

Effect of Cardiopulmonary Resuscitation Training Program on Nurses Knowledge and Practice

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Abstract The ability to respond quickly and effectively to a cardiac arrest situation rests on nurses being competent in the emergency life-saving procedure of cardiopulmonary resuscitation while the lack of resuscitation skills has been identified as a contributing factor to poor outcome in cardiac arrest victims. This study aimed to assess the impact of cardiopulmonary resuscitation training program on knowledge and performance of Tanta Cancer Institute nurses. The study was carried out in Faculty of Nursing, Tanta University and Tanta Cancer Institute, Ministry of Health. The sample consists of all nurses working in Tanta Cancer Institute. Two tools were used. Tool one was nurses' knowledge related to cardiopulmonary resuscitation questionnaire which was developed to assess nurses' knowledge and it comprises two parts; part one related to bio-socio-demographic characteristics of the nurse and part two related to information regarding cardiopulmonary resuscitation. Tool two was nurses' performance related to cardiopulmonary resuscitation observational check list; it was developed to measure nurses' skill regarding cardiopulmonary resuscitation. Data were collected over a period of three months started from May to July 2012. The results revealed that majority of nurses had poor knowledge and performance related to CPR pre the training program which has been improved immediately, and deteriorated one month post the program and the only positive correlation was found between knowledge and nurses' socio-demographic characteristics was related to educational level pre and one month after the program. Conclusion explained that training program was effective in improving nurses' knowledge and performance related to CPR which has been sharply increased immediately post the program and then decreased one month later, the study recommended annually assessment and refreshing courses to nursing staff in accordance with up- to- date guidelines to impart both cognitive knowledge and psychomotor skills of CPR and to provide a standardized care to cardiac arrest victim.

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1. Introduction

Cardiopulmonary resuscitation (CPR) is an important medical procedure which is needed for individuals who face sudden cardiac arrest. It is a combination of rescue breathing and chest compressions which is delivered to the victims who are thought to be in cardiac arrest⁽¹⁾. Sudden cardiac arrest (SCA) is life threatening condition and a leading cause of death among adults over the age of 40 years in the United States and other countries⁽²⁾. Modern published studies reported that about 1,000,000 people die of cardiac arrest every year in the United States and Europe, almost one every 30 second with approximately 200,000 treated cardiac arrests among United States hospitalized patients annually. Cardiopulmonary resuscitation (CPR) will be administered to some of them by emergency medical services. Unfortunately only 1 in 5 adults survive in-hospital cardiac arrest⁽³⁾. In addition, cardiopulmonary resuscitation is a critical component of basic life support and the established first line of response to a cardiac arrest in the interim before defibrillation and advanced life support are available, it is an important life-saving first-aid skill and an effective method of

keeping someone who is experiencing a cardiac arrest alive long enough for definitive treatment to be delivered⁽⁴⁾. CPR cannot usually restart the heart, but it makes sure that blood and oxygen continue to circulate through the body, keeping the patient active until help arrives⁽⁵⁾. The aim of CPR is to ensure that body functions are maintained so that the brain and other vital organs receive a sufficient supply of oxygen and nutrients to maintain their functions and that the waste products of metabolism are removed⁽⁶⁾.

A numbers of studies have confirmed that CPR can be life-saving when provided by a well-trained person. In several large investigations, the prompt delivery of CPR has served as an important predictor of survival. In addition, CPR might almost double the chance of survival⁽⁷⁾. The probability of survival from cardiac arrest falls by 10–15% per minute without treatment, and well-performed CPR likely shifts this curve towards a higher probability of survival⁽⁸⁾. Furthermore, other investigations have suggested that CPR maintains the heart in a state favorable for defibrillation. A randomized trial in Norway suggested that in cases of prolonged cardiac arrest, delaying defibrillation in order to first provide

several minutes of CPR significantly improved patient survival⁽⁹⁾. Cardiopulmonary resuscitation measures vary according to the needs of the patient and the knowledge of the nurse giving the treatment. Knowing what to do in an emergency situation is as important as knowing what not to do, because CPR measures misapplied might lead to serious complications such as broken ribs, ineffective lung inflation and cardiac output resulting in brain damage or death⁽²⁾. The importance of performing CPR immediately after cardiac arrest has been demonstrated in numerous studies around the world^(3-5, 7).

