily-submitted data from trauma centers across the United States and Canada. We first identified patients diagnosed with intracranial injury between 2017 and 2022 *via* International Classification of Diseases 10th Edition (ICD10) codes beginning with "S06." We then selected for pediatric patients (<18 years old) with severe TBI (EMS-assigned GCS ≤8). Next, we excluded patients with missing demographic, clinical, or EMS response duration data. Finally, to reduce the impact of outlier data, we excluded patients with an EMS time on scene greater than twice the standard deviation of that variable. The cohort selection process is outlined in Figure 1. The study was approved by the Johns Hopkins University Institutional Review Board (IRB00053752). Patient consent was waived due to the retrospective nature of the study.

Exposure

The initial exposure in this study was EMS duration, defined as the time from EMS dispatch to hospital arrival. This was further separated into three components: i. dispatch to response (time from dispatch to EMS response), ii. EMS time on scene (time spent by EMS on the scene), and iii. transit to hospital (time of EMS transport from scene to hospital). EMS time on scene was our primary exposure of interest.

For patients receiving care from multiple agencies or from both ground and air medical services, TQIP records only the scene time from the transporting agency, meaning that these patients' reported time on scene may be shorter than reality. We attempted to account for this bias in two ways. First, we included hospital-level random effect terms in our regression models to adjust for variation in EMS practices across catchment areas, including system-level patterns that influence dispatch practices. Second, transport mode (*i.e.,* ground vs. air medical service) was included as a covariate in these models to reduce confounding from additional uncaptured scene time from dual-dispatch calls. However, uncaptured time on scene remains a limitation of our use of a national registry, and our findings should be interpreted in that context.

Outcomes

The primary outcome in this study was DOA status upon patient presentation to the hospital. This was defined by whether "arrived with no signs of life" was noted in TQIP for each patient, as opposed to "arrived with signs of life." To further characterize the nature of prehospital care among pediatric patients with severe TBI, we also performed two secondary analyses in our study: one investigating associations with EMS time on scene and another investigating associations with dispatch of a helicopter, rather than ground, ambulance. These secondary outcomes were selected for their potential associations with prehospital survival after EMS activation (27,28).

Potential Confounders

Several confounding factors may influence relationships between variables of interest. We controlled for demographic factors (age, sex, race, insurance status), as well as clinical severity indicators. These clinical variables included blunt versus penetrating mechanism of injury (MOI) – regardless of if the trauma was accidental or non-accidental, Glasgow Coma scale (GCS) assigned by EMS personnel, Injury Severity Score (ISS) assigned upon hospital presentation, and the presence of prehospital cardiac arrest. The ISS assigned at hospital presentation was utilized in the analysis as no ISS was assigned on scene by EMS, and this decision was made under the presumption that ISS would not significantly change in transit to the hospital, unlike other factors such as GCS or pupillary response. With respect to prehospital cardiac arrest, this variable is recorded as an EMS-documented occurrence of cardiac arrest prior to hospital arrival, which may include before EMS arrival, upon initial EMS assessment, or during transport. Additionally, mode of ambulance transportation (i.e., helicopter vs. ground) was considered as a confounder, as described previously.

Statistical Analysis

Univariate comparisons were performed based on patient DOA status. Given nonparametric distributions of data, the

