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Effect of CRISP Method Training on ECG Diagnosis Skills of Prehospital Medical Services Personnel

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Abstract

Aim: In critical care settings where every minute is vital, early diagnosis and timely intervention are essential for preventing complications and improving patient outcomes. Prehospital and emergency department staff must be highly trained and capable of promptly applying medical knowledge, with electrocardiography (ECG) interpretation being a core competency.

Materials and Methods: This randomized controlled trial included 176 participants divided into experimental and control groups. Baseline ECG analysis skills were assessed using a pretest. The control group received training using the classical method, while the experimental group was trained using the Cardiac Rhythm Identification for Simple People (CRISP) method. Post-training knowledge levels were evaluated through a post-test.

Results: Statistically significant improvements were observed in the experimental group in the interpretation of normal sinus rhythm, supraventricular tachycardia, atrial fibrillation, and second-degree atrioventricular blocks (Mobitz type 1 and type 2). The CRISP method demonstrated superior effectiveness compared to the classical method in diagnosing these conditions.

Conclusion: Both the classical and CRISP methods positively influenced participants' ECG analysis skills. However, the CRISP method resulted in significantly better post-test performance and proved especially effective in identifying fatal arrhythmias. Importantly, the CRISP method was not less successful than the classical method in any aspect of ECG interpretation.

Keywords: CRISP method, ECG training, ECG analysis, prehospital education

Introduction

Emergency departments and prehospital medical services are critical settings where life-threatening situations frequently arise. In these environments, rapid and accurate decision-making directly impacts patient survival rates. In scenarios where every minute counts, early diagnosis and timely intervention are essential to prevent complications and improve patient outcomes (1). Consequently, it is imperative for emergency department staff and prehospital medical personnel to be highly trained and possess the ability to swiftly apply medical knowledge.

Electrocardiography (ECG) is a pivotal tool for the rapid and accurate diagnosis of cardiac emergencies (2). ECG records the electrical activity of the heart, facilitating the swift detection of arrhythmias, myocardial infarctions, ischemic changes, and other cardiac abnormalities (2). This diagnostic tool is particularly vital for patients presenting to the emergency department with symptoms such as chest pain, enabling the assessment of the emergency's severity and the immediate initiation of appropriate treatment. The American Heart Association (AHA) recommends the prehospital acquisition and interpretation of electrocardiograms (ECGs) for suspected acute coronary syndrome symptoms. When accurately interpreted, ECGs enable the early detection of ST-

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elevation myocardial infarction and allow for the prehospital activation of the cardiac catheterization laboratory, thereby reducing total cardiac ischemic time. The rapid and accurate information provided by ECGs facilitates timely, life-saving interventions. However, the AHA has highlighted a lack of standardized protocols for prehospital ECG interpretation due to variations in training and procedures across different countries (3).

It is essential for healthcare personnel, particularly nurses and paramedics, to enhance their skills in reading and interpreting ECGs (4). Studies have demonstrated that nurses' ability to correctly interpret cardiac arrhythmias leads to reduced mortality rates (5). Unfortunately, healthcare personnel exhibit varying levels of proficiency in ECG interpretation (6). Given that healthcare professionals frequently encounter cardiac emergencies, they must swiftly identify ECG abnormalities and promptly notify a physician. Accurate ECG interpretation can significantly improve emergency care and patient outcomes. Therefore, regular training in ECG reading is crucial for enabling nurses and paramedics to perform their roles in cardiac emergencies more effectively.

The Cardiac Rhythm Identification for Simple People (CRISP) method, standing for CRISP, is a contemporary approach specifically designed for reading and interpreting ECGs (4). The primary objective of this method is to provide a step-by-step guide for rapid and effective ECG assessment.

C - Calibration: The ECG device is checked for proper calibration. This step ensures that the paper speed and voltage settings are accurate.

R - Rate: The heart rate is calculated by measuring the distance between R waves on the ECG, determining the number of heartbeats per minute.

I - Intervals: Various ECG intervals (PR, QRS, QT, etc.) are measured and assessed to determine if they fall within normal ranges.

S - Shape: Wave shapes are examined by evaluating the morphologies of the P, QRS, and T waves to identify any abnormalities.

P - Pattern: Overall patterns on the ECG are assessed to identify any ischemic changes, arrhythmias, or other pathological conditions.

The aim of this study was to evaluate the effect of CRISP training on healthcare personnel's ability to read and interpret ECGs. Specifically, we sought to determine whether the use of the CRISP method enhances the staff's ability to analyze ECG results more quickly and accurately. This evaluation aimed to demonstrate the contribution of CRISP training to the diagnostic and intervention processes in cardiac emergencies.

