Factors associated with EMS transport decisions for pediatric patients after motor vehicle collisions

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**ABSTRACT**

**Objective:** Prehospital non-transport events occur when emergency medicine service (EMS) providers respond to a scene, but the patient is ultimately not transported to a hospital for evaluation. The objective of this study was to determine the rate of non-transport of pediatric patients who were involved in a motor vehicle collision (MVC) and the factors associated with non-transport decisions.

**Methods:** We searched the National Emergency Medical Services Information System (NEMSIS) database using ICD-10 mechanism of injury codes to identify cases in which EMS responded to a pediatric occupant (age < 18 years) who had been involved in an MVC. We excluded interfacility transports, scene assists, deaths at the scene, and collisions that occurred outside the US. The outcome of interest was if pediatric patients were not transported to a hospital for evaluation. We performed univariate and multivariate analysis to identify which risk factors were associated with non-transport. We also analyzed regional variation and the reasons recorded for not transporting patients.

**Results:** We identified 92,254 pediatric patients who were evaluated by EMS after an MVC, of which 31,404 (34.0%) were not transported to a hospital for evaluation. In our adjusted analysis, the factors associated with non-transport were age < 1 year or > 16 years, male sex, normal Glasgow Coma Scale (GCS = 15), level of training of EMS providers, response time later than 6 a.m., and region of the country. GCS was the most important factor, with only 3.0% (108/3,616) of patients not transported who had abnormal GCS (< 15). In cases of non-transport, 32.7% (10257) were due to patient or caregiver refusal, and 33.3% (10,442) were due to patients being discharged against medical advice. Only 11.5% (3,627) pediatric patients who were not transported were discharged based on an established protocol.

**Conclusions:** Pediatric patients were not transported after EMS responded to an MVC in approximately one-third of cases, and there was considerable variation in the rate of non-transport based on geographic region, provider level, and time of day. The majority of non-transport cases occurred because patients were discharged against medical advice or the patient/caregiver refused transport, which may indicate conflicting priorities between EMS providers and patients.

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**Introduction**

Motor vehicle collision (MVCs) are a significant cause of morbidity and mortality for children in the US. In 2018, the CDC estimated that MVCs resulted in 220,693 injuries and 781 fatalities for occupants under the age of 18 years. (CDC 2020) MVCs are one of the most common mechanisms of traumatic injury for pediatric patients; they are the leading cause of death in patients aged 2-18 years (Tracy et al. 2013; CDC 2019; Cunningham et al. 2018). Additionally, 8% of all pediatric Emergency Department (ED) visits are related to trauma, which results in over 7 million ED visits each year (Rasooly et al. 2014). Most of these patients are transported to the ED by emergency medical services (EMS), with a small proportion transported by private vehicles (Corrado et al. 2017). This dependence on EMS transport makes pre-hospital decision-making a key component of our pediatric trauma systems and delivery of care models.

Research on the triage of pediatric patients involved in MVCs has primarily focused on the decision to transport to trauma centers versus non-trauma centers. Pediatric trauma centers have been shown to improve outcomes for children with severe traumatic injuries. (Sathya et al. 2015; Notrica et al. 2018) However, the existing field triage criteria published by the CDC have been examined in pediatric trauma and found to result in significant under-triage to trauma centers. (Sasser et al. 2012; Lerner, Cushman, et al. 2017; Lerner, Drendel, et al. 2017; Lerner et al. 2020) More advanced methods of injury detection in children using crash telemetry have been shown to be accurate for trauma
center triage, but this technology is still not widely implemented. (Doud et al. 2016, 2018) These studies of trauma triage have not focused on pediatric patients who are discharged by EMS from the scene of an MVC.

It has been well established that many pediatric patients are not transported to a hospital for evaluation when EMS responds to a request for assistance. It is estimated that approximately 7% of EMS responses are for children under the age of 18 years, and 16-28% of these patients are not transported (Gerlacher et al. 2001; Kannikeswaran et al. 2007; Diggs et al. 2016; Ramgopal et al. 2018). Factors associated with these non-transport events include age, mental status, race, time of day, and prehospital interventions (Gerlacher et al. 2001; Kannikeswaran et al. 2007; Ramgopal et al. 2018). Furthermore, a regional study of pediatric EMS responses showed that children involved in a traumatic event have the highest rates of non-transport (Ramgopal et al. 2018). However, rates of transport for pediatric patients after MVCs and the factors associated with transport decisions in this population remain understudied.

