

## Impact of Cardiopulmonary Resuscitation Simulation Based Training Module on Maternity Nurses' Knowledge and Practice

<sup>1</sup>Noha Mohamed Mahmoud, <sup>2</sup>Nermine Mohamed Elcokany and <sup>1</sup>Asmaa Saber Ghaly

<sup>1</sup>Department of Obstetric and Gynecologic Nursing Faculty of Nursing,  
Alexandria University, Alexandria Egypt

<sup>2</sup>Department of Critical Care Nursing Faculty of Nursing, Alexandria University, Alexandria Egypt

**Abstract:** Cardiac arrest in pregnancy is one of the most challenging clinical scenarios. Although most features of resuscitating a pregnant woman are similar to standard adult resuscitation, several aspects and considerations are uniquely different. The aim of this study was to evaluate effect of maternal cardiopulmonary resuscitation simulation based training program on nurses' knowledge and skills retention. This study was conducted at training unit of Smouha University Hospital affiliated to Alexandria University. Subjects of this study were comprised of 100 nurses who were worked at El Shatby maternity university hospital and Borg El Arab hospital. Two tools were used for data collection. Tool (I): Maternity nurses' knowledge about maternal cardiopulmonary resuscitation and Tool II: Maternal cardiopulmonary resuscitation observational checklist. A statistically significant difference was observed between the study subjects in relation to their knowledge before and immediately after program application ( $P = 0.000$ ). In addition, another statistically significant difference was detected between the study group in relation to their performance ( $P = 0.000$ ) before & immediately as well as one month after intervention. It can be concluded that nurses who received maternal cardiopulmonary resuscitation simulation based training program exhibited higher scores in acquired and retained maternal cardiopulmonary resuscitation knowledge and skills.

**Key words:** Maternal Cardiac Arrest • Maternal Cardiopulmonary Resuscitation • Maternity Nurses

### INTRODUCTION

Maternal cardiac arrest during pregnancy is one of the most challenging clinical scenarios with the simultaneous care of two critically ill patients, mother and fetus. These challenges are superimposed upon a general lack of experience in maternal resuscitative measures by obstetric health care teams because cardiac arrest in pregnancy is estimated to occur in 1:30, 000 births. Pregnant woman dies as a result of complications arising during pregnancy, childbirth or puerperium. Worldwide, Maternal Mortality Ratio (MMR) was estimated to be 210 per 100, 000 live births in 2013. However, almost all (99%) of these deaths occur in the developing countries. In Egypt, MMR was estimated as 45 per 100, 000 live births in 2013 [1-3]. There is a wide list regarding the causes of cardiac arrest during pregnancy included bleeding, heart failure, amniotic fluid embolism (AFE), cardiac disease, sepsis, preeclampsia/eclampsia,

cerebrovascular events, complications from anesthesia and thrombosis/thromboembolism. Occasionally, the etiology of maternal cardiac arrest may be multifactorial making the diagnosis and management more difficult [4]. There are anatomic and physiologic changes that can predispose to cardiac arrest during pregnancy, e.g. females with an advanced pregnancy are more susceptible to hypoxemia and acidosis and more likely to develop pulmonary aspiration compared to non-pregnant females. In addition, progesterone leads to the relaxation of the smooth muscle resulting in decreased vascular resistance. This reduces the diastolic blood pressure by 10-15 mm Hg during the first and the second trimesters. Additionally, pregnant women have a dilutional anemia due to a 50% increase in plasma volume. At term, the placenta alone receives 10% of the maternal circulating blood volume. In pregnant women with more than 20 weeks of gestation, the cardiac output is decreased mostly due to aortocaval compression [5, 6].

