


## Brief Communication

# Prehospital medical equipment for care of pediatric injury patients in Japanese ambulances: a nationwide survey

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**Aim:** We evaluated the status of the allocation of medical emergency equipment suitable for pediatric patients of all ages.

**Methods:** In 2019, we surveyed the emergency medical officers from 728 fire defense headquarters around Japan. The questionnaire was designed to evaluate the kind and size of equipment available to ambulance crews for prehospital emergency care of injured pediatric patients. A complete pediatric equipment set was defined as a set containing equipment suitable for children aged 0–14 years.

**Results:** Overall, 599 (82%) fire defense headquarters responded to our survey. Of these, 596 (99.5%) declared that pediatric equipment was available to ambulance crews. The allocation rates of complete pediatric sets were considerably low: blood pressure cuff, 5%; nasopharyngeal airway, 1%; oropharyngeal airway, 7%; laryngoscope, 6%; supraglottic airway device, 13%; endotracheal tube, 0.2%; and bag-valve-mask, 23%. Moreover, none of these fire defense headquarters had complete pediatric equipment sets for all 14 devices assessed in this study.

**Conclusions:** Although most Japanese ambulances can provide prehospital emergency care to pediatric patients, this survey revealed the dispersion and deficiencies in the availability of complete pediatric equipment sets.

**Key words:** Children, emergency medical service, injured children, medical equipment, prehospital emergency care

## INTRODUCTION

IN JAPAN, INJURY is a major cause of death in children.<sup>1</sup> To reduce preventable deaths due to injury, it is essential that severely injured patients receive efficient and specialized prehospital emergency care by emergency medical services (EMSs).<sup>2</sup> Although pediatric prehospital care is an important service worldwide, previous studies have reported deficiencies in the provision of equipment and training to care for critically injured children.<sup>3–6</sup>

In Japan, the fire defense headquarters of the local governments provide EMSs.<sup>7</sup> The Emergency Life-Saving Technician Law of 1991 expanded the roles of ambulance crew members to provide an advanced level of emergency care, including procedures such as airway maintenance using an

airway device, removal of a foreign body from respiratory tracts using forceps, and tracheal intubation/adrenaline administration for patients with cardiac arrest under physician supervision. Only 8.3% of all emergency transportations in Japan are for children younger than 18 years old<sup>8</sup>; therefore, most ambulance crew members perceive dealing with pediatric patients as difficult and stressful.<sup>4</sup> Moreover, because children have anatomical and physiological characteristics distinct from those of adults, it is essential that EMSs provide prehospital emergency care with equipment suitable for children of all ages and physiques for appropriate pediatric monitoring and management.<sup>5,9</sup> The availability of appropriate emergency medical equipment may significantly impact the outcomes of injured children.<sup>10</sup> The identification of gaps in availability will allow EMSs and medical professionals to efficiently direct their efforts toward resolving this issue.

We aimed to evaluate the current status of the allocation of medical emergency equipment suitable for pediatric injured patients of all ages in the Japanese EMSs following the expansion of their prehospital care emergency duties.

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Received 25 Aug, 2020; accepted 1 Nov, 2020

### Funding information

No funding information provided.

## METHODS

**I**N OCTOBER 2019, we sent a questionnaire via email to the emergency medical officers of 728 fire defense headquarters in Japan. They had to respond to this survey within 1 month; no reminders were sent.

The two-part questionnaire was designed to evaluate the kinds and sizes of equipment available to the ambulance crews for the prehospital emergency care of pediatric patients. Part 1 inquired about the allocation of equipment we considered important for pediatric injury patients with a “yes” or “no” response format. If the answer was “yes,” the respondents had to proceed to the second part of the questionnaire. Part 2 inquired about the sizes of equipment using an open response format. The following age definitions were used: neonate, 0–28 days old; infant, 29 days to 1 year old; preschool child, 2–5 years old; and schoolchild, 6–14 years old. We defined complete pediatric equipment set as the one including sizes suitable for neonates, infants, preschool children, and schoolchildren. We assessed the allocation of 14 devices, including monitoring (blood pressure cuff and pulse oximeter sensor), airway management (nasopharyngeal airway, oropharyngeal airway, Magill forceps, laryngoscope, supraglottic airway device, and endotracheal tube), breathing and ventilation management (nasal oxygen cannula, oxygen mask, oxygen mask with reservoir, and bag-valve-mask), and immobilization (stiff neck collar and spinal board) devices.