The primary objective of this study was to understand current practices in EMS regarding the non-transport of children involved in MVCs. We aimed to determine the rate at which pediatric patients are not transported to a hospital, and to identify the factors associated with these non-transport decisions. Further, we aimed to examine the reasons for non-transports and evaluate regional variation.

Methods

Study design

This study was a retrospective, population-based analysis of records from a national database of EMS responses that occurred between January 1, 2017 and December 31, 2018. Data were collected based on state and regional EMS requirements. This study was determined exempt by the Institutional Review Board at the University of Virginia (IRB-HSR #22180).

Data source

Data for this study were obtained from the National Emergency Medical Services Information System (NEMSIS). NEMSIS is a national database of EMS records collected and maintained by the US Department of Transportation’s National Highway Traffic Safety Administration (NHTSA). This dataset includes EMS activations from 9,599 EMS agencies in 43 states and territories (NEMSIS Technical Assistance Center 2019). Cause of injury data is recorded using the 10th edition of the International Statistical Classification of Diseases and Related Health Problems (ICD-10). Data are submitted to state registries, which are aggregated into the national database. Participation is voluntary but has been mandated by many states. These data are available for free by request through the NEMSIS website (https://nemsis.org). These data were obtained in Stata formatting and were converted to comma-separated values (CSV) format using Python programming language (Python Software Foundation, Wilmington, DE).

Participant selection

Cases were included for analysis if they represented a pediatric patient who was an occupant in an MVC. Patients were considered to be pediatric if their age was less than 18 years of age at the time of the EMS response. Prior to analysis, a list was assembled of all ICD-10 injury causation codes that appear in the NEMSIS database for occupants involved in MVCs (Appendix 1 see supplementary information below). Pediatric patients were determined to have been an occupant in a motor vehicle involved crash if their injury code matched one of the ICD-10 codes in this list. Pediatric patients injured by a motor vehicle who were not occupants, (e.g., pedestrians hit by a car) were not included in the analysis since factors associated with transport might be significantly different from those of occupants. Cases were excluded if: 1) the response was not to a scene (e.g., interfacility transport), 2) the record was not for the primary EMS squad responding to the scene or the call was canceled, 3) the pediatric patient died in the field prior to transport, 4) the case occurred in a territory outside of the United States.

Patient demographics and level of consciousness

Patient demographics included sex, age, and race/ethnicity. Patients were placed in the following age groups: infant (<1 year), toddler (1 year), early childhood (2 to 5 years), middle childhood (6 to 10 years), early adolescent (11 to 14 years), and middle adolescent (15 to 17 years). The Glasgow Coma Scale (GCS) values were calculated by adding the motor, verbal, and verbal components of the scale. For pediatric patients with multiple GCS values recorded, the lowest value was used for analysis.

Response characteristics

EMS response characteristics included the level of training of provider(s), time of day, and region of the country. Level of training was determined by the treatment capabilities of the EMS unit responding to the activation and were grouped into basic life support (BLS), advanced life support (ALS), and critical care. The time of day was separated into four equal 6-hour time periods (00:00-05:59, 06:00-11:59, 12:00-17:59, and 18:00-23:59) based on time of arrival to the scene. The region of the country was provided by NEMSIS and is based on the US Census Bureau designated divisions.

Transport determination and reason for refusal

The primary outcome of interest was if a pediatric patient was not transported to a hospital based on the recorded disposition determination. Every case entered into the NEMSIS database must include a disposition, of which there are nine options. The is no guidance offered at the national level as to the definition of these terms beyond the description in...
the data dictionary. Therefore, determinations regarding which cases are appropriate for each category are made at the state or EMS agency level.

Patients with dispositions specified as "Patient Treated, Transported by this EMS Unit", "Patient Refused Evaluation/Care (With Transport)", "Patient Treated, Transferred Care to Another EMS Unit", "Patient Treated, Transported by Law Enforcement", and "Patient Treated, Transported by Private Vehicle" were classified as transported; while patients with dispositions specified as "Patient Evaluated, No Treatment/Transport Required", "Patient Refused Evaluation/Care (Without Transport)", "Patient Treated, Released (AMA)" [AMA-Against Medical Advice], and "Patient Treated, Released (per protocol)" were classified as non-transported. The reasons for refusal were obtained from these disposition descriptions in cases of non-transports ("No Treatment/Transport Required", "Patient Refused Evaluation/Care", "Released (AMA)" and "Released (per protocol)").

