

Online Training on 'ECG Interpretation' for Intern Doctors and Residents – A Pilot Curriculum

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Abstract

Diagnostics plays a vital role in medical knowledge, with the electrocardiogram (ECG) being one of the most important yet challenging diagnostic tools to teach in clinical education. Intern doctors and residents are typically tasked with the initial interpretation of ECGs and need to make treatment decisions based on their evaluations. However, as these learners embark on their training, there can be considerable variation in their proficiency in ECG interpretation. Incorrect ECG assessments often negatively impact clinical decision-making and result in unfavourable patient outcomes. Therefore, we have designed and developed an online training curriculum on 'ECG Interpretation' based on 6 modules targeting intern doctors and residents. Using digital technology has become increasingly prominent and gained popularity among learners (e.g., e-learning) in our country; medical education is not an exception, too. Hence, we have taken this opportunity to incorporate the use of technology as well as different open access resources (that fit within the curriculum) to allow our learners to explore and practice the different elements of ECG and its interpretation. Our curriculum has been designed in a manner that can make ECG teaching easy and accessible, with a range of videos, interactive materials, and practical examples to guide medical interns and residents through the process. Though our target audience initially are intern doctors and residents, anyone from health professions having a keen interest in ECG (as a diagnostic tool) can join the training in future to enhance his/her knowledge and expertise in ECG interpretation. This training would be more effective if coordination among medical colleges and other higher training institutions of the country is ensured; such innovative approach may encourage other medical faculties to come up with more similar short courses in online platform to help us expand proper knowledge, skill and attitude among intern doctors and residents.

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Introduction

The ability to accurately interpret electrocardiogram (ECG) is an essential skill in clinical medicine, as abnormalities in ECG readings can often be an early indication of serious cardiac problems.¹ Intern doctors and residents are typically tasked with the initial interpretation of ECGs and need to make treatment decisions based on their evaluations. However, as these learners embark on their training, there can be considerable variation in their proficiency in ECG interpretation.²

Diagnostics plays a vital role in medical knowledge, with the electrocardiogram (ECG) being one of the most important yet challenging diagnostic tools to teach in clinical education.³ As a fundamental component of clinical practice, the ECG is crucial for identifying different cardiovascular conditions. However, the abstract theoretical concepts

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associated with ECGs, along with their scattered and complexity of contents, create significant obstacles for both educators and learners.^{3,4} Achieving proficiency in ECG interpretation requires an understanding of lead placements, the relationship between pathophysiology and ECG findings, and the clinical importance of various parameters such as heart rate, rhythm, axis, electrical conduction, amplitude, and ECG abnormalities.³⁻⁵ Our experience during bedside teaching in the hospital wards has revealed that the difficulty of comprehending the theoretical knowledge often leads students to depend on rote memorization, which can result in misunderstandings and mistakes in ECG interpretation. Besides, many learners exhibit a lack of enthusiasm for studying ECGs, and the subject's reputation as a complex topic may lead some to resist learning it or even abandon it entirely.⁵ Moreover, the lack of standardized ECG instruction makes many of the intern doctors and residents feel uncertain about their achieved knowledge and skills at undergraduate level, contributing to low accuracy during their hospital duties.^{6,7} If these issues remain unresolved, ECG education may fall short of established teaching standards, potentially affecting our trainees' abilities to accurately interpret ECGs in their future clinical practice. Therefore, it is crucial to re-evaluate traditional teaching methods and develop innovative approaches to improve the quality of ECG instruction.^{4,6}

In response to similar challenges in our settings, we have designed and developed an online training curriculum on 'ECG interpretation', to offer residents a structured e-learning experience, encourage peer teaching, and link ECG interpretation with the clinical management of patients in hospital settings. Given the growing importance of technology, it is vital for

clinical educators to acknowledge the potential of digital platforms to facilitate effective teaching and enhance student engagement.⁶ Our pilot curriculum addresses these issues, emphasizing both the content and the timing of instruction to optimize learning outcomes.

Methods

We adopted the "six-step approach" to curriculum development⁸ (Fig.1).

- 1) Problem Identification:** Our process commenced with identifying the problem, which involved reviewing existing literature on ECG education and analyzing the current local curriculum. This review revealed a lack of standardization in teaching and ambiguous objectives related to the varying training levels of learners. These issues were apparent across all stages of training – undergraduate, postgraduate, and in-practice – but this online training programme specifically targets the needs of intern doctors and residents. The programme's goals and objectives, along with a systematic approach to ECG interpretation, were crafted based on feedback obtained during the needs assessment (i.e., the second step).
- 2) Needs Assessment:** The targeted needs assessment included a short survey among randomly selected intern doctors and residents from three government medical college hospitals to pinpoint gaps in their ECG education and their preferences for instructional methods. Important aspects emerged from the survey included the need for more targeted instruction utilizing a systematic approach to ECG interpretation, to identify common and critical diagnoses, and the

application of ECGs to evaluate common emergency presentations (e.g., syncope, ischaemia, arrhythmias etc.).

