Bridging the Emergency Medical Services for Children Information Gap

Theresa C. Murdock, MD; Jane F. Knapp, MD; M. Denise Dowd, MD, MPH; Jack P. Campbell, MD

Objective: To determine the epidemiological features of pediatric usage of prehospital emergency medical services (EMS) in a defined urban population.

Methods: Residents of Kansas City, Mo, younger than 15 years who used EMS during the calendar years 1993-1995 were included. In this geographic area there is a single provider of prehospital care; all numerator data were taken from this single source. Denominator data were provided by 1995 intercensal estimates based on the 1990 US Census. Rates were calculated as an annual average and reported as the number of children transported per 1000 persons per year.

Results: There were a total of 7296 pediatric EMS transports during the study period, for an annual rate of 21.9. Infants younger than 1 year had the highest rate (47.4), followed by those aged 1 to 4 years (26.2), 5 to 9 years (17.5), and 10 to 14 years (17.3). Medicaid was the insurer for half and 27% were uninsured. One quarter of the patients used EMS more than once. Children living in ZIP codes in the lowest median income tertile were 5.8 times more likely to use EMS than those in the upper income tertile (95% confidence interval, 5.4-6.3). One third of all transports occurred between the hours of 4 and 8 PM.

Conclusions: Children using the Kansas City EMS were more likely to be infants, insured by Medicaid or uninsured, and live in low-income ZIP codes. Further study is needed to determine if this increased usage is due to greater incidence and severity of illness and injury, lack of transportation, lack of education, or other factors.


Editor’s Note: Let your imagination loose, and think of how many cross-correlations you might look for with these sort of data.

Catherine D. DeAngelis, MD

THE INSTITUTE of Medicine report on emergency medical services (EMS) for children, published in 1993, identified major informational gaps in both the quality and quantity of knowledge regarding pediatric prehospital emergency care. Specifically, the report noted, “Without a broad and reliable base of information, it is hard for anyone . . . to determine in any systematic way how successful EMS-C [emergency medical services for children] systems are in providing appropriate, timely care or what they ought to do to improve performance and patient outcomes.” Furthermore, it suggested that assembling descriptive data to answer basic questions should be a high research priority.

Data are especially limited for the pediatric prehospital care component of EMS. Frequently cited studies on prehospital care of children are now almost a decade old. Newer data exist, including studies in both urban and rural settings, but these studies are not population-based and generalizability is limited. The need for up-to-date population-based assessment of the prehospital care of children remains critical to effective EMS planning.

There are several reasons why population-based studies are rare. Prehospital care systems are frequently fragmented, with multiple agencies involved in a single geographic area, making the process of data collection, aggregation, and analysis a monumental task. Recordkeeping is often not standardized or is incomplete, creating serious weakness in the quality and quantity of information. Pediatric emergency transports are far less frequent than adult emergency transports, making meaningful evaluation difficult in many systems. The ability to perform an accurate, population-based description of pediatric prehospital care is greatly enhanced by and identified by a system that can eliminate or minimize these barriers. The Kan-
SUBJECTS AND METHODS

All residents of Kansas City younger than 15 years (1995 population aged 0-14 years = 110 862) who were transported by the Kansas City prehospital EMS (Metropolitan Ambulance Service Trust) for the calendar years 1993-1995 were included for analysis. Those whose ZIP code of residence were incomplete or absent on the ambulance record were excluded from the study. Calls in which an ambulance responded but the patient was not transported were not included in the analysis.

The Metropolitan Ambulance Service Trust is the exclusive provider of ambulance service to Kansas City. The system serves a 350-square-mile area with a base population of approximately 500 000. It is an all advanced life support system, with 51 000 average annual responses. Each unit is staffed by a paramedic and an emergency medical technician. All paramedics complete a minimum of 16 hours of pediatric training.

Paramedics complete a Missouri State standardized prehospital transport form for every patient encounter. This form includes the following information: demographics (sex, age, address, date, and time); the assigned level of priority to which the ambulance responded and left the scene; insurance provider; chief complaint; paramedic’s assessment of the patient and classification by International Classification of Diseases, Ninth Revision (ICD-9) external injury codes (E-codes); transport destination; and procedures and medications given. These “run sheets” are sent to a central office where the information is abstracted and entered into a computerized electronic database. All information for this study was obtained from this single electronic database. In addition to demographic information, other data obtained for the study included the number of times the system was accessed, insurance status, day of week of transport, time of transport, ZIP code of patient, and chief complaint.

