



BMJ Open Physician staffed emergency medical service for children: a retrospective population-based registry cohort study in Odense region, Southern Denmark

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ABSTRACT

Objectives The aim of this study is to determine diagnostic patterns in the prehospital paediatric population, age distribution, the level of monitoring and the treatment initiated in the prehospital paediatric case. Hypothesis was that advanced prehospital interventions are rare in the paediatric patient population.

Setting We performed a retrospective population-based registry cohort study of children attended by a physician-staffed emergency medical service (EMS) unit (P-EMS), in the Odense area of Denmark during a 10-year study period.

Participants We screened 44 882 EMS contacts and included 5043 children. Patient characteristics, monitoring and interventions performed by the P-EMS crews were determined.

Results We found that paediatric patients were a minority among patients attended by P-EMS units: 11.2% (10.9 to 11.5) (95% CI) of patients were children. The majority of the children were <5 years old; one-third being <2 years old. Respiratory problems, traffic accidents and febrile seizures were the three most common dispatch codes. Oxygen supplementation, intravenous access and application of a cervical collar were the three most common interventions. Oxygen saturation and heart rate were documented in more than half of the cases, but more than one-third of the children had no vital parameters documented. Only 22% of the children had respiratory rate, saturation, heart rate and blood pressure documented. Prehospital invasive procedures such as tracheal intubation (n=74), intraosseous access (n=22) and chest drainage (n=2) were infrequently performed.

Conclusion Prehospital paediatric contacts are uncommon, more frequently involving smaller children. Monitoring or at least documentation of basic vital parameters is infrequent and may be an area for improvement. Advanced and potentially life-saving prehospital interventions provide a dilemma since these likely occur too infrequently to allow service providers to maintain their technical skills working solely in the prehospital environment.

INTRODUCTION

Various aspects of emergency medical events have previously been examined in

Strengths and limitations of this study

- This is a retrospective and observational study, and conclusions on causal relationships between study parameters must be made with caution.
- A considerable weakness of the study is that there is no formal validation of a subjective measure of outcome.
- The study does not present follow-up data on morbidity or mortality following admission to hospital.
- The study presents data from single geographical area with relatively short response times, and comparison with other prehospital systems must be done with caution.

Scandinavian studies. Little attention has, however, been paid to paediatric patients,^{1–8} which is unfortunate since robust paediatric prehospital emergency data may allow evaluation of the adequacy of prehospital responses to paediatric emergencies, improvements in the preparation and training of prehospital personnel for paediatric medical issues and prioritisation of future research in this field.

In recent years it has been elucidated that ‘complications in paediatric anaesthesia are directly related to the (in)experience of the anaesthesiologist in charge’.⁹ This has led to the emergence of the concept of ‘10-N-Quality Paediatric Anaesthesia’, and the ‘Safe Anaesthesia For Every Tot’ initiative which aims to define the safe conduct of paediatric anaesthesia.¹⁰ No such initiative exists for prehospital paediatric patients, and the role of the anaesthesiologist in the prehospital setting varies from region to region and country to country. Although the prehospital environment is less controlled than the operating room, several parallels can be drawn with regards to a systematic approach to both the safe conduct of paediatric anaesthesia and the prehospital paediatric case.

The aim of this study was to determine diagnostic patterns in the prehospital paediatric population, age distribution, the level of monitoring and the treatment initiated in the prehospital paediatric case. The hypothesis was that advanced prehospital interventions are rare in the paediatric patient population.

METHODS

Study design

We performed a retrospective population-based registry cohort study paediatric medical emergency calls managed by the Emergency Medical Dispatch Centre, EMDC, in the Region of Southern Denmark from October 2007 to December 2017.

Study setting and selection of patients

We performed a registry-based follow-up study of patients attended by a physician staffed land unit after emergency calls. All patients 18 years or less, who were attended to by a physician-manned emergency medical service (EMS) unit between the dates of 1 October 2007 and 31 December 2017 were included.