Consequently, maternal Cardiopulmonary Resuscitation (CPR) follows American Heart Association (AHA) guidelines undergoes several modifications for pregnant women that should be considered to save the lives of both mother and fetus. Priorities for the pregnant women in cardiac arrest are provision of high-quality CPR and relief of aortocaval compression. Manual left uterine displacement can be beneficial in relieving aortocaval compression during chest compressions if the fundus height is at or above the level of the umbilicus. Furthermore, continuous cricoid pressure should be applied during intubation to prevent the risk of aspiration. The possibility of airway edema should be considered especially in parturient with gestational hypertension which can make airway management difficult. Maternal CPR should be started with two rescue breaths of one second each. Bag mask ventilate at a rate of 8-10 breaths/min and a tidal volume large enough to raise the chest, during pauses of compressions. Chest compressions are performed higher in pregnant women compared to non-pregnant, slightly above the center of the sternum due to the elevated diaphragm and abdominal contents. Chest compressions should be performed a rate of 100-120/min, a depth of 4-5 cm [7, 8].

Both resuscitation and obstetric guidelines suggest that perimortem cesarean delivery (PMCD) should be considered within 4 min. of maternal collapse if there is no return of spontaneous circulation to minimize ischemic neurological damage in both. The clinical decision of performing a PMCD is complex because of variability in the level of team training, patient factor (gestational age, etiology of arrest) and system resources [9].

Moreover, the quality of CPR is often poor in the clinical settings and the lack of resuscitation skills of nurses in basic life support (BLS) has been identified as a contributing factor to poor outcomes of maternal cardiac arrest. Improvements in CPR skills and the ability to respond quickly and effectively to a cardiac arrest situation rest on nurses being competent in the emergency life-saving procedure. So, CPR training is mandatory for nursing staff as nurses often play a major role in the emergency handling of the mothers with cardiac arrest. Thus CPR becomes a fundamental requirement of all nurses [10].

The BLS is a performance that involves a spectrum of cognitive knowledge and psychomotor retention skills. They are vital in ensuring that nurses respond quickly and effectively to maternal cardiopulmonary arrest. A variety of teaching methods have been used by various

health care disciplines trying to improve the retention of CPR knowledge and skills. Many studies have looked at gaming, action cards, peer instruction, computer assisted learning and simulation. Simulation-based training is one of the teaching methods which particularly useful in simulating rapidly deteriorating clinical situations [11, 12]. Globally, simulation is a part of health care workers' (HCWs) education, training, malpractice insurance provision, medical board certification, skill maintenance, performance assessment, clinical rehearsal and human factors research [13, 14].

Many nursing educators have developed and implemented simulation experiences with students. They found that the use of simulation supported knowledge lead to confidence building and team work acquisition. However, unfortunately, few studies have measured learning outcomes with simulation experiences in nursing. Some of these studies actually showed outcome improvement when simulation was used as a learning method [15-17]. Moreover, the current skills, knowledge and implementation of existing guidelines among maternity nurses are poor. Therefore, this study proposed the application of cardiopulmonary resuscitation simulation Based Training Module on Maternity Nurses' Knowledge and Practice. Ultimately, this would improve the safety of the pregnant women and their fetuses.

**Aim of the Study:** This study aimed to evaluate the effect of cardiopulmonary resuscitation simulation Based Training Module on Maternity Nurses' Knowledge and Practice.

#### **Research Hypothesis:**

- Maternity nurses who receive CPR simulation based training module exhibit higher knowledge score.
- Maternity nurses who receive CPR simulation based training module demonstrate higher practice score.

## **MATERIALS AND METHODS**

### **Materials**

**Research Design:** A quasi- experimental research design was utilized to conduct the current study.

**Setting:** The study was conducted at training unit of Smouha University Hospital affiliated to Alexandria University.

**Subjects:** Random sample of 100 nurses out of 450 (representing the average number of maternity nurses worked at El-Shatby maternity university hospital and Borg El Arb hospital) were selected by using simple randomization. The sample size was estimated using Epi info 7 program.

**Tools:** Two tools were used for data collection.

This tool was developed by the researchers after extensive review of recent and relevant literature [1, 5, 7]. It includes two parts:

**Tool I:** Maternity Nurses' Knowledge about Maternal Cardiopulmonary Resuscitation

**Part 1: Basic Data Structured Interview Schedule:** This part entailed age, qualification, position, years of experience and attendance of in-service training.

