

Effect of Educational Program on Nurses' Skill Regarding Electrocardiogram Interpretation in Critical Care Units: A Quasi-Experimental Study

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ABSTRACT

Background: Electrocardiograms non-invasively assess cardiac rhythm and electrical activity. It was the first heart disease diagnosis tool that helped reduce heart disease morbidity and death. ECGs are monitored and interpreted by nurses. The study aimed to determine the effectiveness of an educational program on nurses' skills regarding electrocardiogram interpretation among critical care nurses.

Methods: A quasi-experimental study was conducted on 68 nurses as a non-probability purposive sample working in critical care units at Azadi Teaching Hospital, Kirkuk City, Iraq. This study starts from 20th October 2023 to April 10, 2024. The study tool consists of two parts. Part I is concerned with nurses' socio-demographic characteristics, and Part II (the structured skill questionnaire) was developed by the researcher after reviewing the literature. For validity, the previous study restated topics and submitted them to 12 experts from various specialists. The education program was implemented with group teaching technique-based sessions, and hands-on training was provided. The collected data were analysed using SPSS version 26.0. **Results:** The results showed that most participants (73.5%) were aged between 24 and 28 years old and were female with 1-3 years of experience. Only 14.7% of participants had taken previous ECG training courses. Also, it showed that there is a high significant difference ($Z = -7.153$) at $P < 0.01$ between nurses' total skills pre-test and post-test responses and found that nurses in CCU had high skills compared to other units. **Conclusion:** The overall level of nurses' skills in electrocardiography interpretation is low in the pre-test after implementation of the education program enhances their skills with high statistical significance. The study's findings prove that structured educational programs enhance nurses' skillfulness in ECG interpretation.

Keywords: Education Program; Nurses; Electrocardiography Interpretation; Skills

INTRODUCTION

In every country worldwide, the preceding ten years have seen a progressive rise in mortality rates as a result of chronic and cardiovascular diseases (CVDs). According to data from the American Heart Association, cardiovascular disease was the leading cause of death; more than 17.6 million people died in 2016, and 23.6 million are expected to die by 2030 (Benjamin *et al.*, 2019). The diagnosis of cardiovascular disease is difficult due to the presence or absence of related symptoms. Therefore, early detection of heart disease is essential for reducing mortality rates (Stepińska *et al.*, 2020). The best option for this condition is to perform an electrocardiogram, which is crucial in determining treatment options for cardiology patients due to its simplicity, low cost, and non-invasive nature. It is the most effective diagnostic tool compared to other tests and affordable for society, unlike other advanced devices for detecting heart abnormalities (Liu *et al.*, 2021). People commonly use the ECG, a non-invasive procedure, to document electrical variations within the cardiac organ. It represents the electrical impulses that transpire during each cardiac cycle, exhibiting a sequence of waves (Xie *et al.*, 2020). By examining electrograms (ECG) and heart rate variability (HRV), the cardiac conditions among elders can be accurately identified (Das, 2017). The 12-lead ECG is employed for diagnosing various cardiac conditions, such as dysrhythmias, conduction abnormalities, chamber

Received: April 14, 2024 Received in revised form: May 31, 2024 Accepted: June 2, 2024

hypertrophy, and acute coronary syndrome (ischemia or infarction) (Al-Khatib *et al.*, 2018).

