

Assessment of lethal electrocardiography knowledge levels of non-physician healthcare personnel

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Received: 30th August 2024; **Accepted:** 15th December 2024; **Published:** 01st January 2025

Abstract: *Aim:* This study aimed to determine the extent to which non-physician healthcare personnel recognize life-threatening rhythms in Electrocardiography (ECG), and to identify the importance of professional experience or in-service training in recognizing life-threatening rhythms. *Material and Methods:* This descriptive study was designed to measure the ECG knowledge levels of healthcare personnel. It was completed with a total of 532 non-physician healthcare personnel including Paramedics, Emergency Medical Technicians (EMTs), nurses working in intensive care units, and inpatient clinics in Hatay province, Turkey. An 18-question survey form was used as the data collection tool in the research. Seven of the questions were related to participants' age, workplace, duration of employment, in-service training, etc., while eleven were related to ECG rhythms. *Results:* A total of 532 healthcare workers participated in the study, with the majority falling in the age range of 20-25 years (41.9%). Nurses comprised the largest group among the participants (37.4%). The majority of participants (75%) had been employed for 8 years or more, yet 66.9% had not attended any ECG courses during their employment, and 34% had received formal ECG training as part of their undergraduate or in-service education for five years or more. Among the units where participants worked, it was observed that 49.9% of the respondents were emergency department workers, where ECG applications were very frequent. *Conclusion:* According to the findings of the study, nurses were the group that answered the most questions, and the most frequently answered question incorrectly was about AF and ANT MI. It is suggested that ECG courses be added as compulsory subjects to the nursing and paramedic-EMT training curriculum, accompanied by laboratory and simulation practices.

Keywords: Emergency Medical Technician, Paramedic, Electrocardiography, Life-threatening rhythms, In-service training

Introduction

Although the frequency has decreased in the last 30 years, cardiovascular diseases remain the leading cause of adult mortality, and early diagnosis is the most important factor in reducing deaths related to these diseases. One of the cheapest and most important tests used in the early diagnosis of cardiovascular pathologies is Electrocardiography (ECG). Proper acquisition and interpretation of ECG at the first encounter of the patient by emergency medical personnel play a crucial role in recognizing life-threatening rhythms [1]. Efforts have been initiated in our country to address this gap in pre-hospital healthcare services by incorporating basic ECG rhythm recognition into the training curriculum of

auxiliary healthcare personnel. Currently, ambulances are predominantly staffed by Emergency Medical Technicians (EMTs) and Paramedics [2].

When evaluated in terms of survival, there are significant differences between patients presenting with a shockable rhythm (50%) and those with a non-shockable rhythm (10%) at the initial presentation. However, the proportion of patients presenting with a shockable rhythm is only stated as 20%. Success in treatment depends not only on patient characteristics and existing comorbidities but also on the timing of early defibrillation and initiation of treatment [3].

Despite the ease and rapid applicability of ECG, a study reports that nurses working in critical units have not received adequate training in ECG evaluation or that the training received is insufficient in ECG interpretation and decision-making [4-5].

In Turkey, the Ministry of Health, General Directorate of Emergency Health Services provides 'Advanced Life Support' training as part of in-service training programs. This training includes information on recognizing and intervening in life-threatening rhythms, aiming to ensure that all personnel can recognize and intervene in rhythms requiring early intervention. This study aims to investigate the knowledge of non-physician healthcare workers about life-threatening rhythms in ECG, identify any deficiencies if present, evaluate the benefits of training, and guide the planning of training programs.

Material and Methods

Data for the descriptive-type planned research were collected using a criterion sample with simple random sampling methods. Individuals who met the research criteria and voluntarily agreed to participate were included in the study. Ethical permissions required for the research were obtained from the Non-Interventional Ethics Committee of Hatay Mustafa Kemal University (Decision No: 17/03/2022, Ref No: 05). Additionally, necessary institutional permissions were obtained for the implementation of the study.

Data for the study were collected through a form prepared by the researchers based on the literature and conveyed to the participants via Google Form. This form, consisting of 18 questions, included the first 7 questions covering general information about healthcare workers, while the remaining 11 questions were prepared after reviewing the literature and focused on ECG knowledge. The 18-question form was sent to participants via email, and they were asked to answer the questions if they met the criteria. A total of 532 voluntary participants completed the survey form. Data were coded and analyzed using the SPSS 25.0 package program. In the evaluation of the data, numbers, percentages, and the chi-square (χ^2) test were used, with a significance level set at $p < 0.05$.

