Effect of Frequent Application of Code Blue Training Program on the Performance of Pediatric Nurses

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Abstract: Introduction: Code Blue training is essential for nurses, as nurses often discover the patients of in-hospital cardiac arrest. **Aim:** the study aims to investigate the effect of frequent application of Code Blue training program on the performance of pediatric nurses. **Material and Method:** Quasi-experimental design was used. Simple randomization sampling of 22 pediatric nurses who are working in pediatric inpatient departments at King Fahad Hospital of University composed the study subjects. Observation checklist of pediatric nurses' performance and the training program were developed by the researcher according to American Heart Association guidelines, 2011 and Hospital Policy for Code Blue. The study subjects received the training program for three times in two weeks interval. Nurses' performance of Code Blue was assessed before and after each session. **Results**: It is revealed from the present study that frequent Code Blue training program enhances the performance of pediatric nurses. This upward trend is evidenced by the statistical significant differences in nurses' performance before and after each session of the training program implementation (first session Z=4.109/ p<0.001, second session Z= 4.116/ p < 0.001, third session Z=4.024/ p < 0.001). Additionally, significant differences were demonstrated between the first and second sessions, and between the second and third sessions [(before Z=4.114/ p <0.001, after Z=3.511/ p <0.001), (before Z= 3.966 / p <0.001, after Z= 3.542/ p <0.001) respectively]. **Conclusion and Recommendation**: the frequent application of Code Blue training program enhances the performance of the pediatric nurses, and it is recommended from this study that pediatric nurses should attend Code Blue training frequently.
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1.Introduction:

Code Blue is a term used over the address system to call for assistance for patient in full or impending cardiopulmonary arrest [(1)]**.** It is a rapid response system for resuscitation and stabilization of medical emergency situations that occurs within the hospital area. A Code Blue is to be initiated immediately whenever a child or an adult is found in cardiac or respiratory arrest**.** It is a team activity; that is made up of a variety of healthcare professionals including nurses [(2)].

Code Blue is a multi-tasked event where different responsibilities need to be carried out by the Code team in order to increase the chances of successful resuscitation. The process of Code Blue employs the five-part of "survival chain" concepts, which begin with **recognition** of cardiac arrest, **activation** of the emergency response system, **cardiopulmonary resuscitation (CPR)**, rapid **defibrillation** [(3-4)].

Early recognition of the pre-arrest state by nurses is considerably affecting patient outcome and maximize rates of survival and recovery. Initial assessment of a child in impending cardiopulmonary arrest requires nurses to be proficient in rapid recognition of signs for respiratory distress and cardiovascular collapse that are present in the clinically unstable pediatric patient [(5-6)].

Activating the emergency response system is an essential link of the chain of survival. In a code Blue situation, the first nurse responder should start CPR immediately, while second nurse responder should activate the emergency response system. Nurses should know the process of Code Blue announcement according to the policy of the health organization (whom to call and what to say) [(3)].

The prompt initiation of high-quality chest compressions is an essential part of cardiac arrest resuscitation. If the infant or child is unresponsive and not breathing, nurse will take up to 10 seconds to check for a pulse, brachial in an infant and carotid or femoral in a child, and if no pulse is detected, chest compressions should be started [(7-8)].During cardiac arrest, effective chest compressions produce a blood flow to vital organs that will increase the possibility of return of spontaneous circulation (ROSC) and improve the child's chance of survival by providing heart and brain circulation.

Nurses should focus on delivering a high-quality CPR by doing **compressions within 10**

seconds of recognition of cardiac arrest, **chest compressions of appropriate rate and depth. "*Push fast*"**: push at a rate of at least 100 compressions per minute. "***Push hard***": push with sufficient force to depress at least one third of the anterior-posterior (AP) diameter of the chest or approximately 1 1/2 inches (4 cm) in infants and 2 inches (5cm) in children, allowing complete chest recoil after each compression, minimizing interruptions in compressions, provide effective breaths that make the chest rise, and avoiding excessive ventilation. [8-9].