We obtained informed consent from respondents prior to the survey. This study was approved by the Institutional Ethics Committee of The University of Tokyo (approval no. 2019262NI).

## RESULTS

**O**VERALL, 599 (82%) fire defense headquarters responded to our survey. Of these, 596 (99.5%) declared that pediatric equipment was available to ambulance crews.

Table 1 summarizes the data on the allocation of equipment for monitoring and management of injured pediatric patients at the 599 fire defense headquarters. The allocation rates for devices of any size for pediatric injury patients were as follows: blood pressure cuff, 98% ( $n = 598$ ); pulse oximeter sensor, 86% ( $n = 517$ ); nasopharyngeal airway, 14% ( $n = 82$ ); oropharyngeal airway, 50% ( $n = 299$ ); Magill forceps, 3% ( $n = 16$ ); laryngoscope, 88% ( $n = 530$ ); supraglottic airway device, 69% ( $n = 413$ ); endotracheal tube, 9% ( $n = 52$ ); nasal oxygen cannula, 13% ( $n = 78$ ); oxygen mask, 95% ( $n = 571$ ); oxygen mask with reservoir, 46% ( $n = 277$ ); bag-valve-mask, 98% ( $n = 588$ ); stiff neck

collar, 53% ( $n = 319$ ); and spinal board, 24% ( $n = 144$ ). Compared with these, the allocation rates of complete pediatric emergency sets of all sizes were considerably lower: blood pressure cuff, 5% ( $n = 27$ ); nasopharyngeal airway, 1% ( $n = 4$ ); oropharyngeal airway, 7% ( $n = 43$ ); laryngoscope, 6% ( $n = 33$ ); supraglottic airway device, 13% ( $n = 79$ ); endotracheal tube, 0.2% ( $n = 1$ ); and bag-valve mask, 23% ( $n = 140$ ). Moreover, none of the fire defense headquarters had complete pediatric equipment sets for all 14 devices assessed in this study.

## DISCUSSION

**T**HE HIGH RESPONSE rate to our survey indicates that our results are representative of the current status of medical equipment availability for pediatric injury patients in the prehospital emergency settings throughout Japan. Our results revealed the dispersion and deficiencies in the availability of pediatric medical devices suitable for children of all ages, despite most fire defense headquarters declaring that such equipment was available to ambulance crews.

The goal of emergency care in ambulances is to manage life-threatening conditions. Therefore, the crew should be able to provide timely and appropriate medical intervention after evaluating the patient’s vital signs. A previous study reported that effective monitoring during the transportation of critically ill pediatric patients improved their outcomes.<sup>11</sup> Under such prehospital settings, the ambulance crew needs to measure and monitor the patient’s blood pressure. It is essential to use a blood pressure cuff appropriate for the pediatric patient’s body size to measure the pressure accurately. However, our study revealed that only 5% of the fire defense headquarters had the complete set of cuffs with appropriate sizes for children of all ages. Previous studies have recommended a length-based tape to adjust equipment size for pediatric patients in prehospital settings.<sup>9,12</sup>

The equipment required for prehospital care may vary according to the needs of the population being treated and training level of the ambulance crew who provides the care. Upper airway obstruction and hypoxia are major causes of death, and 0.7% of all pediatric injury patients transferred by ambulance have injury-related out-of-hospital cardiac arrest; thus, pediatric devices to maintain airway and ventilation are essential.<sup>13,14</sup> Bag-valve-mask ventilation is preferred over intubation for such patients in prehospital settings.<sup>15</sup> However, this study showed that the allocation rate of complete pediatric sets for bag-valve-mask, supraglottic airway, and endotracheal tube was extremely low (23%, 13%, and 1%, respectively). These low rates may be explained by the following: (i) the mean time interval between the initial call to emergency services and hospital arrival was 39.5 min,