Study Setting

The study was carried out in the Mobile Emergency Care Unit (MECU) in Odense in the Region of Southern Denmark. The MECU in Odense is a part of the nationally implemented and publicly funded three-tiered emergency medical system in which the basic resource is an ambulance manned with two emergency medical technicians. The MECU in Odense is an anaesthesiologist-manned rapid-response vehicle consisting of an anaesthesiologist and an emergency medical technician supplementing the ordinary ambulances. Danish physician-staffed EMS (P-EMS) units are staffed with senior anaesthesia and intensive care registrars or consultants who work as part time prehospital physicians. It covers a population of approximately 260 000 people living within 2500 km².¹¹

The EMDC responds to calls for assistance from all the Region of Southern Denmark. Thus, it covers a population of 1 210 000 people in both rural and urban areas. Following calls from the public, the EMDC dispatches either an ambulance, an ambulance and a paramedic or an ambulance and a P-EMS unit. For patients younger than 3 years of age a P-EMS is automatically dispatched irrespective of severity.¹²

Data collection

The following data were obtained: age and gender of the patient, dispatch code from the dispatch centre, response time, pharmacological and non-pharmacological interventions performed by the prehospital staff, number and types of monitoring modalities, initial evaluation of the severity of the case and the preliminary diagnosis assigned to the patient by the prehospital physician (according to the WHO International Classification of Diseases-10 classification system). Interventions were labelled as either

basic or advanced. Advanced interventions were defined as interventions exceeding the curriculum of either the emergency medical technician or paramedic. Rate of intervention was defined as a patient receiving one or more interventions.

Exclusion criteria

Patients attended, but whose age or identification details were unknown were excluded.

Patient and public involvement

No patients or the public were involved in either the planning or design of the study.

RESULTS

The study period included 44 882 patient contacts, of which 5240 were patients 18 years or less. In the study database, unidentified patients were registered with a birthdate that was the P-EMS contact date, thus resulting in unidentified contacts being labelled as paediatric patients. Since the real age of these unidentified patients could not be confirmed, they were excluded from the study. This represents an issue with patients born on day of the contact. These patients were likely to be few but would be the result of unexpected or precipitous delivery. These could be premature but viable neonates that would require advanced interventions. Dispatch codes likely to result in newborns were: 'delivery' n=4, 'newborn' n=1, 'prematurity' n=1. However, the database does not permit to distinguish between mother and child, and due to the very low numbers, these contacts were left out of analysis. The total number of these unidentified patients was 197.

Final analysis was carried out in 5043 paediatric cases, amounting to 11.2% (10.9 to 11.5) of all contacts (figure 1). Data in tables are presented as absolute numbers, in percentages of the total number of observations and with 95% CIs.

The median (IQR) age of the prehospital paediatric patient was 4 years (1–14 years). Male gender was predominant, the overall M:F ratio being 1.18, seen most clearly in the younger age groups (figure 2). Median (IQR) response time from dispatch to first patient contact was 7 min (5–11 min). Since many patients were either discharged at site or admitted to hospital without priority transportation without an accompanying physician, time to admission was difficult to interpret and hence omitted from analysis.

One or more vital parameters, that is, blood pressure, pulse rate, saturation and respiration frequency—were recorded in 62.5% of patients (figure 1). Oxygen saturation was measured most often, in 57% of all cases. Only 22.0% had all four vital parameters recorded.

The most common intervention overall was oxygen administration (n=1492) which was performed in 29.6% (28.3 to 30.9) of all contacts. Intravenous access was the most common advanced intervention (n=1041) and was performed in 20.6% (19.5 to 21.8) of all paediatric cases.

