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A randomized control trial comparing use of a novel electrocardiogram simulator with traditional teaching in the acquisition of electrocardiogram interpretation skill

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Abstract

Background: Accurate interpretation of the electrocardiogram (ECG) remains an essential skill for medical students and junior doctors. While many techniques for teaching ECG interpretation are described, no single method has been shown to be superior.

Purpose: This randomized control trial is the first to investigate whether teaching ECG interpretation using a computer simulator program or traditional teaching leads to improved scores in a test of ECG interpretation among medical students and postgraduate doctors immediately after and 3 months following teaching. Participants' opinions of the program were assessed using a questionnaire.

Conclusions: There were no differences in ECG interpretation test scores immediately after or 3 months after teaching in the lecture or simulator groups. At present therefore, there is insufficient evidence to suggest that ECG simulator programs are superior to traditional teaching.

Keywords: Electrocardiogram; Teaching; Interpretation

Introduction

Accurate interpretation of the electrocardiogram (ECG) remains an essential skill for medical students and junior doctors to acquire. Though many modern ECG machines incorporate computer algorithms capable of providing computerized interpretation, these are not always accurate and must always be reviewed by a human expert [1]. The ability to accurately diagnose clinically important conditions using the ECG is crucial not just at the beginning of a doctor's career, but remains relevant across a wide range of clinical specialties.

In spite of this, numerous studies conducted within different healthcare systems have shown that ECG interpretation among both medical students [2] and junior doctors [3] is poor. Additionally, a recent review article [4] identified a wide range of options for delivering teaching of ECG interpretation including tutorials, teaching rounds, lectures, self-directed learning and Web-based learning, but no single method was found to be superior. Furthermore, while certain methods appear effective in teaching ECG interpretation in the short term, the question of which method provides the best long term retention of interpretation skills remains unanswered.

The high speed and widespread accessibility of the internet provide a platform to deliver high quality computer-based teaching programs incorporating 3-dimensional (3D) animation at a time, location and pace convenient to the learner. Accordingly, we hypothesized that medical students and junior doctors using the Epicardio Simulation™ Web-based ECG computer simulator program [5] would demonstrate better ECG interpretation skills immediately and 3 months after using the program than those who received traditional small group teaching. In this article, we present the results of a randomized control trial comparing the effectiveness of this ECG simulator to traditional small group teaching in teaching ECG interpretation to medical students and doctors in their first year of postgraduate training.

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Materials and methods

Study population

Participants in the study were UK medical students from 2 separate medical schools in their 3rd, 4th or 5th year of study and a group of junior doctors in their 1st year of postgraduate training. Care was taken to ensure that none of the medical students included had undergone any formal training in ECG interpretation during the academic year of the study. The junior doctors had a variable degree of prior experience in ECG interpretation. The purpose of having a mixed group of medical students and doctors was twofold; firstly to validate the assessment tool (as doctors would be expected to perform better than students given their level of experience) and secondly to independently validate the ECG simulator computer program.

Inclusion criteria

- Junior doctors in their first year of postgraduate training giving consent to take part in the study
- Medical students in either their 3rd, 4th or 5th year of study giving consent to take part in the study

Ethics committee permission to proceed was obtained from the University of Sheffield Medical School Research Ethics Committee (ref: 001793). NHS trusts provided permission to approach and recruit staff via the NHS Research and Development Departments. Any participant taking part in the study was able to withdraw consent at any time and without having to provide a reason, and their data were removed from the study.

Medical students were recruited on a voluntary basis after an advertisement was placed on their university message board, in accordance with the university medical ethics policy. Junior doctors were recruited on a voluntary basis during their afternoon teaching session in accordance with the hospital medical ethics policy.

Having consented to involvement in the study, participants were randomly allocated to receive 45 min of teaching in either the small group teaching arm or the ECG simulator teaching arm on the basis of a coin toss. In total, 85 were allocated to receive teaching using the ECG simulator teaching arm and 83 were allocated to the small group teaching arm.

Devising teaching materials and an appropriate test of ECG Interpretation skills

In the UK, 1st year postgraduate doctors are required to demonstrate a host of clinical competencies by the end of this training scheme which are listed in the 'Foundation Programme Curriculum' [6]. In the case of 12-lead ECG interpretation, they are expected to be able to correctly identify a normal ECG pattern, common QRS abnormalities (e.g., bundle branch block and ventricular hypertrophy), acute myocardial infarction, bradycardias, broad and narrow complex tachyarrhythmias, hyperkalemia, ventricular fibrillation and ventricular tachycardia.

These diagnoses were used as the topics taught to both the small group and ECG simulator teaching sessions. Additionally, they were used to devise 2 separate ECG interpretation tests to be taken immediately and 3 months after allocation to either the ECG simulator or small group teaching, each comprising 10 different unseen 12-lead ECG examples where participants had to choose the correct answer from a series of multiple choice options with a maximum possible score of 10. Table 1 lists the diagnoses tested in the test taken immediately after teaching.

None of the example ECGs in either test were shown to participants during teaching. The test immediately after teaching was taken under exam conditions. The test at 3 months was sent electronically to study participants via email and it was requested that they refrain from referring to notes or teaching materials during this test.

Small group teaching arm

Participants allocated to the small group teaching arm received a 45-minute tutorial on ECG interpretation comprising of a presentation on the subject with examples of 12 lead ECGs covering each diagnosis (available as supplementary material for download). Teaching was delivered by one of two experienced Cardiology Registrars, any questions asked by participants during the tutorial were answered and note-taking was allowed (though referring to notes was not allowed during the post-tutorial test).

ECG simulator teaching arm

Participants allocated to the simulator arm were given 45 min to work through an interactive computer program [5] covering ECG interpretation which consisted of example 12-lead ECGs of each diagnosis, and an interactive 3D animation of the conductive tissue of the heart and free text explanations of each diagnosis. Each participant had his/her own computer to complete the program and used the software in isolation. Participants were not permitted to ask facilitators questions regarding ECG interpretation (technical issues regarding the software were answered). Note-taking was allowed, but referring to these during the test was not. Participants allocated to this arm were given a password allowing them to access the software at any point in the 3 months following the initial teaching session if they wished, however, they were not obliged to. The software was developed independently of the study research team by an

Table 1
Diagnoses tested in the test taken immediately after teaching.

Question number	Diagnosis tested
1	Normal sinus rhythm
2	Right bundle branch block
3	Inferior ST-segment elevation
4	Mobitz type 2 2:1 atrioventricular block
5	Atrial flutter
6	Ventricular tachycardia
7	Hyperkalemia
8	Left ventricular hypertrophy
9	Ventricular fibrillation
10	Sinus bradycardia