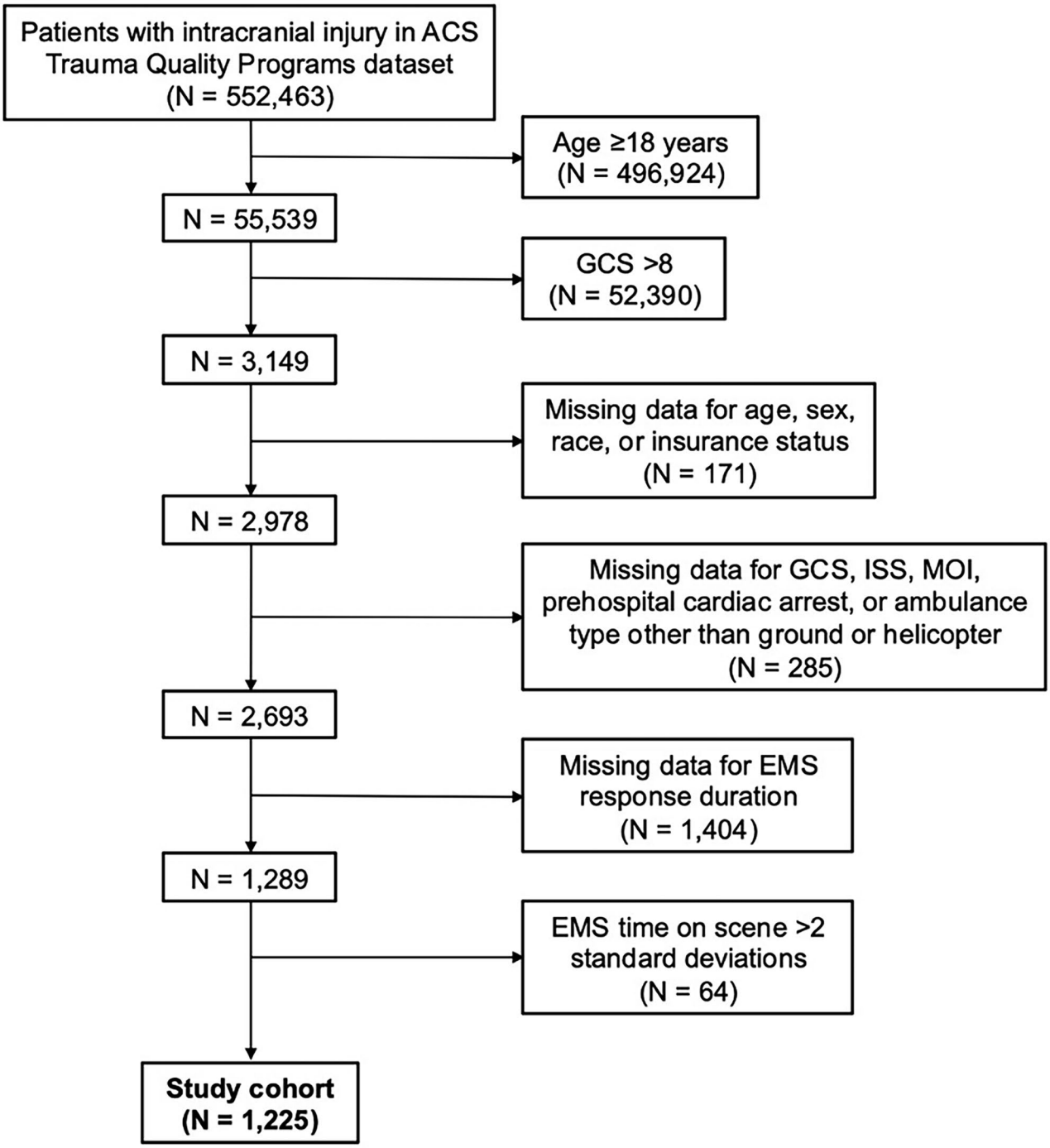

Figure 1. Cohort flow diagram.
ṢGCS, Glasgow Coma Scale; ISS, Injury Severity Score; MOI, mechanism of injury; EMS, emergency medical services.

Kruskal-Wallis test was used for group comparisons of continuous variables. The Chi-squared test was used for group comparisons of categorical variables. Hierarchical logistic regression models were constructed for associations with DOA status, including total EMS duration as a predictor and a random effects term to account for hospital catchment area-level clustering effects. This model was then repeated, but with stratifying EMS response duration into its three components defined above. As a sensitivity analysis to evaluate if our findings held among patients with the most severe clinical presentation, the aforementioned model was repeated in a subgroup of patients with EMS-assigned GCS of 3.