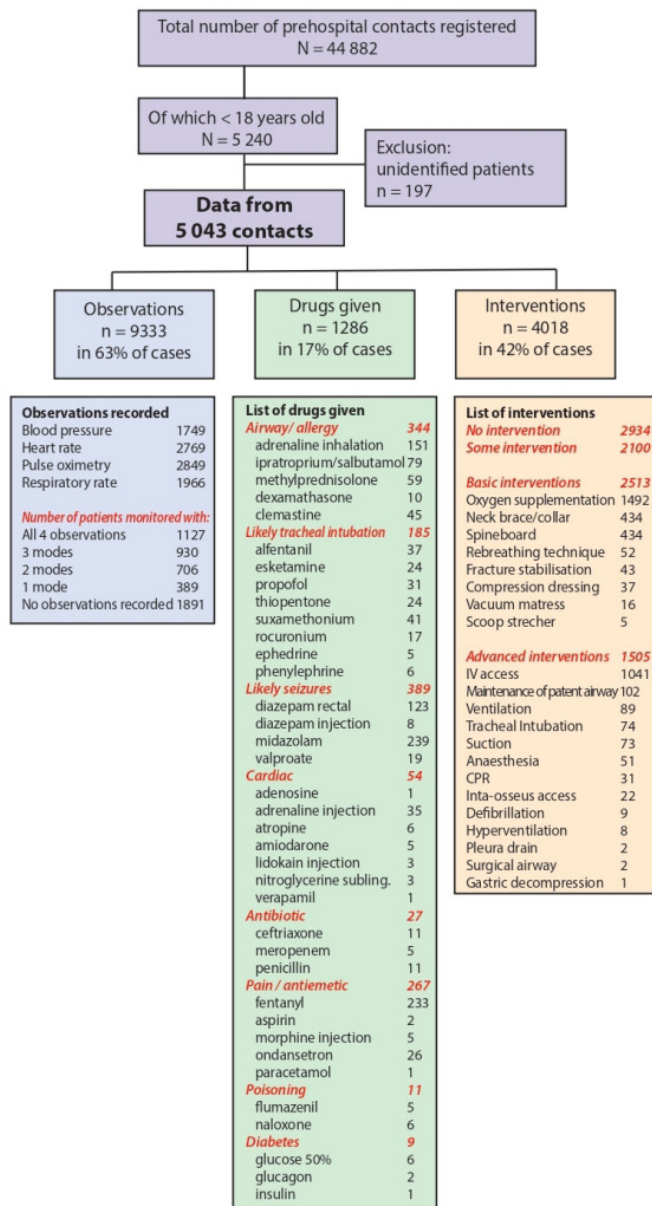


Figure 1 Paediatric prehospital interventions. CPR, cardiopulmonary resuscitation.

Overall rate of any intervention was 41.6% (40.6 to 43.0) and rate of advanced intervention was in 21% (19.9 to 22.1).

During the 10-year follow-up intubation was performed a total of 74 times, overall rate being 1.5%. The rate by age group for intubation was similar to the age distribution for the paediatric patients in general. Intubation was performed 21 times for children younger than 2 years, and 18 times for patients aged 17 and 18. The incidence of cardiopulmonary resuscitation was similarly low. Cardiopulmonary resuscitation (CPR) was performed 31 times, the overall rate being 0.6%. Primary rhythm analysis was registered as asystole n=19; ventricular fibrillation n=4; ventricular tachycardia n=3; other n=5. Only 17% were given medication: midazolam and fentanyl were the most frequently administered drugs.

Table 1 Dispatch codes

Dispatch code	N	% (95% CI)
Breathing difficulties	840	16.7 (15.6 to 17.7)
Traffic accident	721	14.3 (13.3 to 15.3)
Febrile convulsions	704	14.0 (13.0 to 14.9)
Injury, unspecified	678	13.4 (12.5 to 14.4)
Unspecified disease	636	12.6 (11.7 to 13.6)
Convulsions	635	12.6 (11.7 to 13.5)
Unconsciousness	294	5.8 (5.2 to 6.5)
Foreign body in airways	92	1.8 (1.5 to 2.2)
Poisoning	81	1.6 (1.3 to 2.0)
Asthma	72	1.4 (1.1 to 1.8)
Cardiac disease	56	1.1 (0.8 to 1.4)
Allergy	46	0.9 (0.7 to 1.2)
Fall from heights	36	0.7 (0.5 to 1.0)
Diabetes	30	0.6 (0.4 to 0.8)
Meningitis	24	0.5 (0.3 to 0.7)
Cardiac arrest	22	0.4 (0.3 to 0.7)
Unspecified bleeding	21	0.4 (0.3 to 0.6)
Major burns	20	0.4 (0.2 to 0.6)
Not classified	35	0.7 (0.5 to 1.0)
Total	5043	100

The three most common emergency dispatch codes were: breathing difficulties, need for transportation and febrile seizures (table 1). Critical dispatch codes were relatively infrequent: airway obstruction (n=94), meningitis (n=24), cardiac arrest (n=22), major burn injury (n=20).

The three most common diagnoses registered by EMS physicians were: febrile seizure, observation after traffic accident and 'observation for suspected disease' (table 2). Critical diagnoses were infrequent and discrepancies when comparing with the dispatch codes were noted: foreign body airway obstruction (n=97), cardiac arrest (n=13), bacterial meningitis (n=11).