**Part 2: Maternity Nurses' Knowledge about Maternal Cardiopulmonary Resuscitation:** This part comprised of 15 items: causes of maternal cardiac arrest, initial assessment criteria, signs of cardiac arrest, onset of brain death (timeframe), breathing rate for breathless pregnant woman, position of rescue, position of pregnant mother, responsiveness, indications for starting CPR for pregnant woman, time frame for maternal CPR, opening air way, hand placement site, signs of effective breathing, ratio of chest compression to breathing, using AED and complications of CPR. Subjects' response to each item varied between incorrect answer, I don't know (1), correct but incomplete (2), correct and complete (3). For each subject total score ranged from 15-45 and maternity nurse knowledge ranked as follow: poor < 25, fair 25 to <35 and good  $\geq 35$ .

**Tool II: Cardiopulmonary Resuscitation Observational Checklist:** This tool was adapted from the American heart association cardiopulmonary resuscitation guidelines [6, 7] to assess nurses' performance regarding maternal CPR. It included 33 items in 5 main groups: ensuring safety and checking responsiveness (6 items), positioning of pregnant women (2 items), circulation (14 items), Airway and breathing (10 items) and effectiveness of CPR (3 items). Maternity nurses were scored as correctly done (3), incomplete done (2) and not done (1). The total score was ranged between 33- 99. Subjects' skills were ranked as follow: poor < 55, fair 55 to < 77 and good  $\geq 77$ .

## Method

### The Study Was Executed According to the Following Steps:

- An official letter from the Faculty of Nursing was forwarded to the director of Smouha University Hospital affiliated to Alexandria University to obtain permission to conduct the study and collect the necessary data.
- Tool (I) was developed by the researchers based on extensive review of recent relevant literature. Tool (II) adapted and translated into Arabic language.
- Tools were tested for content validity by a jury of five experts in the field of obstetric and critical care nursing. The recommended modifications were done and the final form was finalized after proving valid.
- Tools reliability was tested by Cronbach's alpha test. Tool I was 0.82, Tool II was 0.80. A pilot study was carried out on 10 nurses (excluded from the study subjects) from the previously mentioned setting to assure feasibility of the study, clarity and applicability of the tools and to identify obstacles that might interfere with the process of data collection. Tools were modified accordingly prior to data collection.
- The present study was implemented in four phases (preparation, assessment, implementation and evaluation phase).

**Phase (I): Preparation:** During this phase, the content and researcher were prepared.

**Content:** Interactive simulators training program was developed by the researchers after a thorough review of the literature. Its content involved two main parts:

- Part I (Theoretical part) included causes of maternal cardiac arrest, phases of maternal cardiac arrest, safety during maternal CPR, manual left uterine displacement, position of pregnant mother, responsiveness, checking pulse, checking breathing, time frame for maternal CPR and complications of CPR.
- Part II (Clinical part) involved childbirth simulators and scenarios that were prepared by the researchers. It entailed initial steps for resuscitation including measures and interventions to open the air way, position the pregnant woman, start breathing and bag mask ventilation, apply chest compression effectively and monitor circulation.

### Researchers:

- The researchers have successfully completed the cognitive and skills evaluations in accordance with the curriculum of the American heart Association BLS for health care providers (CPR) and AED) program.

### Phase (II): Assessment Phase:

- Then interviewing the participants to collect baseline data, all study subjects were asked to respond to tool (I) as pretest assessment for subjects' knowledge in relation to maternal CPR. This was done as a self-report on an individual basis and in the presence of the researchers. On the other hand, each nurse was observed only once by the researchers using tool (II) to assess her performance (skills) in relation to maternal cardiopulmonary resuscitation.
- The average time for the completion of each participant interview was around (30-45 minutes), divided as (20 minutes) for the first tool and (20-25 minutes) for the second tool, average number collected was 15-20 participant / day. The total sample was divided into 5 subgroups include 20 participants for each session.