Materials and Methods

This study was designed as a randomized controlled trial. Ethical approval was obtained from the Non-Interventional Clinical Research Ethics Committee of İzmir Bakırçay University (decision number: 1547, date: 17.04.2024). Participants were recruited from the staff of the Aydın Provincial Health Directorate and the Provincial Ambulance Service Chief Directorate. Based on reference studies, a power analysis (G*Power) was conducted with a 90% confidence interval and an α=0.05 margin of error, estimating a required sample size of 172 participants (control group: 86, experimental group: 86). Inclusion criteria comprised individuals aged 18-65, while those working in administrative units were excluded. Participant characteristics such as age, gender, title, educational background, professional experience, region of work, and prior participation in similar training programs were assessed. Simple randomization was employed to allocate participants into control and experimental groups.

Baseline levels of ECG analysis skills were evaluated for both groups using a pre-test. Subsequently, all participants underwent ECG interpretation training. The control group received training using the classical method, which involved detailed explanations of the mechanisms underlying ECG wave formation. Arrhythmia diagnoses were introduced sequentially, with relevant information provided for each, followed by illustrative ECG examples that were reviewed with the participants. The experimental group, in contrast, received training on basic ECG concepts and was introduced to the CRISP algorithm. This was followed by the interpretation of ECG examples guided by the CRISP framework. Both training sessions were standardized in duration, lasting approximately 50 minutes.

ECG examples provided to participants included only the D2 derivation, with evaluations conducted based on this derivation. Each participant was presented with 14 ECG examples, which were used for both pre-test and post-test assessments. Scoring was based on the accurate interpretation of ECG examples, with each correct response assigned a value of one point. Total scores for the pre-test and post-test were calculated for each participant.

Statistical Analysis

Statistical analysis were conducted using IBM SPSS Statistics version 20.0 (IBM Corp., Armonk, NY). Group distributions were evaluated using the Kolmogorov-Smirnov and Shapiro-Wilk tests, as well as visual inspection of the data. Descriptive statistics were presented as medians with interquartile ranges (25^{th}-75^{th} percentiles). Comparisons between the two groups were performed using the Mann-Whitney U test, while within-group changes following the training were assessed using the Wilcoxon signed-rank test. Pearson's chi-square test was employed to evaluate associations between pre-test and post-test outcomes. When the assumptions for the Pearson chi-square test were not satisfied, Fisher's exact test was applied. Statistical significance was defined as a p-value <0.05.

Results

A total of 176 participants were included in the study. There were 89 participants in the control group and 87 in the experimental group. In terms of age, the median age is 36 (range: 29-39) for the control group and 30 (range: 26-37) for the experimental group. There was a statistically significant difference between the groups in terms of age (p<0.001). When comparing the groups based on years of professional experience, the median number of years of service was 12 (range: 9-16) for the control group and 10 (range: 9-16) for the experimental group. There was a statistically significant difference between the groups in terms of professional experience (p=0.005).

When comparing the control and experimental groups by gender, no significant difference was found between the groups (p=0.176) (Table 1). However, when comparing the groups based on prior training, a significant difference was observed between the groups (p=0.016) (Table 2).

Table 1. Gender distribution of study participants

	Gender				
	Female		Male		Total
	n	%	n	%	n
Control group	57	64.0%	32	36.0%	89
Experimental group	47	54.0%	40	46.0%	87
Total	104	59.1%	72	40.9%	176

Pearson chi-square p=0.176

Table 2. Distribution of participants with prior ECG training

	ECG training				
	No		Yes		Total
	n	%	n	%	n
Control group	57	64.0%	32	36.0%	89
Experimental group	40	46.0%	47	54.0%	87
Total	97	55.1%	79	44.9%	176

Pearson chi-square p=0.016, ECG: Electrocardiography

When comparing the pre-training knowledge levels between the experimental and control groups, no significant difference was found (p=0.366). However, a statistically significant difference was observed between the groups in the post-training comparison (p<0.001) (Graphic 1).