Next, as we presumed a non-linear relationship between EMS time on scene and DOA status, we trained a random forest model to predict this outcome among our full cohort, including all potential confounders and the three EMS time components as predictors. The dataset was randomly partitioned into a training set (80%) and a test set (20%) using stratified sampling to maintain class balance. The random forest model was trained on the training set with 500 trees and three variables randomly selected at each split. Model

performance was evaluated using the area under the receiver operating characteristic curve (AUC-ROC) on the test set. Predicted probabilities of survival were extracted for the test set, and the relationship between EMS time on scene and predicted probability of survival was visualized on a scatterplot with a locally estimated scatterplot smoothing (LOESS) curve.

Finally, we performed two secondary analyses. The first involved specifying a hierarchical linear regression model for associations of patient and clinical factors with EMS time on scene, and the second involved a hierarchical logistic regression model for associations with helicopter dispatch. For all analyses, *P* values were deemed significant if less than 0.05, and risk-adjusted odds ratios were reported for each regression model. All analyses were conducted using R (version 4.2.2).

Results

A total of 1,225 pediatric patients with severe TBI were included in this study. The median age was 13 years (IQR, 5–16) and 67% ($N=821$) were male. Most patients (83%; $N=1{,}021$) experienced a blunt MOI, and the median EMS-assigned GCS was 4 (IQR, 3–6). The median total EMS duration was 40 min (IQR, 29–61). Figure 2 shows the distribution of EMS time on scene among our cohort.

A small subset of patients (5.6%; $N=69$) presented to the hospital with DOA status. These patients were more likely to be uninsured (23% vs. 9.5%; $p<0.001$) and had a more severe ISS distribution (median, 26 vs. 19; $p<0.001$) (Table 1). Notably, patients with DOA status had lower total EMS durations in minutes (median, 30 vs. 41; $p<0.001$), and this remained the case when stratifying this variable into its three components, dispatch to response ($p<0.001$), time on scene ($p=0.001$), and transport to hospital ($p<0.001$).

In the hierarchical logistic regression for associations with DOA status, increasing minutes of EMS duration was associated with lower odds of DOA (odds ratio [OR], 0.97; 95% confidence interval [CI], 0.94–0.99; $p=0.015$) (SDC 1, Table 1). When separating this variable into its three components, the only component significantly associated with reduced odds of DOA was increasing minutes of EMS time on scene (OR, 0.92; 95% CI, 0.85–0.99; $p=0.025$) (Table 2). Higher EMS-assigned GCS was also associated with lower odds of DOA (OR, 0.55; 95% CI, 0.31–0.96; $p=0.035$) while prehospital cardiac arrest was associated with significantly higher odds of DOA (OR, 168; 95% CI, 15.0-1,886; $p<0.001$). In the subgroup of patients with an EMS-assigned GCS of 3, the relationship between EMS time on scene and reduced odds of DOA status approached statistical significance (OR, 0.92; 95% CI, 0.86–1.00; $p=0.050$) (SDC 2, Table 2).

A random forest model to predict DOA odds based on variables of interest was specified using the full cohort and found to have an AUC-ROC of 0.946, demonstrating a high discriminatory ability. The LOESS plot fitted using survival probabilities generated from this model is shown in Figure 3. The plot indicates a minimum in survival odds at approximately 3 to 4 min of EMS time on scene, which increases to a maximum at approximately 10 to 12 min. After a slight decrease, survival odds remain high as EMS time on scene increases until the onset of a shallow decline in these odds at approximately 35 min.