### Phase (III): Implementation:

- The program was implemented in 6 weeks by the researchers. 12 sessions were scheduled 2 session / week in the morning (3 hours each). The training course reflected a 9 hour theoretical content and 27 hours of clinical experience. The program sessions was done as follow:
- Session (1-5) included a theoretical part about maternal CPR followed by clinical part for demonstrating the steps of maternal CPR and nurses' role in maternal CPR using childbirth simulator then the trainees re-demonstrated the procedures.
- Session (6-12) implemented through exposing nurses to a variety of maternal CPR scenarios that emphasized assessment and intervention that were developed by the researchers. Each scenario took approximately 5 to 15 minutes, during this time the participant were able to perform initial steps for resuscitation including starting chest compression and positive pressure ventilation using documentation and pregnancy and labor case scenarios to distinguish between cases which need

maternal CPR. An open channel communication was achieved between researchers and participants to ensure understanding, answer any question and to verify information given.

- Teaching methods and aids includes: demonstration and re demonstration using childbirth simulator, external automated electrocardiogram, lectures, group work & discussion, case scenario, reading. Illustrated handout about knowledge was distributed after implementation of the program as a reference.

### Evaluation Phase:

- Evaluation of the program outcomes determined immediately after application of the program (to assess their knowledge and performance improvement) and one month later (to assess their knowledge and skill retention) using tool I and II, thereafter through monitoring the performance of maternal CPR.
- Ethical considerations that were considered all over the study phases:
- Written informed consent was obtained from each maternity nurse who was involved in the study for their participation after explaining the aim of the study.
- Anonymity and confidentiality of the study participants were assured. Moreover, data used only for the purpose of the study and not involved in evaluation of them.

**Statistical Analysis:** The raw data were coded and transformed into coding sheets. The results were checked. Then, the data were entered into SPSS system files (SPSS package version 20) using personal computer. Output drafts were checked against the revised coded data for typing and spelling mistakes. Finally, analysis and interpretation of data were conducted. The following statistical measures were used:

- Descriptive statistics including frequency, distribution were used to describe different characteristics.
- Kolmogorov – Smirnov test was used to examine the normality of data distribution.
- Univariate analyses including Chi-Square test, Fisher's Exact test, Monte Carlo test, Marginal Homogeneity test and McNemar test were used to test for significance among qualitative variables.
- The significance of the results was at the 5% level of significance.

## RESULTS

Table (1) shows socio-demographic characteristics of the studied nurses. Slightly more than three quarters (78%) of nurses were in their twenties. Only 15% of them were in their thirties. About two-thirds (62%) of them had diploma in nursing and less than half (40%) of study subjects had 1 to 5 years work experience. Almost all (90%) of them were holding technical institute certificate. The majority (85%) of them were urban dwellers. Unfortunately, none of them did receive any maternal CPR training.

Table (2) illustrates percent distribution of nurses' knowledge about maternal cardiopulmonary resuscitation before and after one month from the implementation of CPR training module. It was noted that there was a statistical significant difference between the study group regarding their knowledge assessed before and immediately after and after one month of the program implementation. A significant marked advance was observed among 91 and 97% of the study subjects where they had correct and complete answer to positioning of pregnant women during CPR immediately & after one month after program implementation, respectively. Moreover, a significant advance was also found among 95 and 86% of subjects who gave correct and complete answer to timing for starting CPR immediately and after one month after program implementation, respectively. A gradual improvement in their knowledge about signs of effective breathing & Ratio of chest compression to breathing for pregnant woman was noticed, where (65 and 72%) & (86 and 82%) respectively had correct & complete answer.

Table (3) demonstrates distribution of nurses regarding their total score of knowledge about maternal CPR before, immediately and after one month of the training program. Before providing teaching session, slightly less than three quarters (70%) of nurses had poor total scores of knowledge and none of them had a good total score of knowledge. After implementing of the simulation program, nurses showed improvement immediately where 93% of them display good total scores of knowledge. One month later, nurses showed a decline in their knowledge scores with only 88 % achieving a good total score. A Statistically significant difference was found before intervention and immediately after ( $P = 0.0001$ ). Further significant difference was also found between before and one month later  $P = 0.0001$ . In addition, there were no statistically significant differences between immediately after and after one month among nurses.

