Assessment of Electrocardiography Knowledge Among Doctors Working in Emergency Department

Acil Serviste Çalışan Doktorların Elektrokardiyografi Bilgi Düzeylerinin Değerlendirilmesi

Mustafa Emin Canakci[1], Murat Cetin[2], Özge Turgay Yildirim[3], Mevlut Okan Aydin[4], Gurkan Altuntas[5], Nurdan Acar[1]

[1] Emergency Department, Eskisehir Osmangazi University, Eskisehir, Turkey

[2] Emergency Department, Izmir Tinaztepe University, Izmir, Turkey

[3] Cardiology Department, Eskisehir City Hospital, Eskisehir, Turkey

[4] Medical Education Department, Uludag University, Bursa, Turkey

[5] Emergency Department, Recep Tayyip Erdogan University, Rize, Turkey

ABSTRACT

Introduction: Electrocardiography (ECG) is an indispensable method for fast and reliable cardiac assessment in emergency departments. Physicians should have proper knowledge of ECG for accurate patient management. The aim of this study was to evaluate the ECG knowledge of emergency medicine physicians.

Methods: General practitioners (GPs), emergency residents (ERs), emergency physicians (EPs) and cardiology physicians interpreted a total of 40 ECG samples in non-cardiac pathologies, arrhythmias, conduction disorders, and myocardial infarctions.

Results: A total of 178 physicians participated in the study - 27.5% of participants were ERs, 24.7% were GPs, 24.2% were EPs, and 23.6% were cardiologists. The general practitioners had the lowest success in ECG interpretation. Cardiologists were more successful in ECG interpretations of arrhythmias (A) and conduction delays (CD) than GPs, ERs and EPs (p_A<0.001, p_{CD}<0.001; p_A<0.001, p_{CD}<0.001; p_A<0.001, p_{CD}=0.006 respectively). On the myocardial infarction ECGs, they were more successful than GPs and ERs but there was no statistically significant difference between cardiologists and EPs (p<0.001, p=0.001 and p=1.000 respectively). There was no significant difference between EPs, ERs and cardiologists in ECGs for non-cardiac causes.

Conclusion: ECG knowledge level of general practitioners in emergency department was found to be insufficient. ECG knowledge of the physicians should be improved starting from medical school and continuously updated with in-service training during their professional careers in emergency departments.

Key words: Electrocardiography, emergency medicine, medical education

ÖZET

Giriş: Elektrokardiyografi (EKG) acil servislerde hızlı ve güvenilir kardiyak değerlendirme için vazgeçilmez bir yöntemdir. Doğru hasta yönetimi için doktorlar uygun EKG bilgisine sahip olmalıdır. Bu çalışmanın amacı acil tıp hekimlerinin EKG bilgilerini değerlendirmektir.

Yöntemler: Pratisyen hekimler (PH), acil tıp asistanları (ATA), acil tıp uzmanı (ATU) ve kardiyoloji uzmanları; kardiyak olmayan patolojiler, aritmiler, ileti defektleri ve miyokard enfarktüslerinde toplam 40 EKG örneğini yorumladılar.

Bulgular: Çalışmaya toplam 178 hekim katıldı – katılımcıların % 27,5'i ATA, % 24,7'si PH, % 24,2'si ATU ve % 23,6'sı kardiyologdu. Pratisyen hekimler EKG yorumlamasında en düşük başarıya sahipti. Kardiyologlar, aritmi (A) ve ileti gecikmelerinin (İG) EKG yorumlamasında PH, ATA ve ATU'lara daha başarılıydı (sırasıyla p_A <0,001, p_{IG} <0,001; p_A <0,001, p_{IG} <0,001; p_A <0,001, p_{IG} = 0,006) . Miyokard enfarktüs EKG'lerinde kardiyologlar ve ATU'lar, pratisyen hekimler ve ATA'lara göre daha başarılı iken kendi aralarında istatistiksel olarak anlamlı bir fark yoktu (sırasıyla p <0,001, p = 0,001 ve p = 1.000). Non-kardiyak durumlara yönelik EKG'lerde ATA, ATU ve kardiyologlar arasında önemli bir fark yoktu.

