

## Effect of an Educational Program of Electrocardiogram Interpretation on Medical and Maternity Nurses' Knowledge and Skills

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**Abstract:** Electrocardiogram is a diagnostic tool in emergency care. Increase and maintain the knowledge of electrocardiogram interpretation is vital since it has been observed that a nurse's knowledge and skills in electrocardiogram interpretation diminish with time.

**The aim** of the study was to evaluate the effect of an educational program of electrocardiogram interpretation on medical and maternity nurses' knowledge and skills.

**Methods:** The study used a quasi-experimental design. Fifty-five nurses, including 20 nurses working in emergency departments, 20 nurses working in intensive care units and 15 nurses working at high-risk pregnancy unit were recruited for the study. Two learning methods were used: a lecture-based education program and a self-learning handbook. The effect of the methods was evaluated using a questionnaire containing questions in two domains.

**Results:** Data analysis showed that nearly two-thirds of the study group were the ages of 30 or more years. Regarding to level of education it was observed that less than two-thirds of the study group had secondary education. The majority sector of the study group had (general improvement) (satisfactory level of knowledge) in electrocardiogram interpretation in most items posttest phase compared to pretest phase, decreased in the follow up phase.

**Conclusions:** The majority of nurses on the study had unsatisfactory knowledge and skills levels before program implementation.

**Keyword:** Educational program; Electrocardiogram; Interpretation; Skills; Knowledge

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### I. Introduction

Electrocardiogram (ECG) interpretation is a vital clinical skill as it helps rapid diagnosis of potentially life-threatening concerns. According to the European Society of Cardiology's guideline for the management of acute myocardial infarction, the time between the initial medical contact and the recording of the first ECG is a good index of the care quality and shouldn't exceed 10 min. In addition to swiftness, accuracy of the diagnosis derived from an ECG tracing. Cardiovascular disease is highly prevalent so physicians and nurses of any specialty need to be familiar with the basic principles of ECG interpretation and must be capable of identifying important diagnoses (Steget al., 2012; Murray et al., 2013).

ECG is a vital diagnostic measure in emergency care. The benefits of emergency ECG have mainly been studied with regard to the care of patients with acute myocardial infarction (AMI). Patients with AMI who have been diagnosed by emergency ECG have a clearly reduced time to reperfusion therapy by thrombolytic (Crowder, Hubble & Gandhi, 2011)

Currently, an electrocardiogram (ECG) is normally used as the initial tool for initial discovering of cardiovascular disorders and non-invasive diagnosis of life threatening arrhythmias in clinical practice (Sayadi & Shamsollahi, 2011). ECG's provide nurses with information in emergency care settings, about the patient's in a manner that is easy and fast to use. Nurses who care for critically ill patients need to understand the information provided by the ECG, which includes heart rate, regularity of the rhythm, interval characteristics of each individual waveform of the heart.

Most pregnant women complain of palpitation, and various kinds of arrhythmias can be observed. The major adaptations of the maternal cardiovascular system that progress throughout gestation may hide previously unrecognized heart disease and result in significant morbidity and mortality. Soon after conception, the maternal cardiovascular system undergoes major adaptation that progress throughout gestation. In the absence of these adaptations, gestational complications incidence such as fetal growth restriction and pregnancy induced hypertension increased. Cardiovascular changes, which occur normally during pregnancy sometimes, triggers heart disease. Moreover, cardiovascular alterations parameters during pregnancy suggest the likelihood of an altered ECG during pregnancy (Ouzounian & Elkayam, 2012)

Vital efforts to increase and maintain the knowledge of ECG interpretation is needed since it has been observed that a nurse's knowledge and skills in ECG interpretation decrease with time (Nolan et al., 2010). Although there is no one specific method for teaching critical care nurses about arrhythmias, several approaches have been used to increase nurses knowledge and skills (Lack et al., 2013). In a combined interactive web-based collaborative learning activity and validation of staff's competency using a skills checklist, Schultz (2010) suggested that hospital administrators should encourage nurses to participate in a clinical practice development program, to increase their knowledge and skills in arrhythmia monitoring. This can encourage nurses to enjoy learning, which makes it safer for them to master the skill.

