Brief Communication

Targeted age, device deployment, and problems associated with pediatric defibrillation in pediatric prehospital emergency medical care settings in Japan

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Aim: The use of automated external defibrillators was expanded to include infants according to the 2010 cardiopulmonary resuscitation guidelines in Japan. However, deployment has been slower for pediatric patients in Japan, because there are fewer appropriate pediatric patients for automated external defibrillators than adults. This study aimed to investigate the targeted age range for pediatric defibrillation and device deployment of defibrillators for pediatric patients in prehospital emergency medical care settings in Japan, and present the issues associated with automated external defibrillators.

Methods: We administered a web-based survey to the fire defense headquarters in Japan regarding prehospital emergency medical care for pediatric patients in June 2013. We extracted and analyzed some parts of the data related to pediatric defibrillation.

Results: Eighty-eight percent of the fire defense headquarters responded to the survey. Sixty-two percent of the fire defense headquarters applied the expanded indication protocol for pediatric defibrillation, which included infants. Forty-three percent of the fire defense headquarters replied that their emergency medical service personnel were using semi-automatic defibrillators without a pediatric mode, whereas 21% of them were using automated external defibrillators that were not equipped with pediatric attenuators. Moreover, many of the semi-automatic defibrillators are not designed for pediatric defibrillation in patients aged <8 years.

Conclusions: Pediatric prehospital emergency medical care in Japan is inadequately equipped for pediatric defibrillation. It will be necessary to use age-appropriate defibrillators as the targeted age range for automated external defibrillators rapidly expands to include infants.

Key words: Automated external defibrillators, emergency medicine, pediatrics, prehospital care/medical control

INTRODUCTION

THE FIRE DEFENSE headquarters of the municipal government in Japan provides emergency medical services (EMS). The EMS transport approximately 124,000 cardiopulmonary arrest patients annually, which includes

1,100 children aged <9 years.¹ Although all EMS personnel can use automated external defibrillators (AEDs), only emergency life-saving technicians (ELSTs) can provide an advanced level of emergency care such as invasive alternative airways, i.v. lines, and adrenaline administration.² Although regional medical control (MC) councils are supposed to standardize procedures for out-of-hospital pediatric cardiac arrest cases according to the recommendation of the Ministry of Internal Affairs and Communication, there are differences between the nationally defined target age for these procedures (i.e., drug administration for those aged ≥8 years and defibrillation for those aged ≥1 year) and the actual implemented age.

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Despite the lack of uniform indication criteria of ELSTs' life-saving procedures for pediatric cardiac arrest cases in Japan, the targeted age range for AEDs was extended to include infants in Japan Resuscitation Council Guidelines 2010 for cardiopulmonary resuscitation (CPR). It remains unclear how AEDs and semi-automatic defibrillators are used by EMS personnel in Japan.

For this reason, we administered a survey to the fire defense headquarters around the country about the current situation regarding pediatric prehospital emergency medical care to clarify the problems, especially those with defibrillation.

METHODS

FROM JUNE 11, 2013 to June 25, 2013, we administered a web-based survey using a URL link sent by email to the emergency medical supervisors of 767 fire defense headquarters around the country. We mailed the same questionnaire to 14 of the fire defense headquarters that we could not contact by email. This study was approved by the ethical committee of Kyushu University Hospital, Fukuoka, Japan.

In this survey, we asked about pediatric prehospital emergency medical care, including the targeted age range of life-saving procedures for pediatric cardiac arrest and the deployment of equipment. Then we analyzed responses pertaining to the use and types of AEDs and semi-automatic defibrillators.

RESULTS

WE RECEIVED VALID responses from 671 of 767 fire defense headquarters (valid response rate, 87.5%).

Targeted age range for pediatric defibrillation

There was no uniformity in the protocols of the regional MC councils with respect to pediatric defibrillation, and only 62% (413) of the fire defense headquarters had defibrillators available for infants (Fig. 1). Additionally, 24% (160) reported that there were no regulations regarding pediatric defibrillation.

Use of AEDs and semi-automatic defibrillators for pediatric defibrillation

Adult AEDs were used for pediatric defibrillation. Sixty-two percent (413) of the fire defense headquarters replied

Fig. 1. Targeted age range for pediatric defibrillation by emergency medical services according to responses to questionnaires distributed to fire defense headquarters in Japan in June 2013.

that their EMS personnel used pediatric attenuators or a pediatric mode of the AEDs setting, whereas 65% (433) of them used a pediatric mode of the semi-automatic defibrillators (Fig. 2). However, 21% (138) and 43% (285) of the fire defense headquarters replied that their EMS personnel used AEDs and semi-automatic defibrillators, respectively, for infants and children with the same mode used in adults.

Deployed AEDs and semi-automatic defibrillators

Of the AEDs in use at each fire department, 10 of 11 types were appropriate for pediatric use in infants and children (Fig. 3, graph A). In contrast, there were fewer semi-automatic defibrillators for pediatric use in infants and children aged <8 years at these fire defense headquarters, and only 4 of 9 types were appropriate for infants and children aged

Fig. 2. Automated external defibrillators (AED) and semi-automatic defibrillators used for pediatric defibrillation by emergency medical services according to responses to a multiple choice survey distributed to fire defense headquarters in Japan in June 2013.