Primary diagnosis codes were grouped for analysis in the following manner. Nine diagnostic groups were defined based on the primary diagnosis code assigned by the paramedic. Trauma/poisoning was defined as all patients with the diagnosis of fracture(s), hemorrhage, hematoma, overdose, poisoning, inhalation, motor vehicle crash, fall, environmental injury, other injury, shooting, stabbing, accident, suicide, assault, light, amputation, submersion, or burn. Respiratory included all patients with respiratory distress, respiratory failure, pulmonary edema, pneumonia, or tracheal obstruction. Gastrointestinal included any conditions related to the gastrointestinal system including feeding problems. The cardiac group included all arrhythmias, cardiogenic shock, and nontraumatic cardiac arrest. The pain group included all persons with the primary complaint of pain from causes other than trauma such as headache or sickle cell crisis. The neurologic group included unconsciousness (not related to poisoning), seizures, stroke, behavioral problems, and coma. The fever group included all patients with suspected sepsis or fever. The obstetric/gynecologic group included those patients with the diagnosis of vaginal bleeding, infants delivered in the field or impending delivery, or abortion. The other group included diagnoses that did not fit in the aforementioned categories and unknown diagnoses.

Intercessal estimates for 1995 provided denominator population data on age, sex, and the median household income for the ZIP code of the patients enrolled in this study (based on the 1995 Claritas estimate, Kansas City, Mo). Pediatric transport rates were expressed as number of transports per 1000 population and expressed as an annual average for the 3-year period. Relative risks were obtained using the ratio of incidence rate in the population of interest to that of the reference population. Reference groups were designated as the category with the lowest rate for the variable of interest. Ninety-five percent confidence intervals (CIs) were obtained around the relative risk using the method of Greenland and Robins.11

Intergroup differences were compared using χ² tests where appropriate. Probability values of less than .05 were considered to be statistically significant.

An ecological analysis of ambulance usage was performed using ZIP code as the unit of analysis. Simple linear regression analysis was performed to produce a model with median income as the independent variable and rate of transports per 1000 population per year in the ZIP code as the dependent variable. Ninety-five percent CIs for predicted rate were calculated.

RESULTS

Of the 152 830 transports performed by the Kansas City ambulance service during the 3-year study period, 9200 (6%) were for individuals aged younger than 15 years. After excluding nonresidents and those whose ZIP code was missing or inaccurate, 7296 transports were left for analysis. The annual transport rate for children was 21.9 per 1000 persons per year.

Characteristics of the study population are summarized in Table 1. Children aged 1 to 4 years constituted the largest group of transports (33.7%). However, infants younger than 1 year had the highest ambulance usage rate at 47.4 per 1000 persons per year. This was almost 3 times as high as the rate of the 5- to 9-year-old reference group. Males accounted for 55% of the transports and had a usage rate incidence rate of 23.6 per 1000 population per year for a relative risk of 1.2 (95% CI, 1.1-1.2) when compared with females.

Medicaid was the insurer for 51% while 21% of the study group was covered by commercial insurance. Twenty-seven percent of all children were uninsured.

There was a significant inverse linear relationship between the number of transports and median family in-
come in ZIP code of residence. Figure 1 illustrates this relationship by plotting the rate of transports for a given median income in a ZIP code. The ZIP codes in the inner urban core were among the poorest and were those with the highest transport rates.

Figure 2 illustrates the significant fluctuation in number of transports by the hour of the day. Peak usage occurred from 4 to 8 PM hours with lowest usage from 4 to 8 AM (P<.001). There was significant variation observed by day of the week, with the highest number of transports observed on Fridays (n = 1135) and the least number on Wednesdays (n = 958). Additionally, volume of transports varied by month, with a high in March and May (669 each) to a low in September (544) (P<.001).

Of the 6342 patients, 5730 (90%) were transported a single time during the 3-year study period. Six hundred twelve patients accessed the system more than once, accounting for 1566 or 21.4% of the total number of transports in the year (Table 2). These 612 patients accounted for 9.6% of the total number of patients transported. The most common diagnosis of patients using EMS more than once for the same complaint were seizures (36%) and respiratory distress (26%).

Transports of patients younger than 1 year were primarily medically related (75%) while older children were transported for trauma/poisoning or a pain-related complaint. Examples of the most frequent trauma diagnosis were lacerations, motor vehicle crashes, and assaults or child abuse. In fact, 9.9% of the transports for the 1- to 4-year-old age group were for child abuse.

Diagnostics by age categories are depicted in Table 3. The top 3 complaints were trauma/poisoning (36.9%), pain (18.1%), and respiratory problems (15.6%). Infants younger than 1 year were transported primarily for respiratory symptoms followed by trauma/poisoning and neurologic complaints. Among all age groups, those aged 1 to 4 years had the highest percentage of transports for trauma/poisoning, followed by neurologic and respiratory symptoms. There were 38 nontraumatic cardiac arrests in the group aged younger than 1 year.

