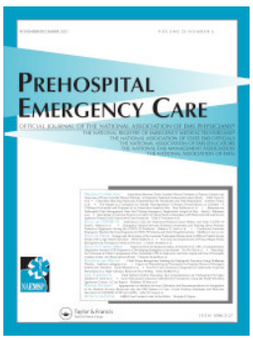

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National Characteristics of Non-Transported Children by Emergency Medical Services in the United States

Caleb Ward, Anqing Zhang, Kathleen Brown, Joelle Simpson, and James Chamberlain

Abstract

Study Objective: Most 911 calls result in ambulance transport to an emergency department. In some cases, transport is refused or deemed unnecessary. The frequency of pediatric non-transport is unknown. Our primary objective was to describe the proportion of pediatric EMS activations resulting in non-transport. Our secondary objective was to identify patient, community, and EMS agency factors associated with pediatric non-transport. **Methods:** We conducted a cross-sectional study using 2019 data from the National EMS Information System registry. We compared non-transport rates for children (<18 y/o), adults (18 – 60 y/o) and elderly (>60 y/o) patients. We then used generalized estimating equations to identify factors associated with pediatric non-transport while accounting for geographical clustering. **Results:** There were 21,931,490 EMS activations, including 1,403,454 pediatric 911 responses. 30% of pediatric 911 responses resulted in non-transport. Non-transport was less likely for adults (19%, OR 0.54 [0.54, 0.55]) and elderly patients (13%, OR 0.35 [0.35, 0.36]). The most common pediatric non-transport dispositions were: refused evaluation/care, and treated/released. Non-transport was associated with: pulmonary (aOR 3.84 [3.30, 4.48]) and musculoskeletal chief complaints (aOR 3.75 [3.22, 4.36]). Non-transport was more likely for: rural EMS calls (aOR 1.28 [1.24, 1.32]); calls classified by EMS as Lower Acuity (aOR 7.88 [5.98, 10.38]); and Tribal EMS agencies (aOR 3.49 [3.09, 3.94]). **Conclusion:** Almost one-third of pediatric 911 activations result in non-transport. Although very few children have been included in pilots of alternate transport processes to date, non-transport is actually more common in children than adults. More work is needed to understand better the patient safety and economic implications of this practice. **Key words:** Emergency Medical Services (EMS); triage; pediatric transport

PREHOSPITAL EMERGENCY CARE 2021;00:000–000

Introduction

Background

Emergency Medical Services (EMS) systems were formally established in the United States (US) in the 1960s to provide rapid patient transport to hospital emergency departments (EDs) for emergent conditions (1). EMS has grown to comprise 28 million EMS responses per year (2). EMS providers are now routinely called for non-urgent illnesses and injuries (3). The traditional EMS model of care has struggled to keep up with this increased demand. The prevailing model of sending an ambulance to treat and transport every patient activating the nation's 911 system to an ED is not sustainable in many parts of the country (4).

In response to these developments, alternative EMS disposition processes (including EMS initiated non-transport) for low acuity patients have recently garnered significant federal and local attention (5–7). The proportion of EMS calls resulting in non-transport is increasing (3, 8). *EMS Agenda 2050* envisages that in the future, "EMS and its partner agencies will coordinate to provide the most appropriate care to the patient, with transport to a healthcare facility being just one option." In 2019, the Centers for Medicare & Medicaid Services (CMS) launched the *Emergency Triage, Treatment & Transport (ET3)* model (5). *ET3* provides incentives for EMS agencies to develop and assess protocols for Medicare patients so that they may be assessed at the scene (including with the use of telemedicine) and not transported, or transported to an alternative site, such as a primary care office. The novel

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Address correspondence to Caleb Ward at caward@childrensnational.org

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Coronavirus (COVID-19) pandemic has further intensified the pressures for non-transport with both EMS agencies and families looking to avoid unnecessary ambulance transport to the ED. Many states have implemented emergency protocols allowing EMS-initiated non-transport (9), and some have shown an increase in EMS non-transport rates during the pandemic (10). Research into more flexible EMS delivery and reimbursement processes is also a frequently identified priority area for prehospital pediatric research (11, 12).

