Published in final edited form as:

Pediatr Emerg Care. 2018 December ; 34(12): 862–865. doi:10.1097/PEC.0000000000000786.

Emergency Medical Services Provider Pediatric Adverse Event Rate Varies by Call Origin Pediatric Emergency Care

David Jones, MD, MCR*, Matt Hansen, MD*, Josh Van Otterloo, MPH†, Caitlin Dickinson, MPH*,†, and Jeanne-Marie Guise, MD*,†,‡,§,||

*Department of Emergency Medicine, Oregon Health & Science University, Portland, OR

†Department of Obstetrics and Gynecology, Oregon Health & Science University, Portland, OR

‡Department of Medical Informatics and Clinical Epidemiology, Oregon Health & Science University, Portland, OR

§Department of Public Health and Preventive Medicine, Oregon Health & Science University, Portland, OR

||Office of the Vice Provost, Oregon Health & Science University, Portland, OR

Abstract

Objective—Emergency medical services providers may be called to a variety of sites to transport pediatric patients, whether it be a scene call for initial evaluation and care, a clinic for transportation of a patient who has been assessed by medical providers, or a hospital where assessment and stabilization have already begun. We hypothesize that there may be a direct relationship between adverse event rates and adverse event severity in transports from less medically stabilizing origins.

Methods—Emergency medical services records of all critical pediatric transports in an urban Oregon county in 2011 were reviewed and abstracted using a standardized tool. From this, UNSEMs (unintended injury, near miss, suboptimal action, error, management complication) were determined, and the potential severity of the issue was assessed. Then, UNSEMs were compared with the origin of transport using logistic regression.

Results—Four hundred ninety records were abstracted: 59 hospital transports, 48 clinic transports, and 384 scene transports. Furthermore, UNSEMs were noted in 24 hospital transports (40.7%), 33 clinic transports (68.8%), and 263 scene transports (68.5%). Severe UNSEMs were reported on 0 hospital transports (0.0%), 12 clinic transports (25.0%), and 65 scene transports (16.9%). The odds ratio of UNSEM occurrence from a hospital compared with nonmedical scenes was 0.35 (95% confidence interval, 0.20–0.60), and the odds ratio of a severe UNSEM from a hospital compared with non-medical scenes was 0.09 (95% confidence interval, 0.01–0.63).

Conclusions—In conclusion, UNSEMs involving the emergency medical services care of children are more likely to occur when transport originates from a clinic or scene compared with a hospital.

Reprints: David Jones, MD, MBS, CDW-EM, 3181 SW Sam Jackson Park Rd, Mail Stop L466, Portland, OR (jonesdav@ohsu.edu).

Disclosure: The authors declare no conflict of interest.

Keywords

patient safety; medical errors; pre-hospital medicine

Emergency medicine has been described as a laboratory for studying medical errors.¹ The chaotic and unpredictable nature of the emergency medical services (EMS) environment is potentially even more prone to errors as EMS providers respond to uncontrolled scenes with minimal knowledge of the situation before arrival. They are tasked with assessing and treating patients on scene and en route to the hospital in a moving and hectic environment. This makes the study of emergency medical errors challenging but important for patient safety. Pediatric patients account for approximately 13% of EMS transports, and because of rarity of true emergency calls in this population, EMS providers often report a lack of comfort with pediatric patients, equipment, protocols, and medical needs, increasing the risk of potential patient safety events.^{2–6} Although pediatric out-of-hospital care has been studied in simulation settings,^{7,8} there has not been a large evaluation of out-of-hospital pediatric adverse events occurring during real patient care.

Emergency medical services providers may be called to a variety of sites to transport pediatric patients, including nonmedical scene calls, clinics, and hospitals. On EMS arrival, a transport originating from a home or other nonmedical scene will have less medical assessment than an outpatient clinic where there was likely to have been some assessment and treatment, which will in turn have less medical assessment and stabilization than a hospital ward or emergency department. In addition, interfacility transports from clinics or hospitals can provide EMS providers with instructions directing the medical care during the transport. Online medical control has been shown to decrease anxiety in EMS providers and provide cognitive offloading to allow focus on specific tasks, and direct medical control may act similarly.^{9,10}

This study seeks to identify the relationship between adverse events occurring during high-risk pediatric transports where red lights and sirens were used and the origin of transportation. We hypothesize that there may be a relationship between the adverse event rate and severity of pediatric out-of-hospital adverse events and the origin of transport.