### **Significance of the study**

Arrhythmias are abnormal heart rhythms due to disturbances in heart automaticity, which cause decrease in cardiac output, a change in heart rate affecting tissue perfusion (Diehl, 2011). Any impulse originating outside the Sino-atrial node can cause an abnormal heart rhythm. Ventricular tachycardia, ventricular fibrillation, pulseless electrical activity, complete heart block, and a systole is the most common types of life threatening arrhythmias (Leijdekkers & Gay, 2006; Diehl, 2011). In Egypt, nearly four million people have arrhythmias (Statistics by Country for Arrhythmias, 2011). Between 2014 and 2015, the number of patients admitted to the intensive care unit (ICU) was 2024; about 70–80% had arrhythmias (Port Said Hospitals Statistical Office, 2018). ECG Interpretation is a vital clinical skill as it allows rapid diagnosis of potentially life-threatening concerns (Steget et al., 2012). Hence, this study has been conducted to increase the knowledge and skills of medical and maternity nurses about ECG interpretation.

### **Aim of the study:**

The aim of the study was to evaluate the effect of an educational program of electrocardiogram interpretation on medical and maternity nurses' knowledge and skills.

### **Research Hypothesis**

For fulfilling the aim of this study, the following hypothesis was formulated:

There will be positive changes in medical and maternity nurses' knowledge and skills after implementing the educational program.

## **II. Methods**

### **Design**

A quasi-experimental design with a one-group pretest/post and follow up tests with punctuated training over time to examine the effects of educational program on the knowledge and skills level of ECG interpretation.

### **Sample and setting**

55 nurses working in an emergency department, ICU department and high risk pregnant woman at Al-Amery and specialist obstetric hospital which frequently encountered patients with cardiac arrhythmia and have more opportunities to perform ECGs and they were more likely to have an interest in learning how to properly interpret ECGs. Therefore, this study used purposive sampling.

### **Ethical considerations**

The ethics committee approved the study protocol. The researcher explained the purpose of the study to the participants. Each participant was assigned a code number, and names were not connected to test scores by the researcher. Participants signed an informed consent form.

### **Research instrument**

It consists of two tools developed by the researcher after reviewing the related literature.

**Tool (1) consist of two parts:**

**Part (1): Demographic data**

The demographic data form consisted of questions regarding age, gender, grade, marital status, and years of experience and attending training program related to ECG interpretation skills

**Part (2): Structured knowledge questionnaire**

Based on clinical experience and a literature review, the researcher developed a questionnaire to examine what the nurses had learned by referring to the ECG training material. The test questionnaire included 22 items about ECG interpretation.

The knowledge section questions were in the form of true and false questions, and was graded in the range of zero (0) to fifty (22). A total of 22 questions measured knowledge in the questionnaire. This part of questionnaire was tested for reliability using Alpha Cronbach's test. The alpha reliability of this part was = 0.81. **Knowledge was considered** satisfactory ( $\geq 60\%$ ), unsatisfactory ( $< 60\%$ ).

**Tool (2): ECG interpretation skills sheet**

Composed of 20 example of ECG strip (normal & abnormal). Include rate, regularity, P waves, PR interval, QRS interval and ECG interpretation.

This tool was made up of 20 items used to assess the skills of the participants as regard ECG. Scoring for each question was a maximum score of one (1) and minimum score of zero (0) giving a cumulative minimum score of zero (0) and maximum score of 20. **skills was considered** satisfactory ( $\geq 60\%$ ), unsatisfactory ( $< 60\%$ ).

**Operational Design**

The operational design of this study included preparatory phase, content validity, pilot study and field work.

**Preparatory Phase**

It included reviews of current and past local and international related literatures, and theoretical knowledge of various aspects of the study using books, articles, and internet periodicals and magazines in order to develop the data collection tools.

**Content Validity**

It was ascertained by a Jury consisting of nine experts of professors and lecturers from the medical surgical department; Faculty of nursing and from medicine, surgery and neurology department Faculty of Medicine, Suez canal University who revised the tools for clarity, relevance, comprehensiveness, understanding and ease for implementation, according to their opinion modifications were applied.

**Pilot study**

Pilot study had been undertaken before starting the data collection phase. It was carried out on 10% of participants to test the feasibility and applicability of the first and second tools and to estimate the time needed to complete the tools according to the pilot study necessary modifications were done. The subjects included in the pilot study were excluded from the study sample.

**Fieldwork description**

Field study was conducted from the beginning of December (2017) to the end of December (2018). The study was carried out through the following phases:

**(1) Assessment:**

Assessment of nurse's knowledge and skills, was done by using tool (I) and (II), respectively. The implementation of the nursing program using teaching aids (pictures and handouts) according to schedule based on the contents of these program.