Nurses are crucial in providing quality healthcare services to the community (Suprpto *et al.*, 2024). Also, nurses are often the first healthcare professionals to encounter patients and are responsible for performing initial assessments, including obtaining ECGs (Obied *et al.*, 2024). Nurses have received training to identify ECG patterns and identify deviations from normal, such as heart rhythms, reduced blood flow, or electrical conduction issues (Nishiguchi *et al.*, 2022). This knowledge allows nurses to promptly recognise and respond to potentially life-threatening cardiac conditions, ensuring timely interventions and improved patient outcomes (De Jesus *et al.*, 2021). In addition, nurses must consistently monitor the ECGs of patients in care environments, especially in critical care settings (Hemida Salem, 2020). Nurses should have the skills to identify variations in ECG patterns, like ST-segment elevation or depression, which could suggest a heart attack or ischemia. This allows nurses to inform the team quickly and start treatments promptly (Abdul-Hussein & Hattab, 2022). By communicating ECG findings and working with the healthcare team, nurses promote a coordinated approach to care that leads to timely treatments and better patient results (Erjavec, Knavs, & Bedenčič, 2022). Cardiovascular patient care programs located in healthcare facilities, private homes, or community settings should have a positive effect on the self-care of heart failure patients (Amalia, Said, & Nambiar, 2024). The nurses must also be highly skilled in resuscitation and have a profound interpretation of electrocardiogram rhythms because they closely monitor these rhythms and make critical clinical decisions based on the detailed information that nurses get through their monitor (Funk *et al.*, 2017); such education programs may help nursing staff interpret electrocardiograms more effectively and assist them in making decisions in patient care (Lee & Choi, 2024).

However, the ability of nurses to interpret ECG is still not appropriate (Nursalam *et al.*, 2024). Studies have shown that nurses often need more competencies in Iraq, leading to potential errors and delays in patient diagnosis. For example, a survey conducted in Samawa City showed that the nurse's proficiency in interpreting electrocardiograms (ECGs) remained suboptimal. Basic measurement techniques limited their skills, necessitating the improvement of their interpretive abilities (Kadush, Hameed, & Jrood, 2023). Research into how educational programs affect nurses' abilities in ECG interpretation is necessary to improve patient outcomes and their professional development. The current study aims to investigate the effectiveness of an educational program on nurses' skills regarding electrocardiogram interpretation, as well as the association between nurses' skills and their socio-demographic characteristics.

METHODOLOGY

Design and Setting

A quasi-experimental study was conducted to evaluate the effectiveness of an educational program on nurses' skills regarding electrocardiogram interpretation among critical care nurses. The study population consisted of all the critical care nurses working in CCUs, RCU, and EDs at Azadi Teaching Hospital, Kirkuk City, Iraq. The study was conducted during the period from October 2023 to April 2024.

Sample

A non-probability (purposive) sample of 68 nurses from critical care units at Azadi Teaching Hospital. The samples from critical care units included ten from emergency (ED), 26 from the respiratory care unit (RCU), and 32 from the coronary care unit (CCU).

Inclusion Criteria

The criteria for selecting the study samples are Nurses who work in critical care units (RCU, ED, and CCU) at Azadi Teaching Hospital agreed to participate in the study. Nurses have a bachelor's degree in nursing, and they work morning and night shifts.

Exclusion Criteria

Nurses who refused to participate in the study, Nurses who had less than one year of experience, Nurses in the pilot study, Nurses who transferred to another hospital during the period of the study, and Nurses who refused to complete the post-test.

Methods of Data Collection

Data were collected using a structured self-administered questionnaire. The questionnaire was adapted according to reviewing the literature of similar studies (Mohammed Ali, Ahmed, & Nadr Ebraheim, 2022; Elawadi, Sanad, & Soliman, 2023; Jamanhari *et al.*, 2023; Kadush, Hameed, & Jrood, 2023; Sabryshehab *et al.*, 2020; Tahboub, & Dal Yilmaz, 2019).

Part (1): Socio-demographic Variables

The part consisted of questions regarding nurses' socio-demographic characteristics of the study sample, including age, gender, years of experience, current units working, ECG information resources, and previous training programs related to ECG interpretation.

Part (2): Nurses' Skills Regarding ECG Interpretation

This part was composed of 8 examples of ECG strips, including various types of normal and abnormal ECG, with four choices (one was correct, the other was incorrect) used to assess the participants' skills regarding ECG.