Table 1: Percent distribution of the nurses according to their socio-demographic characteristic

Socio-demographic characteristics	(n=100) No./%
Age (years)	
• 20-	78 (78%)
• 30-	15 (15%)
• 40-<50	7 (7%)
Educational level	
• Nursing diploma	60 (60%)
• Technical degree	31 (31%)
• University graduate	7 (7%)
Job position	
• Nurse	91 (91%)
• Nursing specialist	9 (9%)
Duration of nursing experience (years)	
• 1-<5	40 (40%)
• 5-<10	18 (18%)
• 10-<15	23 (23%)
• 15-<20	19 (19%)
Residence	
• Rural	15 (15%)
• Urban	85 (85%)
Received training on CPR	
• No	100 (100%)
• Yes	0 (0%)

Table (4) displays percent distribution of nurses' performance regarding different categories of maternal CPR before, immediately and after one month from the implementation of CPR training. It was noted that all nurses (100%) did not perform left uterine displacement during CPR (position of pregnant women) before the program. In addition, most of them did not perform skills related to safety and checking responsiveness and circulation (90 and 97%) respectively. It was also found that there was marked advance in their skills regarding the 5 categories of CPR immediately after implementation of the simulation program. One month later which means their skill retention, it was found that the practice of nurses statistically significant regarding safety and checking responsiveness, positioning of pregnant women, airway and breathing and circulation and effectiveness of CPR ( $P_3 < 0.0001$ ,  $P_3 < 0.0001$ ,  $P_3 < 0.0001$ ,  $P_3 < 0.0001$ ) respectively.

Table (5) portrays the total score of nurses' performance regarding maternal CPR. A Statistically significant difference was found before intervention and immediately after ( $P = 0.0001$ ). Further significant difference was found between before and one month later  $P = 0.0001$  among nurses. That is to say immediately after application of simulation program it was found that all of nurses (100%) had good total score of performance.

Table 2: Percent distribution of nurses' knowledge about Maternal Cardiopulmonary Resuscitation before and after one month from the implementation of CPR training module

		Studied nurses (n=100) No./%			Significance		
Nurses' Knowledge about Maternal Cardiopulmonary Resuscitation		Before	Immediate	One month	Sig. 1	Sig. 2	Sig. 3
Causes of maternal cardiac Arrest	Incorrect	44	6	12	<0.0001*	0.370	<0.0001*
	Incomplete	47	28	23			
	Correct	9	66	65			
Initial assessment criteria	Incorrect	87	39	21	<0.0001*	0.005*	<0.0001*
	Incomplete	4	0	12			
	Correct	9	61	67			
Signs of cardiac arrest	Incorrect	60	5	3	<0.0001*	0.012*	<0.0001*
	Incomplete	37	21	12			
	Correct	3	74	85			
Onset of brain irreversible changes	Incorrect	40	19	0	<0.0001*	0.002*	<0.0001*
	Incomplete	49	0	37			
	Correct	11	81	63			
Breathing rate for breathless pregnant woman	Incorrect	80	17	12	<0.0001*	1.0	<0.0001*
	Incomplete	14	5	15			
	Correct	6	78	73			
Position of rescue to patient	Incorrect	76	11	17	<0.0001*	0.075	<0.0001*
	Incomplete	13	0	6			
	Correct	11	89	77			
Positioning of pregnant woman	Incorrect	90	6	3	<0.0001*	0.150	<0.0001*
	Incomplete	4	3	0			
	Correct	6	91	97			
Indications for starting CPR for pregnant Woman	Incorrect	78	6	11	<0.0001*	0.031*	<0.0001*
	Incomplete	9	3	11			
	Correct	13	91	78			
Timing for starting CPR	Incorrect	74	5	6	<0.0001*	0.041*	<0.0001*
	Incomplete	6	0	8			
	Correct	20	95	86			
Opening air way	Incorrect	74	0	3	<0.0001*	0.371	<0.0001*
	Incomplete	15	8	6			
	Correct	11	92	91			
Hand placement site	Incorrect	52	9	6	<0.0001*	0.178	<0.0001*
	Incomplete	37	13	12			
	Correct	11	78	82			
Signs of effective breathing	Incorrect	75	33	18	<0.0001*	0.022*	<0.0001*
	Incomplete	3	2	10			
	Correct	22	65	72			
Ratio of chest compression to breathing for pregnant woman	Incorrect	61	11	15	<0.0001*	0.365	<0.0001*
	Incomplete	0	3	3			
	Correct	39	86	82			
Indication for using AED	Incorrect	54	16	6	<0.0001*	0.612	<0.0001*
	Incomplete	0	3	18			
	Correct	46	81	76			
Complications of CPR	Incorrect	62	10	6	<0.0001*	0.659	<0.0001*
	Incomplete	3	3	15			
	Correct	35	87	79			

Sig. 1: P-value for Marginal Homogeneity test of significance between before/immediately after results \*significant at  $P \leq 0$ .