The researcher collect data related to nurses' demographic data using tool (I) part (1) and nurses' knowledge and skills related to ECG interpretation were assessed by using (part II and tool II) before and after implementing nursing program.

**(2) Implementation Phase:**

Initially studied nurses divided into 5 groups (11 nurses each) then each group was gathered at the conference room separately for about half-hours. During this meeting the researcher: explain the purpose of the study and give each nurse handout includes procedure steps to facilitate remembers steps about ECG

interpretation knowledge and skills. The program was presented in clear and concise form using different teaching methods as lecture using data show. The nurses was instructed to observe and understand the researcher carefully during the lecture of ECG interpretation because every one of them will answer the question on the strip and determine rate, p waves, QRS interval, regularity and interpretation of ECG in front of the researcher and the researcher will evaluate them. At the end of the researcher's lecture, nurses were asked about any unclear steps, which needed repetitions or explanation before answering.

After 3 month after implementation of the program the nurses' evaluations were done, using the same technique was used in first evaluation and the same tool.

### **(3) Evaluation Phase:**

The researcher evaluate the participated nurses after implementing the nursing program using tool I and tool II immediately after the program and 3 month after the program implementation.

## **III. Administrative Design**

A written permission was obtained from the director of each hospital through an official formal letters from the dean of The Faculty of Nursing, Port Said University to carry out the study after explaining aim and significance of the study.

### **Statistical analysis of the data**

## **IV. Results**

**Table (1)** shows that the age of the study group nearly two-thirds (61.8%) of them were the ages of 30 or more years. Regarding to level of education, it was observed that less than two-thirds (58.2%) of the study group had secondary education, while 5.1 % of them only had a university education. In relation to experiences years, the table reveals that slightly more than two fifth (43.6%) of the studied sample were 10 years or more. Eventually, the table explains that majority sector (94.5%) of the study group reported that each hadn't attended any training courses regards ECG and basic life support.

**Figure (1)** explain the distribution of the study group according level of knowledge. As displayed in the figure, vast majority sector of the study group (92.3%) had satisfactory level of knowledge in the posttest phase, decreased in the follow up phase to 79.5%.

**Table (2) and Table (3)** explain the distribution of the study group according to level of knowledge. The table 2,3 show, the majority sector of the study group had (general improvement) (satisfactory level of knowledge) in ECG interpretation in most items post test phase compared to pretest phase, decreased in the follow up phase.

**Table (4)** reports the distribution of the study group according ECG interpretations skills. As the table reveals that there was highly statistically significant differences between pre-, post-, and follow- up phases regarding regularity, PR interval and ORS interval at  $p < 0.001$

**Figure (2)** reports the distribution of the study group according total score of skills. As displayed in the figure, the entire study group (100%) had satisfactory level of skills in the posttest phase, decreased in the follow up phase to 98.2%.

**Table (5)** demonstrates relation between their knowledge throughout the educational program. As elaborated in the table, there was statistically significant difference between total knowledge of the studied group pre, post and follow up phases of the educational program with highly significant to post phase with mean score  $16.45 \pm 1.43$ .

**Table (6)** puzzles out the relation between total knowledge of the study group and their socio- demographic data throughout the educational program. As exhibited in the table, there was no statistical significant association between socio- demographic data of the study group and their total knowledge score throughout the three levels of the educational

**Table (1):-** Socio- demographic characteristics of studied nurses (n=55)

Personal Characteristics	N	%
<b>Age (years)</b>		
20-less than 30	21	38.2
30 or more	34	61.8
<b>Department</b>		
Emergency	20	36.4
ICU	20	36.4
High risk pregnant women	15	27.2
<b>Education degree</b>		
University	2	5.1
Secondary	32	58.2
Others	21	36.7
<b>Experience</b>		
less than 5 years	23	41.8
5-less than 10	8	14.5
10years or more	24	43.6
<b>Training courses about ECG interpretation</b>		
yes	3	5.5
no	52	94.5
<b>Training courses about basic life support</b>		
yes	3	5.5
no	52	94.5
<b>Protocol about ECG interpretation</b>		
yes	0	0.0
no	55	100