Despite the proven importance of CPR, survival rates remain low, mostly due to its ineffective administration. Good-quality CPR is highlighted in resuscitation guidelines. The survival benefit for cardiac arrest victims receiving high quality CPR has been well documented^(10, 11). Moreover, prompt CPR makes an important impact on outcomes, but the quality of CPR also matters greatly⁽¹²⁾. On the other hand, 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 (BLS) and advanced life support (ALS) has been identified as a contributing factor to poor outcomes of cardiac arrest victims⁽¹³⁾. Improvements in CPR skills should therefore have considerable impact on mortality⁽¹⁴⁾. The ability to respond quickly and effectively to a cardiac arrest situation rests on nurses being competent in the emergency life-saving procedure of cardiopulmonary resuscitation (CPR)⁽¹⁵⁾. So, cardiopulmonary resuscitation training is mandatory for nursing staff and is important as nurses often discover the victims of in-hospital cardiac arrest^(16, 17). Moreover, nurses are an integral part of the healthcare system and are perceived to be knowledgeable in providing institutional care to the patients. Many times, nurses take care of the patients when the doctor is not present in the ward and also in the community settings, the nurses have to play a major role in the emergency handling of the patients, thus, CPR becomes a fundamental requirement of any nurse⁽¹⁾.

In hospitals worldwide, it is usually the nurse who discovers a cardiac arrest (loss of consciousness, absence of pulse and breathing) and initiates the procedure of CPR. Nurses need to know the skills and theories behind CPR as performing quality CPR might improve the patient's chance of survival and increase the opportunity of recovery, thus, nurse's competency in CPR is a critical factor in determining successful patient outcomes from a cardiac arrest⁽¹¹⁾. In addition, nurses should exhibit the knowledge and skills necessary in an emergency to help sustain life until medical help arrives. Nurses are usually the first to respond at the scene of a cardiac arrest and their

ability to provide care might well be critical to the successful outcome of a resuscitation attempt⁽¹⁰⁾. Being important members of the healthcare team, nurses are deemed to possess the basic skills and expertise which are needed to perform CPR. It is documented that a timely performed CPR can largely prevent sudden death and it is hence considered to be an important medical procedure⁽¹⁸⁾. Many times, the doctor may not be present near the patient and hence the nurses are expected to provide this emergency care. To perform the procedure in a meticulous manner, the nurses should be knowledgeable and they should have expertise in the procedure. Contrary to their roles, studies from different countries have reported a poor knowledge among the nurses regarding CPR^(11, 19 - 21).

Poor knowledge and skill retention following cardiopulmonary resuscitation training for nursing and medical staff has been documented over the past 20 years⁽²²⁾. The development of knowledge and skills is an essential component of professional development in nurse education programs. There is universal evidence to suggest that CPR knowledge is poorly recalled by nurses⁽²³⁾. Acquisition and retention of CPR knowledge and skills are vital in ensuring that nurses can respond quickly and effectively to patients in cardiopulmonary arrest⁽²⁴⁾. Education is a way of dealing with both the actual and perceived complexities of CPR. Furthermore, various international organizations on resuscitation have emphasized the importance of education on providing high quality CPR and thus improving survival from cardiac arrest^(25, 26).

Aim of the study:

The study aims to determine the effect of cardiopulmonary resuscitation training program on the knowledge and practice of nurses working at Tanta Cancer Institute.

Research hypothesis:

- 1- Nurses attending training program will exhibit higher knowledge and practice scores immediately post the program than the pre ones.
- 2- Knowledge and practice scores immediately post the training program will be higher than one month later.

2. Material and Method

Design:

The study was a quasi-experimental research study.

Setting:

The study was conducted in Faculty of Nursing, Tanta University for the pre-and immediate post training program assessment and in Tanta Cancer Institute, Ministry of health for one month post training program assessment.

Subjects:

The subjects of this study were consists of all nurses who are working in Tanta Cancer Institute, Ministry of health (111 nurse).

Inclusion and exclusion criteria:

All nurses who were on duty during the study period were enrolled. The ones on leave were excluded from the study.

Tools: Two tools were used in this study:

Tool I: Nurses' knowledge related to cardiopulmonary resuscitation questionnaire sheet:

Questionnaire sheet was prepared by the researchers after review of literature⁽²⁷⁾ related to CPR for data collection and was comprised two parts:

Part A: Nurses' bio-socio-demographic data: It includes: sex, age, level of education, years of experience, working unit, and previous places of work if any.