A single rescuer uses a compression-to-ventilation ratio of 30:2. In case of two-rescuer for infant and child CPR, one should perform chest compressions while the other keeps the airway open and performs ventilations at a ratio of 15:2. Ventilations should be delivered with a minimal interruption in chest compressions [7].

Bag-mask ventilation is an important technique during pediatric resuscitation. Effective bag-mask ventilation requires compound and coordinated steps, therefore bag-mask ventilation is not recommended for a lone rescuer, and is provided only during two-rescuer CPR. [6-8]. Children with sudden witnessed collapse are possibly suffering from ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT) and need immediate CPR and rapid defibrillation. The aim of all health organizations should be directed to have nurses as first responders to deliver early defibrillation when required during resuscitation. Therefore, training nurses for defibrillation and Automated Electronic Defibrillation (AED) is a mandatory. Rescuers should coordinate chest compressions and shock delivery to minimize the time between compressions and shock delivery and to resume CPR, beginning with compressions, immediately after shock delivery [10-12].

In addition, nurses usually perform different other roles. During Code Blue event nurses must place the patient on cardiac monitor as soon as possible to recognize and follow normal and abnormal cardiac rhythms. When the patient has a perfusing rhythm, oxyhemoglobin saturation must be monitored continuously with a pulse oximeter. In a Code Blue event of a pediatric patient nurses should estimate the child's weight accurately. Nurses also should document all intervention by time during the Code event and initiate vascular access. Thus, there is an emphasis on the team approach toward Code Blue event which promote collaboration and effective communication among the Code team members, involving nurses physicians respiratory therapist and other health care providers [10].

The lack of resuscitation skills of nurses and doctors in resuscitation has been identified as a contributing factor to poor outcomes of cardiac arrest victims [10, 13].Poor knowledge and skill retention following cardiopulmonary resuscitation training for nursing and medical staff has been documented over the past 20 years [14]**.** Rebecca, (1996) investigated the retention of resuscitation skills for nurses, and found that they significantly declines in 10 weeks, which suggests that retention of skills quickly deteriorates if not utilized or updated frequently. Various international organizations on resuscitation have emphasized the importance of training on providing high quality CPR and thus improving survival of patients undergoes resuscitation situation [15].

It is important to emphasize that Code Blue training is a vital issue for nurses. Because skills and knowledge deteriorate significantly if not applied or regularly updated; retention of nurses' skills gained from Code blue training after a certain period of time is of a major concern [15], from this perspective, the current study was carried out.

Aim of the Study

The aim of this study is to investigate the effect of frequent application of Code Blue training program on the performance of pediatric nurses.

Hypothesis:

It is hypothesized that the frequent application of Code Blue training program enhances the performance of the pediatric nurses.

2. Material and Methods

Research Design:

Quasi-experimental design was used in this study.

Materials:

I. Setting:

This study was conducted in the Pediatric Medical and Surgical Wards, at King Fahad Hospital of University, University of Dammamm in Al Khobar City. The data collection period started in the 1st of June, (2013) and finished in 29th of July, (2013).

II. Subjects:

Simple randomization sampling of 22 pediatric nurses who are working in medical and surgical pediatric inpatient departments composed the study subjects. They were selected from the previously mentioned setting.

Inclusion criteria:

- Valid certification of Basic Life Support.
- An experience of at least 1year in pediatric inpatient departments.

Exclusion criteria:

- Nurses with muscle-skeletal problems and pregnancy that hinder their performance.

III. Tool of the study

One tool was used for data collection in the present study:

Tool: Observation checklist of pediatric nurses' performance:

The tool was developed by the researcher according to American Heart Association guidelines of Basic Life Support (BLS), 2011[9] and King Fahad Hospital of University Policy of Code Blue[1] to assess the nurses' performance. The tool consisted of two parts:

Part one: Nurses' characteristics:

It included the demographic and occupational data of participant nurses.

Part two: The nurse performance:

It included the assessment of the nurses' performance as a first, second and third responder to a simulated Code Blue event. The items in the study tool were marked as done or not done by the researcher based on the nurse response.