The Scoring methods: the skills variables were closed-ended questions. Which consists of 8 questions. The total skill score was categorised as follows: 0-33% poor skill level --- score 34-66% moderate skill level-- - score 67-100% high skill level

The Content Validity of the Tool and Reliability

The panel of twelve experts assessed the content validity of the study educational program and study tools (questionnaire). A total (7) experts were faculty members from the Nursing College/ University of Kirkuk, while the remaining five were cardiologists. In addition, the educational program was supervised and audited by a cardiologist and internal medicine specialist. The reliability of the questionnaire was determined through the use of (the Alpha Cronbach's test) approach obtained through assessing eight nurses in critical care units; the alpha reliability of skills was = 0.89.

Data Analysis

Statistical Package for Social Science (SPSS) version 26 was used for data analysis. Descriptive statistics (mean, standard deviation, frequency, and percentage) were employed. Wilcoxon Signed Ranks Test(Z), Chi-Square(X), and Kruskal-Wallis (H) test were utilised for quantitative data to assess whether or not there were statistically significant differences in the level of skill scores between the study groups after the implementation of the regarding electrocardiogram interpretation educational program at P -value ≤ 0.05 was considered significant.

Ethical Consideration

The study obtained Ethics approval from the Ethics Committee of the University of Kirkuk, Iraq, the Faculty of Nursing, with reference number 2509 on 1st October 2023.

RESULTS

Table 1 shows the characteristics of the participating nurses; the majority of the nurses were aged (73.5%) between (24-28) years, 67.7% (n=68) were women, 72.1% (n=49), the experience was between (1-3) years. The results indicated that 17.7% (n=10) of the nurses participated in an educatory program on ECG training courses. Concerning the current area of practice, about 10 (14.7%), 26 (38.2%), and 32 (47.1%) of nurses work in emergency units, RCU, and CCUs, respectively. Regarding ECG education Resources, 57.4% of participants reported receiving ECG education from a university, followed by using the Internet (50%). Only 14.7% of participants had taken previous ECG training courses, while 50% of trained nurses had taken the last course less than (2) years ago.

Table 1: Distribution of Participants According to Socio-Demographic Characteristics (N=68)

Variables		Frequency	%
Age	24-28	50	73.5
	29-33	14	20.6
	≥34	4	5.9
Gender	Male	22	32.4
	Female	46	67.6
Years of Experience	1 – 3	49	72.1
	4 – 6	13	19.1
	≥7	6	8.8
Unit Currently Working at	Emergency unit	10	14.7
	Respiratory care unit	26	38.2
	Coronary care unit	32	47.1
ECG Education Resource	University	39	57.4
	Course	10	14.7
	Internet	34	50.0
	Self-learning books	22	32.4
	(others) Colleague nurse	7	10.3
Previous ECG Training Courses	Yes	10	14.7
	No	58	85.3
If yes, the Last year's ECG Course Taken	<2 years	5	50
	2-5 years	3	30
	>5 years	2	20

Table 2: Descriptive Analysis of Nurses' Specific Skill Domains of Electrocardiogram Interpretation for Study Groups before and after Applying the Program

Skill Items	Response	Pre					Post					Chi-Square P=Value (Sig.)
		No.	%	MS	MS%	Ass.	No.	%	MS	MS %	Ass.	
ECG strip (atrial flutter)	Incorrect	50	73.5	0.26	26	P	10	14.7	0.85	85	H	47.7 <0.01 (HS)
	Correct	18	26.5				58	85.3				
ECG strip (ventricular fibrillation)	Incorrect	36	52.9	0.47	47	M	7	10.3	0.90	90	H	28.6 <0.01(HS)
	Correct	32	47.1				61	89.7				
ECG strip (atrial fibrillation)	Incorrect	51	75.0	0.25	25	P	12	17.6	0.82	82	H	45 <0.01 (HS)
	Correct	17	25.0				56	82.4				
ECG strip (ventricular tachycardia)	Incorrect	43	63.2	0.37	37	M	9	13.2	0.87	87	H	36 <0.01(HS)
	Correct	25	36.8				59	86.8				
ECG strip (acute myocardial infarction)	Incorrect	31	45.6	0.54	54	M	7	10.3	0.90	90	H	21 <0.01 (HS)
	Correct	37	54.4				61	89.7				
ECG strip (normal ECG)	Incorrect	48	70.6	0.29	29	P	5	7.4	0.93	93	H	57.2 <0.01 (HS)
	Correct	20	29.4				63	92.6				
ECG strip (supraventricular tachycardia)	Incorrect	39	57.4	0.43	43	M	8	11.8	0.88	88	H	31.2 <0.01 (HS)
	Correct	29	42.6				60	88.2				
ECG strip (third - degree heart block)	Incorrect	45	66.2	0.34	34	M	7	10.3	0.90	90	H	45 <0.01 (HS)
	Correct	23	33.8				61	89.7				

