## PEDIATRICS

# Management and outcomes of pediatric patients transported by emergency medical services in a Canadian prehospital system

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**ABSTRACT**

**Objectives:** There is uncertainty around the types of interventions that are provided by emergency medical services (EMS) to children during prehospital transport. We describe the patient characteristics, events, interventions provided and outcomes of a cohort of children transported by EMS.

**Methods:** This prospective cohort study was conducted in a city of 750 000 people with a 2-tiered EMS system. All children <16 years of age who were attended by EMS during a 6-month period were enrolled. Data were extracted from ambulance call reports and hospital charts, and analyzed using descriptive statistics.

**Results:** During the study period there were 1377 pediatric EMS calls. Mean age was 8.2 years (standard deviation 5.4), and the most common diagnoses were trauma (44.9%), seizure (11.8%) and respiratory distress (8.8%). The ambulance return code was *Urgent* in 7%, *Prompt* in 57%, *Deferrable* in 8% and *Not Transported* in 28%. Fifty-six percent received either an Advanced Life Support or Basic Life Support prehospital intervention. Common procedures included cardiac monitoring (20.0%), oxygen administration (19.8%), blood glucose monitoring (16.3%), spine board (12.2%), limb immobilization (11.1%) and cervical collar (10.0%). Uncommon procedures included administering medications intravenously (IV) (1.4%), bag-valve-mask ventilation (0.3%) and endotracheal intubation (0.1%). Seventy-eight percent of attempted IV lines were successful. Only 9.0% of EMS-transported children were admitted to hospital, and 2.2% were admitted to the intensive care unit.

**Conclusions:** This first study of Canadian pediatric prehospital interventions shows a high rate of non-transport, and a low rate of *Urgent* transports and hospital admissions for children. Very few children receive prehospital airway management, ventilation or IV medications; consequently EMS personnel have little opportunity to maintain these pediatric skills in the field.

**Key words:** children; emergency medical services; advanced life support interventions; basic life support interventions

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**RÉSUMÉ**

**Objectifs :** Il existe des incertitudes entourant les types d'interventions qui sont offertes par les services médicaux d'urgence (SMU) aux enfants pendant le transport vers l'hôpital. Nous décrivons les caractéristiques des patients, les événements, les interventions offertes et l'évolution de l'état d'une cohorte d'enfants transportés par les SMU.

**Méthodes :** La présente étude de cohorte prospective fut menée dans une ville de 750 000 habitants dotée d'un système de SMU à deux paliers. Tous les enfants âgés de < 16 ans qui reçurent les soins des SMU au cours d'une période de six mois furent inclus. Les données furent extraites des rapports d'appels d'ambulances et des dossiers d'hôpital et analysées à l'aide de statistiques descriptives.

**Résultats :** Au cours de la période d'étude, il y eut 1 377 appels demandant des SMU pédiatriques. L'âge moyen des patients était de 8,2 ans (écart-type 5,4), et les diagnostics les plus courants étaient les traumatismes (44,9 %), les crises épileptiques (11,8 %) et la détresse respiratoire (8,8 %). Le code de retour de l'ambulance était *Urgent* dans 7 % des cas, *Rapide* dans 57 % des cas, *Non urgent* dans 8 % des cas et *Non transporté* dans 28 % des cas. Cinquante-six pour cent des patients reçurent soit des soins avancés de réanimation soit des soins de bases en réanimation en situation préhospitalière. Les interventions courantes comprenaient le monitorage cardiaque (20,0 %), l'administration d'oxygène (19,8 %), la surveillance de la glycémie (16,3 %), l'installation sur une planche dorsale (12,2 %), l'immobilisation d'un membre (11,1 %) et la pose d'un collier cervical (10,0 %). Les interventions moins courantes comprenaient l'administration de médicaments intraveineux (IV) (1,4 %), la ventilation à l'aide d'un sac-valve-masque (0,3 %) et l'intubation endotrachéale (0,1 %). Soixante-dix-huit pour cent des tentatives d'installation de lignes IV furent réussies. Seulement 9,0 % des enfants transportés par les SMU furent hospitalisés et 2,2 % furent hospitalisés à l'unité de soins intensifs.