Part B: Nurses' knowledge related to cardiopulmonary resuscitation: it includes 21 yes or no, true or false, and multiple choice questions related to: having knowledge or attending of any previous training program related to CPR, importance of CPR training program, patients' and rescue' position during CPR, how to assess cardiac and respiratory system of the victims, how to open air way, depth and rate of chest compression for adult, child and infant victims, ratio of chest compression to breathing rate in case of one and two rescue for adult, child and infant victims, when to stop CPR and complication of CPR. A scoring system was created, allocating one point to each correct answer while zero score was given to wrong answers. A total score was given to each participant (0 being the lowest and 21 being the highest possible score); the total scores then converted into total score percent. The level of knowledge were categorized as poor (<50%), fair (50-75%) and good (>75%).

Tool II: Nurses' performance related to cardiopulmonary resuscitation observational checklist: It includes 22 steps for adult and child victims, and 8 steps for infant victims related to CPR procedure to assess psychomotor skills of the nurses, the possible responses for each step were done or not done. A scoring system was created, allocating one point to each correctly and completely done step, while zero score was given to incomplete, wrong or not done steps. A total score was given to each participant, (0 being the lowest and 30 being the highest possible score), the total scores then converted into total score percent. The level of performance were categorized as poor (<50%), fair (50-75%) and good (>75%).

Method:

1. An official Permission to carry out the study was obtained from the responsible authorities.

2. Nurses' written consent to participate in the study was obtained after explaining the purpose of the study.
3. Nurses' confidentiality was ascertained.
4. The tools of the study were developed after review of literature containing the knowledge and skills related to CPR procedure.
5. Questionnaire sheet was tested for content validity for clarity and applicability by presenting to 6 experts in medical surgical nursing field and necessary modification was done.
6. A pilot study was conducted on five nurses to test the reliability of the tools, test-retest was calculated at interval of two weeks period, and consistency was .82.
7. Tool I and II were used three times, pre, immediate and one month post implementation of training program related to CPR.
8. The study was conducted on three phases:
 - A- **Assessment phase:** Nurses knowledge and skills were assessed using tool I and tool II at the beginning and prior to implementation of the training program; the questionnaire sheet was given to all nurses included in the study to assess their CPR knowledge, while they were observed during the procedures to assess their skills.
 - B- **Implementation phase:** Training program was implemented through two strategies:
 9. Educational session: was given to all nurses in the study in 11 groups, one group every day, 10 nurses each, the educational session was given for a duration of two hours using lecture, data show, discussion, video tapes, and handout which given to all nurses included in the study. The handout related to CPR was written in Arabic language to be easily understood by all nurses and it includes all knowledge needed regarding; causes and signs of cardiac arrest, steps before and during CPR for adult, child and infant, CPR complication, when to stop CPR and when not to start CPR, handout was tested for content validity for clarity and applicability by presenting to jury of 5 experts in medical surgical nursing field and necessary modification was done.
 - Training session: was given once to all groups immediately after the educational session, each group was subdivided into two groups, 5 nurses each for two hours, CPR steps demonstration was done in nursing laboratory by lecturer, and assistant lecturer using Resusci Anne, Torso and full body manikin for adult and children victim, and infant doll for infant victim, each nurse demonstrate and re-demonstrate the steps individually until she correctly and completely performed the steps, and then evaluated by using tool II.

C- Evaluation phase: The evaluation of the training program was carried out twice:

- Immediately post the application of the training program using tool I and II.
- One month post the application of the training program using tool I and II.

Statistical analysis:

For quantitative variables, mean and standard deviation were calculated; comparison of the difference between two means was done using students t test. The difference in percentage of correct knowledge and performance items of CPR pre and post training program was tested using Wilcoxon signed rank test (z&p). The Pearson's correlation coefficient (r) was calculated for numerical variables. When one or two variable were ordinal, Spearman's test (rho) was used. The level of significance was adopted at $p < 0.05$.

3. Results:

The subjects comprised of 111 nurses working at Tanta Cancer Institute, with age ranged from 20-44 years and years of experience ranged from 1-22 years. As for sex, majority of nurses were females (87.4%), more than half of them (61.3%) had diploma level of education, and less than one third of them had from 11-15 years of experience (31.5%), while majority of them (95.5%) working in inpatient departments.