(*) HS: Highly Sig. at P<0.01; Testing based on chi-square test. Assessment Intervals Scoring Scales Based on MS: [P: Poor (0.00 – 33.33)]; [M: Moderate (33.34– 66.66)]; [H: High (66.67 – 100)].

Table 2 shows that most of the assessed responding items, 5(62.5%) during the pre-test period, were at moderate skill levels, and 3(37.5%) were at poor skills. All the responses during the post-test period were at high levels. Moreover, when analysed by chi-square, the results showed a highly significant statistical association between pre- and post-program tests at a level of significance (0.01) for nurses' skills regarding ECG interpretation.

Table 3: The Effectiveness of Training Courses on Overall Skills During Pre/post Periods with Significant Comparisons

Maim Domain	Period	Mean	N	SD	Assessment	Wilcoxon Signed Ranks Test (P-Value Sig.)
Total Skills	Pre	36.95	68	23.20	M	-7.153 (<0.01 HS)
	Post	88.05	68	12.49	H	

(*) HS: Highly Sig. at $P < 0.01$; Testing based on Wilcoxon Signed Ranks test (Z); since the data concerning skills pre-period doesn't follow the normal distribution function shape, a non-parametric test should be used. Assessments Intervals Scoring Scales: [P: Poor (0.00 – 33.33)]; [M: Moderate (33.34 – 66.66)]; [H: High (66.67 – 100)] N= 68.

Table 3 compares nurses' ECG interpretation skills in the pre- and post-educational periods of the education program. The table shows a highly significant difference between the pre-test and post-test of applying the educational program study group, as all P -values are less than 0.01.

Table 4: The Relationship between Nurses' Skills and Socio-Demographic Characteristics for the Study Group Throughout the Education Program

Variable Subgroup	N	Skill Pre%				Skill Post%				
		Mean	SD	↓ Kruskal-Wallis H	P-Value	Mean	SD	↓ Kruskal-Wallis H	P-Value	
Years of Experience	1-3	49	35.969	22.912	0.315 [‡]	0.574 (NS)	88.520	11.364	0.625 [‡]	0.429 (NS)
	4-6	13	32.692	25.279			85.577	13.352		
	7+	6	54.167	15.138			89.583	20.026		
	Total	68	36.949	23.204			88.051	12.488		
Unit Currently Working at	Emergency	10	23.750	18.114	26.253 [‡]	0.000 (HS)	87.500	10.206	10.225 [‡]	0.006 (HS)
	RCU	26	24.519	21.932			81.731	15.504		
	CCU	32	51.172	16.908			93.359	7.088		
	Total	68	36.949	23.204			88.051	12.488		
ECG Information Resource	University	39	38.141	22.932	0.588 [‡]	0.964 (NS)	90.000	14.191	0.520 [‡]	0.971 (NS)
	Course	10	43.750	29.610			88.235	11.490		
	Internet	34	41.544	22.131			86.932	16.582		
	self-learning books	22	40.909	26.777			89.286	11.247		
	colleague nurse	7	41.071	20.045			88.393	12.524		
	Total	112	40.402	23.609			90.000	14.191		
Previous ECG Training Courses	Yes	10	43.75	29.61	-0.702 [‡]	0.483 (NS)	90.00	14.19	-0.801 [‡]	0.423 (NS)
	No	58	35.78	22.02			87.72	12.28		

(*) HS: Highly Sig. if P -Value < 0.01 ; Sig $p \leq 0.05$, Non-Sig. if P -Value > 0.05 ; Statistical hypothesis based on Analysis by Kruskal-Wallis H.