Sig. 2: P-value for Marginal Homogeneity test of significance between immediately after /follow up results

Sig. 3: P-value for Marginal Homogeneity test of significance between before/follow up results

Table 3: Distribution of nurses regarding their total score of knowledge about Maternal CPR

	Studied nurses (n=100) no. (%)			Significance		
	Before	Immediately	One month	Sig. 1	Sig. 2	Sig. 3
Total score of knowledge						
Poor	70 (70%)	1 (1%)	0 (0%)	<0.0001*	0.363	<0.0001*
Fair	30 (30%)	11 (11%)	7 (7%)			
Good	0 (0%)	93 (93%)	88 (88%)			

Sig. 1: P-value for Marginal Homogeneity test of significance between before/immediately after results

Sig. 2: P-value for Marginal Homogeneity or McNemar test of significance between immediately after /follow up results

Sig. 3: P-value for Marginal Homogeneity test of significance between before/follow up results

\*Significant at  $P \leq 0.05$

Table 4: Practice of Maternal CPR categories among the studied nurses assessed before, immediately after and after one months of the training program

Practice Maternal CPR categories		Studied nurses (n=100) No./%			Significance		
		Before program (1)	Immediately after (2)	Follow up (3)	Sig. 1 (1-2)	Sig. 2(2-3)	Sig. 3(1-3)
Safety and checking responsiveness	Not done	90	2	4	<0.0001*	0.513	<0.0001*
	Incomplete	2	9	11			
	Done	8	89	85			
Positioning of pregnant women	Not done	100	4	4	<0.0001*	0.061	<0.0001*
	Incomplete	0	15	5			
	Done	0	81	91			
Circulation	Not done	97	0	0	<0.0001*	0.002*	<0.0001*
	Incomplete	0	5	19			
	Done	3	95	81			
Airway & breathing	Not done	68	0	0	<0.0001*	0.547	<0.0001*
	Incomplete	30	13	16			
	Done	2	87	84			
Effectiveness of CPR	Not done	44	0	0	<0.0001*	<0.0001*	<0.0001*
	Incomplete	53	27	5			
	Done	3	73	95			

Sig. 1: P-value for Marginal Homogeneity test of significance between before/immediately after results

Sig. 2: P-value for Marginal Homogeneity or McNemar test of significance between immediately after /follow up results

Sig. 3: P-value for Marginal Homogeneity test of significance between before/follow up results

\*Significant at  $P \leq 0.05$ 

Table 5: Distribution of nurses regarding their total score of skills about Maternal CPR

Total score of skills	Studied nurses (n = 100)			Significance		
	Before	Immediately	One month	Sig. 1	Sig. 2	Sig. 3
• Poor	96 (96%)	0 (0%)	0 (0%)	<0.0001*	0.121	<0.0001*
• Satisfactory	4 (4%)	4 (4%)	0 (0%)			
• Good	0 (0%)	100 (100%)	96 (96%)			

Sig. 1: P-value for Marginal Homogeneity test of significance between before/immediately after results

Sig. 2: P-value for Marginal Homogeneity or McNemar test of significance between immediately after /follow up results

Sig. 3: P-value for Marginal Homogeneity test of significance between before/follow up results

\*Significant at  $P \leq 0.05$ 

In addition, the majority (96%) of them had good total score of performance after one month later. In addition, there were no statistically significant differences between immediately after and after one month ( $P = 0.121$ ).

