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The Role of Chronic Illnesses and Behavioral Health Problems

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Abstract

Objective—The increasing use of prehospital emergency medical services (EMS) and its contribution to rising emergency department use and healthcare costs point to the need for better understanding factors associated with EMS use to inform preventive interventions. Understanding patient factors associated with pediatric use of EMS will inform pediatric-specific intervention. We examined pediatric patient demographic and health factors associated with one-time and repeat use of EMS.

Methods—We reviewed data from Baltimore City Fire Department EMS patient records over a 23-month period (2008–10) for patients under 21 years of age (n=24,760). Repeat use was defined as involvement in more than one EMS incident during the observation period. Analyses compared demographics of EMS users to the city population and demographics and health problems of repeat and one-time EMS users. Health comparisons were conducted at the patient and incident levels of analysis.

Results—Repeat users (n=1,931) accounted for 9.0% of pediatric users and 20.8% of pediatric incidents, and were over-represented among the 18–20 year age group and among females. While trauma accounted for approximately one-quarter of incidents, repeat versus one-time users had a lower proportion of trauma-related incidents (7.2% versus 26.7%) and higher proportion of medical-related incidents (92.6% versus 71.4%), including higher proportions of incidents related to asthma, seizures, and obstetric/gynecologic issues. In patient-level analysis, based on provider or patient reports, greater proportions of repeat compared to one-time users had asthma, behavioral health problems (mental, conduct and substance use problems), seizures and diabetes.

Conclusions—Chronic somatic conditions and behavioral health problems appear to contribute to a large proportion of the repeat pediatric use of this EMS system. Interventions may be needed to engage repeat users in primary care and behavioral health services, to train EMS providers on the recognition and management of behavioral health emergencies, and to improve family care and self-management of pediatric asthma and other chronic conditions.

INTRODUCTION

Emergency department (ED) visits have increased in the US from approximately 108 million in 2000 to 130 million in 2010, and this increase, coupled with a decrease in the number of EDs, has placed increasing strains on emergency care systems and may negatively affect the quality of care.¹⁻³ This increase in ED use has been accompanied by a disproportionate increase in use of emergency medical services (EMS) for transportation to EDs.^{1,2} Pediatric ED visits increased by nearly one-fifth between 1993 and 2003.⁴ The Institute of Medicine (IOM) noted a dearth of research on emergency medical care, including prehospital emergency care, to children and youth.⁴

Understanding patterns of EMS use among children and youth is warranted as studies suggest that, as with adults, a considerable proportion of pediatric EMS and ED use is for non-emergent health issues⁵⁻¹⁰ and therefore evidence is needed to inform pediatric-specific preventive intervention. In the present exploratory study we sought to identify demographic and health factors associated with repeat use of EMS among children and youth in a mid-sized urban U.S. population and compare differences in such factors between repeat and single time EMS users. The study is one of the few to date to examine population-level patterns of repeat use of EMS among children and youth. While most of the previous research on EMS use has focused on patients transported to a single ED¹¹⁻¹² or, in the case of a national study⁵, a sample of EDs, there is a dearth of research that examines pediatric use of EMS at a population level and regardless of transport to an ED.¹³ The study findings will inform EMS operations and potential targeted intervention to more effectively address the health needs of the pediatric population, with potential implications for their health outcomes and healthcare costs.

METHODS

Study design and population

The study was a retrospective epidemiologic analysis of Baltimore City EMS data from October 1, 2008 through August 29, 2010, and was part of the BQUEST (Baltimore Quality Urban Emergency Services and Treatment) study, an examination of Baltimore City EMS response to vulnerable populations. The study was approved by the Johns Hopkins Bloomberg School of Public Health's Institutional Review Board, which waived informed consent.