Table 4 illustrates the relationship between nurses' skills and the socio-demographic characteristics of the study group throughout the education program. The results show a highly significant relationship between nurses' skills and demographic characteristics concerning their pre- and post-test working areas ($P < 0.01$).

DISCUSSION

In terms of participant age, the finding reveals that the majority of the sample, 73.5%, were aged between 24 and 28 years. This finding corroborated the studies conducted at Kirkuk Teaching Hospitals, which revealed that most of the nurses evaluated were between the ages of 20 and 29 (AL-Jaleel, Humade, & Shakoor, 2022; Kumait AL-Jumaily & Khudur, 2019). This may be because most study participants were recent graduates who began their careers in critical care units at a young age. This is because providing care in critical care units demands specific attention, which a young, qualified nurse can better deliver.

Concerning gender, the finding demonstrated that over half of the participants, 67.6%, were female, whereas 32.4% were male; this may be due to a larger ratio of female graduates from nursing institutions compared to male graduates in Iraq. The findings were supported by studies that found that two-thirds of the participants were female (Mohammed & Baez, 2023; Shakor, 2019). Previous studies emphasise that the representation of males and females in critical care units differs depending on the location and surroundings (Lat, McGraw, & White, 2021; Spring *et al.*, 2021; Vincent *et al.*, 2021).

In relation to the samples' years of experience, the finding reveals that over two-thirds of the participants (72.1%) had 1-3 years of experience, indicating that the majority of the sample had limited knowledge. This finding agrees with a study performed at Al-Basrah Teaching Hospital in Iraq, which found that 90% of participants had less than five years of experience (Jassim *et al.*, 2023). These differences among studies may be due to age or the inclination of newly allocated nurses at Azadi Teaching Hospital in Kirkuk City to work in critical care units after completing their rotating assignment year.

Regarding the unit where the nurses currently work, the finding reveals that the majority of participants were working in CCU (47.1%) and RCU (38.2%); this result may be due to a policy in Kirkuk hospitals that nurses working in CCU and RCU units must be graduates of nursing colleges. This finding is in line with a study carried out in Fujian Province, China. The study found that the majority of participants were from the ICU and coronary care units, with the emergency unit having the highest number (Buluba, He, & Li., 2023). Various factors such as backgrounds, hospital protocols, and regional healthcare customs may influence the distribution of participants across hospital units.

Regarding the educational sources in ECG, the finding reveals that most participants (57.4%) relied on university resources for their ECG education. Like the study, Neha *et al.* (2019) obtained this finding, which found that the majority (42.0%) relied on research that depended on university resources for ECG education. These findings indicate that nursing colleges are concerned about their students learning everything related to nursing interventions, including reading ECGs.

According to the findings of previous ECG training courses, the majority of participants, 85.3%, hadn't attended any training courses regarding electrocardiogram interpretation. The research by Amini *et al.* (2022) at Ardabil University of Medical Sciences, which revealed that 65.6% of participants had not received any training course regarding electrocardiogram interpretation, was consistent with this finding. The hospitals' failure to provide specific ECG training courses may account for these findings across the studies.