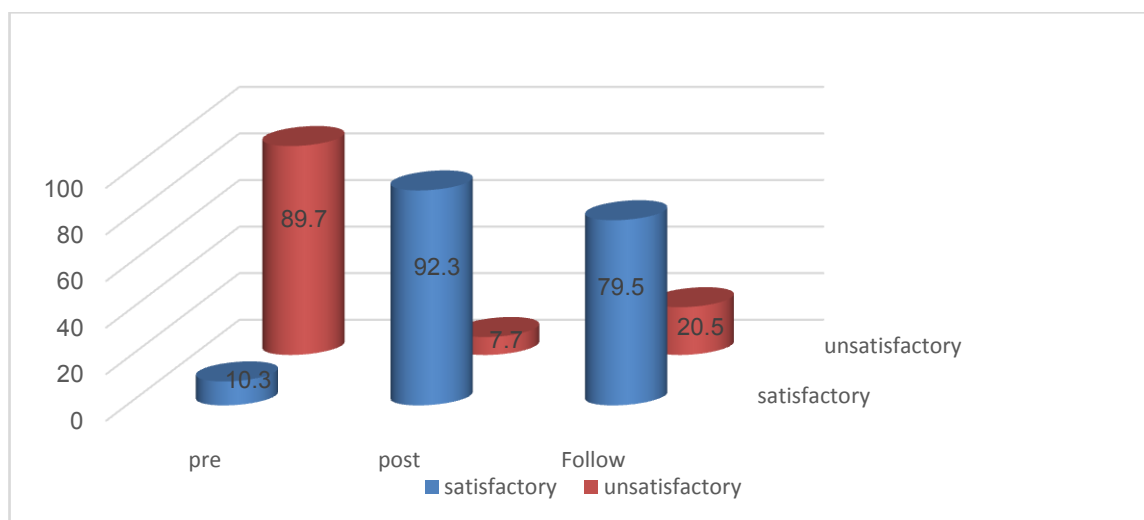
**Table (2):-**General knowledge for studied nurses about ECG interpretation throughout the program implementation ((n=55)

Knowledge items	Pre- Program (n =55)		Post- Program (n =55)		Follow-up (n =55)	
	No	%	No	%	NO	%
<b>Electrocardiography is the recording of waves from the heart</b>						
Satisfactory	50	90.9	55	100	47	85.5
Unsatisfactory	5	9.1	0	0	8	14.5
<b>Planning by means of nine electrical connections</b>						
Satisfactory	38	69.1	43	78.2	35	63.6
Unsatisfactory	17	30.9	12	21.8	20	36.4
<b>ECG has twelve different direction of the heart</b>	53	96.4				
Satisfactory	2	3.6	55	100	48	87.3
Unsatisfactory			0	0	7	12.7
<b>Hess package is the natural regulator of the heart</b>						
Satisfactory	43	78.2	51	92.7	52	94.5
Unsatisfactory	12	21.8	4	7.3	3	5.5
<b>The heart produces different electrical signals</b>						
Satisfactory	43	78.2	50	90.9	47	85.5
Unsatisfactory	12	21.8	5	9.1	8	14.5
<b>The heart cycle begins with a wave (T)</b>						
Satisfactory	23	41.8	44	80.0	44	80.0
Unsatisfactory	32	58.2	11	20.0	11	20.0
<b>The distance is activation from the Hess package</b>						
Satisfactory	14	25.5	4	7.3	4	7.3
Unsatisfactory	41	74.5	51	92.7	51	92.7
<b>The full heart cycle lasts from 0.7 to 1 second</b>						
Satisfactory	18	32.7	53	94.5	55	100
Unsatisfactory	37	67.3	3	5.5	0	0
<b>electrocardiograms affect by all diseases affecting the heart</b>						
Satisfactory	10	18.2	10	18.2	10	18.2
Unsatisfactory	45	81.8	45	81.8	45	81.8
<b>PR and its natural duration is 0.16 seconds</b>						
Satisfactory	6	10.9	48	87.3	48	87.3
Unsatisfactory	49	89.1	7	12.7	7	12.7

