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ORIGINAL RESEARCH

Electrocardiogram Interpretation Competency Among Paramedic Students

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Background: Electrocardiography is an essential emergency tool used in the pre-hospital setting. However, no studies have yet assessed electrocardiogram (ECG) interpretation among emergency medical services (EMS) students in Saudi Arabia. This study aimed to determine the ECG interpretation competency of paramedic students.

Methodology: Cross-sectional, single-center study, a pre-validated, self-administered, two-part questionnaire first created by Coll-Badell et al was used to assess the ECG interpretation competency of paramedic students at Prince Sultan College for Emergency Medical Services (PSCEMS) in King Saud University. Participant data were collected and analyzed to identify factors associated with improved competency.

Results: All students of PSCEMS were included, and 137 of 248 paramedic students completed the questionnaire (55% response rate); 88 students (64.2%) scored >7.5 points, indicating competency in (ECG) interpretation. Factors such as grade point average (GPA) (>3.5) and enrollment in cardiology and advanced cardiac life support courses were found to be significantly associated with competency ($p<0.001$).

Conclusion: The majority of paramedic students were found to be competent in ECG interpretation. GPA and enrollment in cardiology and advanced cardiac life support courses were significantly associated with improved competency.

Keywords: electrocardiography, paramedic, emergency medical services, advanced cardiac life support, cardiology

Introduction

Electrocardiography is an essential emergency tool used in the pre-hospital setting. If utilized appropriately, it can be used to diagnose or guide the management of a variety of life-threatening conditions.[1] Drew et al[2] conducted a study to determine the electrocardiography utilization among emergency medical services (EMS) staff in managing patients with acute coronary syndrome (ACS); their results indicated that the increased use of pre-hospital electrocardiography reduced hospital treatment times. However, many studies concluded that there was underutilization of EMS systems by ACS patients.[3–5] For those who experienced chest pain, early contact with health systems, particularly through prehospital medical providers, proved to have a beneficial role in revascularization following the cardiac ischemic event.[6] Multiple studies found that obtaining a pre-hospital electrocardiogram (ECG) will reduce the door-to-balloon time and lead to faster reperfusion therapy with a lower adjusted risk of mortality among ACS patients.[7–9] Moreover, prehospital ECGs were found to have an insignificant effect on transporting time but significant impact on improving patient outcomes.[10,11] In addition to their clinical impact, prehospital ECGs were found to be cost-effective.[12]

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However, the competency and knowledge level of the clinician interpreting the ECG is a critical factor. There is a reported lack of comprehensive ECG interpretation content in the curriculum medical education programs.[13] Furthermore, O'Brien et al[14] evaluated the training and assessment of ECG interpretation skills in the 3rd year internal medicine internship year across institutions and found that the undergraduate curriculum is lacking in terms of basic ECG interpretation competency. In addition, Stopa et al[15] evaluated ECG interpretation skills among Polish medical, nursing, and paramedic students and found that the overall score was higher among medical students than nursing and paramedic students. These findings, in addition to other evidence, indicate that the ECG interpretation skills of undergraduate students are not satisfactory.[16,17] ECG misinterpretation can lead to inappropriate diagnoses and clinical decisions. However, a limited number of studies have attempted to determine the size of the problem in Saudi Arabia. Alghamdi et al[18] conducted a study to assess the frequency of ECG misinterpretation, address the nature of errors, and analyze the determinants of ECG interpretation accuracy among 6th year medical students and interns of Taif University, Taif, Saudi Arabia. They found that the overall performance of medical students and interns was moderate but that ECG interpretation can be improved by self-learning and providing organized educational courses on ECG. However, no studies have yet assessed ECG interpretation among EMS students in Saudi Arabia. Therefore, this study aimed to evaluate and identify the level of ECG interpretation of paramedic students as it related to their Grade Point Average (GPA) and other factors such advanced cardiac life support (ACLS) certification or attending related courses associated with ECG interpretation improvements and competency among EMS students of Prince Sultan Collage for EMS (PSCEMS), King Saud University, Saudi Arabia, Riyadh.

Materials and Methods

Design, Setting, and Enrollment

A cross-sectional descriptive design was used to determine the level of ECG interpretation among paramedic students at PSCEMS and identify the characteristics of high achievers in this skill via an online standardized research questionnaire. EMS students were enrolled from PSCEMS, King Saud University, Saudi Arabia, Riyadh. The PSCEMS Baccalaureate degree is 4 years; a cardiology course is provided at the beginning of the 2nd year, and the 4th year exclusively comprises an internship with no didactic or laboratory experience.