Goals of This Investigation

Despite this increased attention, the current national rate of pediatric non-transport in the US is unknown. Limited small and mainly urban local studies report pediatric non-transport rates in the US of 16-28% (8, 13, 14). The ability to describe the patient and transport agency characteristics of non-transported children in these studies has been limited by small sample sizes and incomplete consideration of confounding variables (8, 13). A prerequisite for analyzing the safety and economic implications of pediatric non-transport (whether caregiver or EMS initiated) is an accurate understanding of the baseline national epidemiology of pediatric non-transport by EMS. When compared to adult patients, a greater proportion of pediatric EMS cases are for low acuity complaints (15, 16). Therefore, we performed this study to test the hypothesis that a greater proportion of pediatric 911 activations result in non-transport when compared to adult patients. Our secondary goal was to determine whether individual patient demographic and clinical characteristics, EMS transport team/agency characteristics, and population characteristics are associated with pediatric non-transport.

METHODS

Study Design and Data Source

We conducted a cross-sectional study using 2019 data from the National EMS Information System (NEMSIS) database (17). NEMSIS is a voluntary national registry of 911 EMS activations funded by the National Highway Traffic Safety Administration (NHTSA) (18). The database is comprised of electronic patient care reports submitted by local EMS agencies to state repositories. The NEMSIS database is a record of care reports for EMS activations and is not a registry of patients receiving care. The care reports include dispatch data, patient demographics, clinical details, and transportation disposition. Some of these variables are then submitted to the national database. In 2019, the national dataset included 34,203,807 EMS activations submitted by 10,062 EMS agencies serving 47 states and territories.

We obtained covariates of interest from NEMSIS and the 2019 County Health Rankings & Roadmaps (CHR&R) (19). The CHR&R are produced by the Robert Wood Johnson Foundation and the University of Wisconsin Population Health Institute. The rankings are compiled using county-level measures from a range of national and state data sources. We used county data for the zip code where the 911 call originated.

Study Population

We included all 2019 NEMSIS activations for patients aged $0-17$ years of age. 2019 is the last complete calendar year of data available. We excluded medical transports (convalescent, interfacility hospital transfer, and nursing homes), as our patient population of interest was pediatric patients undergoing evaluation after a 911-initiated EMS activation. We also excluded records where there was no patient contact.

Primary Outcome

Our primary outcome was the proportion of pediatric EMS activations that did not result in transport by EMS to a medical facility. We coded the following responses as non-transport: patient refused evaluation/care (without transport); patient treated, release (AMA); patient evaluated, no treatment/transport required; patient treated, release (per protocol); and patient treated, transported by private vehicle.

Covariates of Interest

Our analysis included covariates based on biologic or sociologic plausibility and related to patient demographics, the individual patient encounter, responding EMS agency, and community from where the EMS call originated. We obtained covariate data from NEMSIS and the CHR&R. From NEMSIS, we included patient demographic variables of age, gender, race/ethnicity, and primary payor. These variables are reported in NEMSIS based on field data collected by prehospital EMS providers. We examined non-transport rates and grouped age into the following categories: infants and toddlers (< 2 y/o); preschool children ($2-4$ y/o); school-aged children ($5-11$ y/o); and adolescents (> 12 y/o). These categories are similar to previously published studies using NEMSIS data (20, 21). NEMSIS encounter

Table 1. Emergency Medical Services (EMS) dispositions for 911-activations by patient age.

	Pediatric *0-17y/o*		Adult *18-60 y/o*			Elderly > 60 y/o		
	N	%	N	%	OR (95% CI)	N	%	OR (95% CI)
Non-Transport sub-total	**422,952**	***30.14***	**1,980,146**	***18.98***	0.54 (0.54 – 0.55)	**1,337,519**	***13.25***	0.35 (0.35 – 0.36)
Caregiver initiated non-transport								
Patient refused evaluation/care (without transport)	130,231	*9.28*	678,371	*6.50*		450,431	*4.46*	
Patient treated, Release (AMA)	134,242	*9.57*	648,520	*6.22*		418,318	*4.14*	
EMS initiated non-transport								
Patient Evaluated, No Treatment/Transport Required	93,092	*6.63*	377,253	*3.62*		281,513	*2.79*	
Patient Treated, Release (per protocol)	54,187	*3.86*	251,745	*2.41*		172,214	*1.71*	
Patient Treated, Transported by Private Vehicle	11,200	*0.80*	24,257	*0.23*		15,043	*0.15*	
Transport sub-total	**980,502**	***69.86***	**8,450,559**	***81.02***		**8,759,812**	***86.75***	
TOTAL	**1,403,454**	***100***	**10,430,705**	***100***		**10,097,331**	***100***	

