

Research Article

Electrocardiography Interpretation Competency Among Medical Students in Umm Al-Qura University: A Cross-Sectional Study

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ABSTRACT

BACKGROUND: The interpretation and reading of Electrocardiography (ECG) is one of the core medical skills, as there could be a negative impact on the management and safety of the patients if misinterpreted. Therefore, our study aims to assess electrocardiographic interpretation competency among medical students at Umm Al-Qura University, Makkah, Saudi Arabia.

METHODS: A cross-sectional study was carried out in Umm Al-Qura University. Participants were under-graduated medical students. An online questionnaire was distributed in January during the 2021-2022 academic year.

RESULTS: 427 students from clinical years participated in the study, the distribution of clinical academic years was comparable, fourth year (126; 29.5%), fifth year (150; 35.1%), and sixth year (151; 35.4%). The mean score for all the students out of 10 is: (4.58, SD: 2.32). The number of students who scored 7.5 or more out of 10 (passed): 74 (17.3%).

CONCLUSION: The under-graduated medical student's overall performance was limited regarding their competency in ECG interpretation. Thus, it is recommended to provide more organized educational courses and supervised self-learning on the respective topic to enhance overall ECG interpretation skills.

1. INTRODUCTION

Introduced in 1902 by Willem Einthoven, the Electrocardiography (ECG), which records the electrical activity of the heart, is one of the most commonly used diagnostic tools in clinical settings, due to its many advantages *viz.*, inexpensive, easily accessible, and non-invasive. It is used to diagnose a variety of heart conditions, including myocardial infarction and cardiac arrhythmias. It can also be used as a baseline for new patients that present to the clinical settings, especially if they are known to have a history of cardiovascular diseases (Isiguzo, et al. 2017; Patel, et al. 2005). ECG interpretation is one of the essential key skills due to its significance in day-to-day clinical practice, and incorrect ECG interpretation can have a negative influence on the patients' management and safety (Getachew, et al. 2020).

The directors of internal medicine clerkships in the United States and Canada believed that ECG interpretation skills should be taught to undergraduate medical

students during the clerkship. Analyzing and identifying areas of weakness in ECG interpretation among undergraduate medical students during their clinical years would aid in creating various educational methods to enhance the skill and competence of interpreting ECG throughout the educational years (Alghamdi, et al. 2018; Elnicki, 2004). Another study found that medical students' competence in interpreting ECG varies from year to year during their clinical years, and significant advantages are also dependent on the self-study component in addition to the cardiology course they study throughout their education period, which was found to be insufficient for in improving their abilities in interpretation, as ECG reading is mostly reliant on self-study (Pudło, et al. 2012). We found that many studies focus on graduate medical students and their ECG interpretation competency, whereas studies support the competency of undergraduate medical students in ECG interpretation throughout their educational years. Do they benefit from their cardiology course throughout their clinical years, such as increasing their efficiency in ECG interpretation,

or do they require intensive programs in ECG interpretation during their undergraduate study years?

We aimed to assess how competent medical students in clinical years are at interpreting various ECG results, how much knowledge they gained from the cardiology courses they've taken, and whether that's enough or if they need more intensive programs to improve their ECG interpretation skills.

2. MATERIALS AND METHODS

A cross-sectional study was carried out in January 2022 by conducting an online survey via multiple social media platforms with a sample size of 427 participants who were undergraduate medical students of Umm Al-Qura University, Saudi Arabia. The average number of medical students at UQU during the academic year 2022 is 720. With a confidence level of 95%, a margin of error of 5%, and a response distribution of 50%, the minimum recommended sample size for this study is 251 according to sample size calculator software (www.raosoft.com). However, 427 students participated to complete the survey in case of possible data loss and to ensure reliability. The study sample was equally distributed among the three academic years as convenience sampling was employed. The inclusion criteria consisted of undergraduate medical students from the 4th to 6th year at Umm Al-Qura University, Makkah, Saudi Arabia; 22 uncompleted questionnaires were excluded.