Sonuç: Acil serviste çalışan pratisyen hekimlerin EKG bilgi düzeyleri yetersiz bulundu. Hekimlerin EKG bilgileri tıp fakültesinden başlayarak geliştirilmeli ve acil servislerde mesleki kariyerleri boyunca hizmet içi eğitimlerle sürekli güncellenmelidir.

Anahtar Kelimeler: Elektrokardiyografi, acil tıp, tıp eğitimi

Corresponding author: Mustafa Emin Canakci, Emergency Department, Eskisehir Osmangazi University, Eskisehir, Turkey
E-mail: mustafaeminc@gmail.com
Eskisehir Med. J. 2021; 2(2):103-10.
Received date:17.05.2021 Accepted date:12.06.2021
Authors: Mustafa Emin Canakci (ORCID: 0000-0001-9015-1782), Murat Cetin (ORCID: 0000-0002-0667-7966), Özge Turgay Yildirim (ORCID: 0000-0002-6731-4958), Mevlut Okan Aydin (ORCID: 0000-0002-8060-8803), Gürkan Altuntaş (ORCID: 0000-0001-7390-2513), Nurdan Acar (ORCID: 0000-0002-3532-1803)

INTRODUCTION

Electrocardiography (ECG) has been in use since its discovery in 1902. It detects the differences in electrical potentials on body surfaces arising from the heart (1). Since many pathologies, including cardiac and non-cardiac, may disturb this electrical arrangement, ECG can quickly inform in a wide range of current clinical conditions, making it a cheap, simple, and reliable examination method (2).

Physicians take ECG training starting from medical school and should know ECG at the beginning of their professional careers. Undoubtedly, several specialties such as cardiology and emergency medicine should have a better knowledge of ECG. On the other hand, even basic ECG knowledge diminishes over time in other departments that are less familiar with ECG. A previous study conducted with non-cardiologist physicians revealed that interpretation of the severity of clinical conditions in ECG was low, particularly in asymptomatic cases. The most correctly answered question was Wellens syndrome, in which only 41.7% of the participants answered correctly, which suggested that one may miss even serious pathologies with improper ECG knowledge (3).

Appropriate ECG interpretation is an essential skill that a physician working in the ED should have for an accurate and timely diagnosis of possible life-threatening pathologies. Identifying ECG knowledge gaps will help to improve these skills during medical education and clinical emergency medicine training.

Identifying cardiac pathologies such as myocardial infarction in ECG is relatively easy since the known symptoms make interpretation predictable. However, cases such as drug intoxication, electrolyte disorders, or rare cardiac pathologies necessitate more comprehensive knowledge and experience. Based on this background, we aimed to assess the ECG knowledge of emergency medicine professionals compared to cardiologists to determine the issues to improve.

METHODS

This cross-sectional study included a total of 178 participants to evaluate the emergency department (ED) doctors' general knowledge of ECG comparing with cardiologists. The emergency department physicians consist of general practitioners (GPs), emergency medicine residents (ERs), and emergency medicine physicians (EPs) in the country where the study was conducted. The study period was 26 Feburary 2019 to 27 May 2019. The types of healthcare facilities that participants work in were the state, university, training and research, and private hospitals in Turkey.

ECGs were obtained from the lifeinthefastlane (LITFL) website with the approval of the managers (https://litfl.com/ecg-library/). Before starting the study, the suitability of ECGs were checked by two researchers (MEC, ÖTY). After the approval of the local ethics committee (Eskisehir Osmangazi University Non-Interventional Ethics Committee, 17 May 2018, Decision Number:7), the study was conducted by physicians, who agreed to participate in the study, in the company of the researchers. Each physician/resident participated in the study once. The questions were planned as multiple choice questions. The answers were checked by the researchers who received measurement and evaluation training.

Participants interpreted 10 ECGs in each of four different clinical conditions, including non-cardiac pathologies, arrhythmias, conduction disorders, and myocardial infarctions. The ECGs interpreted by participants included the scenarios in Table 1. The distribution and total numbers of correct answers were compared between specialties and healthcare facility types.