variables included date and time of unit dispatch, incident location type, response mode (determined by the dispatch center), initial and final patient acuity (determined by the EMS providers at scene), and chief complaint organ system. We grouped date & time data into two categories approximating typical hours that primary care offices are open: Monday-Friday 8 am – 5 pm; and all other dates/times. NEMSIS variables about the responding agency included EMS organizational type (fire department, governmental/non-fire, hospital, and private/non-hospital), organizational status (volunteer, non-volunteer, and mixed), and the level of care of the unit (Advanced Life Support vs. Basic Life Support). NEMSIS variables about the geographic region for the incident included US census division and urbanicity. From the 2019 CHR&R, we included the following variables: ratio of population to primary care physicians; ratio of population to dentists; ratio of population to mental health providers; proportion of children living in poverty; and the social association ratio. Social support networks have been identified as predictors of health behaviors (including how care is accessed) (22). The social associations ratio measures the number of membership associations (including civic, religious, political and sports organizations) per 10,000 population.

Statistical Analysis

We calculated the proportion of EMS activations, with 95% confidence intervals (95% CI), that resulted in non-transport. We compared pediatric non-transport rates to those for adults (18 – 60 y/o) and elderly (>60 y/o) patients. We used bivariable and multivariable logistic regression to test for associations of covariates with non-transport, expressing our results as odds ratios with 95% CI. To reduce the risk of over-fitting given the size of the dataset available, pediatric records were divided randomly into a development set (70%) for model building and a validation set (30%). From the list of proposed variables, payor and final acuity were removed from the model because data were missing in more than 40% of records (Supplemental Table 1). We used a backward stepwise selection approach to eliminate candidate variables with a significance level of less than 0.1 in bivariable analyses. Patient gender and race were not included in the final model as they were not significantly associated with non-transport. We used generalized estimating equations (GEE) to account for the subject correlation within census clusters. We chose the exchangeable working correlation (EXCH) for the data set. We used discrimination and calibration to measure the accuracy of the multivariable model. Due to our large sample size, we did not perform a Hosmer & Lemeshow (HL) test. Instead, we plotted the calibration curve to check the agreement between observed and expected numbers by non-transport probability deciles. We used complete case analysis to handle missing data. For the variable Chief Complaint Organ System, data was missing in 33% of records. We confirmed that this data was missing at random. The breakdown by organ system did not significantly change after multiple imputation analysis (Supplemental Table 2). All data analysis was performed in SAS for Windows version 9.4 (SAS Institute Inc., Cary, NC). We used two-sided tests and a significance level of 0.05 throughout the regression model.

TABLE 2. Patient characteristics of pediatric patients included in development and validation sets.