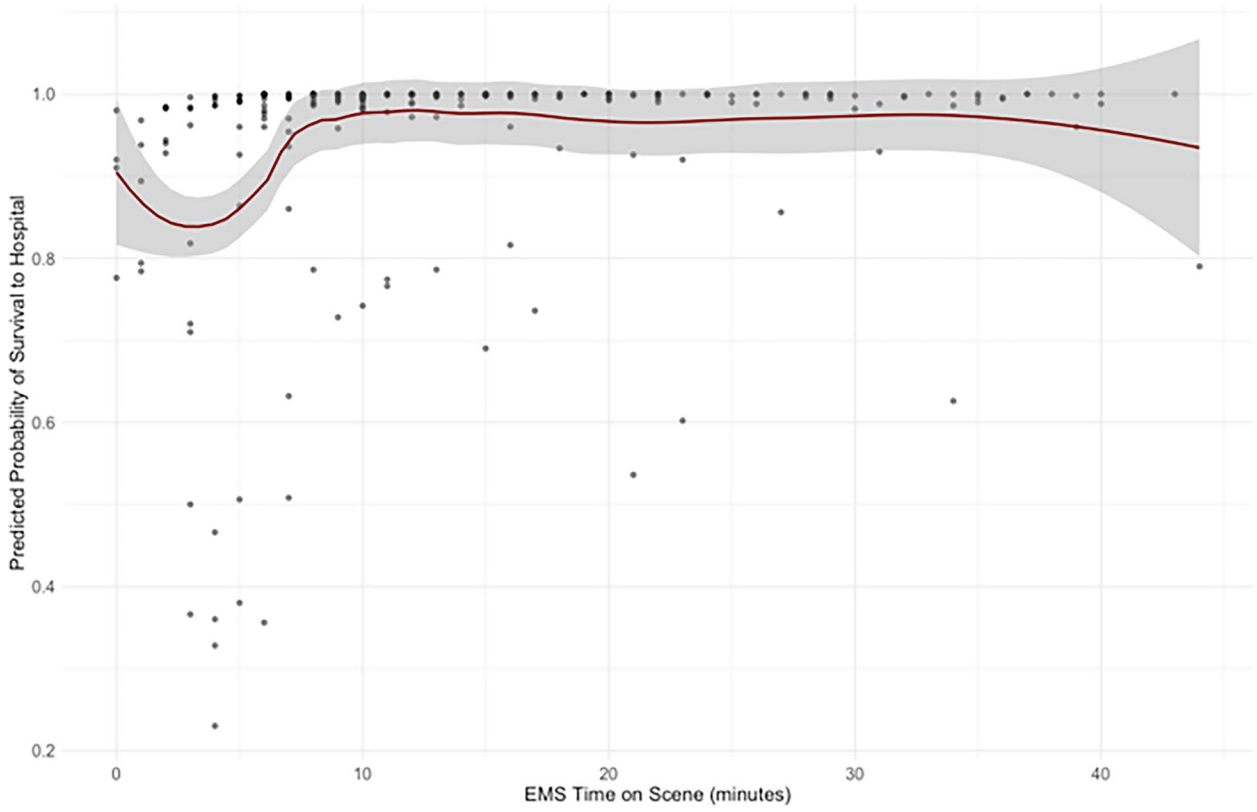

Figure 2. Distribution of emergency medical services time on scene.
EMS, emergency medical services.

Table 1. Characteristics of pediatric patients with severe TBI, stratified by dead-on-arrival status.

	Not DOA	DOA	*P*-value
Patients, No.	1,156	69	
Age, years (median, IQR)	13 (5, 16)	12 (5, 15)	0.398
Male sex	774 (67%)	47 (68%)	0.946
Race			0.063
White	609 (53%)	27 (39%)	
Black	277 (24%)	26 (38%)	
Hispanic	178 (15%)	11 (16%)	
Other	92 (8.0%)	5 (7.2%)	
Uninsured	110 (9.5%)	16 (23%)	**<0.001**
Penetrating mechanism of injury	176 (15%)	28 (41%)	**<0.001**
ISS (median, IQR)	19 (5, 27)	26 (21, 34)	**<0.001**
EMS-assigned GCS (median, IQR)	4 (3, 7)	3 (3, 3)	**<0.001**
Prehospital cardiac arrest	98 (8.5%)	60 (87%)	**<0.001**
Helicopter ambulance	287 (25%)	7 (10%)	**0.009**
EMS response duration, min			
Total (median, IQR)	41 (29, 62)	30 (21, 37)	**<0.001**
Dispatch to Response (median, IQR)	8 (5, 15)	5 (4, 9)	**<0.001**
On Scene (median, IQR)	12 (8, 20)	10 (5, 16)	**0.001**
Transit to Hospital (median, IQR)	18 (12, 28)	13 (10, 17)	**<0.001**

DOA, dead-on-arrival; ISS, Injury Severity Score; EMS, emergency medical services; GCS, Glasgow Coma Scale.