Inclusion Criteria

- Being a healthcare professional.
- Voluntarily agreeing to participate in the study.

Results

A total of 532 healthcare workers participated in the study, with the majority falling in the age range of 20-25 years (41.9%). Upon examination based on occupational groups, the participants were mostly composed of nurses (37.4%). The vast majority of participants (75%) had been employed for 8 years or more; however, a significant portion (66.9%) had not attended any ECG courses during their employment, and it was found that 34% of all participants had received ECG training as part of their undergraduate or in-service education five years or more ago.

When examining the responses of different professions to ECG rhythm recognition questions, it was found that nurses predominantly provided correct answers, while Emergency Medical Technicians (EMTs) were mostly seen among those providing incorrect answers. Significant differences were observed between professions in terms of the distribution of correct and incorrect responses to the questions ($p < 0.05$). The distribution of correct/incorrect responses to the questions by professional groups is detailed in Table 1.

While the rate of correctly answering test questions that queried theoretical knowledge, such as "Which rhythms are shockable in cardiopulmonary resuscitation?" and "Which rhythms are non-shockable in cardiopulmonary resuscitation?" was very high, the level of correct response to rhythm recognition questions prepared from sample ECG images was low. Overall, it was observed that the most frequent errors occurred in identifying atrial fibrillation (AF) and anterior myocardial infarction (ANT MI) rhythms.

When the distribution of responses to all ECG recognition questions was examined based on whether participants received ECG training after graduation, it was found that the rate of incorrect responses among participants who

received ECG training was lower. However, significant differences were observed in the rates of correct and incorrect responses to the questions when comparing participants who received training and those who did not ($p < 0.05$).

In questions concerning the identification of atrial fibrillation (AF) and anterior myocardial infarction (ANT MI), which were the most frequently answered incorrectly by all participants, the rate of incorrect responses among participants who received ECG training after graduation was lower compared to all

participants. The incorrect response rate for AF rhythm among participants who received training was 42%, while it was 38% for ANT MI. Questions regarding Normal Sinus Rhythm (NSR) and Asystole were the least incorrectly answered ECG rhythm recognition questions by both groups, regardless of whether they received training or not. In the group that had previously received ECG training, the incorrect response rate was 3.4% for Asystole and 6.8% for NSR. However, the rates of incorrect responses to other questions were still quite high despite receiving training.

Table-1: Evaluation of Responses to Questions by Occupation Groups

		Paramedics		Nurse		TO		Other		medical officer		P
		%	n	%	n	%	n	%	n	%	n	
Which rhythms are shocked?	TRUE	90,7%	107	93,0%	185	75,0%	90	58,8%	10	82,1%	64	0,000
	Wrong	9,3%	11	7,0%	14	25,0%	30	41,2%	7	17,9%	14	
Which rhythms are non-shockable?	TRUE	97,5%	115	95,5%	190	80,0%	96	64,7%	11	82,1%	64	0,000
	Wrong	2,5%	3	4,5%	9	20,0%	24	35,3%	6	17,9%	14	
What is the rhythm of asystole?	TRUE	96,6%	114	96,5%	192	85,8%	103	70,6%	12	85,9%	67	0,000
	Wrong	3,4%	4	3,5%	7	14,2%	17	29,4%	5	14,1%	11	
What is the VF rhythm?	TRUE	68,6%	81	79,9%	159	53,3%	64	47,1%	8	47,4%	37	0,000
	Wrong	31,4%	37	20,1%	40	46,7%	56	52,9%	9	52,6%	41	
What is the VT rhythm?	TRUE	73,7%	87	85,4%	170	52,5%	63	58,8%	10	64,1%	50	0,000
	Wrong	26,3%	31	14,6%	29	47,5%	57	41,2%	7	35,9%	28	
What is the SVT rhythm?	TRUE	87,3%	103	88,4%	176	53,3%	64	47,1%	8	69,2%	54	0,000
	Wrong	12,7%	15	11,6%	23	46,7%	56	52,9%	9	30,8%	24	
Which is the NSR rhythm?	TRUE	92,4%	109	91,0%	181	74,2%	89	64,7%	11	79,5%	62	0,000
	Wrong	7,6%	9	9,0%	18	25,8%	31	35,3%	6	20,5%	16	
Which is the AF rhythm?	TRUE	37,3%	44	58,3%	116	40,0%	48	11,8%	2	46,2%	36	0,000
	Wrong	62,7%	74	41,7%	83	60,0%	72	88,2%	15	53,8%	42	
What is the INF MI rhythm?	TRUE	63,6%	75	69,8%	139	45,8%	55	47,1%	8	61,5%	48	0,001
	Wrong	36,4%	43	30,2%	60	54,2%	65	52,9%	9	38,5%	30	
What is the ANTMI rhythm?	TRUE	46,6%	55	55,3%	110	34,2%	41	35,3%	6	62,8%	49	0,000
	Wrong	53,4%	63	44,7%	89	65,8%	79	64,7%	11	37,2%	29	
What is the AV BLOK rhythm?	TRUE	62,7%	74	73,4%	146	55,0%	66	29,4%	5	64,1%	50	0,000
	Wrong	37,3%	44	26,6%	53	45,0%	54	70,6%	12	35,9%	28	