	Development Set (N = 982,417)		Validation Set (N = 421,037)	
Variables	N	%	N	%
Age Group				
< 2 y/o	104,473	*10.63*	44,660	*10.61*
2 – 4 y/o	155,879	*15.87*	66,509	*15.8*
5 – 11 y/o	274,535	*27.94*	117,986	*28.02*
≥ 12 y/o	447,530	*45.55*	191,882	*45.57*
Gender				
Female	468,723	*48.23*	200,023	*48.04*
Male	503,037	*51.77*	216,386	*51.96*
Race				
American Indian/Alaska native	4,698	*1.02*	1,955	*0.99*
Asian	6,649	*1.44*	2,749	*1.39*
Black or African American	107,958	*23.33*	45,835	*23.16*
Hispanic or Latino	37,918	*8.19*	16,397	*8.29*
Native Hawaiian or Other pacific Islander	1,595	*0.34*	724	*0.37*
White	303,944	*65.68*	130,246	*65.81*
Primary Methods of Payment				
Community Network	308	*0.08*	140	*0.08*
Contracted Payment	401	*0.1*	178	*0.1*
Insurance	104,262	*25.89*	44,599	*25.87*
Medicaid	77,296	*19.19*	33,199	*19.26*
Medicare	4,174	*1.04*	1,728	*1*
Not Insurance Identified	113,291	*28.13*	48,427	*28.09*
Not billed	11,735	*2.91*	5,006	*2.9*
Other Government	2,974	*0.74*	1,217	*0.71*
Other Payment Option	29,227	*7.26*	12,725	*7.38*
Payment by Facility	162	*0.04*	58	*0.03*
Self Pay	58,797	*14.6*	25,039	*14.53*
Workers Compensation	104	*0.03*	58	*0.03*
Chief Complaint Organ System				
Behavioral/Psychiatric	39,665	*6.01*	16,900	*5.98*
CNS/Neuro	64,490	*9.78*	27,625	*9.78*
Cardiovascular	11,324	*1.72*	4,925	*1.74*
Endocrine/Metabolic	14,493	*2.2*	6,330	*2.24*
GI	22,479	*3.41*	9,577	*3.39*
Global/General	294,683	*44.68*	126,381	*44.75*
Lymphatic/Immune	7,986	*1.21*	3,416	*1.21*
Musculoskeletal/Skin	146,944	*22.28*	62,926	*22.28*
Pulmonary	54,072	*8.2*	22,953	*8.13*
Reproductive	3,337	*0.51*	1,397	*0.49*
Possible Injury				
No	649,967	*66.16*	278,937	*66.25*
Yes	292,662	*29.79*	125,174	*29.73*
Unknown	39,788	*4.05*	16,926	*4.02*
Date & Time Unit Notified by Dispatch				
Office Hours (Mon-Fri, 8am-5pm)	538,984	*54.86*	231,009	*54.87*
Out of Office Hours	443,433	*45.14*	190,028	*45.13*
Incident Location Type				
Medical Facility	53,218	*5.42*	22,840	*5.42*
Residential	463,355	*47.16*	198,895	*47.24*
Roadside	188,410	*19.18*	80.496	*19.19*
School	102.598	*10.44*	44,145	*10.48*
Other	128,044	*13.03*	54,557	*12.96*
EMS Response Mode to Scene				
Emergent	842,289	*85.74*	360,504	*85.62*
Emergent Downgraded to Non-Emergent	14,486	*1.47*	6,309	*1.5*
Non-Emergent	122,469	*12.47*	52,883	*12.56*
Non-Emergent Upgraded to Emergent	3,173	*0.32*	1,341	*0.32*
Initial Patient Acuity				
Critical (Red)	26,189	*3.82*	11,293	*3.84*
Dead without Resuscitation Efforts (Black)	1,431	*0.21*	546	*0.19*

(*Continued*)

Table 2. (*Continued*).