Table 2. Hierarchical logistic regression fixed effects for associations with dead-on-arrival status among pediatric patients with severe TBI.

	Odds Ratio	95% CI	*P*-value
Age, years	0.97	0.88, 1.06	0.498
Male sex	0.94	0.36, 2.45	0.893
Race			
White	REF		
Black	1.22	0.44, 3.43	0.700
Hispanic	1.26	0.34, 4.59	0.729
Other	1.41	0.20, 9.74	0.731
Uninsured	1.43	0.45, 4.62	0.545
Penetrating mechanism of injury	3.74	0.95, 14.7	0.059
ISS	1.01	0.98, 1.03	0.606
EMS-assigned GCS	0.55	0.31, 0.96	**0.035**
Prehospital cardiac arrest	168	15.0, 1,886	**<0.001**
Helicopter ambulance	1.13	0.19, 6.59	0.891
EMS response duration, min			
Dispatch to Response	0.96	0.87, 1.05	0.355
On Scene	0.92	0.85, 0.99	**0.025**
Transit to Hospital	0.98	0.95, 1.02	0.319

ISS, Injury Severity Score; EMS, emergency medical services; GCS, Glasgow Coma Scale.

Table 3 presents β coefficients for associations of patient and clinical factors with EMS time on scene. Regarding race, as compared to White patients, Black (β = –1.6; 95% CI, −2.8 – −0.42; $p = 0.008$) or Hispanic (β = –1.7; 95% CI, −3.2 – −0.30; $p = 0.018$) patients had significantly lower EMS times on scene. Patients with penetrating MOI (β = –2.7; 95% CI, −4.1 – 1.3; $p < 0.001$) experienced lower EMS times on scene, while those undergoing helicopter ambulance transport had higher EMS scene times (β = 9.8; 95% CI, 8.6–11; $p < 0.001$).

Table 3. Hierarchical linear regression fixed effects for associations with emergency medical services time on scene among pediatric patients with severe TBI.

	β Coefficient	95% CI	*P*-value
Age, years	0.05	−0.04, 0.14	0.297
Male sex	−0.71	−1.7, 0.32	0.177
Race			
White	REF		
Black	−1.6	−2.8, −0.42	**0.008**
Hispanic	−1.7	−3.2, −0.30	**0.018**
Other	−0.45	−2.3, 1.4	0.641
Uninsured	1.1	−0.55, 2.7	0.198
Penetrating mechanism of injury	−2.7	−4.1, −1.3	**<0.001**
ISS	0.02	−0.01, 0.05	0.26
EMS-assigned GCS	−0.04	−0.32, 0.24	0.781
Prehospital cardiac arrest	0.66	−0.89, 2.2	0.403
Helicopter ambulance	9.8	8.6, 11	**<0.001**

ISS, Injury Severity Score; EMS, emergency medical services; GCS, Glasgow Coma Scale.

Table 4. Hierarchical logistic regression fixed effects for associations with helicopter ambulance dispatch among pediatric patients with severe TBI.

	Odds Ratio	95% CI	*P*-value
Age, years	1.00	0.98, 1.03	0.776
Male sex	0.97	0.70, 1.34	0.847
Race			
White	REF		
Black	0.35	0.23, 0.53	**<0.001**
Hispanic	0.34	0.21, 0.57	**<0.001**
Other	0.31	0.16, 0.61	**<0.001**
Uninsured	0.84	0.49, 1.43	0.527
Penetrating mechanism of injury	0.64	0.40, 1.02	0.058
ISS	1.02	1.01, 1.03	**<0.001**
EMS-assigned GCS	0.94	0.86, 1.03	0.180
Prehospital cardiac arrest	0.58	0.35, 0.98	**0.041**

ISS, Injury Severity Score; EMS, emergency medical services; GCS, Glasgow Coma Scale.