Table 1. The ECGs according to titles.

Non-Cardiac	Arrhythmias	Conduction Delays	Myocardial Infarctions
Pericardial effusion	Wolff Parkinson White	LAFB+RBBB	deWinter
MAT	Brugada	LAFB	Wellens
Hypothermia	AV Block (1st degree)	Trifascicular Block	Ventricular Aneurysm
TCA Intoxication	AVNRT	LBBB	Anterior MI
Hyperkalemia	Bidirectional VT	HCM	High Lateral MI
Hypercalcemia	SA Block (2nd degree)	RBBB	LMCA lesion
Digitalis effect	AV Block (2nd degree Mobitz 2)	AIVR	Inferior MI
Pericarditis	RVOTT	BER	Inferior+Right MI
Intracranial event	Torsades de pointes	Bigeminy PVC	Inferior+Posterior MI
Pulmonary embolism	Fascicular VT	ICD Malfunction	Anterolateral MI

***Abb. MAT**: Multifocal Atrial Tachycardia. **TCA**: Tricyclic antidepressant, **WPW**: Wolff-Parkinson-White, **AV**: Atrioventricular, **AVNRT**: Atrioventricular Nodal Reentrant Tachycardia, **VT**: Ventricular Tachycardia, **SA**: Sinoatrial, **RVOT**: Right Ventricular Outflow Tract Tachycardia, **LAFB**: Left Anterior Fascicular Block, **RBBB**: Right Bundle Branch Block, **LBBB**: Left Bundle Branch Block, **HCM**: Hypertrophic Cardiomyopathy, **AIVR**: Accelerated Idioventricular Rhythm, **BER**: Benign Early Repolarisation, **PVC**: Premature Ventricular Complex, **ICD**: Implantable Cardioverter-Defibrillators, **MI**: Myocardial Infarction, **LMCA**: Left Main Coronary Artery Disease*

Statistical Analyses

As a result of the pilot study, it was found that there should be at least 39 physicians in each group for the effect size 0.27 (sd 7), 80% power and 5% significance level, in terms of the answers given to the questions asked to GPs, ERs, EP and cardiologists.

Descriptive statistics were presented using either mean and standard deviation or median and interquartile range (IQR) for continuous variables, and frequency and percent for categorical variables. Comparisons between more than two independent groups were made using the Kruskall-Wallis test for non-normally distributed continuous variables. Post-hoc pairwise comparisons were made using the Mann-Whitney U test with Bonferroni correction of Type-I error. Categorical variables were compared using the chi-square test. The statistical significance threshold used in the analyses was 5% of Type-I error ($p<0.05$). Statistical analyses were made in SPSS 25 software (IBM Inc., Armonk, NY, USA).

RESULTS

The study population included a total of 178 participants (61.6% males) with a mean age of 31.5 ± 5.0 years. Of the participants 27.5% were ERs, 24.7% were GPs, 24.2% were EPs, and 23.6% were CPs. Distribution of healthcare facilities ranged between 43.8% for state hospitals and 3.9% for private hospitals (Table 2).

Table 2. Background characteristics of participants

	Mean ± SD / n (%)
Age (years)	31.5 ± 5.0
Gender	
Female	63 (35.4)
Male	115 (61.6)
Specialty	
Emergency resident	49 (27.5)
General practitioner	44 (24.7)
Emergency physician	43 (24.2)
Cardiologist	42 (23.6)
Years in emergency medicine residency	4.0 ± 3.4
Years in residency	
Less than six months	2 (4.1)
6-11 months	4 (8.2)
12-17 months	8 (16.3)
18-23 months	5 (10.2)
>24 months	30 (61.2)
Time of profession in emergency department (months)	21.8 ± 39.8
Healthcare facility	
State hospital	78 (43.8)
Training and research hospital	54 (30.3)
University hospital	39 (21.9)
Private hospital	7 (3.9)