Fig. 3. Deployment status of the automated external defibrillators (A) and semi-automatic defibrillators (S) according to responses to a multiple choice survey distributed to fire defense headquarters in Japan in June 2013. *Monophasic defibrillator; those without an asterisk are biphasic. The striped bars represent the model for off-label use in infants and children aged <8 years.

<8 years (Fig. 3, graph S). The initial defibrillation dose of AEDs and semi-automatic defibrillators adapted to infants and children is 50 J.

DISCUSSION

THIS IS THE first report of the status of pediatric defibrillation in the prehospital setting in Japan. Although investigations and reports on prehospital emergency medical care for children have been reported in other countries,^{3,4} they are less common in Japan. Therefore, we undertook this study to investigate the current situation and clarify the problems associated with pediatric defibrillation. The high valid response rate of 87.5% suggests a high degree of interest in pediatric prehospital emergency medical care among the fire defense headquarters. Therefore, our findings will be a valuable resource for considering the future of pediatric defibrillation in Japan.

Annually, approximately 90 pediatric patients (age, 1–17 years) with ventricular fibrillation or pulseless ventricular tachycardia require defibrillation in prehospital settings in Japan, and one-quarter of them are aged 1–11 years.⁵ Factors of favorable outcomes for out-of-hospital cardiac arrest include ventricular fibrillation, the presence of a witness, and bystander CPR.^{6,7} To increase the survival rate of infants and children with out-of-hospital cardiac arrest of cardiac etiology, patients requiring defibrillation must be managed appropriately, which includes standardizing procedures, establishing age indications, and deploying appropriate devices.

In 2003, defibrillation using AEDs was approved for use by emergency medical technicians in Japan and by the general public in 2004. The nationwide dissemination of AEDs increased the frequency of defibrillation with AEDs, which has contributed to improved outcomes after out-of-hospital cardiac arrests.⁸ Furthermore, accuracy of rhythm detection and the safety of energy delivery have been reported in the use of AEDs for infants and children aged <8 years,^{9–12} and defibrillation of infants became possible according to the 2010 guidelines for CPR. However, our study showed that 12% of fire defense headquarters were not equipped to treat infants aged <1 year, and 24% responded that there were no regulations in actual emergency settings. For these reasons, the rapid implementation of the standard pediatric defibrillation procedure in accordance with the current guidelines is necessary to enable all ELSTs to treat infants and children.

In prehospital settings, defibrillation by ELSTs is carried out using semi-automatic defibrillators in the semi-automatic mode. The analytic function of semi-automatic defibrillators is more sensitive but less specific compared to commercially available defibrillators. Therefore, if defibrillation is deemed appropriate after analysis, it will occur only after the ELST confirms that defibrillation is appropriate based on the electrocardiogram. In our study, roughly 40% of the fire defense headquarters responded that the conditions for using semi-automated defibrillators for pediatric patients were the same as those in adults. Moreover, many of the semi-automatic defibrillators use analytic algorithms of electrocardiographs that are not appropriate for infants and children aged

<8 years. Furthermore, approximately 20% of the fire defense headquarters responded that they use AEDs in the same manner for adults and children. Therefore, the lack of properly implementing and appropriately performing defibrillations for infants and children who can be resuscitated in the prehospital emergency medical care setting is disadvantageous and requires rapid improvement. Emergency life-saving technicians are prohibited from using manual defibrillators because manual defibrillation based on their rhythm analysis for any age is beyond their scope in Japan. In order to make ELSTs use manual defibrillators for infants and children, new education and an implementation strategy should be established.

Our investigation showed the issues with the provision of targeted age ranges and devices for pediatric defibrillation during prehospital emergency medical care. The regional MC councils will need to investigate and improve pediatric prehospital emergency medical procedures quickly to address these issues. As EMTs in Japan are limited to using semi-automated defibrillators, each of headquarters has to reconfirm the targeted age range and the optimal mode of their defibrillators. They also have to check what supplies are required by each department, and develop actionable protocols such as using AEDs and semi-automatic defibrillators differently based on patients' age. For device manufacturers that produce semi-automatic defibrillators that are not indicated for infants and children aged <8 years, studies on algorithms analyzing the pediatric electrocardiogram will be needed.^{9–11}

As the present study did not consider the size of the fire department and the response was limited to one per each fire defense headquarter, the actual condition of the emergency unit and each ambulance was unknown. Although fire departments typically have a variety of AEDs and semi-automatic defibrillators, the number of them was not included in our study findings.

CONCLUSIONS

WE FOUND THAT in some regions of Japan the protocol for pediatric defibrillation in the prehospital emergency medical care setting was inappropriate for pediatric use, and inappropriate devices were being used. Therefore, the urgent and thorough implementation of a protocol for pediatric defibrillation with age-adjusted devices should be carried out by the regional MC councils.

CONFLICT OF INTEREST

NONE.

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