Method:

1- Ethical approval was obtained from the ethical committee of University of Dammam.
2- Gatekeeper permission was obtained from responsible authorities in King Fahad Hospital of University, University of Dammam in Al Khobar City.
3- King Fahad Hospital of University Institutional Review Board requirements were completed and permission was achieved.
4- A written informed consent was obtained from the pediatric nurses who participated in the study.
5- Confidentiality and anonymity of individual responses were guaranteed.
6- The tool was developed by the researcher.
7- The validity of the tool was asserted by five experts on pediatric field, the result was 95%.
8- To test feasibility and applicability of the tool, pilot study was carried out on five nurses and necessary modification was made accordingly.
9- Reliability of the tool was tested through test and retest. The correlation coefficient was 0.87.
10- The researcher developed the Code Blue training program and training manual for pediatric nurses in accordance of the American Heart Association guidelines, 2011[9] and the King Fahad Hospital of University Policy[1]. This was achieved under the following objectives;

A. Comprehend the processes of a Cod Blue event.
B. Prepare the equipment needed in Code Blue event.
C. Activate the emergency response system.
D. Demonstrate Code Blue procedure.
E. Integrate effective communication techniques.

Content of the training program includes;

A. The process of Code Blue event.
B. Equipments needed in Code Blue event.
C. Assessment and recognition of patient who needs cardiopulmonary resuscitation.
D. Activating the emergency response system, Whom to call, what to say?
E. Performing Effective cardiopulmonary resuscitation.
F. Application of Automated Electronic Defibrillator.
G. Communication during the Code Blue event.
H. Documentation of a Code Blue event.

11- The demographic and occupational data of all study subjects were obtained by the researcher, using the study tool. The training manual was distributed among the participant nurses.
12- The training program was implemented where all participant nurses received three sessions in total. Sessions were scheduled and delivered as one 30-minutes session every two weeks during a period of six weeks. All the content of the training program was covered in every session.
13- The training program was carried out using in–situ simulation where a vacant patient room in surgical pediatric ward was prepared to conduct the session. Equipments were collected and assembled for the simulation including: crash cart with LIFEPAK 12 3D Biphasic Monitor/ Defibrillator and Ambo-bag, vital signs monitor, little junior CPR manikin, Baby Anne CPR manikin, Laerdal pocket mask, a projector and laptop.
14- Participant nurses who were available in the morning, afternoon and night shifts attended the sessions in their break times according to a schedule that was prepared by the researcher with the collaboration and support of the unit supervisor.
15- In every session, power point presentation was delivered by the researcher to reinforce knowledge and steps of different procedures in Code Blue situation. Also demonstration and re-demonstration on Mock Code Blue using the CPR manikins were employed by the researcher to conduct the training program in each session.
16- The performance of pediatric nurses was assessed by the researcher before and after each session of Code Blue training program.

Data Analysis

Scoring system:

Items in the observation checklist of pediatric nurses' performance were classified into five categories including a total of 39 items as follows: **recognition** of cardiac arrest (7 items), **activation** of the emergency response system (3 items), **cardiopulmonary resuscitation (19 items)**, defibrillation (5 items), and complementary tasks, such as IV insertion and documentation (5 items). For each item score one indicates 'Done' and zero indicates 'Not done'.

Statistical analysis of the data was carried out by the researcher using the SPSS program for Windows Version 19. Data was collected, tabulated. Minimum and maximum, mean and standard deviation, median and Interquartile ranges were calculated. Wilcoxon significant test was used. *P*-value of <0.05 was considered statistically significant.

3. Results

The results of the current study consist of two parts: Nurses' characteristics and Nurses' performance. Part one includes one table showing the Demographic and occupational data of studied nurses. Part two includes three tables and two figures illustrating the **mean of total percent scores of nurses' performance.**

Part 1: Nurses' characteristics

Table (I): Demographic and occupational data of studied nurses.