Participants interpreted ECGs in 4 main groups of pathologies: non-cardiac conditions, arrhythmias, conduction delays, and myocardial infarctions. In general, the success rates were lowest among GPs. Cardiologists had better results on average in all groups. In the non-cardiac causes group, ERs and EPs were statistically significantly better than cardiologists in

Table 3. Success rates in ECG interpretations

	Overall	General Practitioner	Emergency Resident	Emergency Physician	Cardiologist	p[+]
	%	%	%	%	%	
Non-cardiac causes						
Pericardial effusion	95.5	95.5	95.9	97.7	92.9	0.758
MAT	66.3	38.6	59.2	86 GP,ER	83.3 GP	**< 0.001**
Hypothermia	58.4	43.2	59.2	65.1	66.7	0.103
TCA intoxication	30.3	6.8	42.9 GP,C	53.5 GP,C	16.7	**< 0.001**
Hyperkalemia	69.7	52.3	67.3	81.4 GP	78.6	**0.013**
Hypercalcemia	41.6	18.2	42.9	44.2	61.9 GP	**0.001**
Digitalis effect	83.7	68.2	85.7	81.4	100 *	**0.001**
Pericarditis	87.6	77.3	83.7	93	97.6 GP	**0.018**
Intracranial event	47.2	38.6	51	32.6	66.7 EP	**0.009**
Pulmonary embolism	69.1	38.6	75.5 GP	76.7 GP	85.7 GP	**< 0.001**
Arrhythmias						
WPW	86.5	72.7	85.7	90.7	97.6 GP	**0.006**
Brugada	83.7	56.8	89.8 GP	88.4 GP	100 *	**< 0.001**
1st degree AV block	80.9	61.4	85.7 GP	81.4	95.2 GP	**0.001**
AVNRT	69.7	40.9	61.2	79.1	100	**< 0.001**
Bidirectional VT	66.3	40.9	65.3	69.8 GP	90.5 GP,ER	**< 0.001**
2nd degree SA block	18	4.5	14.3	20.9	33.3 GP	**0.005**
Mobitz Type-2	68.5	59.1	77.6	69.8	66.7	0.288
RVOT	24.7	22.7	16.3	14	47.6 ER,EP	**0.001**
Torsades de pointes	88.2	77.3	95.9 GP	86	92.9	**0.030**
Fascicular VT	21.9	9.1	20.4	14	45.2 GP,EP	**< 0.001**
Conduction delays						
LAFB+RBBB	58.4	31.8	63.3GP	55.8	83.3 GP,EP	**< 0.001**
LAFB	57.3	29.5	51	58.1 GP	92.9 GP,ER,EP	**< 0.001**
Trifascicular block	27.5	11.4	24.5	25.6	50 GP	**0.001**
LBBB	60.1	25	65.3 GP	74.4 GP	76.2 GP	**< 0.001**
HCM	75.8	43.2	73.5 GP	90.7 GP	97.6 GP,ER	**< 0.001**
RBBB	80.3	63.6	85.7	88.4 GP	83.3	**0.014**
AIVR	75.3	45.5	77.6 GP	79.1 GP	100 *	**< 0.001**
BER	82.6	52.3	87.8 GP	90.7 GP	100 *	**< 0.001**
Bigemini PVC	89.9	72.7	89.8	100 *	97.6 GP	**< 0.001**
ICD malfunction	71.3	45.5	73.5 GP	74.4 GP	92.9 GP	**< 0.001**
Myocardial infarction						
Dewinter	43.8	31.8	44.9	48.8	50	0.297
Wellens	60.7	27.3	65.3 GP	76.7 GP	73.8 GP	**< 0.001**
Ventricular aneurysm	63.5	31.8	57.1	69.8 GP	97.6 GP,ER,EP	**< 0.001**
Anterior MI	90.4	77.3	91.8	93	100*	**0.003**
High lateral MI	81.5	56.8	81.6	93 GP	95.2 GP	**< 0.001**
LMCA lesion	57.9	38.6	55.1	67.4 GP	71.4 GP	**0.009**
Inferior MI	87.6	68.2	91.8 GP	93 GP	97.6 GP	**< 0.001**
Inferior + right MI	91	77.3	91.8	95.3 GP	100 *	**0.002**
Inferior + posterior MI	91	75	89.8	100 *	100 *	**< 0.001**
Anterolateral MI	88.2	77.3	83.7	95.3	97.6 GP	**0.008**

