Healthcare professionals' knowledge, skills, and attitudes regarding defibrillator use in pediatric emergency and intensive care clinics

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Healthcare professionals' knowledge, skills, and attitudes regarding defibrillator use in pediatric emergency and intensive care clinics

Abstract:

Purpose: Successful resuscitation and early defibrillation are critical in survival after in- or out-of-hospital cardiopulmonary arrest. This study aimed to determine the knowledge, skills, and attitudes of the pediatric healthcare professionals about the defibrillator use and to offer solutions if there was room for improvement.

Procedures: This was a multicenter survey study.

Findings: The study included 716 healthcare professionals with an average age of 30.1 ± 5.8 years; 50% (n=358) were pediatric residents and 41.3% (n=296) had less than three years of professional experience. Self-declared level of knowledge about defibrillation/cardioversion was low-to-medium for 66.5% (n=476); 60.8% (n=435) had never practiced these procedures and 22.2% (n=159) had never received any training about defibrillator use. There was a significant relationship between professional experience and the proportion of participants who correctly responded to the first-shock dose for defibrillation but not for cardioversion.

Conclusion: Professional experience is crucial in the correct defibrillator use. However, the defibrillation/cardioversion procedures are prone to errors since they are not commonly applied in day to day practice. An ideal approach to improve the experience of personnel could be to use practical training with case-based simulations and to educate the personnel about the features of the defibrillators available in their clinics.

Keywords: cardioversion, children, defibrillation, defibrillator, education, knowledge

What is Known:

- The chance of survival decreases by 7-10% for every minute without intervention in patients with out of hospital cardiac arrest. When used effectively, defibrillators have an important role in increasing survival.
- Since cardiac arrest is rare in children, these procedures are prone to errors as they are not commonly applied in children.

What is New:

- The professional experience is significant in the correct use of a defibrillator and related procedures.
- Healthcare professionals have deficiencies in knowledge, skills and attitudes regarding defibrillation practices, recognizing rhythm and providing appropriate therapy.

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Introduction

Defibrillators are devices that are used to restore normal heart rhythm after a rhythm disorder. In order to use these devices effectively, we should know details about the patients' condition and make necessary corrections needed for defibrillator usage. Unfortunately in emergency situations it is not always possible to achieve these Therefore, a detailed knowledge about the features of the device as well as its proper and effective use will increase the chance of success.

Unlike in adults, the most common causes of cardiac arrest in children are the progressive deterioration of respiratory or circulatory function and shock.[1] Cardiac arrest due to underlying cardiac problems is very rare in children. Ventricular fibrillation (VF) and pulseless ventricular tachycardia (VT) are the cause of about 5-10% of in-hospital and out-of-hospital cardiac arrests,[2-7] and are less common than in adults.

Studies on resuscitation and the guidelines demonstrate the role of defibrillators in increasing survival when used effectively. With successful resuscitation and early defibrillation, there has been a significant improvement in the survival rates after in-hospital cardiac arrests while there has been no change in the survival after out-of-hospital cardiac arrests.[8] It has been shown that delayed defibrillation (>2 minutes) was associated with poor clinical course and the chance of survival decreased for each minute of delay in adult in-hospital cardiac arrest cases.[9] It has also been shown in a graphical modeling study that the chance of survival

decreases by 7-10% for every minute without intervention in the patients with out-of-hospital cardiac arrest.[10]

Since VF and pulseless VT is less common in children, healthcare professionals working with pediatric patients have less practical experience about the use of defibrillators than those working with adult patients. Although they have sufficient theoretical knowledge about the use of a defibrillator, they need more practical training. Therefore, healthcare professionals should be well trained about early cardiopulmonary resuscitation management and defibrillator use.

This study aimed to investigate the knowledge, skills, and attitudes of the healthcare professionals working with pediatric patients about defibrillators, defibrillation/cardioversion, rhythm recognition, and choosing the appropriate treatment. The outcomes of this investigation will be used to identify shortcomings in current pediatric practices and offer.