Nurses' Demographic and Occupational Data	No. (n=22)	%
Age:		
• <30 years	7	31.8
• 30 -40 years	9	40.9
• >40 years	6	27.3
Min-max	24 -56	
Mean ±SD	37.2 ± 11.1	
Education:		
• Diploma	6	27.3
• Bachelor	16	72.7
Years of experience:		
• <10 years	9	40.9
• 10-20 years	8	36.3
• >20 years	5	22.8
Min-max	1-29	
Mean ±SD	12.4 ± 9	
Median (IQR)	10.5 (16.7)	
Attendance to previous Code Blue training:		
• Yes	4	18.2
• No	18	81.8
Participating in Code Blue for patients:		
• Yes	15	68.2
• No	7	31.8

Table (I) illustrates the characteristics of the studied nurses. The age of 40.9% of nurses was ranging from 30 to 40 years. It was less than 30 years for 31.8% of them; the age of 27.2% was more than 40 years. About three quarter of the studied subjects (72.7%) had a bachelor degree, and only 27.2% of them had diploma degree. The nurses' experience was less than 10 years for 40.9%. It ranges from 10 to 20 years for 36.3%, and 22.7% of them had more than 20 years of experience. It was noticed that the majority of nurses (81.8%) did not attend previous training program for Code Blue and only 18.1% of them who were attend. On the other hand, more than half of the nurses (68.1%) reported that they had participates in Code Blue for patients management.

Table (II) illustrates the mean of total percent scores of nurses' performance categories before and after the Code Blue training program implementation. It was shown that there were a significant differences in recognition category of nurses performance before and after first session [(Z =4.055 / *p* =<0.001], second session [Z =3.559 / *p* <0.001], and third session [Z=2.178 /*p*=0.029]. The same results were found before and after each session of the other categories of nurses' performance as following; in activation[first session (Z=3.659/ *p*

<0.001), second session (Z=2.309/ *p* =0.021),and third session(Z=2.333/ *p* =0.020)], in CPR[first session (Z=4.115 / *p* <0.001), second session (Z=4.115 / *p* <0.001), and third session (Z=3.855/ *p* <0.001)], in defibrillation [first session (Z=3.824/ *p* <0.001), second session (Z=2.208 / *p* =0.027), third session (Z=1.897/ *p* =0.058)], and in complementary tasks [(First session (Z=4.164/ *p* <0.001), second session (Z=4.093/ *p* <0.001), and third session (Z=2.887/ *p* =0.004)].

It was found from table (IV) and Figure (2), that there were significant differences between the total percent scores of nurses' performance in code blue training program before and after each session (first session Z= 4.109 *p* <0.001, second session Z= 4.116 *p* <0.001, and third session Z=4.024 p *p* <0.001).

Part 2: The nurses' performance.

Table (II): The mean of total percent scores of nurses' performance categories before and after each session of Code Blue training program implementation