Baltimore City, the Baltimore City Fire Department (BCFD) EMS catchment area, is 81 square miles and had a population of approximately 610,433 residents at the time of the study.¹⁴ The city has high levels of risk factors that contribute to EMS use, including poverty, asthma, substance abuse, and a majority African American population.¹⁵ The BCFD EMS is a single tiered, all advanced life support system, with universal access to care and ED transport offered to all requesting care. Baltimore City medical-related 9-1-1 calls were received and processed at a single dispatch center, which used the computer-assisted Emergency Medical Dispatch system. We identified probable medical-related incidents from dispatch of an EMS unit or an incident code corresponding to a medical issue, and then matched such dispatch data with EMS patient records by incident number. Analysis

examined EMS patient encounters with data on age, and included both transported and non-transported patients.

Patient records and measures

Patient data were collected using the Electronic Maryland Ambulance Information System (EMAIS) through a contract with Affiliated Computer Services, Inc., from which patient data were obtained. The observation period coincided with the initiation of electronic EMS patient data collection, which was recorded on mobile devices. Patient records included paramedic reported impression of the primary health concern and the nature of the call based on the patient's primary complaint. Provider impression was recorded by selection from among 126 predefined categories reflecting medical signs or conditions, or was specified as recorded by hand. The nature of call data were recorded by selection from 43 predefined categories reflecting medical signs, conditions or administrative outcomes (such as police arrest).

For the study, health problems were defined in two ways, and coded by post-baccalaureate pre-medical student research assistants. First, provider impression data were coded based on a prior EMS data categorization scheme,¹⁶ with indeterminate data coded by supplemental use of nature of call data. Overall, there were 913 different categories of impression values. To ensure intercoder reliability of data coding, coders discussed the coding scheme prior to beginning coding and exchanged a random sample of data to ensure consistency in coding decisions among coders. Second, we examined select health problems identified in the literature as contributing to emergency services use, i.e., asthma, seizures, mental health problems, substance use, and diabetes.² We defined these health problems by any mention of each of these terms and possible alternative terms in patient level data aggregated from multiple data fields, i.e., impression, nature of call, and pre-existing conditions. For example, any mention of alcohol or drug abuse, heroin, cocaine, etc. in these data fields were defined as evidence of past or current substance use problems.

Analysis

For analyses, variables were treated as non-ordinal, categorical variables. Contingency tables and chi-square test of independence were used to compare demographics of pediatric repeat users versus one-time EMS users, and the demographic distributions for these groups were compared to the city youth population (under 21 years of age) using 2010 census data. Age groups were chosen based on developmental considerations and health problems specific to developmental ages. Multivariable logistic regression was used to examine differences in the distributions of race/ethnicity and sex across age groups, which was determined using the likelihood ratio test comparing models with and without interaction terms.

Next, we compared medical problems of repeat versus one-time EMS users utilizing the chi-square test of independence. Finally, in incident-level analyses we examined differences in health problems of EMS incidents involving repeat as compared to one-time users within age strata. Statistical analyses were conducted using IBM SPSS Statistics 19¹⁷ and Stata/IC 12.1.¹⁸

RESULTS

From October 1, 2008 through August 29, 2010, there were 205,360 recorded EMS patient encounters, of which data on age were missing for 20,676 (10.1%). Among the 24,914 cases of encounters with persons under age 21 years, data on sex were missing for 154 (0.6%). Analyses were conducted on the remaining 24,760 encounters, except when reporting demographics, in which an additional 101 encounters (0.4%) were excluded due to missing data on race.

Person-level outcomes

The 24,760 pediatric encounters in the analysis constituted 13.5% of all EMS incidents in the observation period with patient data on age and sex. We identified 1,931 persons under 21 years involved in more than one EMS incident in the 23-month period, with 70% involved in 2 incidents, 15% involved in 3 incidents, and 15% involved in 4 to 47 incidents.