Variables	Development Set (N = 982,417)		Validation Set (N = 421,037)	
	N	%	N	%
Emergent (Yellow)	151,810	*22.13*	65,468	*22.27*
Lower Acuity (Green)	506,658	*73.85*	216,618	*73.7*
Final Patient Acuity				
Critical (Red)	14,663	*2.87*	6,242	*2.85*
Dead without Resuscitation Efforts (Black)	830	*0.16*	323	*0.15*
Emergent (Yellow)	108,007	*21.13*	46,216	*21.1*
Lower Acuity (Green)	387,637	*75.84*	166,245	*75.9*
Level of Care of this Unit				
ALS-Paramedic	822,472	*83.72*	352,523	*83.73*
BLS-Basic/EMT	159,945	*16.28*	68,514	*16.27*
EMS Organizational Status				
Mixed	220,853	*22.48*	94,740	*22.5*
Non-Volunteer	736,205	*74.94*	315,258	*74.88*
Volunteer	25,359	*2.58*	11,039	*2.62*
EMS Agency Organization Type				
Fire Department	459,974	*46.82*	197,421	*46.89*
Governmental, Non-Fire	210,453	*21.42*	90,619	*21.52*
Hospital	66,335	*6.75*	27,957	*6.64*
Private, Nonhospital	242,233	*24.66*	103,573	*24.6*
Tribal	3,422	*0.35*	1,467	*0.35*
Urbanicity				
Rural	58,753	*6.2*	25,410	*6.25*
Suburban	48,791	*5.15*	20,768	*5.11*
Urban	825,316	*87.06*	353,676	*87.06*
Wilderness	15,144	*1.6*	6,407	*1.58*
US Census Division				
East North Central	106,673	*10.87*	46,010	*10.94*
East South Central	48,794	*4.97*	20,481	*4.87*
Middle Atlantic	81,188	*8.28*	34,889	*8.3*
Mountain	95,373	*9.72*	40,644	*9.66*
New England	39,444	*4.02*	16,991	*4.04*
Pacific	141,003	*14.37*	60,407	*14.36*
South Atlantic	284,180	*28.97*	121,615	*28.92*
West North Central	46,024	*4.69*	19,799	*4.71*
West South Central	138,430	*14.11*	59,693	*14.19*
Incident Patient Disposition				
Patient Evaluated, No Treatment/Transport Required	65,279	*22.03*	27,813	*21.97*
Patient Treated, Transported by Private Vehicle	7,952	*2.68*	3,248	*2.57*
Patient refused evaluation/care (without transport	91,182	*30.77*	39,049	*30.85*
Patient treated, Release (AMA)	94,080	*31.74*	40,162	*31.73*
Patient treated, Release (per protocol)	37,880	*12.78*	16,307	*12.88*
	Mean	***SD***	**Mean**	***SD***
% of children living in poverty	0.19	0.08	0.19	0.08
Ratio of population to primary care physicians	1672.46	1326.90	1669.37	1318.71
Ratio of population to mental health providers	793.00	1148.71	790.46	1138.95
Ratio of population to dentists	1826.97	1346.78	1826.76	1350.77
Social associations expressed as memberships per 10,000 population	0.0009	0.0004	0.0009	0.0004

The Institutional Review Board at Children's National Hospital approved this study.

Results

There were 21,931,490 EMS activations resulting from a 911-activation that involved patient contact submitted to NEMSIS in 2019. Among these, 1,403,454 (6.5%) were for children (Table 1), of which 30.1% resulted in non-transport. Non-transport of adults and elderly patients was much less common than for pediatric patients (OR 0.54 and 0.35, respectively) (Table 1). The most common reported pediatric non-transport dispositions were: patient treated and released (against medical advice); and patient refused evaluation/care (without transport). One-third of pediatric non-transport

TABLE 3. Factors associated with pediatric non-transport by Emergency Medical Services (EMS).