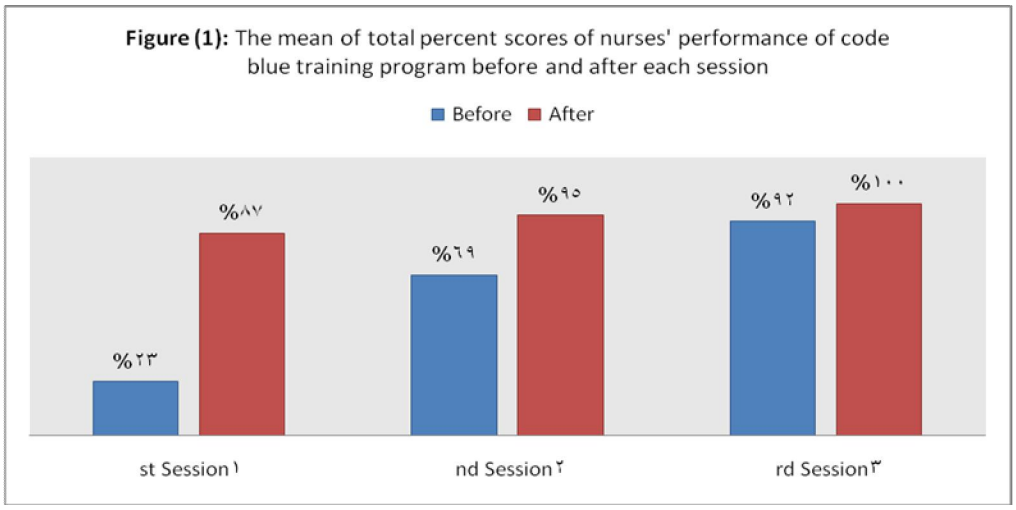
Items of nurses' performance	1st session			2nd session			3rd session		
	Before	After	Significant test (Wilcoxon)	Before	After	Significant test (Wilcoxon)	Before	After	Significant test (Wilcoxon)
Recognition (7 items) Min-max Mean ±SD Median (IQR)	 1-5 2.9±1.3 2.5 (2)	 3-7 5.9±1.2 6 (1.3)	Z=4.055 P<0.001	 1-7 5.1±1.5 6 (1)	 6-7 6.6±0.5 7 (1)	 Z=3.559 p<0.001	 4-7 6.3±0.9 7(1.25)	 6-7 6.8±0.4 7(0.25)	 Z=2.178 p=0.029
Activation (3 items) Min-max Mean ±SD Median (IQR)	 0-3 1.2±1 1(1.25)	 1-3 2.6±0.7 3 (1)	 Z=3.659 p<0.001	 1-3 2.5±0.6 3(1)	 2-3 3±0.3 3 (0)	 Z=2.309 p=0.021	 1-3 2.7±0.6 3 (1)	 -	 Z=2.333 p=0.020
CPR (19 items) Min-max Mean ±SD Median (IQR)	 0-7 2.9±2.1 3(3.25)	 9-18 15.2±2.7 16 (3.5)	 Z=4.115 P<0.001	 4-15 10.5±3.5 11(5)	 15-19 17.4±1.2 17(1.25)	 Z=4.115 p<0.001	 6-19 16±3 17(3.2)	 17-19 18.7±0.6 19(1)	 Z=3.855 p<0.001
Defibrillation (5 items) Min-max Mean ±SD Median (IQR)	 0-5 1.6±1.6 1.5 (3)	 1-5 4.7±1 5 (0)	 Z=3.824 p<0.001	 2-4 4.5±2.3 4 (2)	 4-5 4.9±0.3 5 (0)	 Z=2.208 p=0.027	 3-5 4.7±0.7 5(1)	 4-5 5±0.2 5(0)	 Z=1.897 p=0.058
Complementary tasks (5 items) Min-max Mean ±SD Median (IQR)	 0-3 1.1±0.9 1(1.25)	 3-5 4.6±0.7 5 (1)	 Z=4.164 p<0.001	 0-5 3±1.2 3 (2)	 3-5 4.7±0.5 5 (0.25)	 Z=4.093 p<0.001	 3-5 4.5±0.6 5(1)	 -	 Z=2.887 p=0.004

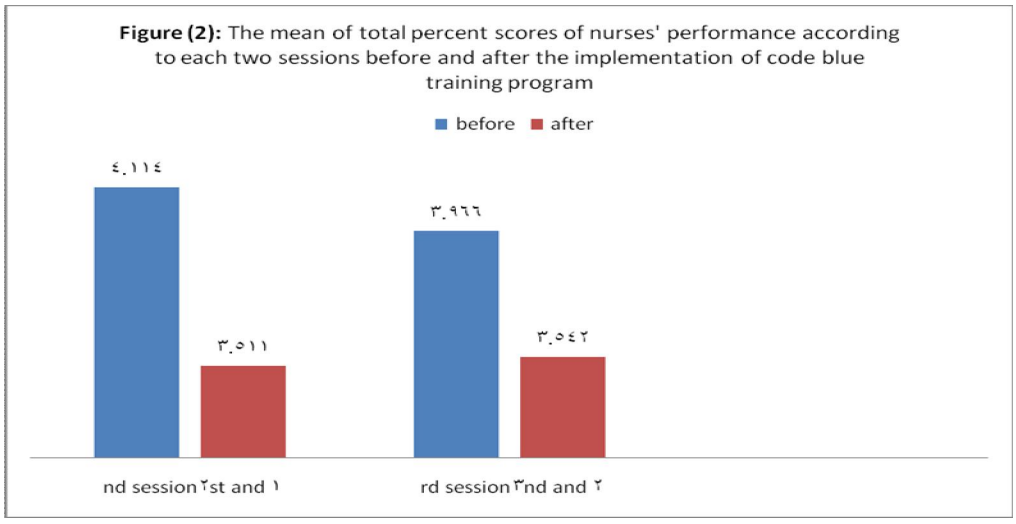
Table (III): The mean of total percent scores of nurses' performance of Code Blue training program before and after each session.

