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CLINICAL RESEARCH STUDY

# Competency in electrocardiogram interpretation among internal medicine and emergency medicine residents

**Jeffrey S. Berger, MD,[a] Lewis Eisen, MD,[a] Valerie Nozad, DO,[a] John D'Angelo, DO,[b] Yvette Calderon, MD,[c] David L. Brown, MD,[a,d] Paul Schweitzer, MD[a]**

[a]*From the Department of Internal Medicine and*
[b]*Department of Emergency Medicine, Beth Israel Medical Center, New York, New York, and the*
[c]*Department of Emergency Medicine and*
[d]*Department of Epidemiology, Albert Einstein College of Medicine, New York, New York.*

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**ABSTRACT**

**PURPOSE:** Accurate interpretation of the electrocardiogram is critical, yet there are no evidence-based guidelines for assessing competency. Our study evaluated the ability of internal medicine residents and emergency medicine residents to interpret a variety of electrocardiograms.

**METHODS:** The 120 participants included 87 internal medicine residents and 33 emergency medicine residents at two hospitals. Participants reported their sex, training level, adequacy of training, career interest in cardiology, and estimated electrocardiogram proficiency. They then took a test containing 12 electrocardiograms and recorded their diagnosis and certainty. Two cardiologists independently established the correct diagnoses. Two blinded, independent graders scored each electrocardiogram (0 = incorrect, 1 = partially correct, 2 = correct).

**RESULTS:** The median proficiency was 6 out of 10, total electrocardiogram score was 15 of 24, and certainty was 33 of 48. There was no significant difference in overall competency between emergency medicine and internal medicine residents (14.0 vs 15.0, $P = 0.239$). Internal medicine residents interested in a cardiology career scored higher than those not interested in a cardiology career (17.3 vs. 14.1, $P = 0.003$). When analyzing the most critical diagnoses, we found that the mean score for ventricular tachycardia was 1.6 of 2.0, for myocardial infarction was 1.3 of 2.0, and for complete heart block was 0.8 of 2.0. Over half of the participants felt their electrocardiogram training was inadequate.

**CONCLUSION:** Despite improvement in interpretation with clinical experience, overall performance was low. Research is needed to find optimal methods to improve electrocardiogram competency.


Electrocardiography is the most commonly used procedure for the diagnosis of heart disease.[1] Electrocardiographic abnormalities may be the first indication of ischemia, metabolic disturbance, or life-threatening arrhythmia.[1] While the electrocardiogram is a powerful tool, prior studies have shown that faulty interpretations can lead to inappropriate clinical decisions.[2,3] Therefore, electrocardiogram training is an essential part of graduate medical education.

Both the American Boards of Internal Medicine and Emergency Medicine have a general requirement for house staff training in electrocardiography.[4,5] Despite this requirement, only 21% of emergency medicine programs test for electrocardiogram competency and only

Requests for reprints should be addressed to Jeffrey S. Berger, MD, Division of Internal Medicine, Beth Israel Medical Center, Baird Hall 20th Floor, First Avenue at 16th Street, New York, NY 10003, or
E-mail address: jberger@chpnet.org.