[+]: Multigroup comparisons. The superscripts in each cell depict the statistically significant differences in pairwise comparisons.
***Abb. GP:** General practitioner, **ER:** Emergency resident, **EP:** Emergency physician, **C:** Cardiologist, ***:** not included in comparisons.*
***MAT**: Multifocal Atrial Tachycardia. **TCA**: Tricyclic antidepressant, **WPW**: Wolff-Parkinson-White, **AV**: Atrioventricular, **AVNRT**: Atrioventricular Nodal Reentrant Tachycardia, **VT**: Ventricular Tachycardia, **SA**: Sinoatrial, **RVOT**: Right Ventricular Outflow Tract Tachycardia, **LAFB**: Left Anterior Fascicular Block, **RBBB**: Right Bundle Branch Block, **LBBB**: Left Bundle Branch Block, **HCM**: Hypertrophic Cardiomyopathy, **AIVR**: Accelerated Idioventricular Rhythm, **BER**: Benign Early Repolarisation, **PVC**: Premature Ventricular Complex, **ICD**: Implantable Cardioverter-Defibrillators, **MI**: Myocardial Infarction, **LMCA**: Left Main Coronary Artery Disease*
Δ statistically low success rates are indicated as superscript.

Table 4. Total number of correct answers according to specialty and healthcare facility

ECG Diagnoses	Median (IQR)	Median (IQR)	Median (IQR)	Median (IQR)	Median (IQR)	
Non-cardiac Causes	7 (5-8)	4.5 (4-6)	7 (6-8)^{GP}	7 (6-8)^{GP}	8 (7-9)^{GP}	**<0.001**
Arrhythmias	6 (5-7)	4.5 (3-6)	6 (5-7)^{GP}	6 (5-7)^{GP}	7 (7-9)^{GP,ER,EP}	**<0.001**
Conduction Delays	7 (5-9)	4 (3-6)	7 (6-8)^{GP}	8 (6-9)^{GP}	9 (8-10)^{GP,ER,EP}	**<0.001**
Myocardial Infarctions	8 (7-9)	6 (3-8)	8 (7-9)^{GP}	9 (8-9)^{GP}	9 (8-10)^{GP,ER}	**<0.001**
TOTAL	28 (22-32)	19 (14-23)	28 (25-30)^{GP}	30 (27-32)^{GP}	33 (30-36)^{GP,ER,EP}	**<0.001**
		State hospital	**Training and research hospital**	**University hospital**	**Private hospital**	**p**
		Median (IQR)	**Median (IQR)**	**Median (IQR)**	**Median (IQR)**	
Non-cardiac Causes		6 (5-8)	7 (5-9)	7 (6-8)	7 (4-8)	0.18
Arrhythmias		6 (4-7)	6 (5-7)	6,5 (5-7)	7 (3-7)	0.49
Conduction Delays		6 (4-8)	8 (6-9) ^{SH}	7 (7-9)	9 (4-9)	**0.031**
Myocardial Infarctions		8 (6-9)	8 (7-9)	8 (7-9)	7 (3-8)	0.10
TOTAL		26 (19-32)	29 (26-34)	29 (26-32)	29 (13-33)	0.11

M^{*}: Median (IQR). The superscripts in cells depict the statistically significant differences in pairwise comparisons. ***Abb. GP:*** *General practitioner,* ***ER:*** *Emergency resident,* ***EP:*** *Emergency physician,* ***SH:*** *State hospital*
Δ statistically low success rates are indicated as superscript.