The findings regarding nurses' skills regarding electrocardiogram interpretation showed that roughly two-thirds of the assessed responding items during the pre-test period were at moderate skill levels, and one-third were at poor skill levels. In contrast, all the responses during the post-test period were high, with an increase in total mean scores from (36.95) in the pre-test to (88.05) in the post-test. Furthermore, the study demonstrates that there were statistically significant differences ($Z = -7.153, p < 0.01$) in overall nurses' electrocardiography skills throughout the educational programs. The academic program's success in enhancing nurses' ECG interpretation skills is responsible for this substantial improvement. The findings align with a descriptive correlative study conducted at Chennai hospitals to assess emergency nurses' competence by applying ECG skills. 53.3% of nurses had adequate knowledge, whereas 46.6% lacked ECG skills (Sasikala & Venkatesan, 2022). Also, studies that looked at how an educational intervention affected nurses' ECG knowledge and skills showed that their

overall ECG skills got better across all stages of the intervention (Elawadi, Sanad, & Soliman, 2023; Pandurangan *et al.*, 2022).

The noticeable enhancements in nurses' skills in interpreting ECG across studies after the program's introduction can be linked to crucial factors. Initially, the academic curriculum was structured to be thorough and interactive, incorporating diverse learning activities like sessions, case studies, and practical demonstrations. This method enabled nurses to interact with the material to grasp ECG interpretation concepts—moreover, the nurses. Their curiosity about advancing their expertise and knowledge in this field might have influenced their involvement and interaction with the educational program. Nurses are more inclined to grasp and remember knowledge. Nurses' eagerness to refine their ECG interpretation skills could have motivated them to participate in the content, pose queries, and seek clarification. All of which are conducive to effective learning.

Concerning differences between nurses' skills and some socio-demographic characteristics, the study findings indicate no significant statistical difference between nurses' skills with years of experience, ECG information resources, and previous ECG training courses ($P > 0.05$) in pre- and post-training courses. At the same time, there was a significant difference between the pre- and post-tests with working units. The finding is similar to the study by Rose *et al.* (2022), which discovered that nurses from the coronary care unit have a notably superior level of proficiency compared to those from the emergency room, intensive care unit, and high deficiency unit. In addition, the finding agrees with AL-Husaunawy's (2015) study, showing that those working in the coronary care unit, intensive care unit, and emergency department possess a high level of knowledge and practice in electrocardiography (ECG) among teenage patients. The researcher confirmed that the differences between the CCU and other units may be due to the majority of patients admitted to the coronary care unit requiring close monitoring of various body systems, including the cardiovascular system, which necessitates that those nurses in this unit be proficient in ECG interpretation to avoid further cardiac complications.

CONCLUSION

The study reveals that most nurses had unsatisfactory skill levels regarding electrocardiogram interpretation before implementing the educational program. After the education program, there were noticeable improvements in nurses' competency levels, with high statistical significance in total nurses' skills regarding ECG interpretation between pre- and post-tests. The study concluded that a highly significant difference exists between the ECG interpretation skills of nurses and those of their current units working in critical care units at both the pre- and post-test stages. The study's findings prove that structured educational programs enhance nurses' skillfulness in ECG interpretation. The researcher suggested that health facilities should prioritize nurses' ECG interpretation by providing continuous training courses, particularly for nurses in critical care units. To enhance the efficacy of nurses' electrocardiogram (ECG) skills, further research suggests applying the educational training program to a more extensive sample of nurses from varied geographical areas of Iraq. Nurses in critical care units should increase their scientific competence regarding interpreting ECG through participation in workshops and courses, self-learning, reading books, watching videos, and practicing daily, as nurses in this area are the first-line.

Limitations

This study's limitation stems from its specific time frame of conduct. Therefore, it is important to note that the duration of the educational program's effect on nurses' competencies beyond this time frame is unknown. The study was limited to being generalised because it was conducted in a single hospital, and the sample size was small. This study was conducted in the critical care units of a single hospital, so the results cannot be generalised to all nurses.

Conflict of Interest

The authors declare that they have no competing interests.

ACKNOWLEDGEMENT

The authors express their sincere gratitude to all the nurses who participated in this study, as well as to Dr. Heman Tahseen, a cardiologist who audited the educational program. They also extend their thanks to the Kirkuk Department of Health, Kirkuk Nursing College, and Azadi Teaching Hospital in Iraq for their contributions.

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