How can we improve teaching of ECG interpretation skills? Findings from a prospective randomised trial

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Abstract

Background: There is an ongoing debate on how ECG interpretation should be taught during undergraduate medical training. This study addressed the impact of teaching format, examination consequences and student motivation on skills retention.

Methods: A total of 493 fourth-year medical students participated in a six-group, partially randomised trial. Students received three levels of teaching intensity: self-directed learning (2 groups), lectures (2 groups) or small-group peer-teaching (2 groups). On each level of teaching intensity, end-of-course written examinations (ECG exit exam) were summative in one group and formative in the other. Learning outcome was assessed in a retention test two months later.

Results: Retention test scores were predicted by summative assessments (adjusted beta 4.08; 95% CI 1.39–6.78) but not by the type of teaching. Overall performance levels and motivation did not predict performance decrease or skills retention.

Conclusions: Summative assessments increase medium-term retention of ECG interpretation skills, irrespective of instructional format.

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Introduction

Electrocardiogram (ECG) interpretation is an important clinical skill as it allows rapid diagnosis of potentially life-threatening diseases [1]. According to the European Society of Cardiology's guideline for the management of acute myocardial infarction [2], the time taken between the first medical contact and the recording of the first ECG is a good index of the quality of care and should not exceed 10 min. In addition to swiftness, accuracy of the diagnosis derived from an ECG tracing is key to patient outcome [3]. Given that cardiovascular disease is highly prevalent [4], physicians of any specialty need to be familiar with the basic principles of ECG interpretation and must be capable of identifying important diagnoses. However, concerns have been raised that in many countries physicians lack these basic skills [5,6]. One potential reason for this may be a

failure of medical education to equip physicians with the knowledge and skills required to interpret an ECG. In fact, a recent survey among German medical school graduates revealed that 60% felt inadequately prepared for post-graduate training. Specifically, student replies indicated deficits in the ability to read an ECG [7]. Similar findings have been reported for graduates in New Zealand [8].

Numerous studies have addressed the question of how best to teach ECG interpretation skills [9–12]. A recent review of these studies [13] concluded that based on the available evidence, 'no single method or format of teaching is most effective in delivering ECG interpretation skills'. The authors noted that in most studies, learning outcome was assessed either shortly after or immediately after teaching and called for more research on the impact of teaching interventions on medium- and long-term skills retention.

Recent research [14] indicated that the consequences of a final exam (i.e. whether it generates a grade and can be failed ('summative') or just provides some feedback ('formative')) might outweigh any effect of teaching interventions carefully tailored to help students learn how to read an ECG.

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However, in that study students were aware of exam consequences, and it may be hypothesised that students taking a formative exam could have scored higher but did not feel incentivised to put much effort into the exam as they could not fail it. In addition, this study only assessed short-term learning outcome.

The primary aim of this study was to examine the effect of teaching intensity (peer teaching, lectures or self-directed learning, SDL) and examination consequences (summative versus formative) on medium-term retention of ECG interpretation skills (two months after the end of teaching). In addition, we aimed at identifying predictors of the change in student performance levels between the end of the teaching module and the retention test. We hypothesised summative exams to have a significant effect on skill retention but expected more intensive teaching to be associated with a lesser degree of performance decline towards the retention test.

Methods

Study design

This is a follow-up study of an earlier trial on the effect of teaching interventions and exam consequences on short-term learning outcome regarding ECG interpretation skills. Details on the design of this six-group (3 × 2), partially randomised and single-blinded trial can be found elsewhere [14]. In brief, four consecutive cohorts of fourth-year medical students enrolled in a six-week cardio-respiratory module at Göttingen Medical School were included in the trial. All students were provided with a written guide to ECG interpretation and were invited to attend three introductory lectures during which electrophysiological principles and the basics of ECG interpretation were discussed. Following this, students were either asked to work through the written ECG guide and practice their interpretation skills on the 40 tracings provided therein (reference condition: SDL), or they were randomised to either receive eight lectures on specific diagnoses or participate in eight small-group teaching sessions facilitated by more advanced medical students ('peer teachers') who had received specific teacher training [15]. The content addressed (i.e. the ECG tracings discussed during sessions) was identical on all three levels of teaching intensity. While students in the SDL condition did not receive any additional formal instruction, students attending lectures were shown how to interpret the 40 ECG tracings contained in the written guide (five ECGs per session, organised in sections on stable coronary artery disease, acute myocardial infarction, ventricular hypertrophy, bundle branch blocks, bradycardia, tachycardia, miscellaneous findings and a summary section). Students allocated to small-group teaching were asked to discuss the same tracings and arrive at their own findings, supported by their respective peer teacher. Tracings in the written guide were not accompanied by information on the clinical context in order to avoid cueing effects. Correct ECG interpretations were available to all students in an online repository.

Initial performance levels were assessed in a written ECG exam held on the first day of the module (entry exam). During the last week of the cardio-respiratory module, students sat an ECG exit exam that was either summative (first and third cohort) or formative (second and fourth cohort; see [14] for details). Summative exams generated credit points relevant for students' overall marks at the end of undergraduate medical education while, following a formative exam, students were merely provided with the total score they had achieved. The study was partially randomised as we were unable to randomise exit exam consequences within cohorts, i.e. exam consequences were manipulated for entire cohorts, and students were aware of the nature of the exit exam (summative vs. formative). Thus, randomisation of three levels of teaching format within cohorts and the allocation of two different exams between cohorts resulted in a total of (2 × 3) six study groups. Only one-half of the final cohort (summer 2010) was included due to the other half being invited to participate in a different study in which exit ECG performance was incentivised financially. Since this was expected to impact on exam performance, these students were excluded from the present analysis.

Medium-term retention of ECG interpretation skills was assessed in an unannounced retention test that occurred eight weeks after the end of the cardio-respiratory module. Participation in the retention test was incentivised by giving all students (regardless of teaching intensity during the module or examination consequences in the ECG exit exam) the opportunity to score two bonus credit points for general medicine if they achieved half of all available raw points.

Assessment tools

Tracings of ECGs with medically important findings were used for the three ECG assessments. The entry exam, exit exam and retention test consisted of three, five and two tracings, respectively. Students were asked to provide a full written interpretation of rhythm, rate, axis, conduction times, signs of hypertrophy and ST segment abnormalities. Their entries were compared to correct interpretations provided by expert electrocardiographers, and a total of 10 raw points was available for each tracing. In order to avoid cueing, different tracings were used for each exam, but the same exams were used in all four student cohorts. The main findings in the entry exam were a normal ECG, an AV block I° with right bundle branch block and a STEMI. Main findings of the ECGs presented in the exit exam were Mobitz II° AV block, STEMI, atrial fibrillation, left ventricular hypertrophy and QT prolongation. Tracings used in the retention test featured tachyarrhythmia with left bundle branch block and acute right heart strain, both of which require urgent medical attention. None of these tracings were available to students or teachers (lecturers/peer teachers), and ECGs used for assessments were not included in the written ECG guide. Two raters blinded to student identity independently scored exams, and inter-rater agreement was high (weighted kappa >0.9 for all three exams).

In order to adjust our analysis for general performance levels, we also obtained student scores achieved in a