TCA intoxication question (p= 0.042 and p <0.001). It was observed that the EPs were more successful than cardiologists in the diagnosis of multifocal atrial Tachycardia (MAT) and hyperkalaemia, but there was no statistically significant difference. There was no statistically significant difference between the groups for hypothermia and pericardial effusion ECGs. Cardiologists performed better than ERs and/or EPs in intracranial events in the non-cardiac conditions group; bidirectional ventricular tachycardia, right ventricular outflow tract Tachycardia (RVOT), and fascicular VT in the arrhythmias group; left anterior fascicular block+right bundle branch block (LAFB+RBBB), LAFB, and hypertrophic cardiomyopathy in the conduction delays group; and ventricular aneurysm in the myocardial infarction group (Table 3).

Table 4 summarizes the total number of correct answers to different clinical conditions. For the non-cardiac causes, cardiologists, ERs and EPs had more correct answers than GPs (p<0.001 for all groups). For arrhythmias, cardiologists were significantly better than GPs, ERs and EPs (p<0.001 for all groups). For conduction delays group, cardiologists were significantly better than GPs, ERs, and EPs (p<0.001, p<0.001 and p=0.006 respectively). For myocardial infarctions group cardiologists were significantly better than GPs, ERs (p<0.001 and p=0.002 respectively); ERs and EPs were significantly better than GPs (p=0.004 and p<0.001 respectively); there were no significantly difference between EPs and cardiologists (p=1.000) and ERs (p=0.171). Comparisons between healthcare facilities revealed that only the number of correct answers to conduction delays were significantly higher in training and research hospitals than state hospitals. Evaluation of ECG classes according to groups and the total success has given separately (Figure 1).