**Table (2):-** Information and knowledge for studied nurses about ECG throughout the program implementation ((n=55)

Phases Knowledge items	Pre-Program (n =55)		Post-Program (n =55)		Follow-up (n =55)	
	No	%	No	%	No	%
Wave U always appears in ECG	9	16.4	51	92.7		
Satisfactory	46	83.6	4	7.3	48	87.3
Unsatisfactory					7	12.7
The head axis crosses time in milliseconds	6	10.9	51	92.7	48	87.3
Satisfactory	49	89.1	4	7.3	7	12.7
Unsatisfactory						
horizontal axis determines the electrical voltage	14	25.5	51	92.7	48	87.3
Satisfactory	41	74.5	4	7.3	7	12.7
Unsatisfactory						
heart axis	37	67.3	49	89.1	47	85.5
Satisfactory	18	32.7	6	10.9	8	14.5
Unsatisfactory					3	
When the positive end of the device is connected to the right hand called aVR	49	89.1	55	100	52	94.5
Satisfactory	6	10.9	0	0	3	5.5
Unsatisfactory						
When it is associated with the left hand called Avl	47	85.5	55	100	52	94.5
Satisfactory	8	14.5	0	0	3	5.5
Unsatisfactory						
When it is associated with the left foot is called aVF	45	81.8	55	100	49	89.1
Satisfactory	10	18.2	0	0	6	10.9
Unsatisfactory						
The ECG is evaluated on the basis of 4 rules	16	29.1	51	92.7	5	9.1
Satisfactory	39	70.9	4	7.3	50	90.9
Unsatisfactory						
heart beats are less than 60 this is called bradycardia	51	92.7	54	96.4	5	9.1
Satisfactory	4	7.3	2	4.6	50	90.9
Unsatisfactory						
<b>SINUS Arrhythmia</b>	11	20.0	35	63.6	33	60.0
Satisfactory	44	80.0	20	36.4	22	40.0
Unsatisfactory						
<b>Premature atrial contraction</b>	5	9.1	33	60.0	30	54.5
Satisfactory	50	90.9	22	40.0	25	45.5
Unsatisfactory						

F: F test (ANOVA) with repeated measures p value for comparing between pre with post and pre with follow up  
 \*: Statistically significant at  $p \leq 0.05$

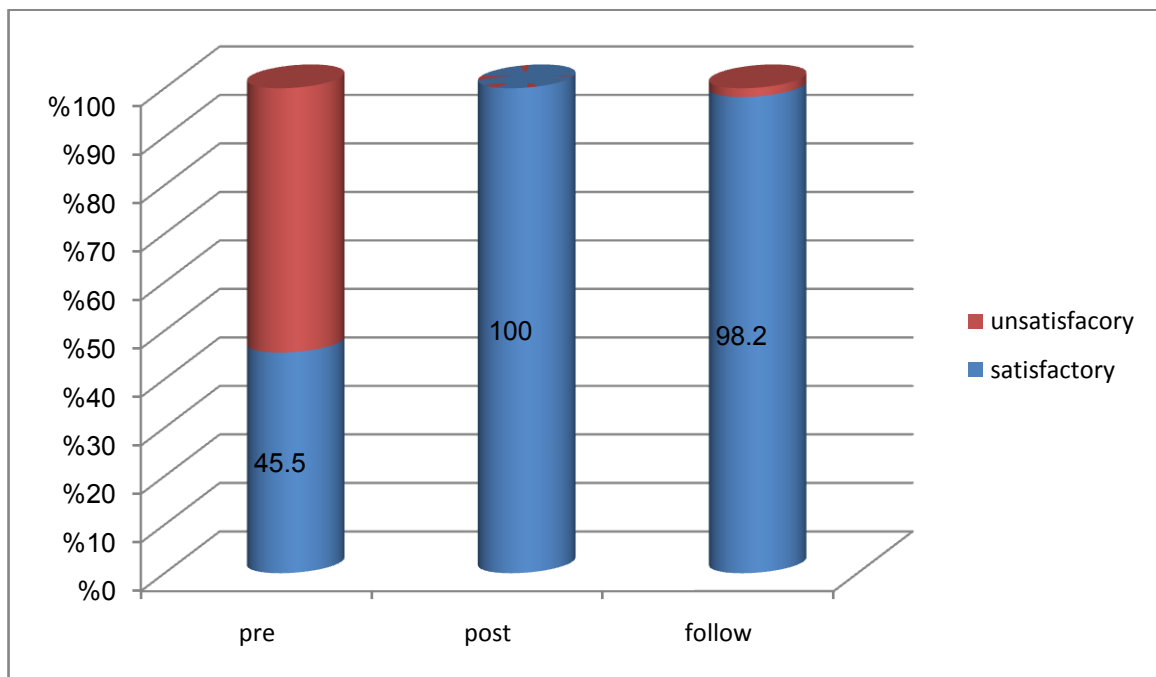


**Figure (1):** Level of total knowledge for studied nurses about ECG interpretation throughout the program implementation ((n=55)