Material and Method

This study is a prospective, multicenter survey study. The study was conducted in clinics that provide pediatric emergency and intensive care and have a clinical administrator who had a certificate of specialty in pediatric emergency and intensive care in Turkey. The target audience of the study were faculty members working in related fields, pediatric emergency and intensive care specialists, subspecialty assistants, nurses, paramedics, and pediatric residency trainees working in pediatric emergency and intensive care during their training. Currently, university hospitals, training and research hospitals, and state hospitals run pediatric emergency and intensive care units with faculty members, specialists, and subspecialty assistants in all parts of Turkey.

Initially, an e-mail was sent out to all clinics to inform them about the scope of this study. Then, the clinics to be included in the study were determined. A total of 32 clinics/units

accepted the invitation to participate, including the center conducting the study. The survey was prepared and made available by the researchers to two or three contact persons from each clinic/unit who accepted the responsibility to administer the survey in their institutions to all healthcare professionals who met the eligibility criteria.

The questionnaire was prepared as an online survey (SurveyMonkey free basic version, SVMK Inc., USA) so that the target audience could be reached more easily. After the ethics committee approval, the link of the questionnaire was shared with the contact persons in participating centers. They were asked to administer the survey to the healthcare personnel in their clinics. The survey was administered by sharing the web link or having the participants fill out the printed forms. The data gathered from the printed forms were recorded in the electronic format by the responsible contact person.

The questionnaire consisted of 36 questions organized into four sections. The estimated response time was 10 minutes. The first section included questions about the demographic characteristics of the participant (age, gender, institution, and professional experience, training information). The second section was related to the defibrillation practices. In this section, the participant was asked about their competence and experience in defibrillation/cardioversion. The third section consisted of questions about the use of a defibrillator device. These included the types and features of defibrillators, most frequently used positions, the types of conductors used in defibrillation application, the use of "paddles" and "adhesive pads", whether to interrupt the oxygen treatment during the procedure, whether or not to attempt defibrillation when faced with a "pulseless" patient according to the basic and advanced life support guidelines, which rhythm disorders they used defibrillator devices for, whether they applied sedation/analgesia during the procedure, which drugs they preferred for sedation/analgesia, if they experienced any complications during defibrillation and previous experience with using an automatic external defibrillator (AED). In the last section,

the participant was asked to recognize the rhythms of the patients who were described with short medical histories and electrocardiographic (ECG) images and to make the appropriate treatment plan.

Based on the 2015 Pediatric Basic and Advanced Life Support guidelines by the American Heart Association (AHA), those who responded with 1 J/kg for cardioversion and 2 J/kg for defibrillation were considered correct.[8,11]

"Code Blue" is an emergency management tool that provides intervention to patients with cardiopulmonary arrest, as soon as possible. Hospital administrations decided about who should work in blue code teams, blue code equipment and blue code trainings. In case of developing cardiopulmonary arrest, blue code teams should have knowledge about defibrillator/AED use, since the underlying cause is often VF, especially in adults. For this reason, in order to determine the level of knowledge of the participants in this field, it was questioned whether there were blue code teams in their hospitals.

The study included the healthcare personnel (faculty members, subspecialists, subspecialty assistants, pediatrics residents, nurses, and paramedics) working in clinics providing pediatric emergency and intensive care services. Institutions that did not offer pediatric emergency and intensive care services and their personnel were excluded.

Ethical approval

Local ethics committee approval was obtained before the study.

Statistical analyses

Descriptive data were summarized as a mean ± standard deviation for numerical variables. Categorical variables were given as numbers and percentages. Pearson chi-squared test was used for comparison of categorical variables. Statistical analyses were performed with Jamovi (Version 1.2.7) and JASP (Version 0.11.1.0) programs. The statistical significance level was set as $p<0.05$.

Results

A total of 716 healthcare professionals participated in the study, with an average age of 30.1 ± 5.8 years. Of the participants, 71.2% (n=510) were female, 67% (n=480) were working at a university hospital, 50% (n=358) were pediatrics residency trainees, 41.3% (n=296) had less than three years of professional experience in the relevant field, and 43.1% (n=314) had never received a training for the certified basic and advanced life support. The demographic characteristics of the participants were summarized in Table 1.