**Conclusions :** La première étude des interventions pédiatriques préhospitalières révèle un taux élevé de non transport, et un faible taux de transports *Urgents* et d'hospitalisation pour les enfants. Très peu d'enfants reçoivent des soins de protection des voies aériennes, de ventilation ou d'administration de médicaments IV en situation préhospitalière; par conséquent, le personnel des SMU a peu d'occasions de mettre ces habiletés en pratique sur le terrain.

## Introduction

Children account for 5%–10% of the overall emergency medical services (EMS) transport population.[1–3] Pediatric EMS utilization has been well described in the United States,[1–11] but there is no Canadian population-based research describing the use of EMS for children; consequently the population characteristics, prehospital interventions provided and their impact on patient outcomes are unknown.

There has been debate and uncertainty regarding the role of pediatric ambulance services. Some authors note the high proportion of inappropriate EMS transports for non-urgent patients,[12–14] and in one report the authors described the majority of pediatric ambulance transports as being a medically unnecessary "taxi service."[15] Other studies have pointed out important EMS interventions that are underused among children, such as aggressive treatment for respiratory distress and seizure.[16,17] It has also been noted that a large proportion of critically ill or injured children who present to the emergency department (ED) do not use the EMS system.[18]

The current investigation is a substudy of the Ontario Prehospital Advanced Life Support (OPALS) Study.[19] The OPALS study used a before–after clinical trial design to assess the sequential introduction of 2 specific interventions: rapid defibrillation (phase II),[20] and Advanced Life Support (ALS) including intubation and intravenous drug therapy (phase III).[21] Within this framework, after the implementation of ALS, we conducted an observational cohort study to examine pediatric EMS transports. The specific EMS interventions studied were endotracheal intubation, bag-valve-mask ventilation, establishment of an intravenous (IV) line, and the provision of IV medications.

Our objective was to describe the pattern of pediatric EMS use in a single Ontario region, including patient characteristics, prehospital interventions used and patient outcomes. Children with seizures were identified as an *a priori* subgroup; we hypothesized that these patients may be more likely to require EMS intervention. This information will be important in identifying areas in which to focus EMS pediatric training. It will also inform future planning for pediatric prehospital intervention trials.



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## Methods

### *Setting*

This prospective cohort study was conducted in Ottawa, Canada, which has a population of 750 000 and a 2-tiered EMS response system, including Basic Life Support with Defibrillation (BLS-D) and ALS. This system is a combined rural and urban service with a catchment area of 2757 $km^2$, operating from 8 rural stations and a central urban station. High-density areas, with 24 or more responses per square kilometer per year, accounted for 14.3% of the study region, while low-density areas comprised 85.7% of the region. The vast majority of children are transported directly to the tertiary care pediatric hospital ED; however, those with compromised airway, breathing or circulation are transported to the closest hospital. In addition, children with less urgent conditions may be transported to 1 of 2 community hospitals in the region.

### *Patients and calls*

All children under 16 years of age who were assessed by prehospital personnel during a 6-month period (Apr. 1 to Sept. 30, 2001) were identified, using the common ambulance call report used throughout the province of Ontario. Eligible patient encounters were identified using ambulance call reports collected from the base hospital program for the period of the study. Cases were excluded if pick-up location did not fall within the pre-determined geographic catchment area, or if the EMS service was used for a between-hospital, or air-to-hospital transfer.

The following EMS Return Priority Codes were assigned by paramedics: *Urgent*, for calls requiring immediate transport because of life or limb threat; *Prompt* for calls involving serious illness or injury; and *Deferrable* for routine calls that could be delayed without being detrimental to the patient.

### *Data collection*

Patient demographics, EMS assessment of return priority, location of patient pick-up, reason stated by paramedics for parental or guardian refusal of transport, patient's primary problem as stated by paramedics, and prehospital procedures performed by paramedics were abstracted from the ambulance call reports. Emergency department disposition and final diagnosis were gathered by reviewing relevant hospital charts. We attempted no follow-up of children who were not transported by EMS.