Table 2: Evaluation of the answers given to the questions about the status of taking an ECG course

		Status of Taking An ECG Course					
		Yes		No		Total	P
		%	n	%	n	n	
Which rhythms are shocked?	TRUE	35,5%	162	64,5%	294	456	0,004
	Wrong	18,4%	14	81,6%	62	76	
Which rhythms are non-shockable?	TRUE	34,7%	165	65,3%	311	476	0,024
	Wrong	19,6%	11	80,4%	45	56	
What is the rhythm of asystole?	TRUE	34,8%	170	65,2%	318	488	0,004
	Wrong	13,6%	6	86,4%	38	44	
What is the VF rhythm?	TRUE	39,0%	136	61,0%	213	349	0,000
	Wrong	21,9%	40	78,1%	143	183	
What is the VT rhythm?	TRUE	38,4%	146	61,6%	234	380	0,000
	Wrong	19,7%	30	80,3%	122	152	
What is the SVT rhythm?	TRUE	38,0%	154	62,0%	251	405	0,000
	Wrong	17,3%	22	82,7%	105	127	
Which is the NSR rhythm?	TRUE	36,3%	164	63,7%	288	452	0,000
	Wrong	15,0%	12	85,0%	68	80	
Which is the AF rhythm?	TRUE	41,5%	102	58,5%	144	246	0,000
	Wrong	25,9%	74	74,1%	212	286	
What is the INF MI rhythm?	TRUE	40,3%	131	59,7%	194	325	0,000
	Wrong	21,7%	45	78,3%	162	207	
What is the ANTMI rhythm?	TRUE	41,8%	109	58,2%	152	261	0,000
	Wrong	24,7%	67	75,3%	204	271	
What is the AV_BLOK rhythm?	TRUE	39,3%	134	60,7%	207	341	0,000
	Wrong	22,0%	42	78,0%	149	191	

The distribution of responses to the questions based on whether participants received ECG training is detailed in Table 2.

When the incorrect responses were evaluated based on the time since the last ECG training, it was found that the rate of incorrect responses was higher among those who received training more than 5 years ago, while no significant difference was found among those who received training within 5 years.

Upon examining the distribution of all responses to the questions based on the unit of work, it was

observed that correct responses were mostly provided by emergency department workers (80%). However, the pre-hospital healthcare service teams, another step in emergency patient care, had the highest rate of incorrect responses (40.5%). Additionally, the overall rate of incorrect responses from ward and intensive care unit staff was 38%. When comparing the responses of different units to the questions, significant differences were found in all questions except for ANT MI rhythm ($p > 0.05$) ($p < 0.05$). Details regarding the units of work and responses to the questions are provided in Table 3.

Table 3: Evaluation of correct/incorrect answers to questions according to the unit studied