In the hierarchical logistic regression for associations with helicopter ambulance dispatch, compared to White patients, Black ($p < 0.001$), Hispanic ($p < 0.001$), and patients of Other races ($p < 0.001$) had significantly lower odds of helicopter ambulance dispatch (Table 4). Increasing ISS was associated with higher odds of helicopter ambulance dispatch (OR, 1.02; 95% CI, 1.01–1.03), while prehospital cardiac arrest was associated with lower odds (OR, 0.58; 95% CI, 0.35–0.98; $p = 0.041$).

Discussion

The effect of prehospital time on outcomes in patients with severe TBI remains an active area of investigation (29,30). Our study showed that longer EMS time on scene was associated with decreased odds of DOA, with a positive association observed up to a certain point, as such that the probability of survival decreased when EMS time on scene exceeded approximately 12 min. However, our primary finding should be interpreted with caution, as the upper bound of the confidence interval approached, but did not reach, the null value. The aforementioned results challenge the

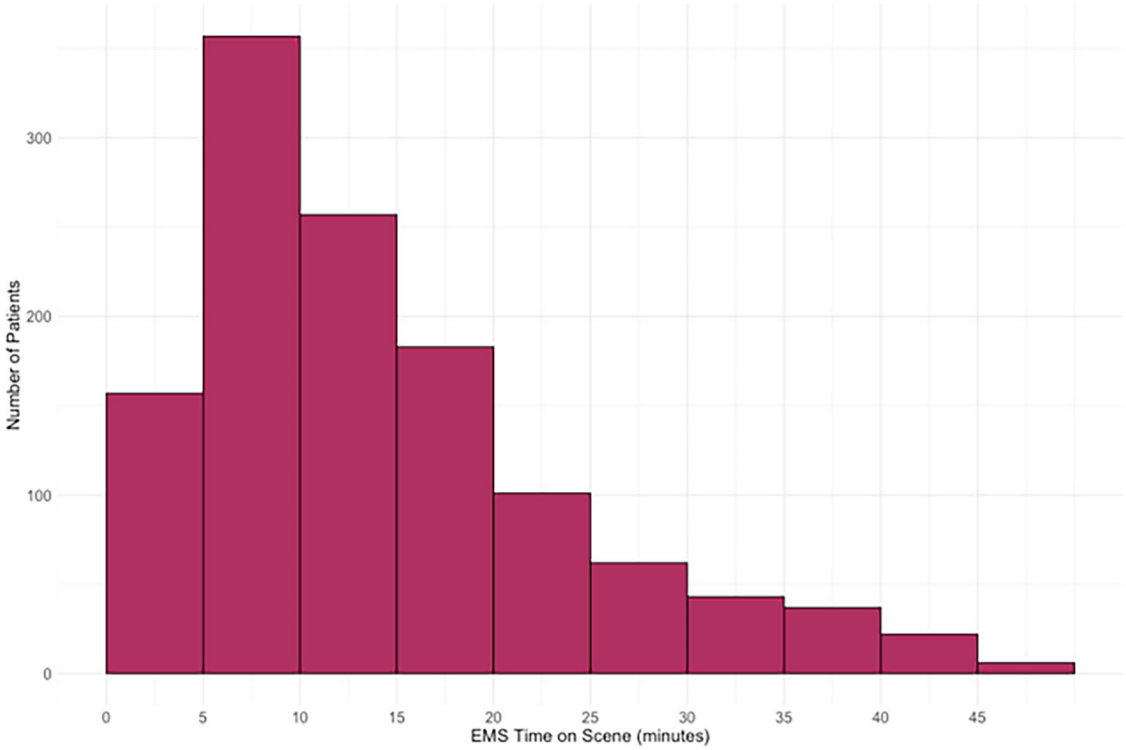

Figure 3. Locally estimated scatterplot smoothing curve estimating predicted probability of prehospital survival to hospital by emergency medical services time on scene.
EMS, emergency medical services.

assumption that expedited transport to a trauma center alone optimizes patient outcomes and highlights the nuanced nature of prehospital care.