	Non-transported (%)	Transported (%)	OR (95% CI)	aOR (95% CI)
Variable				
Age Group				
≥ 12 y/o	28.37	71.36	Reference	
< 2 y/o	28.75	71.25	1.02 (1.00, 1.03)	1.19 (1.16, 1.22)
2 – 4 y/o	31.03	68.97	1.14 (1.12, 1.15)	1.26 (1.23, 1.29)
5 – 11 y/o	33.15	66.85	1.25 (1.24, 1.26)	1.27 (1.25, 1.29)
Gender[§]				
Male	29.89	70.11	Reference	
Female	30.14	69.86	1.01 (1.00, 1.02)	
Race[§]				
American Indian/Alaska Native	29.97	70.03	Reference	
Asian	30.91	69.09	1.05 (0.96, 1.14)	
Black or African American	30.29	69.71	1.02 (0.95, 1.08)	
Hispanic or Latino	30.54	69.46	1.03 (0.96, 1.10)	
Native Hawaiian or Other Pacific Islander	31.02	68.98	1.05 (0.93, 1.19)	
White	30.62	69.38	1.03 (0.97, 1.10)	
Chief Complaint Organ System				
Reproductive	8.66	91.34	Reference	
Behavioral/Psychiatric	11.57	88.43	1.38 (1.22, 1.56)	1.16 (0.99, 1.35)
Endocrine/Metabolic	15.45	84.55	1.92 (1.69, 2.19)	2.15 (1.83, 2.52)
Cardiovascular	16.33	83.67	2.05 (1.81, 2.34)	2.56 (2.18, 3.02)
CNS/Neuro	16.69	83.31	2.11 (1.87, 2.39)	2.32 (1.99, 2.70)
GI	20.28	79.72	2.68 (2.36, 3.04)	2.37 (2.03, 2.77)
Lymphatic/Immune	20.4	79.60	2.70 (2.36, 3.08)	2.75 (2.33, 3.25)
Pulmonary	22.49	77.51	3.06 (2.70, 3.45)	3.84 (3.30, 4.48)
Global/General	30.44	69.56	4.61 (4.08, 5.21)	3.79 (3.26, 4.41)
Musculoskeletal/Skin	32.27	67.73	5.03 (4.44, 5.65)	3.75 (3.22, 4.36)
Possible Injury				
No	29.04	70.96	Reference	
Yes	31.21	69.79	1.11 (1.10, 1.12)	0.83 (0.81, 0.85)
Unknown	34.11	65.89	1.27 (1.24, 1.29)	1.04 (0.99, 1.08)
Date & Time Unit Notified by Dispatch				
Out of Office Hours	29.58	70.42	Reference	
Office Hours (Mon-Fri, 8am-5pm)	30.65	69.35	1.05 (1.04, 1.06)	1.03 (1.01, 1.04)
Incident Location Type				
Medical Facility	3.93	96.07	Reference	
Residential	27.35	72.65	9.20 (8.80, 9.62)	9.29 (8.69, 9.94)
School	28.40	71.60	9.70 (9.26, 10.15)	10.46 (9.75, 11.23)
Other	31.09	68.91	11.03 (10.54, 11.54)	14.47 (13.50, 15.51)
Roadside	43.14	56.86	18.54 (17.73, 19.38)	16.05 (14.98, 17.20)
EMS Response Mode to Scene				
Non-Emergent Upgraded to Emergent	17.81	82.19	Reference	
Emergent	30.26	69.74	1.99 (1.82, 2.19)	1.35 (1.19, 1.54)
Emergent Downgraded to Non-Emergent	30.99	69.01	2.07 (1.87, 2.28)	1.30 (1.13, 1.50)
Non-Emergent	29.74	70.26	1.94 (1.78, 2.14)	1.52 (1.33, 1.73)
Initial Patient Acuity				
Dead without Resuscitation Efforts (Black)	5.80	94.20	Reference	
Critical (Red)	6.82	93.18	1.19 (0.88, 1.61)	1.15 (0.87, 1.53)
Emergent (Yellow)	11.21	88.79	2.06 (1.43, 2.75)	1.83 (1.39, 2.42)
Lower Acuity (Green)	33.41	66.59	8.17 (6.11, 10.94)	7.88 (5.98, 10.38)
Level of Care of this Unit				
BLS-Basic/EMT	27.19	72.81	Reference	
ALS-Paramedic	30.75	69.25	1.19 (1.18, 1.20)	1.30 (1.27, 1.33)
EMS Organizational Status				
Mixed	29.77	70.23	Reference	
Non-Volunteer	30.28	69.72	1.02 (1.01, 1.04)	1.16 (1.14, 1.18)
Volunteer	30.29	69.71	1.03 (1.00, 1.05)	1.22 (1.16, 1.28)
EMS Agency Organization Type				
Private, Nonhospital	22.28	77.72	Reference	
Hospital	30.08	69.92	1.5 (1.47, 1.53)	1.39 (1.34, 1.43)
Fire Department	32.11	67.89	1.65 (1.63, 1.67)	1.72 (1.69, 1.76)

(*Continued*)

Table 3. (*Continued*).