Of the participants, 78.2% (n=560) reported having a blue-code team in their institution, 96.2% (n=689) knew the purpose of blue-code procedure, 41.3% (n=296) mentioned that there was no pediatrician in the blue-code team, and 35.8% (n=256) were not aware of the presence of a pediatrician in the blue-code team. Of the participants, 66.5% (n=476) considered their knowledge about defibrillation/cardioversion medium or low while 44.7% (n=320) considered their experience about defibrillator use sufficient; 24.7% (n=177) did not have any experience with defibrillator use.

The participants' self-declared knowledge about and real-life experience with defibrillation and cardioversion procedures and their prior theoretical or practical training experience were given in Table 2. Of the participants, 88.1% (n=631) stated that they knew the difference between defibrillation and cardioversion, 60.8% (n=435) had never made these attempts before, 22.2% (n=159) had not received any training about the use of defibrillators.

The survey also probed the participants' theoretical knowledge about several practical aspects of defibrillator use. Participants' familiarity with the defibrillator they use and their preferences during defibrillator use were summarized in Table 3.

A first shock dose of >2 J/kg and adult dose for cardioversion was reported by 23.6% (n=169) of the participants; 49.2% (n=352) preferred a first shock dose of 2 J/kg for

defibrillation. Accordingly, the proportions of physicians who correctly identified the first shock dose for cardioversion and defibrillation were 16.1% (n=115) and 49.2% (n=352), respectively (Table 4). Participants were also evaluated for their previous defibrillation/cardioversion experience. Accordingly, 20.7% (n = 90) of the physicians, who have not previously performed cardioversion/defibrillation, responded > 2 J/kg and adult dose for the first dose of cardioversion; but 53.6% (n = 233) of the same group responded 2 J/ kg for the first shock dose of defibrillation. 17.7% (n = 77) of physicians who did not perform any procedures before responded correctly for the first shock dose of cardioversion while the correct response ratio was 53.6% (n = 233) for the the first shock dose of defibrillation in the same group (Table 5).

The participants were presented sample cases with given ECG and clinical status and asked which treatment plans they would prefer; their responses were given in Table 6. When the responses of the participants to the case examples are evaluated, it is seen that the correct response rates are quite low (54.1% for case 1, 39.2% for case 2, 32.7% for case 3 and 30.2% for case 4, respectively). In addition, no significant relationship was found between the participant's professional experience and their ability to identify the rhythm or the treatment plan correctly ($p>0.05$ for each). However, the physicians who knew the difference between defibrillation and cardioversion were found to have higher success rates in identifying the rhythm or treatment plan ($p=0.006$, $p=0.027$, $p <0.001$, and $p <0.001$ for different cases presented). When the responses given to the case samples were evaluated according to the participants' previous defibrillation/cardioversion status, it was seen that the correct response rates of the physicians were quite low. (Table 7).

A significant relationship was found between the participants' professional experience since graduation and their ability to identify the dose of the first shock in defibrillation correctly ($p=0.001$). Those with a work experience of 3-5 years, 5-10 years, or more than ten years

were more successful in identifying the first-shock dose correctly than those with less than three years of work experience. However, no significant relationship was found between the participants' work experience and identifying the dose of the first shock in cardioversion correctly ($p>0.05$) (Table 8).

The participants' knowledge, skill, and attitude regarding the defibrillator use were also examined and presented in Table 8, Table 9, and Table 10, respectively.