Effective prehospital resuscitation and treatment of pediatric TBI patients rely on rapid assessment, timely decision-making, and the initiation of appropriate interventions to optimize outcomes. Given the critical nature of traumatic brain injuries, EMS providers must balance the benefits of on-scene stabilization with swift transport to a trauma center with the capacity to perform more advanced treatments. Among our study cohort of pediatric patients with severe TBI, longer total prehospital time was associated with decreased odds of DOA. This association may initially seem counterintuitive given that longer time to hospital presentation can delay critical treatments and increase morbidity, as is the case with adult ischemic stroke patients (31). However, as demonstrated by our sub-analysis, EMS time on scene approached significance in being positively associated with survival even among the most severely injured patients (i.e., EMS-assigned GCS of 3) in our cohort. Emergency medical services personnel are responsible for critical roles with regards to patient stabilization after injury, especially with regards to airway, breathing, and circulation. As such, our finding may be explained by earlier initiation of critical interventions in the prehospital setting, such as intubation, volume resuscitation, and immediate control of critical bleeds. A prior randomized control trial reported that prehospital intubation for adult patients with TBI was associated with improved functional outcomes, and secondary analysis of the phase III Progesterone for Traumatic Brain Injury Experimental Clinical Treatment Trial (ProTECT III) cohort also demonstrated that prehospital intubation was associated with lower mortality and better neurologic outcomes (32,33). Moreover, implementation of Out-of-Hospital Traumatic Brain Injury Treatment Guidelines, which included EMS protocols and algorithms for prevention and treatment of hypoxia, hyperventilation, and hypotension, in participating Arizona trauma centers led to increased survival to hospital presentation and discharge among pediatric patients with severe TBI (34).

Importantly, EMS time on scene was beneficial only up to a certain duration, and our analysis demonstrated that the probability of survival to hospital presentation decreased slightly when EMS scene time exceeded approximately 12 min. This finding suggests that while on-scene stabilization may play a critical role in increasing odds of survival to hospital presentation, delaying hospital transport past a certain point has diminishing returns. Emergency medical service interventions for patients with severe TBI focus on airway management, hyperventilation when concerned for herniation, and intravenous therapy for hemodynamic support. Definitive treatment requires transport to a trauma center where diagnostic imaging and further intervention can be performed (e.g., extra-ventricular drain placement, decompressive craniotomy). Moreover, the benefits of advanced prehospital interventions, such as endotracheal intubation, remain disputed with some studies reporting worse associated patient outcomes (35–37). The association between prehospital stabilization and patient outcomes may vary significantly depending on other factors such as EMS resource availability, clinical experience, and distance to the nearest trauma center (38,39). An additional consideration is

variability in EMS system structure across the United States. Many regions rely on a combination of Advanced Life Support (ALS) and Basic Life Support (BLS) units, which differ in training, scope, and availability of advanced interventions. Basic Life Support units are more common in lower-resource settings and may have fewer on-scene capabilities, potentially influencing the length and content of prehospital care. However, as the TQIP database does not include ALS versus BLS designation, we were not able to adjust for this variability and therefore unmeasured EMS composition differences may have contributed to our observed findings.

Finally, our investigation identified disparities in social determinants of health in EMS care, specifically as it pertains to race, with Black and Hispanic patients experiencing significantly shorter EMS scene times. Our findings are in parallel to previous studies that found that non-White patients are more likely to have shorter EMS scene time (40,41). The association between patient race and ethnicity with EMS scene time likely has multifactorial causes. Non-White minorities have been systemically oppressed throughout United States history, resulting in high rates of residence in lower-income areas often with higher rates of crime (42). Perceived lack of scene safety in areas where non-White patients live may bias EMS providers against initiating on-scene interventions, thus resulting in shorter scene times. Additionally, high call volumes and resource constraints may pressure EMS providers to shorten scene time in an effort to respond to additional emergencies. Our study also found that Black, Hispanic, and other race pediatric patients with severe TBI were less likely to receive helicopter transport compared to their White counterparts. Prior investigation of severely injured adult trauma patients has identified a similar racial disparity (26). One explanation for this observed disparity may be that non-White patients in our study lived may have lived more frequently in urban areas, where ground transport is faster than air, Yet, given that helicopter transport has been associated with improved patient outcomes in adult and pediatric trauma populations, our study highlights an unmet need for the equitable expansion of helicopter transport services to reduced TBI-associated morbidity and mortality (26,43,44).