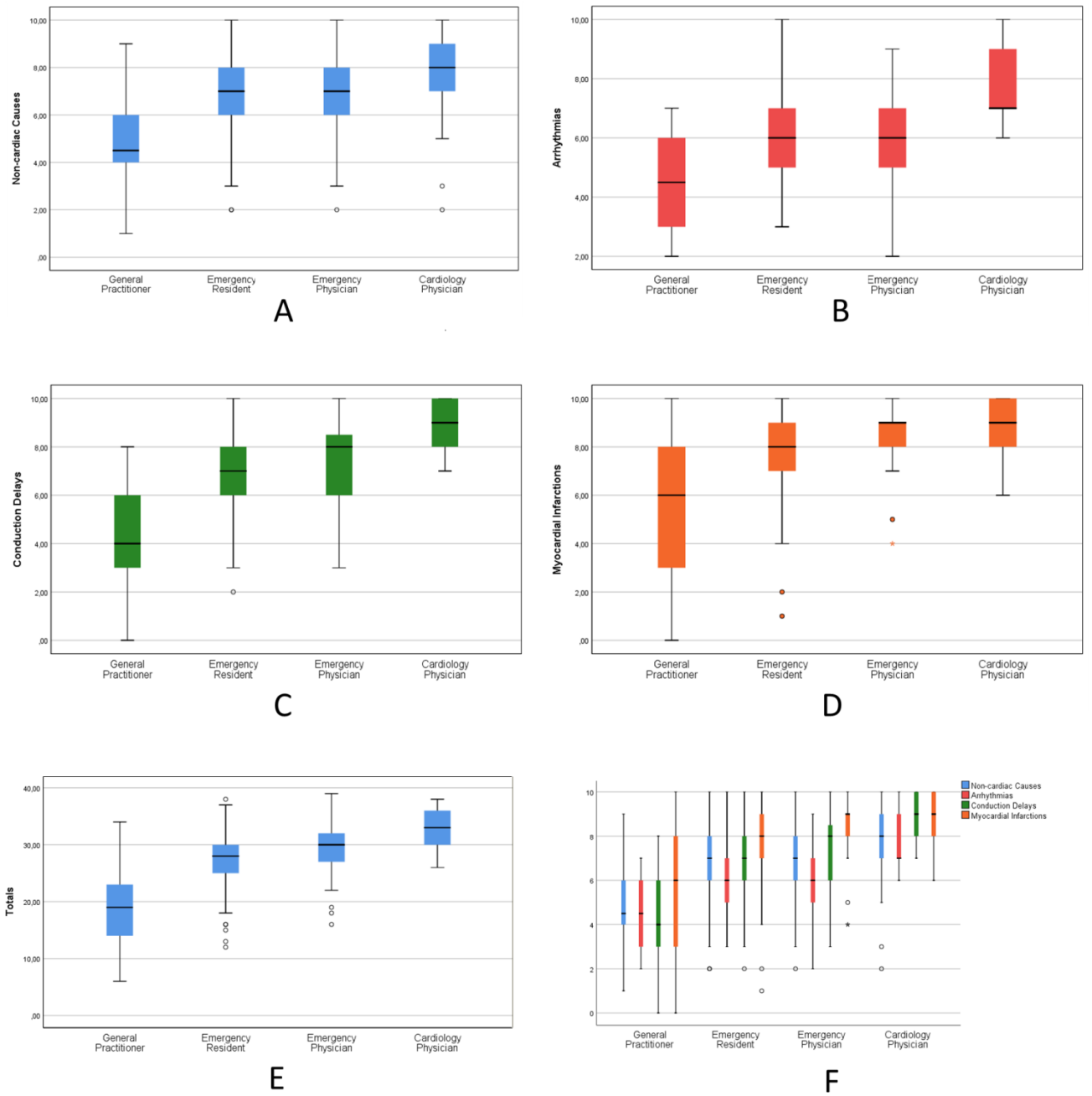

Figure 1. Evaluation of ECG classes according to groups with box-plot graphics.
A. Non-cardiac Causes, **B**. Arrhytmias, **C**. Conduction Delays, **D**. Myocardial Infarctions, **E**. Totals, **F**. Success graph for all participants.

DISCUSSION

This study evaluated the general knowledge of frequently seen ECG pathologies among ED physicians comparing with the cardiologists. The analyses revealed that GPs had the lowest accuracy in interpreting the ECGs, and ERs and EPs performed better than GPs and mostly similar to cardiologists.

The medical sciences are evolving in parallel with advances in medical equipment technologies, which also affect practice patterns and clinical applications. Nevertheless, physicians rely on technologic methods more and more than conventional diagnostic

approaches. In today's medical practices, residents and even young cardiologists are criticized for losing their ability to interpret simple ECGs and replace its importance with advanced cardiac imaging and diagnostic methods (4). This is somewhat indirectly observed in our study. The success rates in several clinical scenarios were considerably low among cardiologists, which may be as low as 16% in TCA intoxications. Of course, attributing these low levels to the inadequate ECG knowledge or relying on advanced technologies is unfair, but cardiologists are expected to have higher success in ECG interpretations.

However, not every patient presents with typical symptoms or admits to the cardiology department, and accurate cardiac evaluation is crucial at first contact in EDs, even in asymptomatic patients. Previous studies that evaluated the ECG knowledge in severe conditions among non-cardiologist physicians also revealed a significant gap between current knowledge and what it should be in this population (5). This was also a striking finding in our study. The GPs working in EDs had the lowest success rates to interpret ECGs accurately. Since appointing an EP to every ED in the country is impossible, GPs working in EDs should have adequate and appropriate knowledge and understanding of ECG to prevent misdiagnoses of cardiac pathologies. Only proper medical education and in-service trainings can achieve these expected levels of ECG literacy among physicians. There have been several efforts to rehabilitate ECG interpretation competence, of which one of the most comprehensive was the Clinical Competence Statement on Electrocardiography by American College of Cardiology and the American Heart Association (2). However, subsequent reports on this guideline declared that it was not evidence-based, and covered the topic from an emergency medicine aspect (6), which was the reason why Society for Academic Emergency Medicine did not endorse the recommendations (4).

Studies on the need for ECG training in emergency medicine generally conclude on a common point that the curriculums of residency programs should be improved (7). Unfortunately, this has not changed since the beginning of the 2000s. Those times, the residency program directors reported that they believed ERs are adequately preparing to interpret ECGs through improved teaching modalities (8). Of course, significant improvements have occurred since then. Several institutions reported that novel methods such as utilizing a checklist in ECG interpretation, particularly by the first and second year ERs, will contribute much to this goal (9). Nevertheless, there is still a considerable way to be taken, as suggested by our results.