A significant relationship was found between the participants' self-declared knowledge level about the procedures (low, medium, high, or very high) and their success rate in identifying the dose of the first shock in defibrillation ($p<0.001$) (Table 9). In table 9, surprisingly the response rate of the participants who defined the level of knowledge about defibrillation/cardioversion as high and excellent is very low for the first shock dose of cardioversion (17.6% and 12.8%, respectively). Again, when the correct response rates for the defibrillation first shock dose of the same group are analyzed, the response rates are low (59.1% and 61.7%, respectively). Those with medium, high, or very high self-declared knowledge levels had higher success rates than those who reported a low knowledge level about defibrillation/cardioversion. A significant difference was also found between these groups' performances in terms of using the defibrillator devices for correct rhythm treatments ($p=0.036$), where those who declared less knowledge about defibrillation/cardioversion had higher success rates in using the defibrillator devices for correct rhythm treatments. Other comparisons indicated no statistically significant findings ($p>0.05$ for each).

When the participants who defined themselves as competent in defibrillation were evaluated, it was seen that only 19.4% of the participants correctly defined the first shock dose of cardioversion and correct response rate was 58.8% for the defibrillation first shock dose. A significant relationship was found between the participants' self-confidence level about using defibrillators and their ability to identify the dose of the first shock in cardioversion and

defibrillation correctly ($p=0.028$ and $p<0.001$, respectively) (Table 10). Those who were confident about their knowledge had higher success rates in identifying the dose of the first shock in these procedures. Other comparisons indicated no statistically significant differences between the groups ($p>0.05$ for each).

A significant relationship was found between the participants' self-confidence level about which patients should have cardioversion or defibrillation procedures and their ability to identify the appropriate conductive material and dose to be used for the first shock in these procedures ($p=0.034$, $p<0.001$, and $p=0.011$, respectively) (Table 11). Those who were confident about their knowledge had higher success rates in identifying the appropriate conductive materials and doses in these procedures compared to those who were not. Other comparisons indicated no statistically significant differences between the groups ($p>0.05$ for each).

Discussion

For successful defibrillation/cardioversion, the patient characteristics such as why and how the defibrillator would be used, transthoracic impedance, the type and duration of arrhythmia, current medications, or the presence of a pacemaker and the device characteristics such as the type of electrodes (paddles or adhesive pads), the position of electrodes, the size of pads, whether the device is monophasic or biphasic, or the dosage should be well known.[12] Since it would not be possible to change the patient characteristics, it is critical to know the features of the device in greater detail and to use it properly. It was found that most of the participants were aware of the differences between defibrillation and cardioversion, but only a third applied these procedures at least once on a patient. As this study demonstrated, these procedures are prone to errors since they are not commonly applied in day to day practice. Therefore, such studies would be useful in reexamining healthcare professionals' competence

and attitudes in using these devices for treatments and in prompting them about the correct practices regarding the use of defibrillators.

The critical issue is to use the appropriate electrode, not to use a specific type of electrode. In our study, most of the participants were found to prefer paddles in anterolateral position. These preferences may be because paddles are more accessible and more commonly used for training purposes and that anterolateral position is more convenient during defibrillator training, as well as high success rates in this position.

A successful defibrillation procedure also requires an adequate electric flow. High transthoracic impedance reduces the likelihood of success. For this reason, it is necessary to apply water-based gels with high conductivity (defibrillator gels) on the thorax to increase the electrical flow.[13] Defibrillators should not be used without using the conductive gels, nor should they be used with other conductive liquids such as saline, alcohol, or ultrasound gels. These substances are not effective enough, and they may also result in adverse events such as fire risk when alcohol is used.[12] Unlike defibrillator gels, ultrasound gels do not provide an electrical conductivity and are used to acquire clear images during ultrasound imaging. In our study, we found that the majority of the participants used defibrillator gel and ultrasound gel. Such a common use of ultrasound gels with defibrillators may be because they are more commonly available in clinics and because differences between the two gels are not commonly known.