Most of the paediatric patients in this study were transported from scene to hospital and most of these

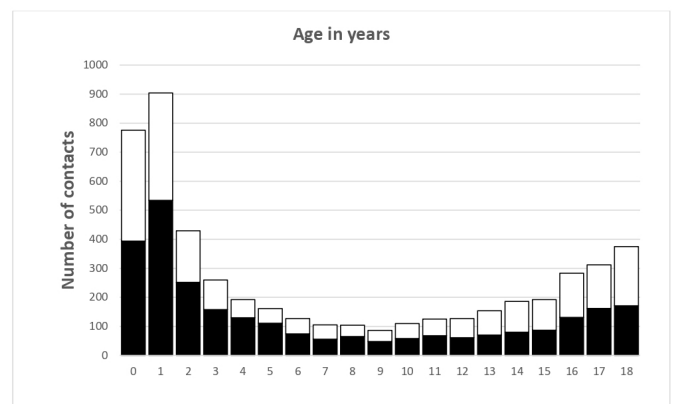


Figure 2 Age distribution of paediatric prehospital patients.

**Table 2** The 20 most frequently used diagnoses set at scene by emergency medical service physician

ICD 10 code	Diagnosis	N	% (95% CI)
R56.0	Febrile convulsions	935	18.5 (17.5 to 19.6)
Z04.1	Examination and observation following transport accident	623	12.3 (11.5 to 13.3)
Z03.9	Observation for suspected disease or condition, unspecified	403	8.0 (7.3 to 8.8)
R56.8	Other and unspecified convulsions	368	7.3 (6.6 to 8.1)
Z04.3	Examination and observation following other accident	346	6.9 (6.2 to 7.6)
Z04.8	Examination and observation for other specified reasons	278	5.5 (4.9 to 6.2)
J05	Acute obstructive laryngitis (croup) and epiglottitis	248	4.9 (4.3 to 5.6)
R50.9	Fever, unspecified	190	3.8 (2.7 to 4.3)
G40.9	Epilepsy, unspecified	167	3.3 (2.8 to 3.8)
R06.4	Hyperventilation	118	2.3 (1.9 to 2.8)
S06.0	Concussion	108	2.1 (1.8 to 2.6)
J96.9	Respiratory failure, unspecified	106	2.1 (1.8 to 2.5)
R55.9	Syncope and collapse	105	2.1 (1.8 to 2.5)
T17.9	Foreign body in respiratory tract, part unspecified	97	1.9 (1.6 to 2.3)
T78.4	Allergy, unspecified	80	1.6 (1.3 to 2.0)
T07.9	Unspecified multiple injuries	79	1.6 (1.2 to 1.9)
J45.9	Asthma, unspecified	76	1.5 (1.2 to 1.9)
J18.9	Pneumonia, unspecified	52	1.0 (0.8 to 1.4)
T14.0	Superficial injury of unspecified body region	44	0.9 (0.6 to 1.1)
T12.9	Fracture of lower limb, level unspecified	42	0.8 (0.6 to 1.1)
	Other diagnoses	578	11.5 (10.6 to 12.4)
Total		5043	100

ICD, International Classification of Diseases.

transportations were carried out without a physician's escort (table 3). As many as 17% of the patients were treated and subsequently discharged at the scene and thus required no transportation.

In the study database, clinical outcome is registered for each patient treated by the P-EMS (table 3). Most of the patients were scored as either 'status unchanged' or 'some improvement'. Approximately 10% of all cases were labelled with either 'significant improvement' or 'lifesaving'. Only about 1% of the patients were labelled 'deteriorating' or 'death'.

DISCUSSION

Prehospital paediatric contacts are uncommon. More frequently they involve smaller children. Most contacts took place with children under 5 years of age, and a clear peak was seen with children less than 2 years of age. Monitoring of vital parameters was applied to approximately two-thirds of all cases, and measurement of oxygen saturation was the most common monitoring procedure carried out. The most common interventions were oxygen supplementation and intravenous access. Other than intravenous access, advanced interventions such as intubation, CPR, intraosseous access and pleural drainage were rare.

In this study, 11.2% of all patient contacts concerned patients 18 years old or younger. This is similar to other existing studies,^{6–8} where the rate of paediatric contacts has been reported to be between 5% and 7%. The slightly higher percentage in this study may be explained by the fact that our EMDC protocol sends a P-EMS to all children less than 3 years of age, irrespective of severity. This dispatch policy is likely to partly explain the low intervention rate per patient contact for children and probably explains the high number of febrile convulsions in the data set.