## DISCUSSION

Emergency care of pregnant women and survival of the fetus require prompt, high-quality CPR with some modifications in basic cardiovascular life support techniques as they apply to pregnancy. Cardiopulmonary resuscitation is an important medical and nursing procedure which is performed in an effort to manually preserve intact brain function until further measures are taken to restore normal spontaneous blood circulation and breathing. The management of cardiac arrest in pregnancy is considered an important task in emergency

department and delivery room. However, all medical staff especially nurses should be applying CPR for pregnant women skillfully and following general basic cardiac life support guideline. Having basic knowledge of CPR will be a crucial task of maternity nurses. As nurses comprise the greatest group of obstetrical health-care providers and are the ones responsible for the quality of care provided to the pregnant women [18, 19].

Furthermore, maternity nurse is deemed to pass the basic skills and expertise which are needed to perform CPR. The 2003–2005 Confidential Enquiry into Maternal and Child Health (CEMACH) [20] described deficiencies in knowledge and poor resuscitation skills among obstetrical caregivers and recommended that all clinical staff undergo regular training in basic and advanced CPR. Recent studies at different settings also demonstrate inadequate theoretic knowledge of CPR for pregnant

women. However, there is sparse literature on the quality of CPR in actual or simulated obstetric cardiac arrest scenarios [21]. Therefore the aim of this study was to evaluate the effect of simulation based CPR training program on knowledge and skills of maternity nurses.

Regarding the nurses' knowledge about maternal CPR, the findings of the present study revealed that before providing teaching session, about three quarters of nurses had poor total scores of knowledge. Lack of nurses' knowledge before the program could be attributed to absence of maternal CPR as a learning topic in the course syllabus of either emergency nursing or obstetric nursing curriculum. In addition, the newly appointed nurses did not receive any training courses, gain information later during orientation to the clinical area or through in-service training. Moreover, simulation CPR models are not present in their working areas.

These findings were in line with three studies. The first study was a survey done by Einav *et al.* [22] who surveyed the labour ward clinicians' knowledge of maternal cardiac arrest and resuscitation in Israel. They concluded that midwives nurses had a limited knowledge regarding maternal cardiac arrest. Cohen *et al.* [23] study in USA assessed knowledge regarding CPR of pregnant women among midwives nurses and obstetricians. They concluded that knowledge of important basic concepts, including the need for left uterine displacement (LUD) and the potential benefit of early cesarean delivery during cardiac arrest is inadequate among midwives nurses and obstetrician. The present result is also consistent with the findings other two studies Lipman *et al.* [23] and Berkenstadt [24] showed that study participants have poor knowledge of resuscitation of the pregnant patient resuscitation. They found that poor score of knowledge was obtained in both the experimental and control group.

After program implementation, it was found that there was a statistical significant difference among the study group regarding their knowledge assessed before, immediately after the program implementation. This could be attributed to internal validity of the maternal CPR course training, which was specifically designed to enhance knowledge and skill competence in BLS for maternity nurses. The core concepts of maternal CPR were included in the course curriculum and theoretical knowledge was linked to practice using a simulated case scenario. Moreover using simulator increases the feeling of self-efficacy, independence and simulates the actual work situations as well as matching with the ability to repeat the content as many times as needed [26, 27].

This result is congruent with Walker *et al.* [28] in Australia who studied the perceptions of interprofessional education in the Australian advanced life support in obstetrics (ALSO) course. They found that there were significant increases in midwives' knowledge in advanced life support in obstetrics course 6 weeks following the course.

Akhu-Zaheya *et al.* [29] in Jordan studied the effectiveness of simulation on knowledge acquisition, knowledge retention and self-efficacy of nursing students. They found that students trained with high fidelity simulation achieved higher scores in acquired and retained BLS knowledge, with no significant difference on knowledge retention between the two groups. Aqel [30] examined the high-fidelity simulation effects on CPR knowledge, skills, acquisition and retention in nursing students. His results showed significant differences in favor of the participants in the high-fidelity simulator group on the acquisition of knowledge. Tawalbeh [30] studied the effect of simulation on knowledge of advanced cardiac life support, knowledge retention and confidence of nursing students in Jordan. They found that nurses showed higher knowledge of advanced cardiac life support after implementation of program.