All abstracted data were transferred to a structured data collection form, including date, relevant dispatch, scene, and transport times, patient age and gender, return priority code, patient status on arrival at ED, and chief complaint as determined by the EMS classification system. The data were then entered into a database using SAS Version 8.

### *Data analysis*

Descriptive statistics, including means and standard deviations (SDs) for continuous variables and percentages for categorical variables, were calculated. Patients with seizures were identified as an *a priori* subgroup; these data were included in the primary analysis and in pre-defined subgroup analyses. Data analysis was performed using SAS Version 8. The study was approved by the Hospital Research Ethics Board.

## Results

During the 6-month study period there were 30 793 EMS calls, of which 1377 (4.6%) involved patients under the age of 16. Table 1 shows that mean age in the study population was 8.2 years (SD = 5.4) and that 57% were male. A bimodal distribution was evident with more frequent calls for children under the age of 2 years and over the age of 13 (Fig. 1). For children under age 2, medical problems

**Table 1. Characteristics of 1377 study patients**

| Variable | No. (and %)* of patients |
|---|---|
| Mean age, yr (and SD) | 8.2 (5.4) |
| Male | 781 (56.7) |
| ***Location of EMS response*** | |
| Residence | 709 (51.5) |
| Public place | 249 (18.1) |
| Street / highway / road | 229 (16.6) |
| School | 110 (8.0) |
| Other | 80 (5.8) |
| ***Primary prehospital problem*** | |
| Minor trauma | 618 (44.9) |
| Seizure | 162 (11.8) |
| Respiratory distress | 121 (8.8) |
| Poisoning / drug overdose | 62 (4.5) |
| Abdominal pain | 43 (3.1) |
| Fever or diarrhea | 40 (2.9) |
| Allergic reaction | 34 (2.5) |
| Psychiatric / behavioural | 31 (2.2) |
| Unconsciousness NYD | 27 (2.0) |
| Major trauma (ISS >11) | 11 (0.8) |
| Diabetic emergency | 7 (0.5) |
| Cardiac arrest | 1 (0.1) |
| Other medical | 220 (16.0) |

SD = standard deviation; EMS = emergency medical services; NYD = not yet diagnosed; ISS = Injury Severity Score
*Unless otherwise indicated.



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dominated, accounting for 75.9% of calls; whereas over age 9, injuries and trauma were more common (54.3% of calls). Minor trauma was the most frequent reason for EMS activation (44% of calls), followed by seizures (12%) and respiratory distress (9%). The remaining cases reflected a wide range of medical problems. Eleven children suffered major trauma (Injury Severity Score >11), and there was 1 child with cardiac arrest. Most EMS responses were to a place of residence (52%), a public place (18%) or a street (17%).

Of those children assessed by EMS, 7% were judged to require *Urgent* transport to the hospital, 57% required *Prompt* transport, 8% were considered *Deferrable* and 28% were *Not Transported* to the hospital (Table 2). This relatively high non-transport rate was similar to the non-transport rate of the total EMS call population, which was 31.6% (9728 of 30 793 calls). In over half of the pediatric non-transport cases, no reason was documented. In many cases, the guardian indicated they would transport the child to hospital themselves (24%) or monitor the child's condition at home (17%). In 3% of cases, ambulance attendants deferred the transport to another EMS crew or to helicopter. Table 2 also shows that mean response time from "call receipt to vehicle stops" was 11.0 minutes and the mean time at the scene from "vehicle stops to depart scene" was 15.9 minutes. Mean travel time from scene to hospital was 16 minutes.

Vitals signs were recorded on the majority of patients. Heart rate was documented in 1221 (88.7%), respiratory rate in 1235 (89.7%), systolic blood pressure in 756 (54.9%), and diastolic blood pressure in 552 (40.1%). Most responses (62%) involved an advanced care paramedic. Table 3 summarizes prehospital interventions, showing that 767 children (56% of those assessed) received one or more interventions and 44.0% received none. In the intervention group, 598 (43.4%) received at least 1 BLS intervention and 368 (26.7%) received at least 1 ALS intervention (Table 3).