**Table 1.** Allocation of equipment for monitoring and management of injured pediatric patients

Variables	In ambulances (N = 599)
<b>Monitoring devices, n (%)</b>	
Blood pressure cuff	589 (98)
Complete pediatric set	27 (5)
For neonates	38 (6)
For infants/preschool children	328 (55)
For schoolchildren	556 (93)
Pulse oximeter sensor (for child)	517 (86)
<b>Airway management devices, n (%)</b>	
Nasopharyngeal airway	82 (14)
Complete pediatric set	4 (1)
For neonates	4 (1)
For infants/preschool children	4 (1)
For schoolchildren	82 (14)
Oropharyngeal airway	299 (50)
Complete pediatric set	43 (7)
For neonates	62 (10)
For infants/preschool children	141 (24)
For schoolchildren	277 (46)
Magill forceps (for children)	16 (3)
Laryngoscope	530 (88)
Complete pediatric set	33 (6)
For neonates (size 0)	154 (26)
For infants (size 1)	457 (76)
For preschool children (size 2)	455 (76)
For schoolchildren (size 3)	117 (20)
Supraglottic airway device	413 (69)
Complete pediatric set	79 (13)
For neonates (LTS #0 or LMA #1)	338 (56)
For infants (LTS #1 or LMA #1.5)	362 (60)
For preschool children (LTS #2 or LMA #2)	395 (66)
For schoolchildren (LTS #2.5 or LMA #3)	95 (16)
Endotracheal tube	52 (9)
Complete pediatric set	1 (0.2)
ID 3.0 mm	8 (1)
ID 3.5 mm	2 (0.3)
ID 4.0 mm	7 (1)
ID 4.5 mm	2 (0.3)
ID 5.0 mm	24 (4)
ID 5.5 mm	18 (3)
ID 6.0 mm	38 (6)
<b>Breathing and ventilation management devices, n (%)</b>	
Nasal oxygen cannula for children	78 (13)
Oxygen mask for children	571 (95)
Oxygen mask with reservoir for children	277 (46)
Bag-valve-mask	588 (98)

**Table 1.** (Continued)

Variables	In ambulances (N = 599)
Complete pediatric set	140 (23)
For neonates	300 (50)
For infants/preschool children	295 (49)
For schoolchildren	514 (86)
<b>Immobilization devices, n (%)</b>	
Stiff neck collar (for children)	319 (53)
Spinal board (for children)	144 (24)

ID, inner diameter; LTS, laryngeal tube suction; LMA, laryngeal mask airway.

which may limit the amount of prehospital care activity required of the ambulance crew, and (ii) the regional medical control councils prohibit most fire defense headquarters from using the tracheal tube or supraglottic airway devices on patients younger than 15 years old, although the Emergency Life-Saving Technicians Law allows these lifesaving instruments for resuscitation of pediatric patients by ambulance crews. The current international guidelines recommended a standardized list of minimum equipment suitable for each country.<sup>5,9</sup> Considering the limited time and restricted protocols for young patients in Japan, ambulances should carry the equipment necessary for the pediatric population in sizes suitable for children of all ages.

Education, training, and availability of medical equipment are important for providing high-quality prehospital emergency care; however, the low frequency of instances requiring treatment of severely injured pediatric patients may impact the ability of the ambulance crew to maintain their training.<sup>4</sup> The United States, UK, and Canada provide off-the-job training on pediatric prehospital care to paramedics each year as a refresher course.<sup>4,5</sup> In Japan, the status of providing ambulance crews with continuing education on pediatric prehospital care is unclear. In addition, every ambulance should carry a standardized minimum of equipment suitable for the Japanese prehospital emergency setting. Moreover, the ambulance crews should be regularly educated and evaluated for the quality of their prehospital care as recommended by guidelines.<sup>5,9</sup>

This study has some limitations. We did not consider the size of the fire defense headquarters, and the survey was limited to the questionnaires directed to these headquarters. Moreover, we did not conduct a content analysis or validity assessment of this survey. Finally, we did not evaluate the frequency and quality of prehospital care for pediatric patients. Therefore, the actual situation in ambulances is unknown.

## CONCLUSIONS

ALTHOUGH MOST JAPANESE ambulances can provide prehospital care to pediatric patients, our survey revealed the dispersion and availability of pediatric emergency devices for children aged 0–14 years. Our findings will help paramedics to ensure that ambulances carry standardized minimum pediatric equipment suitable for prehospital emergencies.

## ACKNOWLEDGEMENTS

WE THANK ALL the Japanese defense headquarters that participated in this study. We also thank Professor Morimura Naoto and Moriya Takashi for useful discussions. This work was supported by a grant from the General Insurance Association of Japan.

## DISCLOSURE

Approval of the research protocol: The protocol for this research project was approved by the Ethics Committee of The University of Tokyo and conforms to the provisions of the Declaration of Helsinki. Approval No. 2019262NI.

Informed Consent: Informed consent was obtained from all respondents prior to completion of the questionnaire.

Registry and Registration No. of the study/Trial: N/A.

Animal Studies: N/A.

Conflict of Interest: C.T. received a grant from the General Insurance Association of Japan.

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