The questionnaire consisted of two sections. The first section collected academic and demographic information such as gender, year of study, grade point average (GPA), and participation in ECG interpretation classes. The second section contained a set of 12 questions on ECG interpretation competency (ten clinical questions and two theoretical questions) taken from previously validated questionnaires (Coll-Badell, et al. 2017). These questions were designed to assess the level of competency of the students in ECG interpretation skills. Participants' responses were collected using Google Platform, and all the questions had one option to select. According to the questionnaire's creators, the tool uses a standard scoring method, with 1 point given for a correct answer, 0 for an incorrect answer, and for the "I don't know" choice. To simplify the interpretation, the participants' scores were determined by counting the right answers and converting the total score to a score of ten. The eligibility score was set from 0 to 10. A minimum score of 7.5 out of 10 was determined for ECG interpretation competence.

The data obtained from the questionnaire were entered into SPSS version 22. The socio-demographic and academic characteristics of the participants were summarized using descriptive parameters. Tables and graphs were used for descriptive purposes. Multiple logistic regression analysis and Chi-square test were used to evaluate the relationship of various parameters that are linked to ECG interpreting skills. As a measure of effect size,

odds ratios, and their associated 95 percent confidence intervals (CIs) were used. A p-value is considered significant if it was less than 0.05. Umm Al-Qura University's ethical committee approved this study with IRB number: (HAPO-02-K-012-2021-12-898). This survey followed the principles of the Declaration of Helsinki. All data were collected confidentially and anonymously, with the student's consent.

3. RESULTS

427 clinical-year students participated in the survey. The statistical tables are displayed in the supplementary index. Table 1 shows students' characteristics and specific questions. The distribution of clinical academic years was comparable, fourth year (126; 29.5%), fifth year (150; 35.1%), and sixth year (151; 35.4%). It was observed that most of the students were males (250; 58.5%), and the remaining were females (177; 41.5%). Most of the students who completed the questionnaire had a GPAs degree that is higher than 3.50 (295; 69.1%). Almost half of the students (226; 52.9%) state that the university curriculum is adequate to comprehend the principles of ECG and the remaining students (201; 47.1%) state that the university curriculum is not adequate to comprehend the principles of ECG. Most of the students attended additional courses to understand ECG interpretation skills (276; 64.6%) (Table 1).

Table 1: Participants Characteristics & Specific Questions

	Mean	SD	P-Value
Academic year:			
- Fourth year	4.54	2.38	<0.51
- Fifth year	4.44	2.19	
- Sixth year	4.75	2.40	
Gender			
- Male	5.03	2.35	<0.001
- Female	3.94	2.13	
GPA:			
- >3.5	4.85	2.33	<0.001
- <3.5	4.04	2.22	
was the cardiology course within your university's curriculum enough to understand ECG interpretation?			
- Yes	4.82	2.29	<0.02
- No	4.29	2.32	
have you attended additional courses to understand ECG interpretation?			
- Yes	4.89	2.30	<0.001
- No	4.01	2.26	

The mean score for all the students out of 10 is: (4.58, SD: 2.32). The number of students who scored 7.5 or more out of 10 (passed): 74 (17.3%). Significant differences were observed between the scores of males Vs females (5.03, SD:2.35), (3.94, SD:2.13), (P= 0.001).

Students with a GPA above 3.5 (4.85, SD:2.33) received a higher score than students with a GPA less than 3.5 ($P=0.001$). Students who state that the university's curriculum is enough to understand ECG got higher scores (4.82, SD:2.29). Significant differences were observed between

students who attended additional courses to understand ECG and scored an average of 0.88 points higher than those who did not attend ($P=0.001$) (Table 2). In Table 3 we have presented the data of the ECG interpretation analysis.

Table 2: Sample description of academic year, gender, GPA, university's curriculum cardiology course satisfaction and additional ECG courses (Mean score is out of 10).