	Non-transported (%)	Transported (%)	OR (95% CI)	aOR (95% CI)
Governmental, Non-Fire	34.93	65.07	1.87 (1.85, 1.90)	1.89 (1.85, 1.93)
Tribal	36.24	63.76	1.98 (1.85, 2.13)	3.49 (3.09, 3.94)
Urbanicity				
Urban	29.58	70.42	Reference	
Wilderness	32.25	67.75	1.13 (1.09, 1.17)	1.36 (1.28, 1.45)
Suburban	32.85	67.15	1.16 (1.14, 1.19)	1.19 (1.15, 1.23)
Rural	34.52	65.48	1.26 (1.23, 1.28)	1.28 (1.24, 1.32)
% of children living in poverty			0.53 (0.50, 0.57)	0.19 (0.17, 0.21)
Ratio of population to primary care physicians			N/A*	N/A*
Ratio of population to mental health providers			N/A*	N/A*
Ratio of population to dentists			N/A*	N/A*
Social associations expressed as memberships per 10,000 population			N/A**	N/A**

Note: * *coefficient is close to 0, no odds ratio reported;* ** *coefficient is a large negative value, no odds ratio reported.* § No significant association in bivariable analysis so variable not included in final model.

cases were EMS-initiated (patient evaluated, no treatment/transport required; and patient treated, release (per protocol)). We summarize the characteristics of pediatric patients included in our regression in Table 2. We did not find significant differences between our development and validation cohorts. The mean patient age was 9.65 (SD 5.67) years, and 52% were male.

Results of the final multivariable regression model are presented in Table 3. On the receiver operating characteristic curve (ROC) curve for our model, the area under the ROC for the development set was 0.73, indicating good discrimination (Supplemental Figure 1). The calibration plot using the validation data set fell on the identity line, indicating excellent agreement between the observed and mean predicted non-transport rates across each of the risk deciles (Supplemental Figure 2).

Multivariable regression revealed that within our pediatric cohort, non-transport was slightly more likely for children aged $2-4$ y/o and $5-11$ y/o compared to children <2 y/o and ≥ 12 y/o. When analyzing encounter variables, the highest odds for non-transport were observed with the following chief complaints: musculoskeletal/skin, global/general, and pulmonary, compared to reproductive chief complaints. Non-transport was much more likely for patients with an EMS Lower Acuity classification compared to those classified as Emergent or Critical. EMS calls dispatched to Roadside locations were much more likely to result in non-transport when compared to those dispatched to residential or school facilities.

When analyzing EMS agency factors, non-transport was more likely with tribal and governmental based agencies, volunteer-staffed agencies, and when the responding unit was ALS. Community factors associated with higher levels of non-transport were EMS calls originating in rural and wilderness areas and areas with lower levels of child poverty. Every percentage point increase in child poverty was significantly associated with a reduction in the likelihood of non-transport of 81%. The density of healthcare resources (physicians, dentists, and mental health providers) was not statistically associated with non-transport.

Discussion

Using a large national database, this study offers a comprehensive overview of pediatric non-transport in the US. Our data show that almost one-third of pediatric 911 activations result in non-transport, almost double the rate for adults, thus confirming our primary hypothesis. A majority of non-transport cases were due to caregiver refusal, but the decision was EMS-initiated in one-third of cases. Children may have higher rates of non-transport when compared to adult patients because a higher proportion of pediatric EMS calls are for low acuity complaints (15, 16). The decision to not transport a pediatric patient, however, may be riskier than for adults (3). EMS providers have relatively less experience and less comfort when assessing pediatric patients (21, 23–25).

Our study found a higher rate of non-transport for children by EMS than has previously been described. Previous local and regional studies based on urban EMS agencies have reported non-transport rates for children of $16-28\%$ (8, 13, 14). There are similar non-transport rates in Canada and Europe (26–30). Previous studies do not consistently include details about whether the caregiver or EMS initiated a decision not to transport. Children in our study have higher rates of both caregiver and EMS-initiated non-transport when compared to adults. The proportion of EMS-initiated non-transports may be

even higher than we report. A previous survey of parents who refused transport for their children found that one of the reasons for refusal was the perception that paramedics implied transport was unnecessary (31).

Our secondary objective was to analyze factors associated with non-transport. Age had a weak association with non-transport in our study, but other patient demographics were not associated with non-transport. Previous studies in the US have found that non-transport was less likely for younger children (8, 13). Our study also differs from these local studies in that we did not find an association of patient race/ethnicity with non-transport. Previous studies have described lower rates of non-transport for Hispanic (13) and Black children (8). The greater sample size in our study, and the ability to control for a larger number of confounders, may explain these differences.

