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IS COMPUTER INTERPRETATION OF "NORMAL ECG" RELIABLE?

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Abstract: *Electrocardiographs (ECG) taken on an emergency clinic should be evaluated by emergency physician within 10 minutes. However, since the number of emergency physicians is not sufficient, physicians have to look at these ECGs during other patient examinations, which causes interruptions. Today, most ECG devices have computer-based analysis systems. Our aim is to determine how reliable the computer interpretations are to determine if patients with "Normal ECG" also need immediate attention.*

Key words**:** *Electrocardiography, Computer interpretation, emergency department*

1.Introduction

Cardiovascular diseases are the leading cause of mortality and morbidity worldwide [1]. According to World Health Organization, 30% of all deaths are originated from cardiovascular system disorders [1,2]. Electrocardiography (ECG) interpretation is an important part of the emergency and cardiology examination. According to the American Heart Association guidelines, the ECG of a patient with cardiac complaints in an emergency department should be taken and assessed as an emergency physician within 10 minutes [3]. Due to the low number of physicians in the emergency departments, separation of a doctor only for the evaluation of the ECGs will not be time and cost-effective. However, due to this fact, the physician had to evaluate the ECGs during other patients' examinations, which causes interruption of the patient examination, loss of attention. This situation may cause wrong diagnosis, treatment and even medical malpractice.

The first computer program for ECG analysis was developed in 1961 [4]. From this time, ECG analysis systems have continued to develop and most ECG devices now have ECG analysis algorithms in it and automatically give results to the physicians [5]. These algorithms report the results as "Normal ECG" or report any abnormalities that they have found at the ECG of the patients. There is a limited number of studies comparing ECG devices to physician evaluations [6-8]. The aim of this study is to determine whether the ECGs reported by the device as "normal ECG" are correct and determine the negative predictive value and sensitivity of these ECG analysis.

2.Methods

For this retrospective study all triage ECGs taken between 01.03.2018 to 31.03.2018 were evaluated. Patients under 18 years of age were excluded from the study. The ECGs were taken by using

Nihon Kohden – ECG1250K Cardiofax S Electrocardiograph and interpreted by device's analysis program. All ECGs were interpreted by the cardiology physician. The ECGs that the device interpreted as normal were separated from the abnormal ones and evaluated by the cardiologist. If the ECG device's normal interpretation differ from the cardiologist, these ECGs are then evaluated by the emergency specialist. The emergency specialist decided if these ECGs are clinically important or not. Then the diagnosis, laboratory results, follow up and treatment of these patients were investigated from hospital medical records.

Data are presented as mean ± standard deviation (SD) and as proportions for categorical variables. Confidence Intervals (CIs) were calculated using Wilson's method of CI on a proportion. The Negative Predictive Value (NPV) and sensitivity of the device's normal ECG interpretation were determined. The data were analyzed using SPSS 20.0 (IBM SPSS Ver. 20.0, IBM Corp, Armonk NY, USA).

The study was approved by the local ethics committee.

3.Results

From 01/03/2018 to 31/03/2018 at the emergency department a total of 1250 patient needed ECG interpretation so for this study 1250 patients were evaluated. 25 patients were excluded because they were under 18 years old. At the end 1225 patients were included for this study. Mean age of the patients was 53.1 ± 18.7 and 50.4% (n=618) of the population was male. 72.2% (n=884) of the ECGs were interpreted as abnormal and 27.8% (n=341) were interpreted as "normal ECG" by the ECG device. From the ECGs which the computer interpreted as normal, 5.3% (n=18) of them were assessed by cardiologist as "not normal". These 18 ECGs were also assessed by emergency specialist as abnormal. According to these results negative predictive value (NPV) of automated ECG device interpretation was 94.7% with the 95% CI= (92.3%, 97.1%) and sensitivity was 98.0% with the 95% CI= (97.1%, 98.9%). Interpretations of the cardiologist and emergency specialist of the ECGs and follow-up of the patients mentioned were shown in Table 1. Four of the patients' ECGs were interpreted as "early repolarization" and medical records showed that 3 of these patients were discharged from the emergency department after the examination and one of them was followed at the clinic and his examination and cardiac marker results were normal so he also discharged from emergency department. Other 14 patients had ST and T wave changes. All of these patients were followed at the emergency department and 13 of them discharged from the emergency department after their cardiac marker results showed no abnormality. One on the patients was hospitalized not for cardiac problems but due to ischemic cerebrovascular event.

Table 1. The cardiologist's and emergency specialist's interpretations of ECGs and follow-up results of these patients.