Convenience sampling was utilized to select the participants. All paramedic students and interns in PSCEMS were allowed an equal chance of inclusion in this study, and participation was voluntary. This study was approved by the institutional review board of King Saud University Medical City, and written informed consent was obtained from all participants. This study adhered to the principles of the Declaration of Helsinki 2013.

Assessment of ECG Interpretation Competency

A standardized research questionnaire created by Coll-Badell et al[19] was used. This was a two-part questionnaire; the first part pertained to the profile of the respondents, such as age, grade point average (GPA), year of higher education and history of enrollment in extracurricular courses such as advanced cardiac life support (ACLS) or any other courses related to ECG and these courses' mode of delivery. The second part comprised a 12-item survey (ten clinical questions and two theoretical questions) aiming to measure the level of competency of the respondents in ECG interpretation. Furthermore, Coll-Badell et al[19] stated that a minimum score of 7.5 was needed to attain competence in ECG interpretation. The respondents who received a score of <7.5 failed the ECG competency evaluation. It was proven to be a valid and reliable instrument by the original authors, and it has also been used by other researchers; hence, there is no need to validate it further. Permission to reuse the questionnaire was cordially asked before the study was conducted.

Data Collection and Analysis

The data were gathered via direct, official emails from all 248 PSCEMS students. The responses of each individual and group of respondents were tallied and analyzed. The data regarding respondents' profiles were gathered and converted into simple frequency counts, percentages, and means. Multiple regression analysis was used to determine the relationship between the profiles of the respondents and their level of competency in ECG interpretation.

Results

The questionnaire was sent to 248 students via their university email; 139 students responded for a response rate of 56%. Two forms were excluded because they were not completed. The average age of respondents was 21.5 years. In terms of the number of students in each academic year, 29 (21.2%) were in 1st year, 34 (24.8%) were in 2nd year, 34

Table 1 Competency Score per Level

Study Level	n (%)	Mean Age (Years)	Score of >7.5 n (%)
1st Year	29 (21.1)	19.8	1 (4)
2nd Year	34 (24.8)	21.1	22 (65)
3rd Year	34 (24.8)	21.8	30 (88)
4th Year (Internship)	40 (29.2)	23	35 (88)

(24.8%) were in 3rd year, and 40 (29.2%) were in their internship year. The mean overall competency score was 7.29 with a wide range from 0 to 12 and the mode was 8. A total of 88 (64.2%) of the respondents scored >7.5 points, indicating competency in ECG interpretation. The most common question that students answered incorrectly was regarding the pathological Q wave; only 30 (22%) students answered it correctly. In addition to that, 81 (59%) students were not able to identify ventricular extra-systole in patients with known digitalis overdose.

Table 1 presents the study level, mean age for each group, and percentage of each group that achieved competency in ECG interpretation.

The 1st year students performed significantly more poorly than the remaining students in terms of the overall score (Tables 1 and 2). This was potentially because the 1st year students had not yet completed the cardiology course. However, despite the fact that the 3rd year and internship students had been exposed to a greater number of patients than had the 2nd year students, there was no significant difference among these groups regarding their competency in ECG interpretation.

As indicated in Table 3, GPA was found to be predictive of competency in ECG interpretation; a GPA of >3.5/5 was positively associated with competency ($p<0.001$).

Table 2 Group Differences According to Study Level

(I) Study Level	(J) Study Level	Mean Difference (I-J)	Std. Error	P
1st Year	2nd Year	−6.08902-	0.52934	0.000
	3rd Year	−7.08456-	0.52549	<0.001
	Internship	−6.77961-	0.51191	<0.001
2nd Year	3rd Year	6.08902	0.52934	<0.001
	3rd Year	−0.99554-	0.52137	0.058
	Internship	−0.69059-	0.50768	0.176
3rd Year	1st Year	7.08456	0.52549	<0.001
	2nd Year	0.99554	0.52137	0.058
	Internship	0.30495	0.50367	0.546
4th Year (Internship)	1st Year	6.77961	0.51191	<0.001
	2nd Year	0.69059	0.50768	0.176
	3rd Year	−0.30495-	0.50367	0.546

Table 3 Group Differences According to GPA

(I) GPA	(J) GPA	Mean Difference (I-J)	Std. Error	P
≤3.5	3.51–4.50	−5.02941-	1.42208	<0.001
	≥4.51	−5.93678-	1.51826	<0.001
3.51–4.50	≤3.5	5.02941	1.42208	<0.001
	≥4.51	−0.90737-	0.71240	0.205
≥4.51	≤3.5	5.93678	1.51826	<0.001
	3.51–4.50	0.90737	0.71240	0.205

As demonstrated in Table 4, enrollment in extracurricular courses such as advanced cardiac life support (ACLS) or any other courses related to ECG was significantly associated with ECG interpretation competency.