**Table (4)** Distribution of the study group according ECG skillsthroughout the program implementation ((n=55)

Phases practice items	Pre- Program (n =55)		Post- Program (n =55)		Follow-up (n =55)		Significant	
	No	%	No	%		No	F	p-value
<b>Rate</b>								
Correct	27	49.1	55	100	50	90.9	.176	.677
Incorrect	28	50.9	0	0	5	9.1		
<b>Regularity</b>							3.188	<0.001*
Correct	21	38.2	39	70.9	37	67.3		
Incorrect	34	61.8	16	29.1	18	32.7		
<b>P waves</b>							3.188	<0.001*
Correct	21	38.2	39	70.9	37	67.3		
Incorrect	34	61.8	16	29.1	18	32.7		
<b>PR interval</b>							8.384	<0.001*
Correct	29	52.7	51	92.7	49	89.1		
Incorrect	26	47.3	4	7.3	6	10.9		
<b>QRS interval</b>							12.527	<0.001*
Correct	16	29.1	51	92.7	43	78.2		
Incorrect	39	70.9	4	7.3	12	21.8		
<b>Interpretation</b>							12.527	<0.001*
Correct	16	29.1	51	92.7	43	78.2		
Incorrect	39	70.9	4	7.3	12	21.8		

F: F test (ANOVA) with repeated measures  
 p value for comparing between pre with post and pre with follow up  
 \*: Statistically significant at  $p \leq 0.05$



**Figure (2)** Level of total skills for studied nurses about ECG interpretation throughout the program implementation ((n=55)

**Table (5):** Relation between Total Knowledge Pre, Post, and Follow Up Program (N=55)

Total knowledge	M	SD	pre	post	Follow
Pre-program	10.78	2.92		0.000*	0.000*
Post-program	16.45	1.43			0.000*
Follow up-program	15.60	1.66			

F test (ANOVA) with repeated measures  
 \*: Statistically significant at  $p \leq 0.05$

**Table (6):** Relation between total knowledge of the study group with their socio- demographic data throughout the educational program (n=55)

	pre			post			Follow		Significant
	M	SD		M	SD		M	SD	
<b>Age (years)</b>									
20-less than 30	.1905	.4023	t=2.315 P=.128	.9048	.3007	t=0.067 P=.796	.8095	.4023	t=0.19 P=.890
30 or more	.0588	.2388		.8824	.3270		.7941	.4104	
<b>Education degree</b>									
Secondary			F=1.182 P=0.315	1.00	.000	F=0.176 P=0.839	.500	.707	F=0.564 P=0.572
University	.062	.245		.875	.336		.812	.396	
Others	.190	.402		.904	.300		.809	.402	
<b>Experience</b>									
less than 5 years	.173	.387	F=2.928 P=0.062	.913	.288	F=0.937 P=0.398	.782	.421	F=0.159 P=0.853
5-less than 10	.250	.462		.750	.462		.750	.462	
10years or more	.000	.000		.916	.282		.833	.380	

### V. Discussion

In critical, emergency and high risk pregnant women care settings, bedside nurses play a vital role in identification and management of arrhythmia. The current practice is that nurses gather data, and notify the physician, who makes treatment decisions based on the rhythm interpretation of the nurse, or institutes pharmacologic and counter shock therapies consistent with unit-specific protocols or algorithms. Thus, efforts are needed to increase and maintain the knowledge of ECG interpretation since it has been observed that a nurse's knowledge and skills in ECG interpretation diminish with time (Nolan et al., 2010). This study was to evaluate the effect of an educational program of electrocardiogram interpretation on medical and maternity nurses' knowledge and skills.

As regards nurses' knowledge about ECG interpretation the current study revealed an obvious improvement in the total mean knowledge scores of nurses after program implementation as compared with preimplementation scores, which was highly statistically significant, slightly decline in follow up phase. This improvement might be related to the fact that the majority of them were had years of experience and enthusiastic to learn. This finding shows that program had a good impact positive change in improving nurses' knowledge, which could be due to the concise presentation of each session using simple language and clear educational methods and instructional media.