Regarding knowledge retention slight decrease in knowledge retention was noted after one month of the program implementation. These finding may be due to the fact that 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. This finding is consistent with several studies. Elazazay [31] studied the effect of CPR training program on nurses' knowledge and practice in Egypt. They found that majority of nurses had poor knowledge and performance related to CPR pre the training program which has been improved immediately but deteriorated one month post program. Aqel A study [30], reported significant loss of CPR knowledge, occurred at 3 months after training. Moreover, Ehlers [33] studied CPR knowledge and skills of registered nurses in Botswana. They found all nurses' knowledge and skills improved after training, but deteriorated over the three months until the post-test was conducted.

Furthermore, there is another study supported this study results titled "knowledge and skills retention among health providers trained in advanced life support in obstetrics in Cameroon" done by Bongban [34]. It showed that knowledge and practice at various time intervals with 30 months interval being the highest. Thomas [35] studied



the influence of high fidelity simulation on responder retention of CPR knowledge in Florida. They concluded that retention of detailed knowledge for adult learners is difficult for skills that are rarely used regardless of the time nurses were trained using high-fidelity simulation.

The level of nurses' performance regarding maternal CPR was unsatisfactory before the implementation of the training program. While after the implementation of the program there was a significant improvement in their performance of maternal CPR immediately after and after one month. These findings might be due to the fact that resuscitation training was based on in-hospital scenarios and current evidence-based guidelines and that it was taught using simulations on a variety of cardiac arrest scenarios. This will ensure that the training reflects the potential situations that nurses may face in their clinical practice. The training included the use of a manikin with a feedback mechanism and a specialized instructor (licensed) to ensure that chest compressions and ventilations are adequate at the time of training.

This result is in line with several other studies. Lipman *et al.* [23] studied the deficits in the provision of cardiopulmonary resuscitation during simulated obstetric crisis. They found that multiple deficits were noted in the provision of CPR to parturients during simulated arrests. Hards *et al.* [36] studied the Management of simulated maternal cardiac arrest by residents: didactic teaching versus electronic learning in Canada. They concluded that there are gaps in the knowledge an implementation of resuscitation protocols and the recommended modifications for pregnancy among residents. Didactic learning showed improving in skill acquisition and early knowledge retention. Frequent training and practice in managing maternal cardiac arrest is necessary to improve decision-making. Fourth Roth *et al.* [37] examined the effectiveness of an obstetrics-based advanced cardiac life support education program. They found that the scores of nurses who completed the ACLS OB course were significantly greater overall when performing ACLS Mega Code algorithms ( $z = -6.08$ ,  $p < .001$ ).

The role of simulation in obstetrics is supported in the literature. Jeffries [37] studied constructing maternal-child learning experiences using clinical simulations in USA. They stated that simulation was an essential tool for practicing routine and critical events and improving technical proficiency and teamwork. Simulation can serve as a strategy for improving procedural and behavioral skills, potentially mitigating and adverse perinatal events. Parfitt *et al.* [38] examined

obstetric-based advanced cardiac life support improves performance and self- efficacy in Scottsdale. They concluded that using simulation in educating the ACLS for obstetric patients and using scenarios encountered in obstetric setting improved nurses' performance. It also increased self-satisfaction and self-confidence in obstetric nurses' abilities to perform CPR skills. Aqel A [30] who studied high-fidelity simulation effects on CPR knowledge, skills, acquisition and retention in nursing students in Jordan. He showed significant differences in favor of the- participants in the high-fidelity simulator group on both the acquisition and retention of knowledge and skills over time.

## CONCLUSIONS

Based on the finding of the present study, it can be concluded that nurses who received maternal cardiopulmonary resuscitation simulation based training program exhibited higher scores in acquired and retained maternal cardiopulmonary resuscitation knowledge and skills.

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

- The curricula of basic nursing / midwifery education as well as continuing education could be enriched with, correct, relevant evidence – based information about maternal cardiopulmonary resuscitation simulation
- In-service training programs for all maternity nurses about maternal cardiopulmonary resuscitation are recommended.
- Further research is needed to study the effect of maternal cardiopulmonary resuscitation simulation based training program on healthcare professionals' self-perceived attitudes.

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