		Unit of study										P
		Ambulance		emergency room		Other		Service-YB		Emergency Command M		
		%	n	%	n	%	n	%	n	%	n	
Which rhythms are shocked?	TRUE	76,0%	19	93,6%	247	85,0%	85	82,3%	51	66,7%	54	0,000
	Wrong	24,0%	6	6,4%	17	15,0%	15	17,7%	11	33,3%	27	
Which rhythms are non-shockable?	TRUE	80,0%	20	96,6%	255	88,0%	88	83,9%	52	75,3%	61	0,000
	Wrong	20,0%	5	3,4%	9	12,0%	12	16,1%	10	24,7%	20	
What is the rhythm of asystole?	TRUE	88,0%	22	97,7%	258	90,0%	90	87,1%	54	79,0%	64	0,000
	Wrong	12,0%	3	2,3%	6	10,0%	10	12,9%	8	21,0%	17	
What is the VF rhythm?	TRUE	68,0%	17	78,4%	207	57,0%	57	56,5%	35	40,7%	33	0,000
	Wrong	32,0%	8	21,6%	57	43,0%	43	43,5%	27	59,3%	48	
What is the VT rhythm?	TRUE	68,0%	17	84,1%	222	63,0%	63	58,1%	36	51,9%	42	0,000
	Wrong	32,0%	8	15,9%	42	37,0%	37	41,9%	26	48,1%	39	
What is the SVT rhythm?	TRUE	76,0%	19	88,3%	233	70,0%	70	50,0%	31	64,2%	52	0,000
	Wrong	24,0%	6	11,7%	31	30,0%	30	50,0%	31	35,8%	29	
Which is the NSR rhythm?	TRUE	68,0%	17	92,4%	244	84,0%	84	82,3%	51	69,1%	56	0,000
	Wrong	32,0%	8	7,6%	20	16,0%	16	17,7%	11	30,9%	25	
Which is the AF rhythm?	TRUE	32,0%	8	53,0%	140	41,0%	41	48,4%	30	33,3%	27	0,009
	Wrong	68,0%	17	47,0%	124	59,0%	59	51,6%	32	66,7%	54	
What is the INF MI rhythm?	TRUE	52,0%	13	70,1%	185	61,0%	61	40,3%	25	50,6%	41	0,000
	Wrong	48,0%	12	29,9%	79	39,0%	39	59,7%	37	49,4%	40	
What is the ANT MI rhythm?	TRUE	56,0%	14	53,4%	141	51,0%	51	35,5%	22	40,7%	33	0,051
	Wrong	44,0%	11	46,6%	123	49,0%	49	64,5%	40	59,3%	48	
What is the AV BLOK rhythm?	TRUE	68,0%	17	71,2%	188	59,0%	59	56,5%	35	51,9%	42	0,007
	Wrong	32,0%	8	28,8%	76	41,0%	41	43,5%	27	48,1%	39	

When the distribution of responses to the ECG questions was examined according to the years of work, it was found that incorrect responses were mostly from groups with 8 years or more of work experience. Another notable finding was that as the years of work increased, the rates of incorrect responses to the questions also increased.

Discussion

Rapid and accurate rhythm recognition is an essential skill for medical professionals across various disciplines. Electrocardiograms (ECGs) are performed in pre-hospital settings, doctor's offices, emergency departments, during surgeries, and throughout hospitals. Emergency Medical Technicians (EMTs), nurses, and doctors are responsible for recognizing potentially dangerous

rhythms and providing appropriate patient care before they pose a vital threat. It is argued that rapid and accurate rhythm recognition by everyone in the healthcare team reduces morbidity and mortality. When interpreting ECG rhythms, it is important to consider the patient as a whole; in this context, the knowledge of a requested ECG for a patient may necessitate a more critical rhythm assessment and lead to more accurate interpretation.

Recognizing potentially dangerous rhythms in ECGs is crucial, but it is necessary to first recognize Normal Sinus Rhythm (NSR). In a study conducted by Kırmızıgül et al. (2023) involving a sample group of nurses, the

average score they obtained on the critical rhythms test was 15.13 out of 20 [6].

However, a study by Werner, Kander, and Axelsson (2014) found that the level of ECG knowledge among nurses working in ambulances was inadequate [7]. In this study, 15% of healthcare professionals who had received ECG training provided incorrect answers to the NSR rhythm identification question, despite 6.8% of them having received ECG training. This finding is consistent with the literature, suggesting that educational strategies need to be reconsidered to achieve complete success in ECG recognition among healthcare professionals.

The majority of out-of-hospital cardiac arrest (OHCA) cases develop due to arrhythmias, particularly ventricular fibrillation (VF). Early recognition of VF and defibrillation play a key role in the favorable outcomes of these cases. A study conducted in the Netherlands found that out of 6155 OHCA cases, 2401 were in VF rhythm. Indeed, the importance of recognizing this rhythm is emphasized in the study by Doğu et al., where it was found that 29.4% of participants misidentified the rhythm [8].