In relation to nurses' previous information and training related to CPR, the study revealed that 73% of them don't have previous training and 27% of them don't have any information about CPR and the main source of the information was gained through training program more than one year ago (22.5%), while the majority of them (98.2%) reported that CPR training program should be included in nursing school and faculties curricula, also (99.1%) and (94.6%) of them were willing to attend CPR training program and reported that they have the capacity to perform CPR respectively.

Table (1): Comparison of percentage of correct CPR knowledge items pre and post training program. In this table, the percentage of correct answers pre the program ranged from 23.4% to 82.0% while there was statistically significant differences in nurses knowledge pre, immediate and one month post training with $P = 0.001$ in all knowledge items, with highest percentage of correct answers pre the program were related to; breathing assessment of arrested patient and rescue position related to the patient with (82%) and (73%) respectively.

Table (2): Comparison of percentage of correct CPR performance items pre and post training program. This table revealed that nurses' performance related to CPR steps were very poor pre the program, which had been sharply increased to ultimate level

immediately post the program and decreased one month later, the percentage of correct answers immediately post the program ranged from 97.3% to 100% and there was statistically significant differences in nurses performance pre, immediate and one month post training program with $P = 0.001$ in all performance items and the lowest percentage of performance items at one month post the program were related to; applying of face mask (21.6%), insertion of air way (24.3%) and using of proper size face mask for ambo bag (28.8%).

Table (3): Distribution of nurses according to their total percentage score of knowledge and performance pre and post training program. This table illustrated that more than one third of the nurses (35.1%) had poor knowledge pre the program while (89.2%) and (72.1%) of them had good knowledge immediately post and one month later post the program respectively. Regarding nurses' performance related to CPR, it was found that, all nurses had poor performance pre the program (100%), while (98.2%) of them had good performance immediately post the program and (71.2%) had fair performance one month post the program.

Table (4): Comparison of mean knowledge and performance total score related to CPR pre and post training program. It was noticed that there were statistically significant differences between knowledge and performances pre the program in relation to immediately and one month post the training program with P value = 0.001.

Table (5): Correlation between nurses' knowledge and performance related to CPR pre and post training program. It can be seen that the only statistically significant correlation was found between CPR knowledge and performance one month post the program with p value = 0.001.

Table (6): Correlation between nurses' knowledge and performance related to CPR and their socio-demographic characteristics. This table showed that there was statistically significant positive correlation between nurses' knowledge related to CPR and their level of education pre and one month post the program with $p = 0.008$ and 0.033 respectively, while there was statistically significant negative correlation between nurses' performance and their educational level pre the program with $p = 0.018$.

Table (7): Correlation between nurses' knowledge and performance related to CPR and their workplace. This table showed that there were no statistically significant differences between nurses' knowledge and performance related to CPR and their workplace since p value > 0.05 .

4. Discussion:

Being important members of the healthcare team, nurses are deemed to possess the basic skills and

expertise which are needed to perform CPR. Cardiopulmonary resuscitation training is mandatory for nursing staff and is important as nurses often discover the victims of in-hospital cardiac arrest. People who suffer from sudden cardiac arrest (SCA) depend on prompt basic life support (BLS). Patients who receive bystander cardiopulmonary resuscitation (CPR) have a two to three times higher survival rate⁽¹⁷⁾.

Bio-socio-demographic characteristics of the nurses showed that about one third of them have age from 20 to 25 years, with years of experience ranged from 1-22 years, less than one third of them had from 11-15 years of experience, and about two third of them have diploma, while most of them working in inpatient departments. **Hussain et al. (2009)**⁽¹¹⁾ reported that majority of the study sample were female, with age ranged from 20-50 years while the majority had general diploma in nursing with average years of experience of 12 years. Also **Parajulee et al. (2011)**⁽²⁸⁾ stated that the mean age of respondents was 22.07 years and the mean of years of experience was 11.45. The result of the present study also revealed that more than third of the nurses don't have any previous information regarding CPR, and mostly all of them were willing to attend training program and reported that they have the capacity to perform CPR. This result is in accordance with **Damjan et al. (2012)**⁽²⁹⁾ who mentioned that university students showed poor theoretical knowledge and demonstrated willingness and motivation for courses on basic life support. Whereas, **Nagashema et al. (2012)**⁽³⁰⁾ was in contrast with the present study and stated that the majority of the nurses are much interested in CPR, and most of them had received education and training in CPR as students or after the graduation.