EMS-agency level factors were significantly associated with non-transport in our study. Non-transport was more common for patients treated by ALS than BLS units. This may be because only ALS providers can initiate non-transport in some jurisdictions (32). An alternative explanation may be that ALS providers have more experience and training and thus confidence to recommend non-transport (33). Hospital-based and private non-hospital agencies were the least likely to not transport a pediatric patient. Private agencies are more reliant on billable services (which usually require patient transport) and have significantly lower non-transport rates than publicly funded services (34, 35).

Beyond the individual patient and EMS agency level, we found that community-level factors are associated with EMS non-transport. Non-transport was much less likely for children in areas with higher levels of child poverty. The proportion of records with missing data prevented us from analyzing individual insurance status in our study. However, our community-level finding is consistent with previous studies that describe higher rates of EMS transport for individuals with Medicaid coverage or no health insurance (36, 37). Families living in poverty and covered by Medicaid may lack transport to access care and be more reliant on EMS as a safety net health service ()(37). Individuals with private health insurance may also be more concerned about the cost of ambulance transport ()(37). Non-transport was more common for calls originating in rural and wilderness areas than urban and suburban areas. The physical distance and transport time to the nearest ED may deter families and EMS agencies from transporting children with low acuity complaints.

Given the high prevalence of pediatric non-transport, it is concerning that there are limited data regarding the safety of this practice. It is essential that we know when and how pediatric non-transport can be done safely. There is little published literature about how pediatric non-transport protocols operate. A recent meta-analysis examining the safety of EMS non-transport for patients of all ages noted heterogeneous study design and estimates for adverse patient outcomes (38). This analysis found a pooled estimate of 21% for non-transported patients subsequently presenting to the ED; and 8% requiring hospital admission. Limited pediatric studies have reported subsequent hospital admission rates of $2-11\%$ and ICU admission rates of $0-1\%$ (31, 32). These studies do not have sufficient power to analyze whether patient versus EMS initiated non-transport is associated with differences in outcomes.

Despite our finding that children have higher rates of non-transport by EMS than adult patients, children have been excluded from many alternative EMS disposition protocols. Possible reasons for this include protocols targeted toward disease conditions uncommon in children (39–41), and higher rates of caregiver opposition (42). The current ET3 pilot system is targeted toward Medicare recipients thus covers very few children. The 2011 NAEMSP resource document states that non-transport of patients has inherent risks and that jurisdictions implementing non-transport protocols should have: protocols supported by peer-reviewed studies; increased training for providers; a QI process; and active physician oversight (3). Our study indicates that there is an urgent need to develop this evidence base for children.

LIMITATIONS

This study has several limitations. First, the data quality of individual care reports may be variable. We are not able to verify that a decision to not transport was truly following local protocols. While we could not verify the validity of the specific non-transport reason, it is unlikely an EMS provider would select a non-transport disposition if they transported the patient. Second, the NEMSIS database is a repository of care reports, not a patient registry. Therefore, if multiple EMS units respond to the same 911-call and submit separate reports, we would underestimate the proportion of non-transports, as the denominator of patients would be smaller than EMS care reports. This feature of the NEMSIS database also precludes analysis of patient outcomes after repeat EMS calls for the same chief complaint. Third, for some variables (such as

insurance status), the proportion of responses with missing data were sufficiently high that the variable was excluded from our analysis. Fourth, the data in NEMSIS is a very large convenience sample. It represents the best available national estimate for EMS care provided in the US, but it is not a census of all care delivered. Finally, our analysis of 2019 data predates the COVID-19 pandemic. Preliminary studies show that EMS non-transport was more common during the pandemic (10).

Conclusion

In summary, approximately one-third of pediatric 911-activations in the US result in non-transport by EMS. This includes both caregiver and EMS-initiated non-transports. EMS non-transport is much more likely for children than adult or elderly patients. Non-transported children are more likely to be classified as low acuity by EMS. Non-transport is more common for EMS calls originating in rural areas and areas with lower levels of child poverty. Given how common pediatric non-transport appears to be in the US, there is an urgent need to understand this practice's safety implications better and ultimately develop evidence-based prehospital pediatric triage guidelines.

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