In univariate analysis of data on pediatric EMS use, the distributions of race, sex, and age group differed significantly between repeat and one-time EMS users (all $p < 0.001$) (see Table 1). Compared to the city population, African Americans were over-represented among both single and repeat EMS users. Though males predominated among one-time users, females were the majority of repeat users and were over-represented among repeat users as compared to their population distribution. A bimodal age distribution in both one-time and repeat use was revealed, with peaks in the youngest (0–4 years) and oldest (18–20 years) age groups. Compared to one-time users, repeat users were overrepresented in the 15–17 year and 18–20 year age groups, with 41.5% of repeat users in the 18–20 age group. Compared to the city population, repeat users were especially under-represented in the 5–9 year and 10–14 year age groups, and over-represented in the 18–20 year age group.

Table 2 presents the distributions of race/ethnicity and sex within each age group for the one-time and repeat EMS users. In multivariable analyses of repeat EMS use by age and sex, the distribution of sex varied significantly by age group ($\chi^2_{(5)} = 211.3$, $p < 0.001$). Compared to males, females were found to have significantly higher levels of repeat use in the 15–17 year and 18–20 year age groups (both $p < 0.001$). In multivariable analyses of repeat EMS use by age and race/ethnicity, no significant differences were found ($\chi^2_{(8)} = 14.6$, $p = .07$).

In person-level analyses of aggregated health data (Table 3), repeat users compared to one-time users were more likely to have evidence in their EMS records of asthma, behavioral health (i.e., mental, conduct and substance use) problems, seizures and diabetes (all $p < 0.001$). Of repeat users, 41.2% had evidence of asthma and 21.1% behavioral health problems, as compared to 21.2% of one-time users' EMS incidents being asthma related and 12.6% behavioral health related. Among repeat users with behavioral health problems bimodal peaks were observed at ages 10–14 and 18–20.

Incident-level outcomes

Table 4 presents the distributions of medic impressions for incidents involving repeat and one-time users of EMS by age group. Trauma-related incidents accounted for a greater proportion (29.1%) of single-use EMS transports than of repeat-use transports (14.0%;

$p < 0.001$). Incidents among repeat versus one-time users were especially more likely to be related to asthma, seizures, and obstetric/gynecologic (OB/Gyn) problems (all $p < 0.001$). As proportions of repeat and one-time pediatric EMS incidents, asthma-related incidents peaked in the 5–9 year age group, and OB/Gyn-related and behavioral health-related (i.e., mental health and substance use) incidents peaked in the 18–20 year group. Among one-time users, seizures peaked in the 0–4 year age group, and among repeat users they peaked in the 10–14 year group. Blunt trauma incidents were found to peak in one-time and repeat users among 5–9 year olds, whereas violent trauma incidents peaked among older adolescents, including 15–17 year olds for one-time users and 18–20 years for repeat EMS users.

DISCUSSION

These findings provide insights into demographic patterns of pediatric use of prehospital EMS in an urban, predominantly high-risk population. We found that one-time and repeat use EMS differed by age group, sex, and race/ethnicity. For age, a bimodal pattern was observed for one-time users with higher than expected proportions in the 0–4 and 18–20 year age groups, and, among repeat users, those in the 18–20 year age group were most overrepresented relative to the demographic profile of the city. This is consistent with prior research indicating that EMS use increases overall with age, and that among young persons, EMS use shows a bimodal age pattern, with use peaking in early years and late adolescence.⁷ In one of the largest comparable studies to date of repeat pediatric EMS use, Broxterman and colleagues¹⁹ found that of pediatric transports in the Albuquerque EMS system, the age distribution was bimodal for repeat as well as one-time transports. They found that 49.0% of repeat pediatric transports occurred among 17 to 20 year-olds. This compares to our finding of 49.1% of repeat pediatric users were in 18–20 year olds in the present study. Furthermore, we found that asthma, OB/Gyn problems, and seizures were associated with both one-time and repeat use of EMS in this highest utilizing age group.

Findings on the sex distribution on one-time and repeat pediatric use were consistent with the Albuquerque study. In the present study, females accounted for 47.9% of one-time and 56.5% of repeat pediatric EMS users, while Broxterman and colleagues¹⁹ found that females accounted for 48.5% of single and 51.4% of repeat transports. The sex distributions of one-time and repeat pediatric use also varied by age group, with the proportion of females increasing with age; in the 18–20 year age group, over two-thirds of repeat users were female.