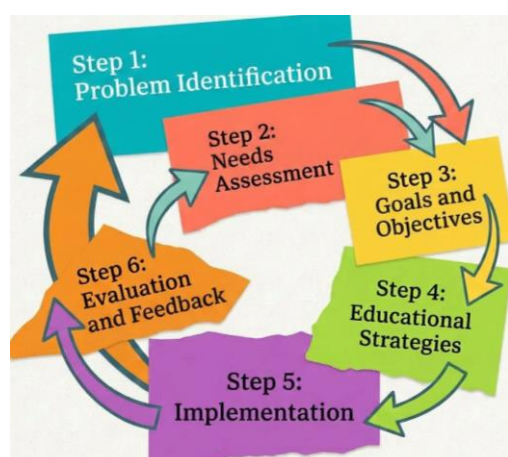


Fig. 1: Steps of curriculum development (modified from Kern).⁸

3) Goals and Objectives: The goal of this training is to provide the theoretical knowledge and the practical competencies required to *interpret ECG through a systematic approach* and correlate the findings with the other clinical evidence in emergency clinical management. Our objectives described that the trainee(s) will be able to:

- i) Describe the normal anatomy and physiology of electrical conduction through the heart;
- ii) Identify and relate waveforms to the cardiac cycle;
- iii) Understand the different lead placements and purpose of each placement;
- iv) Utilize a systematic process when approaching the interpretation of the ECG;
- v) Identify normal and abnormal components on ECG
- vi) Recognize sinus, atrial, junctional and ventricular dysrhythmia on ECG and relate cause, significance, symptoms and treatment (interpretation of ECG and clinical correlation).

4) Educational Strategy: We have included contents based on standard guidelines,⁹ and methods including synchronized didactic lectures, along with asynchronized reading materials, videos, open access resources, peer-learning through discussions, and practice sessions. A total of 6 modules have been included. Each module has specific lesson plan and assessments. Initially duration of the training course is limited to 6 weeks. Case-based learning format is also introduced here

We have mentioned earlier that we have designed 6 comprehensive, progressive, step-wise modules for our learners. These are as follows:

Module 1 – Anatomy and Electrophysiology of the Heart: Cardiac conduction system, cardiac cycle and wave components (P,QRS,T,U).

Module 2 – Technical Aspects and Troubleshooting: Lead placement, properly recording an ECG, troubleshooting, and understanding calibration.

Module 3 – Systematic Interpretation: Developing a method for analyzing rate, rhythm, axis, and intervals.

Module 4 – Basic Rhythms and Dysrhythmias: Sinus rhythms, tachycardia, bradycardia, and common atrial/junctional rhythms.

Module 5 – Advanced Rhythms Abnormalities: Heart blocks (1st, 2nd, 3rd-degree), ventricular dysrhythmias, and AV blocks.

Module 6 – 12-Lead Interpretation: Identifying ischaemia, infarction, bundle branch blocks, hypertrophy and other disorders.

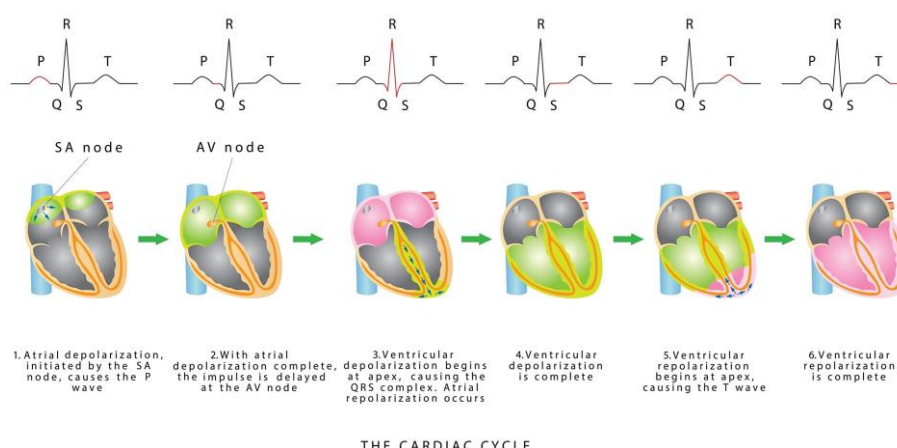


Fig. 2: A sample of content of didactic lecture from Module 1.