Test Score	All(N=427)	
	N	%
Academic year:		
- Fourth year	126	29.5
- Fifth year	150	35.1
- Sixth year	151	35.4
Gender		
- Male	250	58.5
- Female	177	41.5
GPA:		
- >3.5	295	69.1
- <3.5	132	30.9
was the cardiology course within your university's curriculum enough to understand ECG interpretation?		
- Yes	226	52.9
- No	201	47.1
have you attended additional courses to understand ECG interpretation?		
- Yes	276	64.6
- No	151	35.4
Do you think an ECG study is important for understanding cardiology?		
- Yes	413	96.7
- No	14	3.3

4. DISCUSSION

This study aims to assess Electrocardiographic interpretation competency among medical students at Umm Al-Qura University. Therefore, in general aspects, our sample reveals that the mean score of all participants out of 10 is 4.58, with 74 (17.3%) scoring 7.5 or higher, indicating low competence of the medical students. Another study done at Taif University targeting sixth-year medical students revealed a moderate level of ECG misreading (Alghamdi, et al. 2018). Subsequently, another study at George Washington University School of Medicine and Health Sciences revealed a limited level of competency among graduate medical students (Jablonover, et al. 2014).

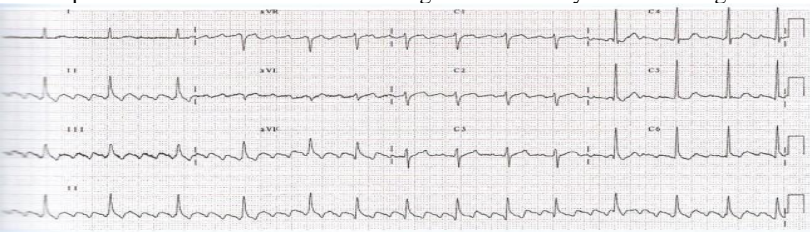


A study conducted on medical students from Poland revealed that they had a high degree of proficiency in reading basic ECG parameters such as heart rate, rhythm origin, and electrical axis of the heart. Nonetheless, their ability to recognize ECG signs of life-threatening diseases and common cardiac abnormalities is limited. This also demonstrates that ECG interpretation competency is determined by self-education rather than frequent attendance at ECG classes (Kopeć, 2015). Another study that was conducted in Spain to assess emergency nurses' skills in ECG interpretation found that they have a high level of competency (Coll-Badell, et al. 2017). Although our study revealed that medical students had limited competency in ECG interpretation,

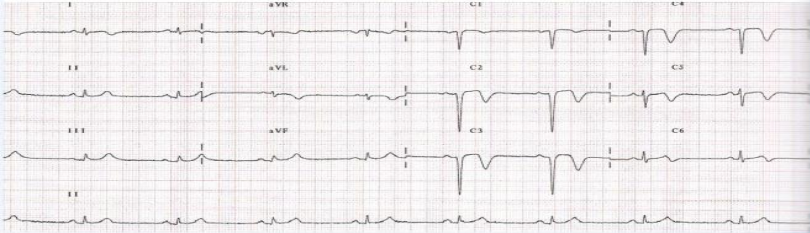

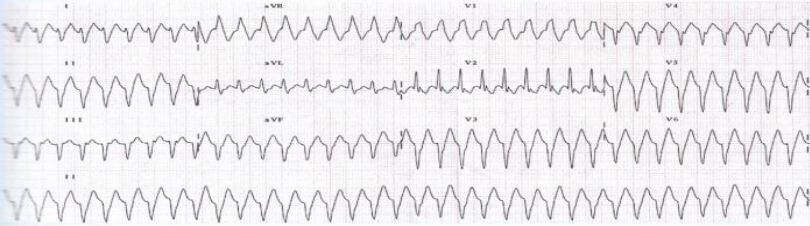
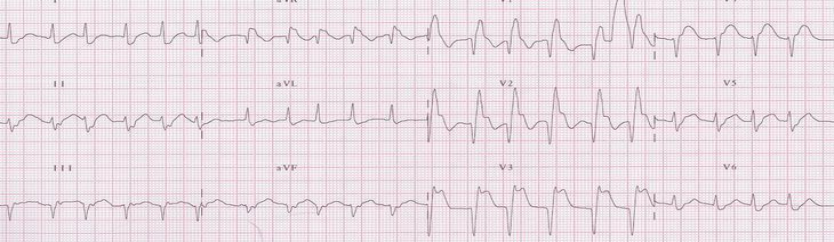
we should not have solid conclusions just yet since further and more extensive studies with large samples need to be conducted.