METHODS

This study was a retrospective chart review. Prehospital records of critical pediatric transports running red lights and sirens were obtained from multiple EMS services spanning both fire departments and single-tier advanced life support EMS in the large metropolitan area of Multnomah County in Oregon in 2008 to 2011. Records obtained were electronic in the format used by the EMS or fire service and were supplied by the services for analysis. All transportations were by private advanced life support ambulances, although the fire department may have been involved in the initial response. We included all transports where red lights and sirens were used, including scene calls, transports from primary clinics and urgent cares, and interfacility transportations (both between inpatient units and between emergency departments). Red lights and sirens are activated at the discretion of the transport team. Red lights and sirens were chosen as the inclusion criteria to denote significant

concern for the patient by the transport team. Transportations specifically made by specialized pediatric transport teams were excluded. To validate the restricted case review, a random sample of 30 non-red light and siren pediatric transports from the same area and period was reviewed to ensure that outcomes, errors, and procedures deemed critical for this study were not actually routine components of EMS care.

A standardized clinical chart assessment tool was created to abstract the prehospital record, and reviewers underwent training to standardize the approach and review of each record. The standardized clinical assessment tool was adapted from landmark hospital patient safety studies by Brennan et al¹¹ and Leape et al¹² and informed by focus groups conducted by our EMS research team. Cognitive interviews were conducted to assess face validity, clarity of content, instructions, and usability of the abstraction tool.¹³ Briefly, a think-aloud interviewing method was used asking EMT-paramedics, emergency physicians, and EMS program directors to vocalize their comprehension of questions and to think aloud as they retrieved information and analyzed and interpreted which information to use to complete the abstraction tool questions. All charts were de-identified before review, and chart reviewers were not affiliated with agencies providing charts for review.

Each record was independently reviewed and abstracted by an emergency physician and a paramedic who were blinded to the other reviews. Multiple combinations of reviewers were used but always with a physician and prehospital provider. Safety events were classified into the following categories: unintended injury or consequence, near misses, suboptimal actions that are amenable to improvement, errors, and management complications, collectively called UNSEMs. The chart reviewers assigned a severity score for the potential harm associated with UNSEMs according to the following 3 categories: no harm likely or a near miss, mild or temporary harm including additional treatment, and permanent or severe harm including death. A severe UNSEM was categorized as permanent or severe harm including death. A pediatric emergency physician with expertise in EMS served as an arbiter to resolve discrepancies between the physician and prehospital providers. Further details about the methods used are provided in a manuscript by Guise et al.¹⁴

Statistical analysis was completed with SAS v9.4 (Cary, NC) using logistic regression and descriptive statistics.

RESULTS

The patient characteristics for the study are summarized in Table 1. Four hundred ninety records were abstracted, with 59 hospital transports, 48 clinic transports, and 384 scene transports. Furthermore, UNSEMs were noted on 24 hospital transports (40.7%), 33 clinic transports (68.8%), and 263 scene transports (68.5%). Severe UNSEMs were reported on 0 hospital transports (0.0%), 12 clinic transports (25.0%), and 65 scene transports (16.9%). As shown, trauma, seizure, and respiratory issues were the most common reasons for dispatch. Figure 1 demonstrates the relative proportions of UNSEMs by call origin. As shown, there was a statistically significant and disproportionately high rate of severe UNSEM occurrences among cardiac arrest cases. Table 2 shows logistic regression results for UNSEMs and severe UNSEMs relative to call origin. Compared with scene calls and calls from medical

facilities (eg, clinics, medical offices) other than hospitals, calls originating from a hospital had a significantly reduced rate of UNSEMs (odds ratio, 0.35) and severity of potential harm (odds ratio, 0.09). There was no difference between scene and calls originating from other medical providers. Regardless of origin, longer time on scene by EMS was related to an increased rate of UNSEM and severe UNSEM occurrence (Table 3).

DISCUSSION

The literature on out-of-hospital patient safety is sparse, with even fewer studies investigating the safety for pediatric patients.¹⁵ Most of the pediatric out-of-hospital patient safety literature involves critical care topics such as airway management, trauma, dedicated pediatric transport teams, and medication dosing errors.^{16–19} Many adverse events in the pediatric population may go unreported.²⁰ To the best of our knowledge, the effect of the origin of transport on the UNSEM rate has not been previously studied on adult or pediatric populations.