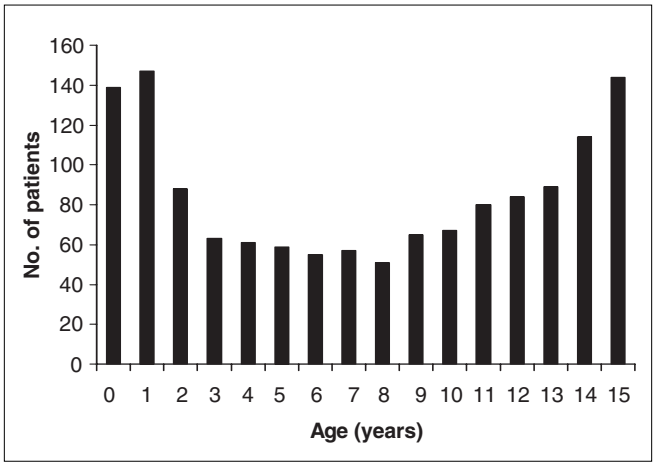


**Fig. 1. Age distribution of pediatric prehospital patients (*n* = 1377).**

Of the 992 transported patients, 896 (90.3%) were transported to the tertiary care pediatric hospital, 69 (7.0%) to community hospitals and 27 (2.7%) to adult tertiary care hospitals. Patient status on arrival to ED was documented in 814 of 992 (82%) transported cases. Of those documented, the patient's status improved during transport in 41%, was unchanged in 58% and deteriorated in 1%.

Table 4 provides a summary of outcomes, showing that most patients (82.6%) were discharged home after ED treatment, that 89 children (9.0%) were admitted to the hospital and 22 (2.2%) were admitted to the intensive care unit (ICU). The admitted patients had a mean hospital length of stay of 8.4 days (SD 15.7). The final diagnosis for hospitalized children was most often related to trauma (30.4%), respiratory illness (18.0%) or psychiatric illness (12.4%). During the study period, only 1 child suffered a cardiac arrest (i.e., vital signs absent). There were no deaths in the study cohort; however, follow-up data could not be obtained for 41 cases (4.1%).

Seizures were the most common non-injury-related reason for transport (*n* = 162; 11.8%). Seizure-related calls were most often to a residence (79%), a public place (9.3%) or a school (7.4%). Mean age in this group was 5.4 years

**Table 2. EMS response and patient characteristics for the 1377 study patients**

| Variable | No. (and %) of patients |
|---|---|
| ***EMS Return Priority Code*** | |
| Urgent | 99 (7.2) |
| Prompt | 782 (56.8) |
| Deferrable | 111 (8.1) |
| Not transported | 385 (27.9) |
| Guardian will take child to hospital | 92 (23.9) |
| Guardian will monitor condition | 66 (17.1) |
| Other EMS / helicopter to transport | 12 (3.1) |
| No reason stated | 215 (55.8) |
| | No. of minutes (and SD) |
| ***Time to treatment*** | |
| Call receipt to crew notified | 2.3 (20.3) |
| Crew notified to vehicle stops | 8.7 (6.3) |
| Call receit to vehicle stops | 11.0 (21.3) |
| Vehicle stops to patient's side | 2.0 (0.4) |
| Vehicle stops to depart scene | 15.9 (8.9) |
| Depart scene to arrive hospital | 16.0 (7.9) |

EMS = emergency medical services; SD = standard deviation



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(SD = 4.8) and, based on EMS determination, 63 children (39%) had febrile seizures, 33 (20%) had "new-onset, non-febrile seizure" and 59 (36%) had a chronic seizure disorder. The seizure ended before EMS arrival in 135 cases (83%), while EMS was at the scene in 3 (1.9%), and on route to hospital in 7 cases (4.3%). Of the 162 children with seizures, 143 (88%) were transported to hospital and only 5 (3%) were still convulsing at the time of ED arrival.