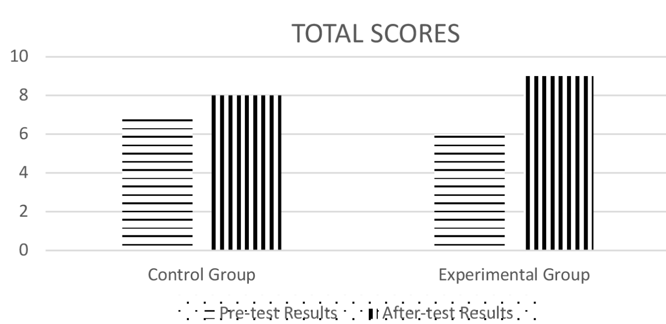
In the control group, the median score was 7 (range: 4-8) before training and increased to 8 (range: 7-10) after training. This difference was found to be statistically significant (p<0.001, Wilcoxon) (Graphic 1).

In the experimental group, the median score was 6 (range: 5-9) before training and increased to a median of 9 (range: 8-11) after training. The difference in scores before and after training was statistically significant (p<0.001) (Graphic 1).

In the pre-test phase, there was no significant difference between the experimental and control groups in the recognition of normal sinus rhythm. However, a difference was detected between the groups after training, with the experimental group showing better results. A similar situation was observed in ECG examples of supraventricular tachycardia, atrial fibrillation, second-degree Mobitz type 1, and Mobitz type 2 atrioventricular block. The CRISP training method was found to be more successful in diagnosing these conditions than the classical method.

For ECG examples of sinus bradycardia and second-degree Mobitz type 2 atrioventricular block, no statistically significant difference was observed between the experimental and control groups in the post-test. However, in the pre-test phase, the control group was less successful, indicating that CRISP training had a greater impact on these diagnoses.

No differences were found between the two training methods for the diagnosis of atrial flutter, first-degree atrioventricular block, third-degree atrioventricular block, ventricular tachycardia, ventricular fibrillation, and asystole (Table 3).



Graphic 1. Comparing scores

Table 3. Pre- and post-training evaluations

	Control group				Experimental group				p value
	Wrong		Correct		Wrong		Correct		
	n	%	n	%	n	%	n	%	
Pre-test NSR	33	37%	56	63%	37	43%	50	57%	p=0.460
Post-test NSR	18	20%	71	80%	7	8%	80	92%	p=0.021
Pretest sinus tachycardia	71	80%	18	20%	62	71%	25	29%	p=0.189
Posttest sinus tachycardia	52	58%	37	42%	42	48%	45	52%	p=0.177
Pretest sinus bradycardia	74	83%	15	17%	59	68%	28	32%	p=0.018
Pretest sinus bradycardia	50	56%	39	44%	41	47%	46	53%	p=0.229
Pre-test SVT	30	34%	59	66%	20	23%	67	77%	p=0.115
Post-test SVT	17	19%	72	81%	5	6%	82	94%	p=0.007
Pretest AF diagnosis	35	39%	54	61%	35	40%	52	60%	p=0.902
Posttest AF diagnosis	19	21%	70	79%	7	8%	80	92%	p=0.013
Pre-test Atrial Flutter	25	28%	64	72%	29	33%	58	67%	p=0.451
Post-test Atrial Flutter	8	9%	81	91%	12	14%	75	86%	p=0.315
Pre-test First-Degree AV Block	75	84%	14	16%	63	72%	24	28%	p=0.056
Posttest First-Degree AV Block	52	58%	37	42%	38	44%	49	56%	p=0.050
Pre-test Second-Degree Mobitz 1 AV Block	72	81%	17	19%	76	87%	11	13%	p=0.242
Post-test Second-Degree Mobitz 1 AV Block	76	85%	13	15%	59	68%	28	32%	p=0.006
Pre-test Second-Degree Mobitz 2 AV Block	74	83%	15	17%	61	70%	26	30%	p=0.041
Post-test Second-Degree Mobitz 2 AV Block	57	64%	32	36%	46	53%	41	47%	p=0.133
Pre-test Second-Degree Mobitz 2 AV Block	85	96%	4	4%	82	94%	5	6%	*p=0.486
Post-test Second-Degree Mobitz 2 AV Block	85	96%	4	4%	71	82%	16	18%	p=0.004
Pretest Third-Degree AV Block	77	87%	12	13%	81	93%	6	7%	p=0.149
Posttest Third-Degree AV Block	71	80%	18	20%	77	89%	10	11%	p=0.113
Pretest VT Diagnosis	15	17%	74	83%	15	17%	72	83%	p=0.966
Posttest VT Diagnosis	8	9%	81	91%	3	3%	84	97%	p=0.129
Pre-test VF	19	21%	70	79%	17	20%	70	80%	p=0.766
Post-test VF	9	10%	80	90%	3	3%	84	97%	p=0.079
Pre-test Asystole	5	6%	84	94%	2	2%	85	98%	*p=0.231
Post-test Asystole	1	1%	88	99%	2	2%	85	98%	*p=0.491