**Data analysis**

Data analysis included an unadjusted univariate logistic regression and an adjusted multivariate logistic regression. Values for data elements missing <20% were imputed. Imputation was performed five times for each missing value. No 78079 (84.6%) 52625 (86.5%) 25454 (81.1%)

Results

There were a total of 1,640,447 records of EMS responses for children in the NEMSIS database for the timeframe examined. The inclusion criteria yielded 95,265 (5.8%) cases where EMS responded for a pediatric patient involved in an MVC, of which 3,011 records were removed based on the exclusion criteria (Figure 1). This resulted in 92,254 records for analysis, of which 31,404 (34.0%) were not transported to a hospital.

The mean age of patients analyzed in the study was 11.2 years (SD: 5.4 years), and 55.5% percent of occupants were female (Table 1, full table: Appendix 2 see supplementary information below). EMS responses were most common in the afternoon (12:00-17:59) and were for children with normal GCS (GCS = 15). In most cases, race data were missing (59.7%). Of the patients who were not transported, the majority either refused treatment 32.7% (10,257/31,404) or were discharged against medical advice 33.3% (10,442/31,404) (Table 2). Only 11.5% (3,627/31,404) of all pediatric occupants involved in an MVC were discharged from the scene of a crash using an established protocol.

The results of the univariate analysis demonstrate that all variables had values that were statistically significantly correlated with transport decisions (Table 3 see supplementary information below). In the multivariate analysis, normal GCS (GCS = 15) was the most significant predictor of non-transport (OR: 14.68, 95% CI: 12.23-17.61). Response occurring after 6 a.m. (06:00-23:59) were more likely to result in non-transport than early morning response (00:00-05:59). There was significant regional variation in the odds of transport when controlling for other

| Table 1. Abbreviated demographics of pediatric patients included in this analysis based on transport decision. Variables in columns may not add up to 100% due to missing data. See supplementary material for full table. |
|---------------------------------|-----------------|-----------------|-----------------|
| Overall (n = 92254) | Transported (n = 60850) | Not transported (n = 31404) |
| Sex | | | |
| Female | 50765 (55.0%) | 33762 (55.5%) | 17003 (54.1%) |
| Male | 41028 (44.5%) | 26912 (44.2%) | 14116 (44.9%) |
| Age | | | |
| <1 year | 3608 (3.9%) | 2301 (3.8%) | 1307 (4.2%) |
| 1 year | 2610 (2.8%) | 1763 (2.9%) | 847 (2.7%) |
| 2 to 5 years | 12717 (13.8%) | 8572 (14.1%) | 4145 (13.2%) |
| 6 to 10 years | 19574 (21.2%) | 13033 (21.4%) | 6541 (20.8%) |
| 11 to 14 years | 16857 (18.3%) | 11539 (19.0%) | 5318 (16.9%) |
| 15 to 17 years | 36888 (40.0%) | 23642 (38.9%) | 13246 (42.2%) |
| Altered mental status (lowest GCS < 15) | | | |
| Yes | 3616 (3.9%) | 3508 (5.8%) | 108 (0.3%) |
| No | 78079 (84.6%) | 52625 (86.5%) | 25454 (81.1%) |

Note: GCS = Glasgow coma scale.
predictors. The odds of non-transport were highest in New England division, lowest in the East South Central division. Sensitivity analyses that excluded cases with missing values (Appendix 4 see supplementary information below) and used mean mode imputation (Appendix 5 see supplementary information below) demonstrated similar results.

Pediatric occupants who were not transported were examined further. Reasons recorded for non-transports were compared between geographic division (Figure 2). In all divisions, the smallest subset of patients was those treated and discharged by a protocol. The rates at which EMS providers determined a child did not require treatment or transport varied considerably in different areas of the country, as did rates of patients being discharged against medical advice (AMA). However, in all divisions, greater than 50% of patients who were not transported either refused treatment or were discharged against medical advice.

Discussion

Our analysis of a national EMS database found that pediatric occupants involved in MVCs are not transported to the hospital for evaluation in approximately one-third of cases. Among the factors examined, GCS was the most important in predicting non-transports. We also found that there is significant regional variation in transport rates among different geographic regions and with significant differences in the stated reasons for not transporting the patient. Over half of non-transports were due to patient refusal of care or were discharged against medical advice in all regions, while few pediatric patients were discharged from the scene of a crash based on an established protocol.

The strengths of this study include the large cohort of cases collected by NHTSA in the NEMSIS database. The adoption of the current version of NEMSIS has been rapidly expanding, with the number of cases collected tripling between 2017 and 2018. Additionally, this study was not limited to a single state or EMS system, allowing for comparisons between geographic regions. Also of significance was that the NEMSIS database is aggregated for the purpose of performing prehospital research, and most variables examined in this study were complete.