The nurses' competency in CPR is a critical factor in patient outcome from cardiac arrest. CPR competency is defined as possessing cognitive knowledge and psychomotor skills to be able to perform CPR in a cardiac arrest situation⁽³¹⁾. The finding of the present study proved that nurse's knowledge scores were poor in all knowledge items pre the training program which has been strongly increased immediately post the program and then decreased one month later which may be explained that the nurses lacked the motivation to review the handout which has been given to them in the implementation phase, and that the retention of knowledge quickly deteriorates if not used or updated regularly, it was noticed that the lowest score of knowledge items in the pre training assessment were related to initial assessment criteria for arrested patient, when to stop CPR, ratio of infant chest compression per minute and breathing rate for pulsated, breathless child, moreover the finding of the

present study proved that the majority of the nurses had poor and fair total percentage score of knowledge related to CPR pre the training program while most of them had good knowledge immediately and one month later post the program. **Bakhtiar et al. (2007)**⁽³²⁾ supported this present finding and stated that experiences showed that in many critical situation, nurses don't have sufficient basic CPR knowledge, also **Hussain et al. (2009)**⁽¹¹⁾ stated that the majority of the nurses have poor CPR knowledge and **Damjan et al. (2009)**⁽²⁹⁾ mentioned that the study revealed a disappointing level of knowledge of the fundamentals of basic life support in both study groups, also **Devlin (1999)**⁽³³⁾, **Crunden (1991)**⁽³⁴⁾ and **Badger et al. (1998)**⁽³⁵⁾ found that CPR knowledge score of the subjects was low and below the passing mark. However the present study showed sharply increased in nurses knowledge immediately post the training program with little decrease one month post the program these result was in agreement with **Madden (2006)**⁽¹⁷⁾, **Broomfield (1996)**⁽³⁶⁾, **Inwood (1996)**⁽³⁷⁾ and **Moule (1997)**⁽³⁸⁾ who stated that following CPR training program, there was a significant acquisition in nurses CPR cognitive knowledge and added, when comparing nurses post test score of knowledge with re- test score, the decrease in score was statistically significant and the questions with lowest score were related to CPR ratio of infant, CPR ratio of adult and depth of chest compression.

Regarding CPR performance, the present study proved that nurses performance was very poor in all performance items pre the program which has been strongly increased immediately post the program and then decreased again one month later with the lowest score of performance items at one month post the training program were related to; applying of face mask, insertion of air way and using of proper size face mask for ambu bag, this may be attributed to the fact that the complex of resuscitation procedures and there was no exposure to actual clinical situation which require demonstration of CPR, moreover the study showed that all nurses had poor total percentage score of performance and none of them had good or fair total percentage score related to CPR performance pre the program while majority of them had fair and good total percentage score immediately and one month later post the program, this result was disagreed with **Meissner (2012)**⁽³⁹⁾ who observed significant improvement and good retention rate of CPR performance four months after training, in addition **David et al. (1983)**⁽⁴⁰⁾ founded that after 6 month of training program, the nurses has significant decrease only in knowledge, whereas, **Madden (2006)**⁽¹⁷⁾, **Broomfield (1996)**⁽³⁶⁾, **Handly (2003)**⁽⁴¹⁾, and **Timsit (2006)**⁽⁴²⁾ supported the present study and demonstrated a positive training effect and a

significant acquisition in psychomotor skills that decreased with time and added that there was a significant deterioration in CPR skills' performance 10 weeks following CPR training and the ventilation volume and depth of chest compression was the poorest performance skill.

The American Heart association suggests that knowledge retention does not decline at the same rate as skills. Acquisition and retention of CPR knowledge and skills are vital in ensuring that nurses can respond quickly and effectively to patients in cardiopulmonary arrest⁽⁴³⁾.

The finding of the study indicated a positive significant correlation between nurses knowledge and performance related to CPR pre and one month post the training program, these result are in line with the result reported by **Amer (2001)**⁽⁴⁴⁾ who found that the relation between performance and knowledge is so close, which means that if the level of knowledge is high, the level of practice will be also high, also **Akel (1997)**⁽⁴⁵⁾ added that correlation between knowledge and performance scheduling was a positive one, and **Aly (2010)**⁽⁴⁶⁾ reported that there was significant correlation between total basic life support knowledge and practice scores, moreover, **Gomma (1992)**⁽⁴⁷⁾ stated that; basic scientific knowledge of CPR has significant effect in the management and successful skill in performance of CPR. On the other hand, this finding is contraindicating with the result reported by **Moule et al. (2002)**⁽⁴⁸⁾ who identified that no correlation found between knowledge of basic life support and skill attainment, also **Gould (1996)**⁽⁴⁹⁾ reported that there was discrepancy between nurses' knowledge and practice.