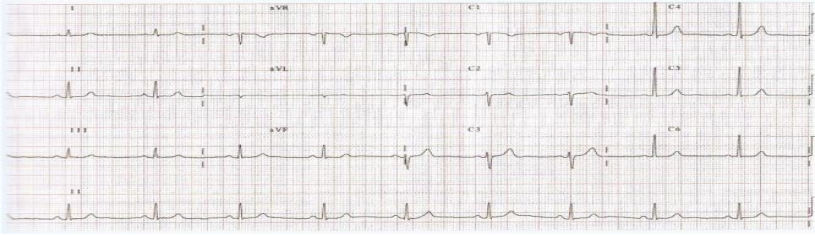
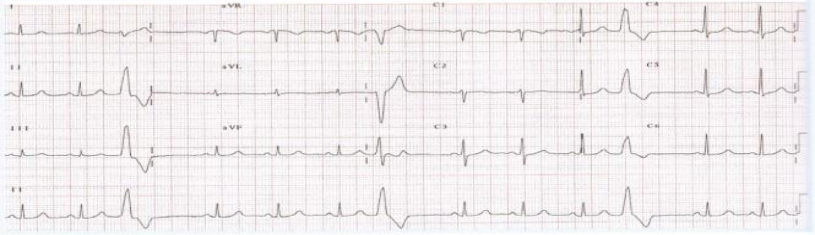
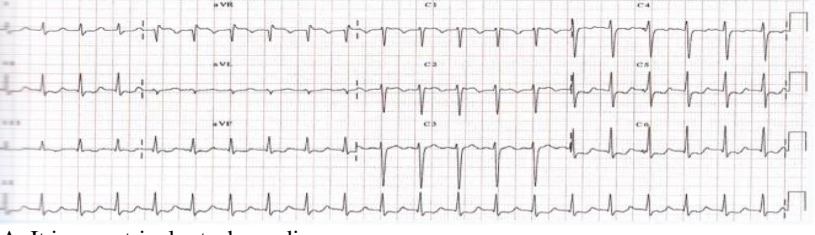
Our study has several limitations. As this study involved undergraduate medical students in their fourth and sixth years, it is necessary to mention that the fourth-year medical students recently completed a basic ECG course and our survey included ten clinical questions that may be challenging for them, thus, it may be possible that the level of competency in ECG interpretation was underrated in our study. Additionally, our study targeted a single university which makes the results less effective than targeting several universities, and that could assist in developing and improving the educational programs in Saudi Arabia.

5. CONCLUSION AND RECOMMENDATION

This study was conducted on 427 medical students in their clinical years to assess their knowledge and comprehension of clinical ECG interpretation, which is critical in the diagnosis of various heart diseases. Interpreting ECG is one of the core skills due to it being important in clinical practice and misinterpreting it can have a negative impact. Our results revealed a limited level of competency in ECG interpretation among clinical years medical students, suggesting that they require intensive self-education and frequent attendance at educational courses for ECG interpretation, and a larger sample size may be required for more precise results.

Table 3: ECG interpretation results		All(N=427)	
		N	%
1. What is the correct order of EKG waves and intervals? A. <u>P wave, QRS complex, T wave, PR interval, ST interval, U wave</u> B. T wave, P wave, QRS complex, PR interval, ST interval, U wave C. QRS complex, P wave, PR interval, T wave, ST interval, U wave D. I do not know		317 67 26 17	74.2 15.7 6.1 4
2. If in an EKG the p wave does not appear, what is your first thought? A. There is a conduction problem between the ventricles B. <u>There is a conduction problem between the atriums</u> C. It is normal, it does not have to appear in an EKG D. I do not know		63 296 23 45	14.8 69.3 5.4 10.5
3. You perform an EKG and observe this register. What do you think it might be?  A. A third degree heart block B. <u>An atrial flutter</u> C. A supra-ventricular tachycardia D. I do not know		42 244 71 70	9.8 57.1 16.6 16.4
4. You perform an EKG and observe this register. How would you act?  A. <u>Ask for help without leaving the patient alone because it is a ventricular fibrillation</u> B. Ask for help without leaving the patient alone because it is an atrial fibrillation C. Perform another EKG because it looks like there may be interference D. You do not know how to act but you know it must be a serious problem		252 67 46 62	59 15.7 10.8 14.5
5. A patient comes to the Emergency Department due to a respiratory distress. He has 140 beats per minute. You perform an EKG and observe the following:  A. It is an atrial tachycardia B. <u>It is an atrial fibrillation</u> C. It is an atrial extra-systole D. I do not know		80 176 49 122	18.7 41.2 11.5 28.6