Our study demonstrated a higher rate of non-transport of pediatric occupants compared to other studies which

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Table 2. Dispositions selected based on transport decision.

| Disposition                                      | Transported (n = 60850) | Not transported (n = 31404) |
|--------------------------------------------------|-------------------------|-----------------------------|
| Patient Evaluated, No Treatment/Transport Required| –                       | 7078 (22.5%)                |
| Patient Refused Evaluation/Care (With Transport) | 67 (0.1%)               | –                           |
| Patient Refused Evaluation/Care (Without Transport)| –                       | 10257 (32.7%)               |
| Patient Treated, Released (AMA)                  | –                       | 10442 (33.3%)               |
| Patient Treated, Released (per protocol)         | –                       | 3627 (11.5%)                |
| Patient Treated, Transferred Care to Another EMS Unit | 4065 (6.7%)            | –                           |
| Patient Treated, Transported by Law Enforcement  | 65 (0.1%)               | –                           |
| Patient Treated, Transported by Private Vehicle  | 657 (1.1%)              | –                           |
| Patient Treated, Transported by this EMS Unit     | 55996 (92.0%)           | –                           |

Notes: AMA = Against medical advice, EMS = Emergency medical services.

Table 3. Abbreviated odds ratios (ORs) based on univariate and multivariate logistic regression associated with the transport of pediatric patients after an MVC. Higher ORs indicate a greater chance of non-transport to a hospital. See supplementary material for full analysis.

| Variable                      | Univariate Analysis | Multivariate Analysis |
|-------------------------------|---------------------|-----------------------|
|                               | OR (95% CI)         | p-value               | aOR (95% CI)         | p-value               |
| Sex                           |                     |                       |                      |                      |
| Female                        | Ref.                | –                     | Ref.                 | –                     |
| Male                          | 1.04 (1.01-1.07)    | < 0.01                | 1.07 (1.04-1.10)     | < 0.01                |
| Age                           |                     |                       |                      |                      |
| <1 year                       | Ref.                | –                     | Ref.                 | –                     |
| 1 to <2 years                 | 0.85 (0.76-0.94)    | < 0.01                | 0.81 (0.73-0.91)     | < 0.01                |
| 2 to <6 years                 | 0.85 (0.79-0.92)    | < 0.01                | 0.82 (0.75-0.89)     | < 0.01                |
| 6 to <12 years                | 0.88 (0.82-0.95)    | < 0.01                | 0.84 (0.77-0.91)     | < 0.01                |
| 12 to <16 years               | 0.81 (0.75-0.87)    | < 0.01                | 0.78 (0.72-0.85)     | < 0.01                |
| 16 to 17 years                | 0.99 (0.92-1.06)    | 0.71                  | 0.98 (0.91-1.06)     | 0.57                  |
| Mental Status                 |                     |                       |                      |                      |
| GCS < 15                      | Ref.                | –                     | Ref.                 | –                     |
| GCS = 15                      | 14.68 (12.23-17.61) | < 0.01                | 14.83 (12.14-18.12)  | < 0.01                |

Note: GCS = Glasgow coma scale.

![Figure 2](image-url) Reason recorded in cases of non-transport as a percentage of all non-transport for different geographic divisions. AMA = Against medical advice.
included both medical and trauma-related pediatric EMS responses. Ramgopal et al. found an overall rate of non-transport for pediatric patients of 16.3% in Pennsylvania. However, responses for patients classified as trauma-related had substantially increased odds of non-transport (Ramgopal et al. 2018). Two studies of large urban EMS systems showed non-transport rates of 19.8% and 27.7% (Gerlacher et al. 2001; Kannikeswaran et al. 2007). Again, MVCs were among the most frequent reason for EMS evaluation in cases of non-transport in both studies. Our non-transport rate appears to be higher than previous studies due to our focus on pediatric occupants involved in MVCs.

Level of consciousness, as measured by GCS, and time of response were significant predictors of hospital transport, which has been well documented in previous studies. The largest previous study on this topic showed that altered mental status was significantly associated with transport (Ramgopal et al. 2018). This finding is not surprising since altered mental status is associated with worse outcomes in both medical illnesses and trauma (Parshuram et al. 2009; Lerner, Drendel, et al. 2017). The increased rates of transport in the early morning (00:00-06:00) might be due to decreased traffic at those times, leading to higher travel speeds and more severe crashes. Although studies that included both medical and trauma-related EMS responses have also shown higher rates of transport in the early morning (Gerlacher et al. 2001; Ramgopal et al. 2018).