Compared to the 2010 census data for Baltimore, Black children were overrepresented among pediatric EMS users. This is consistent with findings of overrepresentation of Blacks in national surveys of ED use.^{3,4} Among repeat users this was even more pronounced, with Blacks representing nearly 9 of 10 pediatric repeat users. However, the association between race/ethnicity and repeat user status did not vary statistically significantly across the age groups.^{3,4}

Demographic patterns of EMS use may be driven by the demographic patterns of health conditions, patient acuity, and access to and utilization of non-emergency care. For older pediatric patients, it is likely that as with their high use of EDs, their high EMS use is

explained in part by their lower healthcare coverage and access to primary care.^{7,20} High rates of utilization of emergency health services among Black male youths have been explained by their particular disparities in access to health care and greater use for non-emergent issues, as indicated in the Affordable Care Act.⁶ However, a recent study suggest this pattern of emergency health services use may be changing.²¹ Studies suggest the increasing role of impediments to patients' regular source of healthcare in contributing to pediatric use of EDs.^{22–24} A representative US sample found that non-Hispanic Black children were less likely to use EDs for non-emergent health problems than were non-Hispanic White children.²⁵

In regards to the types of health problems found, trauma-related incidents were far more common among one-time users (29%) than among repeat pediatric users (14%), and violent trauma was more common in the 15–17 and 18–20 year age groups. In the earlier Albuquerque study, trauma was also less likely among one-time and repeat pediatric ambulance users,¹⁹ although trauma was much more common in our study. In general, it appears from the literature that the proportion of trauma-related pediatric incidents varies by patient age and urban/rural location. Results of a study of adolescent use of an urban Louisiana ED indicated that 64% of visits were for medical problems, with most of the remainder for trauma related problems.²⁰ For EMS transports of persons under 15 years in Kansas City, 27% of EMS incidents were found to be trauma related.²⁶ A multicounty California study of pediatric use of EMS found that medical related issues were more common for patients under 5 years and urban residents, whereas trauma was more common for patients 5–14 years and in rural areas.²⁷

Among the medical problems for incidents among one-time users, generalized illness and pain were most common, and asthma and behavioral health problems were also common (Table 4). These findings reflect the burden of chronic conditions among US children and youth, and to their families and the health care system in managing them, as rates of pediatric chronic conditions have more than doubled in the past decade.^{28,29} There is a particular need for preventive intervention with pediatric (repeat) EMS users with asthma and behavioral health problems. Asthma is the second most prevalent childhood health condition in the US, the most prevalent chronic condition among children, and among the most costly of pediatric conditions.^{30–32} Moreover, asthma is associated with a 50% increased risk of hospital admission among pediatric ED patients, with Black children having the greatest rates of asthma-related ED use and hospitalization.^{33,34} Prior research suggests that repeat asthma-related use of EDs may indicate challenges accessing or engaging in effective care, and lack of access to optimal treatment.³⁵

While diabetes was evident among only a small proportion of EMS users in the study, their disproportionately high level of repeat use of EMS merits consideration, especially considering prior evidence of diabetics' high acuity and healthcare costs.³⁶ Obesity is the most prevalent childhood health condition in the US, and diabetes rates are expected to continue growing in the coming years.³¹ Diabetes poses particular challenges to pediatric health as evidence suggests it is more difficult to control in children and youth than in adults, and diabetes-related ED use appears to be associated with higher acuity and costs compared to other common pediatric chronic conditions.^{36,37} In a study of utilization of a Baltimore

pediatric ED, 41% of diabetes-related visits resulted in hospital admission, as compared to 12% for asthma-related visits, and these differences were also found among repeat ED users.³⁶

Our results also reflect the city's high rates of drug use disorders and associated violent crime.¹⁵ We found that 14.5% of pediatric EMS incidents were related to substance use, mental health problems or violent trauma. This is highly similar to the finding of 14.9% of chief complaints related to such problems in a prior study of pediatric EMS transports in Albuquerque.³⁸