Frequency of nurses' performance	The mean of total percent scores of nurses' performance		
	Before	After	Significant test (Wilcoxon)
1st session Min-max Mean ±SD Median (IQR)	 5.1-43.6 24.9±11.2 23.1 (16)	 66.7-97.4 84.6±9.2 87.2 (13.5)	Z=4.109* *p* <0.001
2nd session Min-max Mean ±SD Median (IQR)	 41-84.6 66±13.4 69.2 (20.5)	 82-100 93.8±4.7 94.9 (5.1)	Z=4.116* *p* <0.001
3rd session Min-max Mean ±SD Median (IQR)	 59-97.4 88±9.8 92.3 (12.8)	 92.3-100 98.5±2.3 100 (2.6)	Z=4.024* *p* <0.001

Table (IV): The mean of total percent scores of nurses' performance according to each two sessions before and after the implementation of Code Blue training program

Nurses' performance	The sessions of nurses' performance					
	1st session	2nd session	Test of significant (Wilcoxon)	2nd session	3rd session	Test of significant (Wilcoxon)
Before Mean ±SD Median (IQR)	 24.9±11.2 23.1 (16)	 66±13.4 69.2 (20.5)	 4.114 <0.001	 66±13.4 69(20.5)	 88±9.8 92.3(12.8)	 3.966 <0.001
After Mean ±SD Median (IQR)	 84.6±9.2 87.2 (13.5)	 93.8±4.7 94.9 (5.1)	 3.511 <0.001	 93.8±4.7 94.9(5.1)	 98.5±2.3 100 (2.6)	 3.542 <0.001





It was illustrated that there was a significant differences between the mean of total percent scores of nurses' performance according to each two sessions before the implementation of Code Blue training program, the first and second sessions (Z= 4.114, p <0.001), and the second and third sessions (Z= 3.966, p <0.001). The same results were shown regarding to the nurses' performance after training sessions [first and second sessions (3.511, p <0.001), second and third sessions (3.542 p <0.001) respectively], as clarified in table (III) and figure (1).

4. Discussion

Pediatric *nurses* have a *key role* in Code Blue team, and they are often the first health care providers who respond to Code Blue events. It was revealed from the present study that frequent Code Blue training program enhances the performance of the pediatric nurses. This upward is evidenced by the statistical significant differences in nurses' performance before and after each session of the training program implementation (first session Z=4.1 p <0.001, second session Z= 4.1 p < 0.001, third session Z=4.02 p < 0.001) as clarified in table (III) and figure (1). This was supported by Hamilton,[16] who cited that training must be provided as frequently as needed, where expected nurses' roles and skills during Code Blue are regularly reinforced, and this will contributes to the enhancement of performance.

Immediate recognition of cardiac arrest is one part of the first link in the chain of survival, it leads to prompt emergency activation and initiation of CPR, therefore, recognition of sick children should be comprised in Code Blue training program [17]. Recognition consists of assessing the child to determine the signs of cardiac arrest which in the present study involves 7 items that the nurse should accomplish. It was found from this study that there were a significant differences before and after the program implementation in each session of recognition items [first session: Z=4.055/ p <0.001, second session: Z=3.559/ p <0.001, third session: Z=2.178/ p =0.029]. This could be related to the awareness of nurses concerning the importance of early identification of cardiac arrest which will affect the child outcome and maximize rate of survival and recovery [10].

