

Using computerised interactive response technology to assess electrocardiographers and for aggregating diagnoses

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Abstract

The 12-lead electrocardiogram (ECG) is a crucial diagnostic tool. However, the ideal method to assess competency in ECG interpretation remains unclear. We sought to evaluate whether keypad response technology provides a rapid, interactive way to assess ECG knowledge. 75 participants were enrolled [32 (43%) Primary Care Physicians, 24 (32%) Hospital Medical Staff and 19 (25%) Nurse Practitioners]. Nineteen ECGs with 4 possible answers were interpreted. Out of 1425 possible decisions 1054 (73.9%) responses were made. Only 570/1425 (40%) of the responses were correct. Diagnostic accuracy varied (0% to 78%, mean $42\% \pm 21\%$) across the entire cohort. Participation was high, (median 83%, IQR 50%–100%). Hospital Medical Staff had significantly higher diagnostic accuracy than nurse practitioners ($50 \pm 20\%$ vs. $38 \pm 19\%$, $p = 0.04$) and Primary Care Physicians ($50 \pm 20\%$ vs. $40 \pm 21\%$, $p = 0.07$) although not significant. Interactive voting systems can be rapidly and successfully used to assess ECG interpretation. Further education is necessary to improve diagnostic accuracy. Crown Copyright © 2015 Published by Elsevier Inc. All rights reserved.

Keywords:

ECG; Diagnostic accuracy; Interactive response technology

Introduction

The 12-lead electrocardiogram (ECG) plays a crucial role in the diagnostic assessment of patients, providing diagnostic information in many clinical scenarios such as acute coronary syndromes, inherited cardiomyopathies, electrolyte abnormalities, channelopathies, drug induced abnormalities, and arrhythmias such as atrial fibrillation (AF) [1]. Therefore it is vital that anyone who is able to request an ECG should have the ability to recognise key diagnostic patterns on the ECG to provide appropriate clinical management for patients.

An ECG is performed in many different clinical areas such as Emergency Departments, Primary Care Practices, Hospital Clinics and Hospital Wards. With the development of Nurse-led acute assessment units, Primary Percutaneous Coronary Intervention (PPCI) Coordinators, Rapid Access Chest Pain Clinics and Integrated Care Pathways for AF, it is now more important for nurse practitioners to instantaneously interpret and diagnose ECG findings. Nevertheless, it has

been reported that the proficiency of ECG interpretation amongst healthcare professionals is poor [1–5].

The competency of ECG interpretation across senior, junior and community based medical staff along with other allied health professionals remains unknown. Furthermore, assessing competency amongst these groups can be difficult, due to disengagement and impracticalities [3]. For example, the traditional methods of competency assessment can be time consuming and labour intensive and the engagement between the reader and the assessor can be poor in a classroom setting. Thus, the optimal method to evaluate competency in ECG interpretation is unknown [6].

Therefore we firstly sought to determine whether an interactive keypad voting system could be used to assess ECG reading capacity amongst healthcare professionals and secondly to evaluate whether diagnostic accuracy could be calculated between groups of healthcare professionals.

Methods

To assess ECG competency a Powervote™ interactive keypad voting system with accompanying software was

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used. All responses to each of 19 questions were collated into an Excel® Spreadsheet.

To investigate the diagnostic accuracy of ECG interpretation, a number of participants were recruited from several healthcare institutions. Data collection events were held in 4 different geographical locations in Northern Ireland (UK) from January 2015 to April 2015. At each event, all participants were seated together in an auditorium and a total of 18 consecutive ECG cases were projected onto a large screen. Each voting keypad was registered and paired via Bluetooth™ to the Powervote™ Fob. The number of the keypad and designation of each participant (i.e. whether they were a Primary Care Physician, Resident or Nurse) were recorded before the session. Upon entering the auditorium each participant was given his or her designated keypad, which was pre-labelled with a unique identification number. At the start of each question, the presenter displayed and verbalised; (1) the patient case or vignette to provide context, (2) the diagnostic question and (3) the four possible answers (which were ECG interpretations). While a response to every question was not mandatory, the participants were strongly encouraged to answer every question. Participants were informed at the start of the session that all answers were anonymised. By doing so it was felt that it was more likely that the participants would provide a response for every question without fear of any humiliation. All participants were requested not to guess any answers.