Basic Life Support interventions included blood glucose measurement in 114 (70%), oxygen in 98 (60%), suction in 5 (3%) and bag–valve–mask ventilation in 2 (1%). Advanced Life Support interventions included cardiac monitoring in 79 (49%), IV access (attempted in 47 cases; successful in 32) and diazepam administration 10 (6%). No patients required endotracheal intubation. Of the 143 transported children, 128 (90%) were discharged home from the ED, 8 (6%) were admitted to the ward and 1 (0.7%) was admitted to the ICU, with 6 patients (4%) lost to follow-up.

**Table 3. EMS interventions* for the 1377 study patients**

| Variable | No. (and %) of patients |
|---|---|
| Advanced care paramedic on scene | 854 (62.0) |
| ***Any BLS intervention*** | ***598 (43.4)*** |
| Oxygen | 272 (19.8) |
| Blood glucose measurement | 225 (16.3) |
| Spine board | 168 (12.2) |
| Limb immobilization | 161 (11.7) |
| Wound dressing | 142 (10.3) |
| Cervical collar | 138 (10.0) |
| Nebulized salbutamol | 43 (3.1) |
| Suction | 19 (1.4) |
| Airway | 10 (0.7) |
| Extrication | 8 (0.6) |
| Epinephrine (subcutaneous) | 8 (0.6) |
| Bag-valve-mask ventilation | 5 (0.3) |
| Glucagon (subcutaneous) | 3 (0.2) |
| CPR | 1 (0.1) |
| ***Any ALS intervention*** | ***268 (26.7)*** |
| Cardiac monitoring | 276 (20.0) |
| Attempted IV insertion | 139 (10.1) |
| Successful IV insertion | 108 (78.0)† |
| Diazepam | 10 (0.7) |
| Morphine | 9 (0.7) |
| Endotracheal intubation | 1 (0.1) |
| ***No BLS or ALS intervention*** | ***606 (44.0)*** |

EMS = emergency medical services; BLS = Basic Life Support; CPR = cardiopulmonary resuscitation; ALS = Advanced Life Support; IV = intravenous
*Patients may have more than one intervention.
†Success rate.

## Discussion

This is the first Canadian study of the epidemiology of pediatric prehospital care that describes EMS interventions and outcomes. Our data showed that minor trauma, including fractures, head injuries and lacerations, is the most common reason for EMS transport, followed by seizures and respiratory distress. Most children received BLS or ALS interventions, but ALS interventions other than cardiac monitoring were rare. Most transports were not urgent and the admission rate to hospital was relatively low. In addition, many children were assessed by EMS but not transported to hospital.

In this study, children represented only 4.6% of paramedic calls, lower than the 10% reported in other studies and commonly quoted in prehospital and medical literature.[1,2,22] However, these studies included patients up to 19 years of age, and many of these "pediatric" patients are actually of adult size and physiology. Our study is similar to those by McCaig and Ly[3] and by Joyce and colleagues,[4] who defined "pediatric" as <15 years old, and found that pediatric transports accounted for 4% to 5.4% of all ambulance transports. Our finding of a bimodal age distribution is consistent with findings of Tsai and Kallsen[2] who also

**Table 4. Outcomes of the 992 children transported by EMS**

| Variable | No. of patients (and %) |
|---|---|
| ***Emergency department (ED) disposition (n = 992)*** | |
| Discharged home from the ED | 819 (82.6) |
| Admitted to hospital | 89 (9.0) |
| Admitted to special care unit | 22 (2.2) |
| Patient left ED without being seen by a physician | 21 (2.1) |
| Lost to follow-up | 41 (4.1) |
| ***Final diagnosis for patients admitted (n = 89)*** | |
| Injury | 16 (18.0) |
| Injury, major trauma (ISS >11) | 11 (12.4) |
| Psychiatric | 11 (12.4) |
| Gastrointestinal | 10 (11.2) |
| Other respiratory | 8 (9.0) |
| Musculoskeletal | 6 (6.7) |
| Pneumonia | 6 (6.7) |
| Neurologic | 5 (5.6) |
| Asthma | 2 (2.2) |
| Endocrine | 1 (1.1) |
| Hematologic | 1 (1.1) |
| Other | 12 (13.5) |
| ***Survival (n = 992)*** | ***992 (100.0)*** |

EMS = emergency medical services; ISS = Injury Severity Score



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found an early (largely medical) peak in the first year of life and a second peak in the teenage years, which consisted largely of trauma cases.