Healthcare workers often find caring for children to be more stressful than caring for adults.^{13 14} However, most of the children in this study recovered spontaneously or with minor assistance. In addition to the infrequency of children in the prehospital setting, the low incidence of advanced interventions other than intravenous access performed in paediatric patients is striking. Paediatric CPR is rare^{15 16} and in this study, it was conducted only for 31 patients. Paediatric cardiac arrest is most often caused by hypoxia, compared with cardiac reasons in adult patients,^{16 17} and findings of this study support this: only nine patients received defibrillation, presumably due to the rhythm being asystole rather than ventricular arrhythmia. These findings of advanced interventions

Table 3 Prehospital mission outcome and status at completion of mission

Mission outcome	N	% (95% CI)
Transported to hospital without physician escort	3092	61.3 (60.0 to 62.7)
Transported to hospital with physician escort	1078	21.4 (20.3 to 22.5)
Released at the scene following treatment	743	14.7 (13.8 to 15.7)
Mission down-prioritised	70	13.9 (10.8 to 17.5)
Miscellaneous (telephone consultation, administrative tasks)	34	0.7 (0.5 to 0.9)
Patient declared dead	26	0.5 (0.3 to 0.8)
Total	5043	100
Patients status at completion of mission		
Patient status unchanged	2164	42.9 (41.5 to 44.3)
Patient status improved	1993	39.5 (38.2 to 40.9)
Patient status improved significantly	487	9.7 (8.9 to 10.5)
Patient's life saved	47	0.9 (0.7 to 1.2)
Patient status deteriorated	26	0.5 (0.3 to 0.8)
Patient dead during the mission	31	0.6 (0.4 to 0.9)
Status missing	295	5.9 (5.3 to 6.6)
Total	5043	100

applied to paediatric prehospital patients underline the significance of EMS providers' need for training and experience with critically ill children. Intubation and high-quality advanced airway management are considered crucial to critically ill patients and are key interventions provided by physician staffed EMS units.¹⁶ Since advanced airway management in small children is considered more challenging than in adults,^{18 19} and since it is so seldom needed in the prehospital setting, one could suggest that training should be obtained in other settings. An adequate experience with paediatric patients can probably only be achieved through in-hospital work rather than 'training on the job'.

The findings regarding monitoring were surprising: about one-third of all paediatric patients were not monitored with vital parameters, and only about one in five had all four vital parameters measured. This is in stark contrast to the child undergoing general anaesthesia where close to 100% of all cases are monitored to some degree. We argue that the findings in our study reflect the fact that monitoring in the prehospital setting is not based on standards of care but rely on the subjective clinical evaluation of the attending physician. Whether or not this has implications for patient safety is beyond the scope of this paper.

This study supports that the assertion that a critically ill child who is in need for life-saving intervention, is a

rarity for the prehospital physician. However, these patients do exist and occasionally require critical interventions: responding physicians need to be experienced and skilled. When these patients are met, documentation should be done meticulously.

The large number of paediatric patients that are discharged at the scene following treatment (17%), points towards the fact that many children are cared for without the need for admission to hospital. This could indicate both a low threshold for contacting the EMDC when a child in distress is concerned, but also a level of overtriage. It is possible that the accuracy of the dispatch system is not sufficient, and that further understanding of the dispatch element of paediatric case may lead to better usage of resources.

CONCLUSIONS

Prehospital paediatric contacts are uncommon. When they do occur, they frequently involve smaller children. Monitoring or at least documentation of monitoring, of basic vital parameters is infrequent in our material and may be an area for improvement. Advanced and potentially life-saving prehospital interventions provide a dilemma since these likely occur too infrequently to allow the prehospital emergency care providers to maintain technical skills solely in the prehospital environment.

Limitations

An important limitation of the present study is the application of a subjective measure of outcome. This may have given rise to reporting bias as the physician responsible for the mission performed was the one who made the initial assessment of the mission.

This is a retrospective and observational study with data originating from one geographical area. No conclusions can be made about the cause and relationships between the study parameters presented here, and comparison to other prehospital organisations must be done with caution. Larger and prospective studies are needed to study possible associations.

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