At the start of each session, three ‘warm up’ questions unrelated to electrocardiography were used for calibration and to maximise participation. This ensured that all participants knew how and when to vote using the technology. It also served to validate the Bluetooth™ connection between each keypad and the Universal Serial Bus (USB) Fob.

After this initial phase, the first question assessed the interpretation methodology by which medical professionals and nursing staff read ECGs. Subsequently, the presenter consecutively displayed each of the 18 ECG cases (Supplemental Fig. 1A & B). All ECGs were displayed on standard graph paper and the machine diagnoses were concealed. After each case, the presenter would activate the system to allow participants to cast votes for their preferred interpretation within a 30 s interval. To cast a vote, each participant would register his or her vote by selecting an option on the wireless interactive keypad (options: 1, 2, 3 or 4). When a participant casts a vote, the keypad locks out and prevents the participant from casting further votes. After the 30 s interval, the system would also lock preventing any further voting. When the time has lapsed, the computer automatically aggregates the votes and displays the results to reveal the percentage of participants who selected each of the options. The nineteen questions were subdivided into different categories outlined in Table 1. Questions 2 to 18 all consisted of case scenarios. At the end of each session, the assessment data comprising of all the responses were aggregated and exported as a Comma Separated Value (CSV) file format. After each question feedback was provided to explain each ECG.

Table 1

Cases were divided into different cardiovascular topics.

Case	Type
C1	Method to read an ECG
C2–5	Ischaemia/Inflammation
C6	Pre-excitation
C7–9	Drug and Electrolyte induced changes
C10–13	Heart Block
C14–15	Cardiomyopathy
C16	Normal
C17–19	Atrial Arrhythmia

Statistical analysis

Diagnostic accuracy was calculated for each participant over each of the disease groups. The ground truth for each baseline diagnosis was determined through a consensus involving three experienced cardiologists. As the Lilliefors Test for Normality showed a non-parametric distribution, we adopted non-parametric hypothesis testing to compare the performance between the different healthcare professional cohorts and between each of the disease groups. Thus, either the Wilcoxon signed-rank or the Mann–Whitney test was used where appropriate. Statistical significance was determined when P-values <0.05. All data analysis was carried out using R-Studio™ and PRISM™.

Results

A total of 75 participants were recruited consisting of 32 (43%) Primary Care Physicians. The other 43 (57%) consisted of 24 (32%) Hospital Medical Staff and 19 (25%) Nurse Practitioners. Out of a total of 1425 possible decisions (votes/decisions that could have been cast) there were 1054 (73.9%) responses (votes cast) (Fig. 1). Of these only 570/1425 (40%) of the responses were correct (Fig. 2A & B). Diagnostic Accuracy varied widely across each of the cohorts varying from 0% to 78% with a mean of $42\% \pm 21\%$ across the entire cohort. The first of the 19 questions assessed the basic methodology by which medical and nurse professional interpret ECG, however this was answered correctly in only 40% of cases.

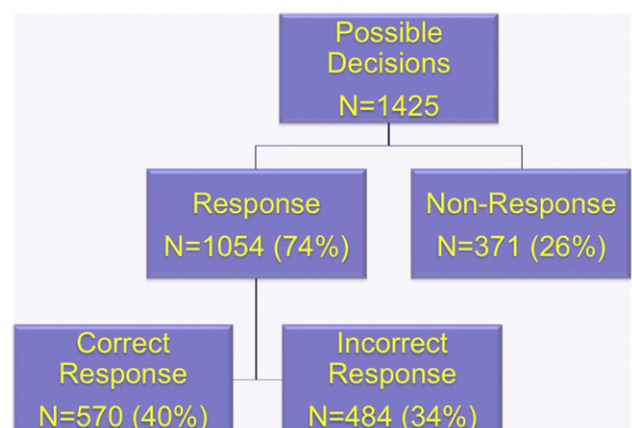


Fig. 1. Flow diagram for responses.

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