We observed significant regional variation in non-transport rates, which has not been previously described in a pediatric population. The protocols and policies for field evaluation and treatment of injured patients differ among EMS systems, some of which allow for more independent evaluation and disposition decisions by EMS providers. However, other factors likely influence transport decisions, such as crash severity. Rural crashes are typically higher severity, and the ratio of collisions in rural versus urban areas almost certainly differ among regions (Wolf et al. 2017). Yet, there were still substantial differences in the reasons recorded for non-transport. For instance, in the Pacific region, 57.0% of patients were discharged against medical advice, compared to 16.4% in New England. These disparate rates may be partly due to varying terminologies used in different regions of the US and different medicolegal requirements placed on these EMS agencies. Despite these confounders, it is striking that most non-transport were recorded as being patient or caregiver initiated (either against medical advice or patient refused evaluation) in every region.

The high rates of patient-initiated non-transport may indicate that there are competing priorities for EMS providers and patients. EMS agencies contend with the potential of medicolegal consequences from non-transport. Also, the Centers for Medicare and Medicaid Services (CMS) has historically not reimbursed agencies for responses unless the patient was transported to a hospital, although new payment models are currently being developed (Goldberg et al. 1990; CMS 2019; HHS 2019). In contrast, patients may incur substantial hospital bills from diagnostic evaluations that ultimately may not reveal any injuries, as well as charges for EMS transport (Blue Cross Blue Shield 2009; Wilkinson et al. 2018). Previous work has shown there is a relatively low rate of hospitalization for pediatric patients who present to an emergency department (ED) after initially refusing EMS transport (Kahalé et al. 2006). These findings illustrate that more balance may be needed between patient and EMS interests.

The existing research on pediatric trauma after MVCs has primarily focused on the decision of whether to transport to a trauma center versus non-trauma center. (Doud et al. 2016, 2018; Lerner, Drendel, et al. 2017; Lerner et al. 2020) The results of our study indicate that there is also a need to develop data-driven protocols to identify patients at low risk for injury who can safely be evaluated and discharged from the scene of an MVC. In our study, we found an established protocol was used to clear pediatric patients in only 11.5% of cases of non-transport (3.9% of all crashes). Various systems have implemented protocols that allow EMS more latitude in transport decisions. However, these initiatives have been limited to specific locales (Hauswald 2002; Haines et al. 2006). The absence of widespread adoption of non-transport protocols is likely due to a lack of research in this area. High-quality protocols to guide transport decisions could offer medicolegal protection to EMS while accurately and safely identifying more patients who do not require transport, without forcing patients or caregivers to refuse transport.

Limitations

There are several limitations to consider concerning this study. Importantly, the outcomes for these patients are unknown so that no definitive conclusions can be drawn about the appropriateness of the transport decisions. Also, our study relied on the secondary analysis of EMS reports that are often recorded for the purpose of billing, medicolegal documentation, and quality improvement. Interpretation of these reports may have been further confounded by the fact that terminology may differ between agencies/regions. As mentioned previously, a portion of the variations in transport rates is likely due to differences in crash severity between regions, which is not captured by this data set. While there was a low rate of missing data, imputation methods could have introduced some bias into our analysis. We attempted to mitigate this limitation by performing sensitivity analyses, which showed similar results.

In conclusion, normal GCS was the most important predictor of non-transport to a hospital in pediatric patients involved in an MVC as occupants. There is a substantial proportion of pediatric patients who are not transported to a hospital for evaluation after EMS responds to an MVC, although the appropriateness of these transport decisions is still unclear. The rates of transport of children to a hospital varied between 22-49% in different geographic regions. Further research into medical outcomes for pediatric patients after MVCs is needed in order to develop protocols to guide prehospital transport decisions.

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Data and code availability

The authors of this manuscript are committed to transparency and reproducibility in research. The data used for this analysis can be requested by contacting the National Emergency Medical Services Information System (NEMESIS) at https://nemesis.org/using-emsl-data/request-research-data/. The R scripts used for this analysis are publicly available at https://github.com/thartka/Peds_MVC EMS. This code is reusable under the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License. To view a copy of this license, visit http://creativecommons.org/licenses/by-nc-sa/4.0/ or send a letter to Creative Commons, PO Box 1886, Mountain View, CA 94042, USA.

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