This finding was congruent with those of (Ali, 2012), who found an improvement in nurses' knowledge score after implementing self-learning modules, with highly statistically significant differences. Also supported by (Ibrahima, Abd-Allah, Arafa and Mohammed, 2019) who study effect of nursing care standards on nurses' performance in caring for patients with cardiac arrhythmia, revealed an obvious improvement in the total mean knowledge scores of nurses after NCS implementation as compared with preimplementation scores, which was highly statistically significant. Further, these results are in agreement with those of (Ahmed, Mohammed and Ghanem, 2015) who stated that nurses had unsatisfactory knowledge on standard of care for patients after coronary artery bypass graft surgery before NCS implementation but showed an improvement after its implementation.

In relation to nurses' skills regarding the interpretation of electrocardiogram procedure, the current study revealed that; low percentage of them did the following: (determines heart rate, regularity, identify P wave, PR interval, QRS complex and report interpretation) preprogram interpretation with significant improvement post program implementation and decline in follow up phase. This finding agreed with (Sheilini and Devi, 2014) who study the effectiveness of educational intervention on ECG monitoring and interpretation among nursing students; stated that majority of the studied student nurse had poor skills in interpreting ECG during pretest and improved posttest.

The results are in the same line with a descriptive study by (Malk and Hassn, 2018) that evaluate of nurses practice regarding electrocardiogram procedure revealed that majority of the study nurse had an unsatisfactory level of skills regarding electrocardiogram procedure this might be due to overlapping of work and poor skills.

Also findings supported by (sheilini, 2008) under the title of effectiveness of a competency program on ECG monitoring and interpretation for staff nurses working in critical care areas found, there was a significant increase in the knowledge  $t=9.35$  and skill  $t=4.78$  [  $t(29) = 2.04, p < 0.05$  ] of critical care staff nurses in ECG monitoring and interpretation after the competency program.

There was statistically significant difference between total knowledge of the studied group pre, post and follow up phases of the educational program with highly significant to post phase with mean score  $16.45 \pm 1.43$  and these improvement slightly decrease in follow up phase. The results agree with (Zhang and Hsu, 2013) who study the effectiveness of an education program on nurses' knowledge of electrocardiogram



interpretation When comparing the pretest and post-test scores, he observed that the first post-test (2 weeks after the lecture-based training) total scores and five domain scores were higher than the pretest scores. There was no difference in the two test scores collected 2 weeks and 4 months after the lecture-based training and before handbooks were delivered. This finding is not surprising because during this period, the participants received no training, and the majority of participants may not have put their knowledge into clinical practice.

There was no statistical significant association between socio-demographic data of the study group and their total knowledge score throughout the three levels of the educational program. These findings disagree with (Sheilini and Devi, 2014) who mentioned that; there is significant relationship ( $p=0.397$ ,  $p=0.011$ ) between the knowledge of nursing students in monitoring and interpreting ECG and skill in interpreting ECG. On the other hand, results agree with (Werner, Kander and Axelsson, 2016) who examine whether factors such as education and professional experience correlated with the ECG interpretation skill among ambulance nurses found that; No such correlation was found, except that CCU working experience was associated with better results on the ECG test

Many of the nurses who attended this research program reported that they were more interested in ECG learning than they had been at the beginning of the study and felt they could now provide safer nursing care to patients with chest pain and heart arrhythmia. These emphasize the importance on the study and achieve the research hypothesis; there is a positive change in nurses' knowledge and skills after implementing educational program on nurses' knowledge and skills. Also from the researcher opinion, ECG interpretation is sophisticated procedure so many continuous educational program must be done for nurses especially those dealing with critical cases in emergency, ICU and high risk pregnant women. If these nurses trained well they help in survive many cases.

## VI. Conclusion

The current study concluded that the majority of nurses had unsatisfactory knowledge and skills levels before program implementation. After program implementation, there was an obvious improvement in nurses' knowledge and skills scores with highly statistically significant differences between pre and post-program and slightly decline in follow up phase

## VII. Recommendations

- (1) Standards of ECG interpretation should be revised, updated, and made available in the ICU, emergency and high-risk pregnant women units in both Arabic and English language.
- (2) Continuous evaluation of nurses' knowledge, skills and practice is essential to identify their needs while caring for patients with cardiac arrhythmias in ICU and emergency units.
- (3) Continuous training and workshops about ECG interpretation especially for nurses working at ICU and emergency care units.
- (4) Further researches are needed with larger sample sizes to evaluate the application of structure and outcome standards in addition to process standards and evaluate its impact on nurses' performance regarding ECG interpretation and patient outcomes.

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