Limitations

Several important limitations exist in our study. First, the retrospective study design limits our ability to make determinations of causality. Second, the exclusion of patients with missing ISS assigned at hospital presentation may have led to survivorship bias, since many patients who were DOA may not have been assigned a hospital ISS. We also relied on EMS-assigned GCS throughout our analyses, which has been previously demonstrated to be generally unreliable among the youngest pediatric patients (45). Similarly, we excluded 1,404 patients, which is larger than our final cohort size, due to missing EMS timing data, which may introduce selection bias if this data were missing in a nonrandom manner.

Discrepancies in documentation between EMS and hospital staff may also introduce bias, as only 87% of patients who were reported to be DOA by hospital staff were reported to have prehospital cardiac arrest by EMS, potentially due to differing EMS assessment timing or incomplete documentation. Our use of a trauma center-based registry likely also introduced additional selection considerations that compound on this vague definition of prehospital cardiac arrest. Specifically, protocols in some regions may require EMS personnel to transport patients to the nearest hospital rather than a dedicated, TQIP-participating trauma center. Moreover, some patients who were in cardiac arrest on the scene may have been pronounced dead and were never transported at all, which may result in TQIP underrepresenting these patients and may confound interpretation of the proportion of patients presenting as DOA in our cohort. Additionally, EMS guidelines for treatment and transport decision-making vary by state and local jurisdiction, which may affect the length of EMS time on scene. In our analysis, we constructed hierarchical regression models to control for the effect of variation in EMS practices on identified associations with survival. However, there may still be effects from variation in EMS practices which remain unaccounted for.

Finally, we are unable to ascertain the various factors which contributed to a longer EMS time on scene for patients in our study, and the severity of patient injury during initial EMS assessment does not necessarily correlate with the length of time on scene. For patients determined to have mild injuries during initial EMS assessment, there may be a delay in hospital transport due to lack of urgent medical need, contributing to the high rates of observed survival with prolonged scene times. Conversely, for patients with severe injury, EMS providers may also decide to spend longer time on scene to provide critical stabilization prior to hospital transport or instead spend shorter time on scene in an effort to expedite transport to a trauma center. We also decided to exclude a small number of patients with scene times greater than twice the standard deviation of that variable, which may have introduced additional bias.

Yet, based on our finding that longer EMS time on scene, as opposed to longer time from EMS dispatch to response or longer transit time to hospital, was specifically associated with increased survival, we hypothesize that the protective effect against mortality is likely related to on scene patient stabilization practices. However, further investigations and higher resolution analyses of on scene interventions and their associations with patient survival are needed to more definitively determine their protective effect. Moreover, our findings are based on analysis of aggregated, national EMS data. Future discussion of whether implementing on scene stabilization versus prioritizing hospital transport must account for EMS resources available at the local level.

Conclusions

Among pediatric patients with severe TBI, increased EMS time on scene was associated with decreased odds of

presenting to the hospital with DOA status. This effect appeared to be non-linear, with survival odds increasing up to EMS scene times of approximately 12 min, then subsequently plateauing and decreasing. Moreover, we observed racial disparities related to prehospital care practices for pediatric patients with severe TBI, as non-White racial minorities experienced shorter EMS times on scene and lower odds of having a helicopter ambulance dispatched. These findings provide context that can be used to help standardize prehospital care patterns for pediatric patients with this injury type.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

Declaration of Generative AI in Scientific Writing

The authors did not use a generative artificial intelligence (AI) tool or service to assist with preparation or editing of this work. The author(s) take full responsibility for the content of this publication.

Authorship Statement

All authors contributed to (1) the conception of the work and/or the analysis and interpretation of data (2), drafting and/or reviewing the manuscript (3), providing final approval of the published work, and (4) agree to be accountable for all aspects of the work.

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