This blinded, retrospective chart review study supports our hypothesis that, in EMS transports, there is a trend for UNSEMs to occur with greater frequency and severity among transports originating from scenes or clinics compared with hospitals. Interfacility transports are often transported by advanced life support by default. Given the low rate of UNSEMs associated with interfacility transfers, more critically evaluating the need for advanced life support for interfacility transports could be a cost- and resource-saving measure. This must however be weighed against the probability of a patient requiring an advanced life support skill set en route or ongoing therapy that exceeds the scope of practice of basic life support providers. Price et al demonstrated that there was a trend toward EMS errors in deteriorating adults with short scene times.²¹ Our data do not show this to be the case with pediatric patients. For every 60 seconds longer on scene, the odds of an UNSEM increased by 1.02 to 1.038 for any UNSEM and severe UNSEMs, respectively. These data should be interpreted cautiously, however, as many of the UNSEMs were related to cardiac arrest patients who had a disproportionately high rate of UNSEMs. There was insufficient data with severe UNSEM occurrence to exclude cardiac arrest cases.

Our study has unique strengths in providing a rigorous evaluation of clinical care; however, it also has limitations. Study limitations include a relatively small sample size, potentially limited generalizability given geographic focus, and the limitations inherent to retrospective chart reviews. Although the sample size limited categorization into more granular groups, obtaining large samples in studies of critically ill children in the out-of-hospital environment is challenging due to the rarity of events, making this a relatively large study for rare events. The data came from 1 large metropolitan area and may not be generalizable to other settings, although this county is a large urban area with 8 separate hospitals that receive EMS transports. Finally, our study has the standard limitations inherent to chart reviews in that we relied upon what was documented in the medical record. Included in the chart review bias may be that the sickest patients transported between facilities would likely have gone by specialized pediatric transportation teams that were excluded from analysis.

This study highlights the significance that the origin of transport can have both on the rate of UNSEMs and the rate of significant UNSEMs that have the potential to cause harm in emergent EMS transportation of children. Although the underlying cause of the difference is not known, stabilization before EMS arrival is likely to play a role. Further study is needed to determine the cause of the difference and how to decrease adverse events in scene and clinic transportations.

Acknowledgments

Supported by the National Institute of Child Health and Human Development, grant no. 1R01HD062478.

References

1. Croskerry P, Sinclair D. Emergency medicine: a practice prone to error? *CJEM*. 2001; 3:271–276. [PubMed: 17610769]
2. Shah MN, Cushman JT, Davis CO, et al. The epidemiology of emergency medical services use by children: an analysis of the National Hospital Ambulatory Medical Care Survey. *Prehosp Emerg Care*. 2008; 12:269–276. [PubMed: 18584491]
3. Fleishman RJ, Yarris LM, Curry TM, et al. Pediatric educational needs assessment for urban and rural emergency medical technicians. *Pediatr Emerg Care*. 2011; 27:1130–1135. [PubMed: 22134229]
4. Joyce SM, Brown DE, Nelson EA. Epidemiology of pediatric EMS practice: a multistate analysis. *Prehosp Disaster Med*. 1996; 11:180–187. [PubMed: 10163380]
5. Cottrell EK, O'Brien K, Curry M, et al. Understanding safety in prehospital emergency medical services for children. *Prehosp Emerg Care*. 2014; 18:350–358. [PubMed: 24669906]
6. Hoyle JD, Davis AT, Putman KK, et al. Medication dosing errors in pediatric patients treated by emergency medical services. *Prehosp Emerg Care*. 2012; 16:59–66. [PubMed: 21999707]
7. Lammers RL, Byrwa M, Fales W. Root causes of errors in a simulated prehospital pediatric emergency. *Acad Emerg Med*. 2012; 19:37–47. [PubMed: 22251191]
8. Lammers RL, Willoughby-Byrwa M, Fales WD. Errors and error-producing conditions during a simulated, prehospital, pediatric cardiopulmonary arrest. *Simul Healthc*. 2014; 9:174–183. [PubMed: 24401924]
9. Williams DM, Rindal KE, Cushman JT, et al. Barriers to and enablers for prehospital analgesia for pediatric patients. *Prehosp Emerg Care*. 2012; 16:519–526. [PubMed: 22823931]
10. Rottman SJ, Schriger DL, Charlop G, et al. On-line medical control versus protocol-based prehospital care. *Ann Emerg Med*. 1997; 30:62–68. [PubMed: 9209228]
11. Brennan TA, Leape LL, Laird NM, et al. Incidence of adverse events and negligence in hospitalized patients: results of the Harvard Medical Practice Study I. *N Engl J Med*. 1991; 324:370–376. [PubMed: 1987460]
12. Leape LL, Brennan TA, Laird NM, et al. The nature of adverse events in hospitalized patients: results of the Harvard Medical Practice Study II. *N Engl J Med*. 1999; 324:377–384.
13. Jobe J, Mingay D. Cognitive research improves questionnaires. *Am J Public Health*. 1989; 79:1053–1055. [PubMed: 2751028]
14. Guise JM, Meckler G, O'Brien K, et al. Patient safety perceptions in pediatric out-of-hospital emergency care: children's safety initiative. *J Pediatr*. 2015; 167:1143e1–1148.e1. [PubMed: 26297483]
15. Bigham BL, Buick JE, Brooks SC, et al. Patient safety in emergency medical services: a systematic review of the literature. *Prehosp Emerg Care*. 2012; 16:20–35. [PubMed: 22128905]
16. Gausche M, Lewis RJ, Stratton SJ, et al. Effect of out-of-hospital pediatric endotracheal intubation on survival and neurologic outcome: a controlled clinical trial. *JAMA*. 2000; 283:783–790. [PubMed: 10683058]