5) Implementation: We have adopted virtual platform of 'Canvas' to launch this training. We have also added pre-module reading materials, a synchronous supervised group teaching (with didactic lecture) (Fig. 2), asynchronous practice session, and discussion board for peer-learning and problem solving in our virtual training.¹⁰ We have added different types of assessments including quizzes in the forms of multiple choice questions (MCQs) and single best answer (SBA) questions. Besides, learners have to complete short answer questions (SAQs) and objective structured practical examination (OSPE) on pathophysiology of heart, cardiac cycle, elements of ECG, interpretation of ECG and clinical correlation in different modules of the training.^{7,11}

6) Evaluation and Feedback: To evaluate effectiveness of the curriculum, we have provisions of pre- and post-tests for the participants after completion of each module. (based on self reporting of personal competences, confidence and satisfaction level and any concern regarding contents and suggestion for modification/improvement of the module). Here, pre- and post- tests are adopted with a 5-point Likert scale to see their evolution in

knowledge, skills and attitudes.¹⁰

Results and Discussion

Interpreting ECGs is an essential clinical skill that medical students must develop during their undergraduate training and continue to refine throughout their internship and residency programmes. This skill is particularly vital in emergency medicine, where timely decision-making can profoundly influence the care of critically ill patients.^{2,6,11} Traditionally, ECG training has focused on rote memorization and pattern recognition, often overlooking a thorough understanding of the underlying pathophysiology and clinical implications. Consequently, many residents resort to self-directed study and clinical experiences to improve their ECG interpretation skills, which can be challenging given their demanding schedules and various educational obligations, leading to anxiety regarding ECG interpretation.^{1,6,7,12}

Interpreting ECGs involves a complex integration of knowledge in anatomy, electrophysiology, and pathophysiology, along with visual pattern recognition

and diagnostic reasoning. As a result, medical educators must be prepared to assess their students' ECG interpretation capabilities.^{7,13} In today's digital age, the complexities of ECG analysis have led many learners to rely on automated interpretation systems or AI tools. However, these technologies still require physicians to be able to accurately interpret and respond to the information provided to make critical diagnoses, as there is a significant risk of errors.¹¹ To prepare medical students for proficient ECG interpretation, a new educational approach is necessary – one that emphasizes fundamental ECG concepts while going beyond simple pattern recognition.^{11,13}

As we have shifted from conventional learning methods to a digital education environment since the COVID-19 pandemics, it is becoming increasingly essential to assess online learning options. An effective online educational program should offer high-quality, evidence-based content that captures students' interest.¹⁴ Additionally, it should facilitate asynchronous and personalized learning, tailor educational tasks to match learners' experience and skill levels, monitor and document their progress, create individualized reports aligned with specific learning objectives, and provide learners with direct access to subject matter experts, all within a digital platform.^{14,15}

Strengths: We have tried to make a well-designed (both synchronus and asynchronus), interactive and engaging lesson plans with the help of many senior medical educators of the country, available evidence and online resources that seem to be helpful for the participants to understand the goals of those instructional modules and achieve maximum. We also have tried to align the curriculum to meet the required competences suggested by the American College of

Physicians (ACP).⁹ Moreover, those instructional materials align with the proposed assessments. Then, we have tried to align the assessment with the learning goals (for each module).^{7,16} Authentic assessment procedure was followed in terms of performance assessment of the learners using real-world contexts.¹⁷ Moreover, it has been created with a technical guidance of Centre for Medical Education (CME), under the Directorate General of Medical Education (DGME), Dhaka, Bangladesh and Health Research Initiatives – a north-south partnership in education and training for the health professionals. We have maintained backup for scalability (maintenance and upscaling the contents and technology when needed) and accessibility in terms of equality in access, navigation, and comprehension of learning materials on smartphones, tablets, laptops or PCs (if anyone needs any visual, auditory, motor, or cognitive accommodation).^{18,19}

Limitations: The most effective method for teaching interns and residents to attain competency in ECG interpretation is still a subject of discussion, with significant differences in the ways they currently learn and varying degrees of success with existing teaching techniques.²⁰ However, as a pilot study, this curriculum for training is restricted initially to the participants from two government medical colleges in Bangladesh. We could not engage all other stakeholders, e.g., CCU nurses, technicians, administrators during curriculum development. Moreover, it is based on western method of training and may skip addressing and integrating local perspectives regarding case scenarios and practice. We could not avail a co-creation model for this curriculum (which could be more effective),²¹ because of time and budget constraints and an institutional top-down approach during curriculum development.

Conclusion

We know that medical interns and residents are always going to interact in the digital world and they need to use new technologies in an appropriate manner to create better learning environments, materials, and networks. Hence, we took this opportunity to incorporate the use of technology as well as different open access resources (that fit within the curriculum) to allow our learners to explore and practice the different elements of ECG interpretation. Our curriculum was designed in a manner that can make ECG teaching easy and accessible, with a range of videos, interactive materials, and practical examples to guide medical interns and residents through the process. Though our target audience initially are intern doctors and residents, anyone from health profession having a keen interest in ECG (as a diagnostic tool) can join the training in future to help expand his/her knowledge and expertise in ECG interpretation. This training would be more effective if coordination among medical colleges and other higher training institutions of the country is ensured; that will also encourage other medical faculties to come up with more similar short courses in online platform to help us expand proper knowledge, skill and attitude among intern doctors and residents.

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