Regarding to correlation between knowledge and age, the present study proved that there was a significant negative correlation between knowledge pre, immediately and one month later post the program and nurses' age which may be explained by the fact that younger nurses were freshly graduated, more interested and motivated to learn and much active than the older ones, in this context; **Parajulee (2011)**⁽²⁸⁾ reported that there was no significant association between the total knowledge score and age of the respondent, while **Aly (2010)**⁽⁴⁶⁾ contradicting this result and stated that there is significant correlation between age and total basic life support knowledge scores. In relation to correlation between knowledge and years of experience, the finding shows negative correlation pre, immediately post and one month post the program, this might be attributed that nursing education system is not preparing nurses to be effective in CPR especially and knowledge will be forgotten and deteriorated by time, **Parajulee et al. (2011)**⁽²⁸⁾ did not found significant association between the total knowledge score and the duration of

experience, and **Mohamed (1998)**⁽⁵⁰⁾ found that no significant differences between knowledge of nurses with different years of experience, also, **Hussain et al. (2009)**⁽¹¹⁾ stated that significant differences were found in terms of knowledge and the demographic variable of working area and years of experience, on the other hand; the finding was in disagreement with **Al Kandary et al. (2011)**⁽²⁰⁾ who proved significant correlation between years of experience and knowledge scores. Regarding to correlation between knowledge and educational level; the present study proved that there was significant correlation in the pre and one month post the program which was in contrast with **Aly (2010)**⁽⁴⁶⁾ who reported that no significant correlation between educational level and total basic life support knowledge.

In relation to correlation between nurses' performance and their age, the present study proved that there was a negative correlation pre and one month post the training program and as regarding to correlation between nurses' performance and years of experience, there was a negative correlation pre, immediately and one month post the training program which may be attributed to that nurses rarely helped in CPR even with more age and more years of experience; **Aly (2010)**⁽⁴⁶⁾ supported this result and mentioned that there was significant negative correlation between age and total basic life support practice score, also **Moule et al. (2002)**⁽⁴⁸⁾ stated that the level of performance appeared to decrease in those greater than 50 years of old,. The result of the present study was contradicting with **Gohary (2001)**⁽⁵¹⁾ who stated that there was an improvement in the level of nurses' performance with the increase in the years of experience. Regarding to correlation between nurses' knowledge and performance and their work place, the present study proved that there was no statistically significant correlation could be detected between nurses' knowledge and performance pre and post the program and their work place, in this context, **Hussain (2009)**⁽¹¹⁾ and **Parajulee (2011)**⁽²⁸⁾ detected significant differences between knowledge and working area of the respondents.

4. Conclusion:

Based on the findings of the present study, it can be concluded that:

- Most of the nurses have poor knowledge and performance related to CPR pre the training program.
- Nurses' knowledge and performance related to CPR was strongly increased immediately and slightly decreased one month post training program.
- There was negative correlation between nurses' knowledge and performance pre and post the

program in relation to their age, years of experience and educational level.

Recommendation:

Based on the findings of this study, it can be recommended that:

- CPR educational program should be included in all nursing schools and curricula
- Structured CPR training program to train and educate all nurses.
- Repetitive periodic CPR training courses to ensure that nurses are competent, up to date and confident responders in the event of a cardiac arrest.

- Annual assessment and certification of CPR according to the latest guidelines.

For further studies:

- Further research is needed in this area for nursing staff in OR, ER, ICUs, CCU, and pediatric units.
- Further studies are needed to determine other factors influencing CPR knowledge and practice.
- Further research to determine the effect of training program by using different methods of teaching strategies.