Our results support the recommendations of the Pediatric Emergency Care Applied Research Network (PECARN) on top EMS pediatric research priorities. Based on expert ranking, PECARN's top 10 recommended priority clinical research areas included trauma, asthma, pain, and seizures.⁴⁵ Our findings suggest that these health problems, as well as pediatric mental health and substance use, are important contributors to pediatric use of EMS, and even more so to their repeat use. Linking pediatric emergency services users to primary care and other community health services may help improve their continuity of care and management of chronic conditions, as well as reduce their use of emergency health services for non-emergent care.

Despite recommendations of the Institute of Medicine expert panel, little attention or resources have been given to promoting EMS' role in public health.⁴⁶ Evidence suggests that interventions targeting ED using pediatric patients with chronic conditions can reduce their related health emergencies and repeat ED use.⁴⁷⁻⁵¹ EMS intervention at point of community contact and coordination with other services delivery systems could enable more effective management of EMS pediatric users' chronic conditions, with potential implications for their improved health outcomes, EMS and ED use, and healthcare costs.^{28,52-54} Consistent with recommendations of the National Association of EMS Physicians and the goals of the Affordable Care Act to utilize evidence-based practices to address patients' barriers to care, the findings highlight the potential role of EMS in identifying and linking pediatric users to preventive community services.^{52,55}

Study limitations

The validity of the study findings are limited by the completeness of health records and quality of the data. Because health records were obtained through a billing contractor, encounters that did not result in ED transport were likely under-represented. It is also likely that the number of repeat pediatric users and the number of incidents per user were underestimated as identifying repeat use required matching patients on personal identifying information. The extent to which these identifiers were missing or not recorded correctly is not known. The data on health problems are subject to potential misclassification as they were primarily obtained from paramedic reports and do not constitute medical diagnoses, nor do they capture the full range of health problems associated with each incident. Also, differences in health problem classification schemes used in the present and prior studies challenge the validity of comparisons across studies.

The validity of the study findings are also limited by the accuracy of demographic classification of EMS patients. Some scenarios may have precluded providers from collecting self-reported information from patients (e.g. critically ill patients), and, as a result, some patients' race/ethnicity, gender, or age could be misclassified. The data presented in this research must be interpreted with this limitation in mind.

Adoption of standard EMS nomenclature and coding schemes would enable better comparisons among studies and would improve the identification of opportunities for enhanced, targeted interventions.¹⁹ More specifically, standard coding schemes should include symptoms or diagnoses related to potential over-use of emergency health services, such as asthma and pain, and patient records should capture inadequate management of chronic conditions and evidence of specific behavioral health problems and homelessness. Because such vulnerabilities are often considered secondary to other health problems, they are likely under-reported, if recorded at all, in EMS records.

Conclusions

EMS-based studies capture a complementary and understudied part of the emergency health care system. EMS patient records are a unique source of information about emergent and about non-emergent pediatric health problems inadequately addressed through other medical services. EMS-based studies may provide data on geographically defined populations that are particularly relevant to informing the development of community-based preventive interventions that link residents to community services.

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Table 1

Demographic distributions of repeat and one-time pediatric users of Baltimore City emergency medical services (October 2008–August 2010) and of the city population (2010).

	Repeat EMS user		Baltimore City (n=166,389) %
	Yes (n=1,928) %	No (n=19,527) %	
Race/ethnicity *			
Black	89.3	81.5	72.3
White	9.0	14.3	17.7
Other	1.7	4.2	10.1
Sex *			
Male	43.5	52.1	50.0
Female	56.5	47.9	50.0
Age in years *			
0 to 4	24.6	31.8	24.7
5 to 9	7.1	11.8	21.3
10 to 14	9.0	12.3	20.6
15 to 17	17.7	15.8	13.6
18 to 20	41.5	28.3	19.7

*p<0.001 for comparisons of repeat vs. one-time pediatric users

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Table 2

Within-age-group distributions of race/ethnicity and sex of pediatric repeat users and one-time users of Baltimore City Emergency Medical Services (October 2008–August 2010).