Finally, as indicated in Table 5, there was no significant difference in the number of points obtained in relation to the time since the last course, mode of the course delivery (in-class vs online), or length of the course.

Table 4 Relationship Between Enrollment in Extracurricular Courses and Overall Score

Question	–	N	Mean	Std. Deviation	T	P
Did you finish the ACLS course?	Yes	74	8.6622	2.25909	53.224	<0.001
	No	63	5.4127	3.97425		
Did you complete any training course related to electrocardiography? (do not consider formal cardiology course)	Yes	31	8.3548	2.77547	7.764	0.006
	No	106	6.8208	3.68212		

Abbreviation: ACLS, advanced cardiac life support.

Table 5 Differences in Score Due to Timing, Delivery, and Length of Course

Q	–	Sum of Squares	df	Mean Square	F	P
When was the last course?	Between Groups Within Groups Total	59.844 1651.294 1711.139	2 134 136	29.922 12.323	2.428	0.092
How was the course delivered?	Between Groups Within Groups Total	59.340 1651.799 1711.139	3 133 136	19.780 12.420	1.593	0.194
How long was the course (h)?	Between Groups Within Groups Total	78.768 1632.371 1711.139	3 133 136	26.256 12.273	2.139	0.098

Discussion

This study aimed to evaluate ECG interpretation competency among EMS students using the two-part questionnaire developed by Coll-Badell et al. The questionnaire was previously demonstrated to be a valid and reliable instrument by the original authors, which was later confirmed by other researchers.[19] Overall, our current sample of paramedic students demonstrated acceptable competency in ECG interpretation. Sixty-four percent (64%) of the students obtained scores of >7.5 Further, after completing their 1st year and the cardiology course during their 2nd year, there was a significant improvement; 22 of the 2nd year students (65%) achieved competency in ECG interpretation (i.e. achieved a score of 7.5, compared to only 4% seen among 1st year students). Although this study supports the findings of previous similar studies, this is the first study to evaluate paramedic student competency in ECG interpretation. Our current findings are indicative of an acceptable level of competency in ECG interpretation among these paramedic students. This finding concurs with that of Werner et al,[20] which demonstrated that 54% of EMS nurses in western Sweden were competent in ECG interpretation. Our result is also in line with that of Whitbread et al,[21] who reported that paramedics could reliably recognize pathological change on an ECG. This study demonstrated that the competency of ECG interpretation varied among the paramedic students who participated in this study, primarily according to their level of education and GPA. Once the students had completed the formal cardiology course at the beginning of their 2nd year, their competency in ECG interpretation improved. Interestingly, no further significant improvement was observed with academic progression. These findings reinforce those of Nik Azlan and Muhamad.[22] Moreover, the ACLS course and other related extracurricular courses were found to play a major role in improving student competency. This finding reinforces the importance of a dedicated undergraduate cardiology course for paramedics, along with specialized courses such as ACLS and other related extracurricular courses. Utilizing distance learning for such courses seems to be equal to in-class learning in terms of achieving an acceptable level of competency in ECG interpretation.

There are some limitations to this study. First, this was a single-center study, and therefore, selection bias cannot be excluded. Further, as the questionnaire was completed via email, it was impossible to ensure that the students did not share answers. Furthermore, these results do not reflect the students' competency in ECG interpretation during real-world stressful emergencies or medical scenarios and therefore the findings cannot be generalized to a provider level and future studies should include assessments of professional Saudi paramedics. The retention of ECG interpretation knowledge might be affected after their graduation, so continuous education in this skill is warranted as they are recently completed formal ECG training but are not yet practicing independently. Finally, this study confirmed the existing opportunity to improve patient outcome as obtaining a pre-hospital electrocardiogram (ECG) will lower adjusted risk of mortality among ACS patients, that might be achieved as relying more on pre-hospital ECG that done by paramedics in the field.

Conclusions

This is the first study to evaluate paramedic student competency in ECG interpretation. The majority of our paramedic students demonstrated acceptable competency in

ECG interpretation. GPA and enrollment in cardiology were significantly associated with improved competency. ACLS courses and other related extracurricular courses were found to play a major role in improving student competency. Future studies should include professional Saudi paramedics and methods on how to retain ECG interpretation knowledge should also be examined.

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Disclosure

The author declares no conflicts of interest in this work.

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