The study data also indicate that 93% of pediatric ambulance transports were non-urgent and that 99% of those transported to the ED were stable or improved after ambulance transport. Admissions to hospital were also low, at 9.0%; however, of those admitted, 24.7% required admission to the ICU. These findings are consistent with previous studies.[4,8,15,18] Ironically, Kost and colleagues[18] found that 87% of high-acuity pediatric cases arrived by private vehicle, suggesting that ambulance services may sometimes be used inappropriately to transport low-acuity patients, while many high-acuity patients are transported by other means.

The vast majority of interventions provided involved providing oxygen, measuring blood glucose, immobilizing trauma patients, and monitoring cardiac rhythm. Given the low acuity of the pediatric prehospital population, other resuscitation skills, particularly airway skills, were rarely used. In fact, during this 6-month study, only 1 child received prehospital intubation, 5 received bag-valve-mask ventilation and 10 had an oral airway inserted. At least in this system, EMS personnel get very little field practice in managing the pediatric airway and most EMS personnel would not have the opportunity to ventilate even a single child in an entire year.

Our results are similar to those of Babl and associates,[23] who studied 555 pediatric ALS transports in an urban setting and reported that 33% of the children had an IV start, 5% had bag-mask ventilation, 3% were intubated and 0.5% received intraosseous access. This equated to a rate per ALS provider (per year) of 3.7 times for IV cannulation, 0.6 times for bag-mask ventilation, 0.3 times for intubation and 0.06 times for intraosseous access. These data suggest that lifesaving pediatric interventions are practised infrequently in the field, and that the same holds true for delivery of ALS medications. Only 19 children received IV medications (10, diazepam; 9, morphine). It is clear that most paramedics would have very little experience in providing IV pain relief to children.

We were surprised to find that 28% of pediatric calls were assessed by EMS but never transported to hospital. Studies of various EMS systems have found that this non-transported population varies widely, from 11%–32% of all pediatric EMS runs.[1,2,4,6,7,12–14] We found that 24% of parents preferred to transport their child by private vehicle, and 17% decided to observe their child at home. Surprisingly 56% of ACRs had no reason documented for the non-transport, a concerning fact, as the non-transport population is responsible for a substantial proportion of litigation against EMS services.[24,25] Future studies should examine characteristics, reason for non-transport and outcomes of the non-transported pediatric population.

In the subgroup of patients with seizures, we found that the large majority of seizures stopped before EMS arrival. The most common prehospital interventions were blood glucose check, provision of oxygen, cardiac monitoring and establishing an IV line. Only 6% received IV anticonvulsants and very few required airway management or ventilation. This information should be useful to those planning prehospital seizure intervention trials in the future.

### *Limitations*

The 6-month study duration may have led to a seasonal bias; for example, trauma is more common in summer and respiratory and viral illnesses are more common in winter. In addition, this study only examined one geographic setting with relatively short transport times, and results may not be applicable to remote environments or other ambulance systems. We did not assess air transport and as a result may have selectively excluded more critical patients. We cannot determine from these data whether all children receiving a procedure benefited from it, or whether all children who may have benefited from a procedure received it.

These findings have implications for pediatric prehospital education and research. The low rates of pediatric EMS transport and invasive procedure use means that ALS providers may have insufficient experience in pediatric ALS care. Prehospital education programs should address this reality. These findings also tell us that most pediatric transport cases are for trauma, seizures and respiratory distress, and that EMS providers have a major role in treating these concerns. The challenge is to balance the educational requirements of being prepared to manage the rare critically ill or injured child while teaching EMS providers about the most commonly encountered pediatric chief complaints. In addition, the large proportion of non-transported children suggests the need to study this group to ensure that these children have optimal outcomes.

## Conclusion

This Canadian pediatric EMS study shows a high rate of *Not Transported*, and a low rate of *Urgent* transports and hospital admissions for children. Very few children receive prehospital airway management, ventilation or intravenous medications; consequently EMS personnel may have little opportunity to maintain these pediatric skills in the field.



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