Limitations

This study also has several limitations to consider when interpreting our results. First, this is a cross-sectional study with a limited study population, which can bias our analyses to underestimating or overestimating ECG competence among participants. Second, heterogeneous participation from multiple settings and backgrounds may decrease the power of conclusions for each participant subgroup. Third, the selection of ECG samples and clinical conditions may not reflect the distribution of admissions in daily emergency departments. Finally, since participants did not evaluate the entire clinical case but only the ECGs, our results can not be generalized in real-life scenarios in emergency healthcare services.

CONCLUSION

As shown in the study, the knowledge level of the physician groups working in the emergency department about ECG may be insufficient. Physicians working at emergency medical services should, and must, have a certain level of accurate ECG knowledge to properly diagnose both symptomatic and asymptomatic patients with possible cardiac conditions. This study puts a spotlight on the current need for ECG training in

emergency departments. This need is evident for GPs, but ERs and EPs also need improvement in ECG interpretation.

Informed Consent: Informed consent was obtained from patients who participated in this study.

Conflict of Interest: Authors declared no conflict of interest.

Financial Disclosure: Any company or institution has not financially contributed to the study.

Acknowledgements: We thank to Mike Cadogan MD and Chris Nickson MD for the ECG support and we thank to Muzaffer Bilgin PhD and Güven Özkaya PhD for the statistical support.

REFERENCES

1. Einthoven W. Weiteres über das Elektrokardiogramm. Pflüger, Arch. 1908;122:517–84.
2. Kadish AH, Buxton AE, Kennedy HL, et al. ACC/AHA clinical competence statement on electrocardiography and ambulatory electrocardiography: A report of the ACC/AHA/ACP-ASIM task force on clinical competence (ACC/AHA Committee to develop a clinical competence statement on electrocardiography and ambulatory electrocardiography) endorsed by the International Society for Holter and noninvasive electrocardiology. Circulation. 2001;104(25):3169-78.
3. Gómez-Polo JC, Higueras Nafría J, Martínez-Losas P, et al. Poor Knowledge of Potentially Lethal Electrocardiographic Patterns in Asymptomatic Patients Among Noncardiologist Physicians, and Underestimation of Their Seriousness. Rev Esp Cardiol (Engl Ed). 2017;70(6):507-8.
4. Patocka C, Turner J, Wiseman J. What adult electrocardiogram (ECG) diagnoses and/or findings do residents in emergency medicine need to know? CJEM. 2015;17(6):601-8.
5. Gómez-Polo JC, Higueras Nafría J, Martínez-Losas P, et al. Poor Knowledge of Potentially Lethal Electrocardiographic Patterns in Asymptomatic Patients Among Noncardiologist Physicians, and Underestimation of Their Seriousness. Rev Esp Cardiol (Engl Ed). 2017;70(6):507-8.
6. Michelson EA, Brady WJ. Emergency physician interpretation of the electrocardiogram. Acad Emerg Med. 2002;9(4):317-9.
7. Bilello LA, Pascheles C, Grossman SA, Chiu DT, Singleton JM, Rosen CL. Electrocardiogram interpretation: Emergency medicine residents on the front lines. Am J Emerg Med. 2019;37(5):1000-1.
8. Pines JM, Perina DG, Brady WJ. Electrocardiogram interpretation training and competency assessment in emergency medicine residency programs. Acad Emerg Med. 2004;11(9):982-4.
9. Talebian MT, Zamani MM, Toliat A, et al. Evaluation of emergency medicine residents competencies in electrocardiogram interpretation. Acta Med Iran. 2014;52(11):848-54.

Cite as: Canakci ME, Cetin M, Turgay Yıldırım Ö, Aydın MO, Altuntas G, Acar N. Assessment of Electrocardiography Knowledge Among Doctors Working in Emergency Department. Eskisehir Med J. 2021;2(2):103-10.