Table (1): Comparison of percentage of correct CPR knowledge items pre and post training program

Items of knowledge	Percentage of correct knowledge			Z_1	p_1	Z_2	p_2
	Pre program	Immediately post	One month later				
1. Rate of breathing to chest compression	67.6	97.3	97.3	5.245	0.001	5.358	0.001
2. Complication of CPR	45.0	91.0	86.5	7.141	0.001	6.782	0.001
3. Assessment of breathing of arrested patient.	82.0	95.5	93.7	3.441	0.001	3.153	0.002
4. Pulse assessment during CPR	49.5	79.3	75.7	5.154	0.001	5.048	0.001
5. Method of air way opening	71.2	98.2	97.3	5.477	0.001	5.209	0.001
6. When to didn't start CPR	62.2	97.3	91.0	6.091	0.001	5.488	0.001
7. Chest compression ratio with one rescue	68.5	91.0	88.3	4.490	0.001	4.315	0.001
8. Initial assessment criteria	23.4	56.8	37.8	5.181	0.001	3.138	0.002
9. Pulse assessment artery for adult and child	64.0	97.3	92.8	5.925	0.001	5.333	0.001
10. CPR pause time	53.2	84.7	79.3	5.000	0.001	4.422	0.001
11. Hand placement site during adult CPR	64.0	89.2	85.6	4.802	0.001	4.243	0.001
12. Position of rescue to patient	73.0	96.4	87.4	4.914	0.001	3.578	0.001
13. When to stop CPR	33.3	63.1	55.9	4.371	0.001	3.727	0.001
14. Ratio of chest compression for infant/minute	24.3	75.7	72.1	6.862	0.001	6.677	0.001
15. Ratio of chest compression to breathing for infant by two rescue	47.7	91.9	82.0	6.379	0.001	5.729	0.001
16. Using of one hand for CPR on infant	44.1	60.4	56.8	2.546	0.011	2.333	0.020
17. When to stop infant CPR	64.9	84.7	81.8	3.569	0.001	3.182	0.001
18. Site of chest compression of infant	42.3	91.0	82.0	6.971	0.001	6.351	0.001
19. Breathing rate for breathless child with pulse	28.8	63.1	53.2	5.078	0.001	4.217	0.001
20. Hand placement site during child CPR	43.2	89.2	85.6	6.640	0.001	6.581	0.001
21. When to stop child CPR	40.5	78.4	73.0	5.612	0.001	5.308	0.001

Z_{1,p_1} = Comparison between pre and immediately after the program

Z_{2,p_2} = Comparison between pre and one month after the program

Table (2): Comparison of percentage of correct CPR performance items pre and post training program

Item of performance	Percentage of items of CPR			Z_1	p_1	Z_2	p_2
	Pre program	Immediately post	One month later				
1. Determine patient consciousness	18.9	100.0	92.8	9.487	0.001	8.741	0.001
2. Call emergency medical service	8.1	100.0	54.1	10.100	0.001	6.877	0.001
3. Determine pulse and breathing	9.9	100.0	83.8	10.000	0.001	8.947	0.001
4. Place victim on hard surface	9.9	99.1	75.7	9.950	0.001	8.111	0.001
5. Assume correct position	10.8	98.2	49.5	9.652	0.001	6.143	0.001
6. Position victim correctly	10.8	98.2	76.6	9.849	0.001	8.319	0.001
7. Kneeling parallel to the victim head	9.0	98.2	54.1	9.950	0.001	6.682	0.001
8. Apply face shield	5.4	98.2	21.6	9.957	0.001	3.530	0.001
9. Initiate chest compression	9.9	98.2	68.5	9.800	0.001	7.407	0.001
10. (For adult) Hands 1-2cm above xiphoid, interlock fingers off chest wall	11.7	98.2	71.2	9.600	0.001	7.672	0.001
11. Proper position of hands	9.9	98.2	70.3	9.800	0.001	7.736	0.001
12. Use head tilt, chin lift method	2.7	99.1	57.7	10.344	0.001	7.685	0.001
13. Use of jaw thrust maneuver	5.4	99.1	45.0	10.198	0.001	6.102	0.001
14. Insert oral airway, if available	0.9	98.2	24.3	10.297	0.001	5.099	0.001
15. Administer artificial respiration	0.0	98.2	40.5	10.440	0.001	6.708	0.001