A prompt activation of emergency response system will lead to the punctual arrival of Code team. Ideally, Code team should arrive to the Code location within 3 minutes to permit early interventions. The time needed for Code team to arrive to the scene varies among health institutions and can take up to 6 minutes [18]. Such delay could reflect the multistep process required to activate the team, therefore ward nurses must be trained and practice the activation of emergency response system. It was shown from this study that there were a significant differences before and after the program implementation in each session of activation of emergency response system items [first session: Z=3.659/ p <0.001, second session: Z=2.309/ p =0.021, third session: Z=2.333 / p =0.020]. This might be explained in the light of nurses understanding of the importance of the prompt activation of the emergency response system, where delaying in this will cause hindrance of essential interventions for patient survival such as intubating and administering medications within 5 minutes by the Code team.

The quality of CPR is often poor in the clinical setting and the lack of resuscitation skills of nurses and doctors in basic life support has been identified as a contributing factor to poor outcomes of cardiac arrest victims [19-20]. This was supported by the findings of the present study, however the mean of the nurses' performance was poor before the program implementation as seen in the first session of training (2.9±2.1) compared to the improvement that have been noticed after the third training session (18.7±0.6) as clarified in table (II). This could be related to nurses realization that the prompt initiation of high-quality chest compressions improves the victim's chance of survival by providing heart and brain circulation and increase the chance of return of spontaneous circulation (ROSC)[6]. Complete chest re-expansion improves the flow of blood returning to the heart and thereby blood flow to the body during CPR. While incomplete recoil during CPR is associated with higher intra-thoracic pressures and significantly decreased venous return, coronary perfusion, blood flow, and cerebral perfusion [3]. Herlitz *et al.* [21] reported that patients who received CPR within 1 minute of collapse were twice as likely to survive as those who did not. Cooper *et al.* [22] also demonstrated that 25% increase in survival was linked to the initiation of CPR within 3 minutes of cardiac arrest

Sudden cardiac arrest (SCA) from ventricular arrhythmias, such as ventricular fibrillation (VF) and ventricular tachycardia (VT), occurs in about 5% to 15% of all pediatric cardiac arrest, where early defibrillation is the first line treatment [4,23]. Early defibrillation is defined as having appropriate equipment and trained nurses available throughout hospitals and affiliated outpatient facilities [25]. Therefore, it is important to integrate early defibrillation into an effective pediatric resuscitation care [3,26].It was found from this study that there were a significant differences in defibrillation mean items before and after the program implementation in each session [first session: Z=3.824/ p<0.001, second session: Z=2.208 / p =0.027, third session: Z=1.897 / p =0.058]. Improvement in nurses' performance could be explained in the light of nurses understanding that prompt defibrillation is the definitive treatment for ventricular fibrillation and ventricular tachycardia. These results supported by Hamilton,[16] who cited that nurses who are not often facing Code Blue events in their clinical practice, should receive training on AED.

Finally, it was shown from the current study that the nurses' performance was improved in each

two sessions before and after the implementation of Code Blue training program as shown in table (IV) and figure (2), where the significant differences were demonstrated between the first and second sessions, as well as between the second and third sessions in a two weeks interval [(before Z=4.114 p <0.001, after Z=3.511 p <0.001), (before Z= 3.966 p <0.001, after Z= 3.542 p <0.001) respectively]. This was parallel with other authors who stated that skills in Code Blue are liable to decline as early as two weeks after training. However, sufficient skills can be achieved and maintained by frequent training [26-27].

Conclusion

It is concluded from the present study that application of frequent Code Blue training program enhances the performance of the pediatric nurses. This is evidenced by the statistical significant differences in nurses' performance before and after each session. The increasing enhancement in nurses' performance with frequent training is demonstrated by the significant differences in nurses' performance between the first and second session and between the second and third session.

Recommendations

It is recommended from this study that pediatric nurses should attend Code Blue training programs frequently (every 2 weeks) and workshops to promote skills retention.

Further studies

Further studies should be conducted to explore nurses' knowledge and skills during real Code Blue events so weak points are discovered and reinforced during training.

Limitations

Circumstances of emergency leave, sick off and vacations of pediatric nurses at the time of the study has contributed to the small sample size.

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