17. Potoka DA, Schaall LC, Gardner MJ, et al. Impact of pediatric trauma centers on mortality in a statewide system. *J Trauma*. 2000; 49:237–245. [PubMed: 10963534]
18. Edge WE, Kanter RK, Weigle CG, et al. Reduction of morbidity in interhospital transport by specialized pediatric staff. *Crit Care Med*. 1994; 22:1186–1191. [PubMed: 8026211]
19. Vilke GM, Marino A, Fisher R, et al. Estimation of pediatric patient weight by EMT-PS. *J Emerg Med*. 2001; 21:125–128. [PubMed: 11489399]
20. Cushman JT, Fairbanks RJ, O’Gara KG, et al. Ambulance personnel perceptions of near misses and adverse events in pediatric patients. *Prehosp Emerg Care*. 2010; 14:477–484. [PubMed: 20662679]
21. Price R, Bendall JC, Patterson JA, et al. What causes adverse events in prehospital care? A human-factors approach. *Emerg Med J*. 2013; 30:583–588. [PubMed: 22802456]

FIGURE 1.
Adverse event domain by call location.

TABLE 1

Patient Characteristics

Patient Characteristics	n	%
Age		
Newborn, 0–28 d	23	4.7
Infant, 29 d–11 mo	61	12.4
Toddler, 1–5 y	169	34.5
Kid, 6–11 y	84	17.1
Adolescent, 12–17 y	153	31.2
Sex		
Female	195	39.8
Male	293	59.8
Time of transport		
Morning: 05:00–10:59	84	17.1
Afternoon: 11:00–16:59	188	38.4
Evening: 17:00–22:59	160	32.7
Overnight: 23:00–04:59	58	11.8
Transport duration: <i>M</i> , 15:30; <i>SD</i> , 07:59		
Fire ALS involvement, yes	205	41.8
Reason for call		
Cardiopulmonary arrest	35	7.1
Trauma	203	41.4
Seizure or ALOC	107	21.8
Febrile seizure	52	10.6
Nonfebrile seizure or ALOC	55	11.2
Ingestion/poisoning	29	5.9
Respiratory distress	79	16.1
Allergic reaction	11	2.2
Pain (nontrauma)	12	2.4
Other	14	2.9
Interfacility transport *	115	23.5
Birth/delivery *	15	3.1

* Birth/delivery and interfacility transport are secondary classifications and do not count toward the total N.

ALOC indicates altered level of consciousness.

TABLE 2
Regression Analyses Predicting UNSEMs by Origin With Scene Calls as the Reference

	Call Origin	OR	Lower CI	Upper CI	P
Any UNSEM	Hospital (n = 59)	0.35	0.20	0.60	<0.001
	Other medical facility (n = 48)	1.14	0.60	2.14	0.697
Any severe UNSEM	Scene (n = 384)	Ref	—	—	—
	Hospital (n = 59)	0.09	0.01	0.63	0.016
	Other medical facility (n = 48)	1.71	0.86	3.38	0.126
	Scene (n = 384)	Ref	—	—	—

TABLE 3

Regression Analysis Predicting UNSEM Based on Time on Scene

Unadjusted Models	OR for 60-s Change	95% CI	
		Lower Limit	Upper Limit
Any UNSEM, full population	1.020	0.994	1.046
Any severe UNSEM, full population	1.038	1.010	1.068
Any UNSEM, scene calls only	1.038	1.003	1.073
Any severe UNSEM, scene calls only	1.036	1.003	1.070