16. Pinch victim nose with thumb and index fingers	5.4	98.2	65.8	9.957	0.001	8.066	0.001
17. Maintain head tilt, chin lift during breathing	6.3	98.2	58.6	10.002	0.001	7.366	0.001
18. (Mouth to nose) Seal lips around victim's nose	4.5	98.2	47.7	10.101	0.001	6.658	0.001
19. (Ambu bag) use proper size face mask	1.8	98.2	28.8	10.294	0.001	5.477	0.001
20. Observe chest wall movement	4.5	97.3	40.5	9.866	0.001	6.325	0.001
21. Suction secretion if necessary	2.7	97.3	30.6	10.057	0.001	5.568	0.001
22. Check for carotid or brachial pulse	5.4	97.3	65.8	10.002	0.001	8.066	0.001
23. (For infant) determine responsiveness	4.5	97.3	86.5	10.052	0.001	9.436	0.001
24. Call emergency medical service	5.4	97.3	44.1	9.815	0.001	6.410	0.001
25. proper position of the infant	4.5	99.1	78.4	10.247	0.001	8.947	0.001
26. Open the airway	7.2	98.2	45.0	10.050	0.001	5.715	0.001
27. Check for breathing	9.9	97.3	58.6	9.652	0.001	6.548	0.001
28. Using appropriate barrier device	11.7	98.2	41.4	9.600	0.001	4.714	0.001
29. Determine brachial pulse presence	8.1	99.1	60.4	10.050	0.001	6.932	0.001
30. Provide correct chest compression	7.2	100.0	70.3	10.149	0.001	7.926	0.001

Z_{1,p_1} = Comparison between pre and immediately after the program

Z_{2,p_2} = Comparison between pre and one month after the program

Table (3): Distribution of nurses according to their total percentage score of knowledge and performance pre and post training program

Variables	Poor (<50%)		Fair (50-75%)		Good (>75%)	
	n	%	n	%	n	%
Knowledge pre training program	39	35.1	59	53.2	13	11.7
Knowledge immediately post training program	1	0.9	11	9.9	99	89.2
Knowledge one month post training program	2	1.8	29	26.1	80	72.1
Performance pre training program	111	100.0	0	0.0	0	0.0
Performance immediately post training program	1	0.9	1	0.9	109	98.2
Performance one month post training program	26	23.4	79	71.2	6	5.4

Table (4): Comparison of mean knowledge and performance total score related to CPR pre and post training program

Variables	Mean	$\pm$ SD	t	p
Knowledge pre training program	52.04	$\pm$ 19.39	-----	-----
Knowledge immediately post training program	84.34	$\pm$ 9.44	14.912	0.001
Knowledge one month later	78.59	$\pm$ 11.61	15.738	0.001
Performance pre training program	7.09	$\pm$ 8.43	-----	-----
Performance immediately post training program	98.41	$\pm$ 7.76	70.145	0.001
Performance one month later	56.94	$\pm$ 11.79	39.094	0.001

Table (5): Correlation between nurses' knowledge and performance related to CPR pre and post training program

Total performance score	Total knowledge score	
	r	p
Performance pre training program	0.111	0.245
Performance immediately post training program	-0.028	0.770
Performance one month later	0.334	0.001

Table (6): Correlation between nurses' knowledge and performance related to CPR and their socio-demographic characteristics.

Variables	Age in years		Years of experience		Educational level	
	rho	p	rho	p	rho	p
Knowledge pre training program	-0.339	0.001	-0.394	0.001	0.250	0.008
Knowledge immediately post training program	-0.199	0.037	-0.133	0.165	-0.017	0.860
Knowledge one month later	-0.233	0.014	-0.219	0.021	0.203	0.033
Performance pre training program	-0.108	0.261	-0.68	0.480	-0.224	0.018
Performance immediately post training program	0.005	0.960	-0.005	0.959	0.181	0.057
Performance one month later	-0.167	0.079	-0.080	0.407	0.007	0.939

Table (7): Correlation between nurses' knowledge and performance related to CPR and their workplace.

Variables	Inpatient	ICU	Outpatient clinic	Operating rooms	F	p
	Mean±SD	Mean±SD	Mean±SD	Mean±SD		
Knowledge pre training program	51.2±19.1	55.0±21.3	44.2±20.0	58.2±16.7	1.283	0.284
Knowledge immediately post training program	84.8±9.3	84.8±8.0	80.9±14.9	84.4±6.8	0.525	0.666
Knowledge one month later	78.9±11.6	80.2±9.7	70.1±15.7	81.3±8.2	2.447	0.068
Performance pre training program	7.2±8.3	8.0±11.5	6.4±5.5	5.7±6.2	0.229	0.876
Performance immediately post training program	98.08±9.2	99.7±1.0	99.7±1.0	97.6±8.9	0.386	0.764
Performance one month later	56.0±11.7	58.7±11.7	53.6±10.7	61.4±12.8	1.235	0.294

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