Age (years)	0 to 4		5 to 9		10 to 14		15 to 17		18 to 20		Total	
	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Repeat EMS use												
(n)	(475)	(6,208)	(137)	(2,308)	(174)	(2,400)	(342)	(3,083)	(800)	(5,528)	(1,928)	(19,527)
Race/ethnicity (%)												
Black	88.4	79.2	94.9	85	92.5	86	90.4	85.4	87.8	78.5	89.3	81.5
White	8.8	15.4	1.5	11	5.7	10.7	8.8	11.8	11.1	17.5	9	14.3
Other	2.7	5.4	3.6	3.9	1.7	3.3	0.9	2.8	1.1	4	1.7	4.2
Sex (%)												
Male	61.5	58.6	62.8	59.6	49.4	55	36.3	46.4	31.4	43.5	43.5	52.1
Female	38.5	41.4	37.2	40.4	50.6	45	63.7	53.6	68.6	56.5	56.5	47.9

Table 3

Health problems[#] of repeat and one-time pediatric (under 21 years old) users of Baltimore City emergency medical services (October 2008–August 2010).

	Repeat EMS user	
	Yes (n=1,932) %	No (n=19,770) %
Asthma *	41.2	21.2
Behavioral health *	21.1	12.6
Mental health *	18.3	7.7
Substance use *	12.4	7.7
Seizures *	11.6	4.9
Diabetes *	3.1	1.4

[#] Any mention of health problem in non-narrative fields of patient record across all encounters for patient.

* p<.001

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Table 4 Distributions of medic impression of primary health problem for patient encounters within age groups among repeat and one-time pediatric (under 21 years old) users of Baltimore City emergency medical services (October 2008–August 2010).

Age (years)	0 to 4		5 to 9		10 to 14		15 to 17		18 to 20		Total	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Repeat user												
(n)	(1,202)	(6,253)	(346)	(2,321)	(463)	(2,406)	(862)	(3,093)	(2,268)	(5,546)	(5,141)	(19,619)
Incidents (%)												
Medical/Surgical	87.5	75.1	84.7	67.7	87.0	62.5	83.3	67.4	85.6	71.7	85.7	70.5
Asthma	14.6	7.1	32.1	14.7	26.8	10.0	12.1	5.3	10.2	4.8	14.5	7.4
Other respiratory (non-asthma)	14.3	12.3	5.7	6.8	3.0	3.0	4.0	2.1	3.5	2.5	6.3	6.1
Seizures	13.1	6.9	12.7	5.2	15.3	3.4	7.8	2.7	4.5	2.5	8.6	4.4
Behavioral health	5.8	5.7	5.5	3.1	7.8	5.8	7.2	10.0	7.7	10.8	7.0	7.5
General illness	27.9	23.3	15.0	14.6	10.8	12.3	12.8	12.0	16.1	12.3	17.7	16.0
OB/Gyn	0.3	0.6	0.0	0.1	1.7	1.0	13.9	6.2	14.4	7.9	8.8	3.5
Pain (including abdominal)	3.8	4.7	7.8	15.3	13.7	17.7	17.6	19.9	19.2	21.5	14.1	14.7
Miscellaneous other	7.7	14.5	5.9	7.9	7.9	9.3	7.9	9.2	10.0	9.4	8.7	10.9
Trauma	12.1	24.3	14.7	32.0	12.7	37.3	16.6	32.3	14.2	28.1	14.0	29.1
Violent trauma	0.3	2.3	1.7	2.0	3.9	7.9	6.0	12.8	6.5	10.8	4.4	7.0
Blunt trauma	11.8	22.0	13.0	30.0	8.8	29.4	10.6	19.5	7.7	17.3	9.6	22.1
Other/Unknown	0.3	0.6	0.6	0.3	0.2	0.2	0.1	0.3	0.2	0.2	0.2	0.4