The Institute of Medicine report has emphasized that EMS data on children are needed at the local, state, and national level; the particular kinds of data needed at each level may vary but, in all cases, data collected for one level should be useful at every level below.1 This study provides population-based information available for systems evaluation and planning for Kansas City and for reference and comparison with other systems.

Table 1. Characteristics of Children Transported by Ambulance in Kansas City, Mo, 1993-1995

<table>
<thead>
<tr>
<th>Age, y</th>
<th>No. (%)</th>
<th>Rate†</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>1093 (15.0)</td>
<td>47.4</td>
<td>2.7 (2.6-2.9)‡</td>
</tr>
<tr>
<td>1-4</td>
<td>2455 (33.7)</td>
<td>26.0</td>
<td>1.5 (1.4-1.6)‡</td>
</tr>
<tr>
<td>5-9</td>
<td>1944 (26.6)</td>
<td>17.3</td>
<td>1.0§</td>
</tr>
<tr>
<td>10-14</td>
<td>1804 (24.7)</td>
<td>17.5</td>
<td>1.0 (0.95-1.1)</td>
</tr>
<tr>
<td>Total</td>
<td>7296 (100.0)</td>
<td>21.9</td>
<td></td>
</tr>
</tbody>
</table>

Sex  
M     | 4010 (55.0) | ...    | 1.2 (1.1-1.2) |
F     | 3286 (45.0) | ...    | 1.0§         |

Medical coverage  
Medicaid | 3712 (51.0) | ...    |             |
No coverage | 1945 (27.0) | ...    |             |
Commercial | 1544 (21.0) | ...    |             |
Other | 95 (1.0) | ...    |             |

* RR indicates relative risk; CI, confidence interval; and ellipses, not applicable.
† Number of patients transported per 1000 persons per year.
‡ P<.01.
§ Reference group.

Table 2. Children Using the Ambulance for More Than 1 Transport in the 3-Year Study Period

<table>
<thead>
<tr>
<th>No. of Times Transported</th>
<th>No. of Persons</th>
<th>No. of Transports</th>
<th>% of Total Transports</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>460</td>
<td>920</td>
<td>12.6</td>
</tr>
<tr>
<td>3-5</td>
<td>132</td>
<td>466</td>
<td>6.4</td>
</tr>
<tr>
<td>6-10</td>
<td>15</td>
<td>104</td>
<td>1.4</td>
</tr>
<tr>
<td>&gt;10</td>
<td>5</td>
<td>76</td>
<td>1.0</td>
</tr>
<tr>
<td>Total</td>
<td>612</td>
<td>1566</td>
<td>21.4</td>
</tr>
</tbody>
</table>

Figure 1. The relationship between rate of transports and median family income. The regression line is surrounded by the 95% confidence intervals for the predicted transport rate.

Figure 2. Pediatric emergency medical services transports by hour of the day.

Table 3. Diagnoses by Age Categories

<table>
<thead>
<tr>
<th>Age, y</th>
<th>Diagnoses</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>Respi (36%), Pain (18%), Trauma/Poisoning (75%)</td>
</tr>
<tr>
<td>1-4</td>
<td>blood (36%), Pain (18%), Trauma/Poisoning (75%)</td>
</tr>
<tr>
<td>5-9</td>
<td>blood (36%), Pain (18%), Trauma/Poisoning (75%)</td>
</tr>
<tr>
<td>10-14</td>
<td>blood (36%), Pain (18%), Trauma/Poisoning (75%)</td>
</tr>
</tbody>
</table>

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This study is the first to define prehospital transport usage rates for a given population of children. It demonstrates that rate of usage of prehospital care decreases up to age 15 years and that infants are at highest risk. Trauma continues to be a significant problem, necessitating prehospital care throughout childhood. Pain has not previously been recognized and reported in this country as a condition requiring transport in children. Residents from poorer ZIP codes use the system more frequently and approximately 10% of the patients are responsible for one fifth of the transports.

Children younger than 15 years represented 6% of all EMS transports. This is close to the 4% reported in a recent multistate pediatric prehospital transport study. Others have reported a rate of pediatric transports as high as 10% but these studies have included a broader age range and, based on usage rate of transport, are the highest-risk group. The practical application of these data is not previously been recognized and reported in this country as a condition requiring transport in children. Residents from poorer ZIP codes use the system more frequently and approximately 10% of the patients are responsible for one fifth of the transports.