Pearson chi-square, *Fisher's exact test, NSR: Normal sinus rhythm, SVT: Supraventricular tachycardia, AF: Atrial fibrillation, AV: Atrioventricular, VT: Ventricular tachycardia, VF: Ventricular fibrillation

Discussion

ECG training plays a crucial role in the early diagnosis and treatment of critically ill patients. In this study, healthcare personnel were divided into two groups and provided ECG training. The effectiveness of the traditional training method was compared to the CRISP method. Both approaches positively impacted participants' ECG analysis skills; however, post-test results indicated that the experimental group trained with the CRISP method achieved significantly better results. Notably, there was no instance where the CRISP method was less effective than the traditional method in any aspect of ECG analysis.

Our findings revealed that the experimental group demonstrated superior recognition of normal sinus rhythm compared to the control group. This ability is critically important in avoiding misdiagnosis and preventing unnecessary or inappropriate interventions. Similarly, Gausche et al. (6) emphasized the importance of rapid, accurate, and effective diagnosis and treatment in their study evaluating the prehospital use of adenosine.

The experimental group also showed statistically significant success in identifying supraventricular tachycardia, atrial fibrillation, and second-degree Mobitz type 1 and type 2 atrioventricular block in ECG samples. These arrhythmias are among the most frequently encountered rhythm disorders in emergency and prehospital settings (7). The capacity to accurately diagnose these potentially fatal arrhythmias through the CRISP method highlights the critical importance of our study. Davis et al. (8) further supported this finding, noting that the early diagnosis of such arrhythmias through prehospital ECG evaluation has significant implications for patient management and outcomes.

Traditional lecture-based training remains the most commonly used approach to teaching ECG interpretation. However, ECG interpretation demands extensive experience and expertise (9). Traditional methods often fail to develop critical thinking and problem-solving skills in students, leaving them in a passive learning role (10).

Similar findings to our study have been reported in the literature. Çıkrıkçı et al. (11) observed that the CRISP method was more effective than traditional methods in their study on nurses, particularly in enhancing the detection of fatal arrhythmias. Additionally, alternative approaches to the CRISP method have been tested to improve ECG interpretation, with results demonstrating greater efficacy than traditional training (12). Understanding healthcare personnel's experiences and insights regarding arrhythmias is vital for assessing their skills and for tailoring effective training methods to meet their needs (13).

Study Limitations

Our study has several limitations. Although no significant difference was observed between the control and experimental groups regarding gender distribution, the groups were not homogeneous in terms of age and professional experience. These factors may have influenced the test results. Furthermore, when comparing the experimental and control groups' prior ECG training, a higher proportion of participants in the experimental group were found to have received such training. This imbalance suggests that the experimental group trained using the CRISP method may have included more participants with prior training experience, potentially extending their training duration and contributing to the higher success rates observed in this group.

Participants were assigned to groups using a randomization method, whereby individuals were randomly allocated to the training groups. However, this method did not effectively ensure group homogeneity. To address these limitations in future studies, it is essential to collect detailed demographic data when forming participant and control groups. Factors such as age, gender, professional experience, educational background, and prior training should be matched, with group assignments conducted systematically by researchers to minimize potential biases.

Conclusion

A single teaching method or format is unlikely to be universally effective in improving ECG interpretation skills. ECG interpretation is inherently challenging, requiring sustained effort to acquire and maintain proficiency (2). Nevertheless, the development of innovative and algorithmic learning techniques has yielded positive outcomes in ECG education. Our study demonstrated that the CRISP method was more effective than traditional approaches for improving ECG analysis skills.

Ethics

Ethics Committee Approval: The necessary permissions for the study were obtained from the Non-Interventional Clinical Research Ethics Committee of İzmir Bakırçay University (decision number:1547, date: 17.04.2024).

Informed Consent: Informed consent was obtained from all participants following the provision of detailed information about the study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: F.M.A., S.Y., Z.K., Concept: M.E., İ.B., Design: M.E., Ö.F.T., Data Collection or Processing: M.E., Ö.F.T., İ.B., F.M.A., S.Y., Z.K., Analysis or Interpretation: Ö.F.T., F.M.A., S.Y., Z.K., Literature Search: M.E., F.M.A., Writing: M.E., Ö.F.T.,

Conflict of Interest: No conflict of interest was declared by the authors.

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