	Gender	Age	Cardiologist interpretation	Emergency Specialist Interpretation	Hospital Follow Up	Result
ECG1	Male	54	Early repolarization	Early repolarization	Not needed	Discharged from ED
ECG2	Male	78	D3 derivation 0,5mm ST elevation, no	Nonspecific ST changes	CK-MB and troponin results	Discharged from ED

			reciprocal change		were within limits	
ECG3	Male	52	Prominent T waves	Early repolarization	CK-MB and troponin results were within limits	Discharged from ED
ECG4	Male	71	Minimal ST depression in D2-3 derivations	Minimal ST depression in D2-3 derivations	CK-MB and troponin results were within limits	Discharged from ED
ECG5	Male	49	Minimal ST depression in anterior leads	Nonspecific ST changes	CK-MB and troponin results were within limits	Discharged from ED
ECG6	Male	67	Nonspecific ST changes	Nonspecific ST changes	CK-MB and troponin results were within limits	Discharged from ED
ECG7	Male	25	Early repolarization	Early repolarization	CK-MB and troponin results were within limits	Discharged from ED
ECG8	Male	66	Minimal ST depression in inferior leads	Minimal ST depression in inferior leads	CK-MB and troponin results were within limits	Discharged from ED
ECG9	Male	49	T wave negativity in inferior derivations	Nonspecific ST changes	CK-MB and troponin results were within limits	Discharged from ED
ECG10	Male	36	T wave negativity in D3 derivation	Nonspecific ST changes	CK-MB and troponin results were within limits	Discharged from ED

ECG11	Female	81	Minimal ST depression in anterior and inferior leads	Nonspecific ST changes and U waves	CK-MB and troponin results were within limits	Discharged from ED
ECG12	Female	22	Early repolarization	Early repolarization	Not needed	Discharged from ED
ECG13	Female	31	Biphasic T waves in anterior leads	Nonspecific ST changes	CK-MB and troponin results were within limits	Discharged from ED
ECG14	Female	54	Minimal ST depression in anterior and inferior leads	Nonspecific ST changes	CK-MB and troponin results were within limits	Discharged from ED
ECG15	Female	22	Early repolarization	Early repolarization	Not needed	Discharged from ED
ECG16	Female	70	Prominent T waves in anterior leads	Nonspecific ST changes	CK-MB and troponin results were within limits	Discharged from ED
ECG17	Female	75	Nonspecific ST changes	Nonspecific ST changes	The patient was hospitalized by neurology department due to cerebrovascular infarction	Hospitalized by neurology department
ECG18	Female	51	T wave negativity in anterior leads	Nonspecific ST changes	CK-MB and troponin results were within limits	Discharged from ED

Abbreviations: CK-MB, creatinine kinase-myocardial band; ECG, electrocardiography; ED, emergency department

According to these results negative predictive value (NPV) of automated ECG device interpretation was 94.7% with the 95% CI= (92.3%, 97.1%) and sensitivity was 98.0% with the 95% CI= (97.1%, 98.9%).

4.Discussion

Patient density and low number of doctors are major problems in the emergency departments. A small number of doctors have to deal with the intensity of the patients and determine the priority patients immediately. Cardiovascular diseases are one of the leading causes of mortality. Early detection of cardiovascular diseases reduces mortality and morbidity significantly. Therefore, these patients need to be identified early in the emergency departments. The American Heart Association guidelines state that a patient with complaints of chest pain should be prioritized in emergency departments and ECG should be taken and assessed by a physician within 10 minutes [3]. One way to ensure this proposal is to separate a doctor specifically for this job. However, this would not be possible because of the low number of emergency physicians. Normally, in the triage area, the ECG of the patient who comes with cardiac complaints is taken by the staff in charge then this ECG is taken to a doctor to evaluate if there is an emergency situation. But mostly there is no free doctor for this job so the physician has to interrupt the examination of the current patient. But the doctor will be distracted by this situation which may cause misdiagnosis or mistreatment in the long term.

Computer programs capable of ECG analysis has been in use since 1961 [4]. With the analysis systems in today's ECG devices, the ECG analysis results are given at the moment of EKG taking. Abnormal ECGs should be assessed urgently by the emergency physician. Our aim with this study was to investigate whether the ECG devices' evaluation of "Normal" were indeed normal. The result of our study showed that the negative predictive value of the ECG device was 94.7% and the sensitivity was 98.0%. A few similar studies have been done before. Hughes et al. [6] evaluated 855 patients and 26% of the ECGs were interpreted as normal by the ECG device. The negative predictive value was found to be 99% for this study. Whereas in another study conducted on pediatric patients (total number of ECGs was 294 and number of normal ECGs was 114) the detection rate of the normal ECG was 100% [7]. In these studies, all ECG changes other than normal ECG was evaluated as abnormal including minor ECG changes, non-specific ST-segment changes, etc. A high rate was also found in our study. Also none of the 18 ECGs' which were evaluated as normal by the device but evaluated as abnormal by the doctors were hospitalized in terms of cardiologic diseases. One patient was hospitalized by neurology because of a cerebrovascular event and her follow-up showed no cardiac pathology. Other 17 patients were discharged to the emergency department.

When we evaluate the results of our study and the studies done before us, it seems that it may not be necessary to evaluate the ECGs immediately if the ECG device's analysis result showed no pathologic result. In this way the emergency physician's evaluation and examination will not be interrupted for these patients. We do not suggest that the devices' analysis programs may replace the doctors but they may save time for the emergency doctors.

Major limitation of the study was the sample size. This study should be repeated with a larger study group on a longer period of time. We aim to evaluate only the "normal ECG" s but this study would be better if abnormal ECGs were also evaluated and specificity and positive predictive values were also obtained.

5.Conclusions

In conclusion the negative predictive value and sensitivity of our study suggests that ECG device's evaluation of "Normal ECG" seems to be reliable and these patients may not need immediate evaluation of the emergency physician. Our study used one ECG device type so this study should be repeated with larger number of patients and different ECG device types and computer programs.

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