This study also found evidence that multiple usage rates for a given population of children. It demonstrates that rate of usage of prehospital care decreases up to age 15 years and that infants are at highest risk. Trauma continues to be a significant problem, necessitating prehospital care throughout childhood. Pain has not previously been recognized and reported in this country as a condition requiring transport in children. Residents from poorer ZIP codes use the system more frequently and approximately 10% of the patients are responsible for one fifth of the transports.


diagnostic Category | <1 | 1-4 | 5-9 | 10-14 | Total
---|---|---|---|---|---
Trauma/poisoning | 239 (21.9) | 1031 (42.0) | 761 (39.1) | 668 (37.0) | 2699 (36.9)
Respiratory | 344 (31.5) | 334 (13.6) | 238 (12.2) | 216 (12.0) | 1132 (15.6)
Pain | 39 (3.6) | 272 (9.5) | 513 (26.4) | 540 (29.9) | 1325 (18.1)
Neurologic | 93 (8.5) | 446 (18.2) | 184 (9.5) | 144 (8.0) | 867 (11.9)
Gastrointestinal | 79 (7.2) | 90 (3.6) | 101 (5.2) | 80 (4.4) | 350 (4.8)
Fever | 77 (7.0) | 146 (5.9) | 48 (2.5) | 10 (0.6) | 281 (3.8)
Cardiac | 49 (4.5) | 14 (0.6) | 13 (0.7) | 20 (1.1) | 96 (1.4)
Obstetric/gynecologic | 77 (7.0)| 4 (0.2) | 0 (0.0) | 30 (1.7) | 111 (1.5)
Other | 96 (8.8) | 157 (6.4) | 86 (4.4) | 96 (5.3) | 435 (5.9)
Total | 1093 (100) | 2455 (100) | 1944 (100) | 1804 (100) | 7296 (100)

*All data are presented as number (percentage). †Test of independence was rejected with P < .001.
*All 77 were newly delivered infants.

Data on the demographic characteristics of the patient population such as age, sex, and residence are essential for understanding who needs care. This study confirms the work of others showing a male predominance, a majority of calls during daylight and evening hours, and spring seasonality. Residents from ZIP codes with the lowest median income had higher usage rates. We were not able to adjust the usage rate for severity of illness or injury, which significantly limited our ability to interpret the meaning of the relationship between median income and usage rate. Future work will be important to determine whether variation of usage by socioeconomic status is due to severity of illness, lack of information or understanding of disease process, lack of transportation, or other factors. Half of the transports were by individuals insured with Medicaid (51%). This is not as high as the 73% of Medicaid- and health maintenance organization Medicaid–insured patients transported reported by Camusso-Richardson et al. That study went on to show that many of the individuals with Medicaid insurance had no medical justification for taking the ambulance to the hospital. The percentage of children younger than 15 years of age insured by Medicaid in Kansas City is approximately 35%, making Medicaid-insured patients overrepresented in those using the ambulance.

This study also found evidence that multiple usage rates for a small group existed; 9.6% of the patients accounted for 21.4% of the transports. This phenomenon has been observed before. During a 12-month study in Hawaii, 3.5% of the patients accounted for 7.8% of the transports. Associations with multiple transports included handicapping conditions, male sex, trauma, wheezing, and Medicaid insurance. A study from New Mexico found that 11.1% of the patients younger than 21 years had multiple transports. The payment source for repeatedly transported patients was primarily self-pay and Medicaid. The proportion of transports funded by Medicaid among repeat users was twice that of singly transported patients.

Pain was a large diagnostic group in our study. Prior studies have shown that pain may be the most common
reason for emergency department visits and is a frequent reason to seek medical care in any outpatient setting.\textsuperscript{15,16} No other epidemiological studies on prehospital care in children have reported pain as a reason for transport.

This study has several limitations. Twenty percent of the sample was lost owing to missing data and the accuracy of the data from the database could not be verified. Patients who should have been included may have been eliminated due to birth date or ZIP coding errors. Diagnostic code groupings determined by paramedics may have been incorrect and may not be comparable to other studies.

Emergency medical services for children represent a continuum of care. Information from the prehospital transport of children can help improve care at several levels. With good descriptive data, primary care providers, planners, evaluators, and researchers can begin to answer the more significant questions regarding system performance and prevention of unnecessary usage. Future in-depth work needs to be undertaken to examine the transports from the poorer areas of the city and the repeat user of the prehospital system.

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REFERENCES


Free Patient Record Forms Available

Patient record forms are available free of charge to ARCHIVES readers by calling or writing FORMEDIC, 12D Worlds Fair Dr, Somerset, NJ 08873-9863, telephone (908) 469-7031.