In our study, about one third of them did not know whether the defibrillator that they used was monophasic or biphasic. Studies have reported that biphasic devices were more effective and allowed defibrillation at lower energy doses in humans and animals and in atrial and ventricular fibrillation.[14,15]

In the AHA 2015 guidelines, a dose of 2 J/kg was recommended for the first defibrillation shock for VF and nVT in pediatric life support interventions while a dose of 0.5-1 J/kg was

recommended for the first cardioversion shock for supraventricular tachycardia (SVT), atrial fibrillation, atrial flutter, and VT with a pulse.[8,11] There is a limited number of studies on the currently recommended doses [16-20], and it is difficult to determine the optimal treatment doses with the results of these studies. In a review of ten observational studies in children, the survival or the return of spontaneous circulation (ROSC) was suggested to be unrelated to the first defibrillation energy dose.[20] However, considering the dose-dependent complications of the procedure (i.e., arrhythmia, myocardial damage, and skin burns), it would be ideal to start the treatment with low doses and to increase the treatment dose in refractory cases.[21] In our study, more than a third of the participants chose 0.5-1 J/kg and 1 J/kg as the starting dose for cardioversion while one fifth chose the adult dose as the first shock dose. While the rate of correct response was low for synchronized cardioversion, almost half of the respondents preferred the 2 J/kg dose for defibrillation. We found that the rate of identifying the defibrillation dose correctly increased as the professional experience increased, but there was no change in the rate of correct response for the synchronized cardioversion dose. This relationship might be because the participants with lesser professional experience have encountered fewer patients with relevant problems and, therefore, lacked experience and found themselves largely inadequate about these practices.

A third of the participants reported that they did not have any knowledge about or did not apply sedation/analgesia during defibrillation/cardioversion procedures, which might be because they supposed that the procedure was not painful or the patient would not feel pain as their consciousness was impaired due to the existing rhythm disorder. Only a third of the participants stated that they performed sedation/analgesia during cardioversion, which was quite low. Because, patients -especially those who require synchronous cardioversion- are often awake and feel pain during the procedure. Even in patients who undergo unstable cardioversion, pre-procedure sedation and cardioversion are recommended provided that they

do not delay the treatment. Only the patients with VF or pulseless VT do not require sedation or analgesia because they are unconscious.[22] The Cochrane 2015 review on sedoanalgesia for cardioversion suggested that there was no significant difference between propofol, etomidate, midazolam, diazepam, and ketamine used in various studies in terms of their efficacy and adverse effects; and what was critical was to use the effective doses and combinations rather than the choice of drug.[23] In our study, almost 80% of the participants preferred midazolam, and 60% used ketamine. It has been recently reported that dexmedetomidine may be used in combination with other sedoanalgesics in the patients with spontaneous breathing since it does not depress breathing and can stop spontaneous SVT by itself. [23-25] However, as mentioned above, the key is to remember that sedoanalgesia should be utilized without causing any delay in treatment.

For an effective use of defibrillator, it is critical to evaluate the patient's hemodynamic status and to identify the type of arrhythmia. Defibrillation is preferred in VF and pulseless VT while synchronous cardioversion is preferred in SVT and the VT with a pulse.[8,11]A few participants stated that they used defibrillator for sinus tachycardia and asystole; one-third stated that they used defibrillators for patients with pulseless electrical activity. Our study also investigated the participants' treatment preferences by presenting them case scenarios. The participants mostly identified and selected the correct treatment options for pulseless VT and unstable SVT cases. However, they commonly misidentified and mistreated the hemodynamically stable SVT case as sinus tachycardia. Almost half of the participants preferred defibrillation for the asystole case. These case questions indicated that the participants had weaknesses in recognizing arrhythmias and choosing the right treatment approach as well. Simulations and case-based training programs may help to overcome these weaknesses.

Conclusion

Professional' experience are significant in the correct use of a defibrillator and related procedures. Given the importance of early defibrillation in survival, the importance and proper use of defibrillators should be emphasized in undergraduate and post-graduate training programs as well as in certified advanced life support courses. The training should be shifted from majority the theoretical aspects to magnify practical competence, case-based simulations should be included, and the features of specific devices respective workplaces should be explained. Improving the knowledge, skills, and attitudes of healthcare professionals about defibrillation/cardioversion and increasing their self-confidence about using these procedures will promote early defibrillation and increase the patient survival.

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