<p>6. A patient comes to the Emergency Department with precordial pain for more than 8 hours. You perform a 12-branch EKG. After observing the EKG, what catches your attention?</p>  <p>A. You can see pathological pauses <u>B. You can see pathological Q waves</u> C. The patient has a low cardiac rhythm D. I do not know</p>	<p>76 106 137 108</p>	<p>17.8 24.8 32.1 25.3</p>
<p>7. What pathology you think the patient with this EKG has?</p>  <p>A. A first-degree heart block B. He does not have any pathology <u>C. A third-degree heart block</u> D. I do not know.</p>	<p>79 52 197 99</p>	<p>18.5 12.2 46.1 23.2</p>
<p>8. A hospitalized patient who had had surgery due to an AMI is transferred to the Emergency Department to be monitored because his vital signs are unstable. You perform an EKG and observe the following:</p>  <p><u>A. The patient presents a ventricular tachycardia</u> B. The patient presents a supra-ventricular tachycardia C. The patient presents an atrial tachycardia D. I do not know</p>	<p>213 118 33 63</p>	<p>49.9 27.6 7.7 14.8</p>
<p>9. You are in triage and call a patient who reports medium-intensity precordial pain. He tells you that the pain appeared after leaving an important meeting two hours ago. He is 52 years of age and hypertensive and a few months ago he was diagnosed with Diabetes Mellitus II. You perform a 12-branch EKG and observe the following:</p>  <p>A. It is a supra-ventricular tachycardia <u>B. It is an acute myocardial infarction</u> C. It is an acute myocardial infarction with a pathological Q wave D. I do not know.</p>	<p>46 169 105 107</p>	<p>10.8 39.6 24.6 25.1</p>

<p>10. A 24-year-old male comes to the Emergency Department He is athletic and slim. He reports feeling a pricking sensation in the left area of his chest since he finished doing exercise (3 hours earlier). You perform an EKG and observe the following:</p>  <p>A. It is an atrial bradycardia B. He has conduction problems <u>C. It is a normal EKG</u> D. I do not know</p>	<p>91 81 145 110</p>	<p>21.3 19 34 25.8</p>
<p>11. A patient with digitalis intoxication comes from a hospitalization ward. Before monitoring him you perform an EKG and obtain the following:</p>  <p>A. You observe an atrial extra-systole <u>B. You observe a ventricular extra-systole</u> C. You observe that he is carrying a pacemaker D. I do not know</p>	<p>49 108 76 194</p>	<p>11.5 25.3 17.8 45.4</p>
<p>12. A 30-year-old woman comes to the Emergency Department reporting palpitations, chest tightness and dyspnea. You perform an EKG and observe the following:</p>  <p>A. It is a ventricular tachycardia B. It is an atrial extra-systole <u>C. It is an atrial tachycardia</u> D. I do not know.</p>	<p>96 67 122 142</p>	<p>22.5 15.7 28.6 33.3</p>

AUTHOR CONTRIBUTION

All authors contributed to the study's conception and design. Material preparation, data collection, and analysis were performed by Osama Abdullah Abdulrahman, Fahad Saleh Alharthi, Muath Mohammed Alzahrani and Naif Fahad Alotaibi. The first draft of the manuscript was written by Muhanna Musaad Almatrafi, Abdulaziz Khalid Alsaeedi and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript after supervision by Abdulhalim Salim Serafi.

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CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

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