In another study involving healthcare workers, it was found that the recognition rate of life-threatening rhythms by emergency department staff was 100%. However, nearly 50% of pre-hospital emergency medical service personnel in this study provided incorrect answers to the VF recognition question. In contrast, command control center staff coordinating ambulance teams had an even higher rate of incorrect responses. This finding contrasts with the literature, suggesting that the identification of this life-threatening rhythm may be related to our study sample.

The accurate timing of performing an electrocardiogram (ECG) and interpreting it correctly is crucial in identifying cardiac causes [9-10]. Especially, in-service training aimed at enhancing ECG knowledge among pre-hospital emergency medical teams is believed to be effective and may increase survival rates in patients. A study conducted by DOĞAN et al. with first and second-year students of a university's health services vocational school's emergency medical program examined students'

ability to recognize fatal rhythms, and it was observed that the ability to recognize ventricular fibrillation (VF), a fatal rhythm, increased after the training. [2].

Similarly, in our study, participants who received ECG training had a higher rate of correctly identifying fatal rhythms. When evaluating responses based on the time since the last training, participants who received training more than 5 years ago had higher rates of incorrect responses, while there was no significant relationship found between the timing of training and misidentification of ECG rhythms when considering all timeframes. These findings suggest that the content of in-service training is more crucial than the frequency of training sessions. Additionally, a study by Demirtaş et al. (2019) with emergency healthcare professionals working in ambulances showed that factors such as profession, experience, and receiving ECG training in the last year did not significantly affect ECG evaluation results [11].

Therefore, it is believed that in-service training methods need to be reconsidered, and new methods in addition to traditional ones may be effective. This study also supports the findings of our study. Moreover, Kızıltepe et al. (2023) conducted a study with final-year nursing students, where after theoretical and practical elective ECG classes in the fall semester, computer-assisted simulators were used during the practical phase of the course, involving case analyses with ECG samples [12].

Students who took the "Basic ECG" course in the fall semester of the 2021-2022 academic year went for clinical practice sessions during the spring semester (for 14 weeks, four days a week). It was concluded that the basic ECG course provided to final-year nursing students positively influenced their personal and professional development, contributing to better preparation for the roles required in nursing profession [12]. Thus, it can be said that methods such as simulation and long-term clinical practice positively affect educational success. In this study, it was observed that the number of incorrect responses was lower

among trained participants; however, there were still participants who incorrectly identified VF rhythm (22.7%) and ANT MI (38%) despite receiving training. This underscores the importance of enriching education with simulation and clinical practices instead of relying solely on traditional methods.

When examining the units where the participants in our study worked, it was observed that 49.9% were emergency department staff, and when looking at their lengths of service in the units, 67.5% had been working in the same unit for 4 years or more. As the years of service increased, it could be assumed that the interest in in-service training decreased, and efforts to improve the knowledge levels of the staff were adversely affected. Another perspective could be that due to workload, there may not have been sufficient time allocated for training, which could be among the reasons for this finding.

Conclusion

In conclusion, the findings of our study indicate that healthcare professionals generally have weak skills in recognizing ECG rhythms. Nurses appear to be more successful compared to other professional groups. Additionally, it can be considered that the ECG training provided during undergraduate education is more effective and lasting compared to in-service training. Based on

these results, various recommendations can be proposed to improve healthcare professionals' ability to recognize ECG rhythms: More emphasis should be placed on ECG training during undergraduate education.

Effective educational strategies such as laboratory studies, simulations, and interactive learning methods should be employed. In-service training programs should be organized, and these programs should include more practical exercises to improve ECG rhythm recognition skills. Periodic tests should be conducted to continuously assess healthcare professionals' ECG interpretation skills. These tests can help identify deficiencies and plan additional training in necessary areas.

More utilization of expert resources such as ECG technicians and specialists should be made, and these experts should provide mentoring and guidance to healthcare personnel. Leveraging technology, continuous education and resources should be made accessible through mobile applications and online learning platforms. Implementing these recommendations can contribute to improving healthcare professionals' ability to accurately and quickly identify ECG rhythms, thereby enhancing the quality of patient care and ensuring patient safety.

Financial Support and sponsorship: Nil

Conflicts of interest: There are no conflicts of interest.

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Cite this article as: Polat M, Karakus A, Kara B and Belen VK. Assessment of lethal electrocardiography knowledge levels of non-physician healthcare personnel. *Al Ameen J Med Sci* 2025; 18(1): 5-12.

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