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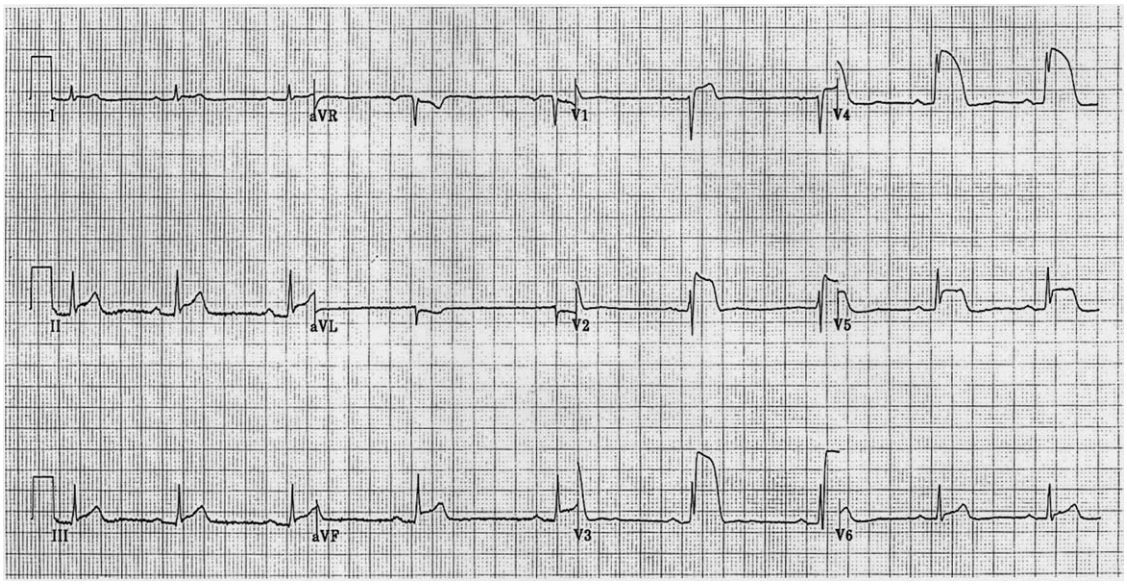


**Figure 1** Acute myocardial infarction.

12% require residents to demonstrate competency to graduate.[5] Estimates of the number of electrocardiograms that must be read in order to become competent vary widely from 100 to 800.[6,7] While several organizations stress the importance of electrocardiogram interpretation, there is insufficient data explaining how competency should be achieved or assessed.[8] Moreover, factors associated with successful electrocardiogram interpretation are largely unknown.

We have conducted a study to evaluate the ability of internal medicine residents and emergency medicine residents to interpret a variety of electrocardiograms. The aims of this study were to identify specific factors that are associated with successful electrocardiogram interpretation, differences between emergency medicine and internal medicine interpretations of electrocardiograms, and particular weaknesses that can be targeted for further instruction.

## Methods

### Study design

Two authors selected 12 electrocardiograms from the teaching file of an internal medicine training program. The electrocardiograms were chosen as representative examples of conditions that an internal medicine or emergency medicine house officer should be able to diagnose. Specifically chosen were 3 examples of electrocardiographic emergencies – myocardial infarction (Figure 1), ventricular tachycardia (Figure 2), and complete heart block (Figure 3).

All the electrocardiograms were reviewed independently by 2 experts in the field of cardiology with a subspecialty interest in the field of electrophysiology. The experts were asked to give a diagnosis or differential diagnosis for each electrocardiogram. They were blinded to any demographic data, clinical information, or previous electrocardiograms. Each electrocardiogram had only one correct primary diagnosis, as well as a short list of secondary findings. There were no disagreements between the experts about the diagnoses. Table 1 lists the electrocardiograms included in the study.

Standard electrocardiographic training took place at both hospital sites. For internal medicine residents, didactic sessions include a monthly conference led by a cardiology attending where an average of 12 electrocardiograms are reviewed and a monthly conference led by a chief resident where an average of 20 electrocardiograms are reviewed. The most intense cardiology experience consists of 2 telemetry ward months during the first and third years and 5 critical care months during the course of residency training. During each of these months, internal medicine residents review an average of 100 electrocardiograms under the supervision of an attending cardiologist or critical care specialist. In addition, residents are exposed to electrocardiograms on other inpatient rotations, outpatient rotations, and electives. Residents particularly interested in cardiology may engage in additional activities, including computer-based instruction modules, textbooks and formal cardiology electives.

During a 12-hour shift, an emergency medicine resident might review over 10 electrocardiograms. During each month in the emergency department, they interpret an average of 150 electrocardiograms under the supervision of an attending physician. In addition, they receive additional training during the 1 month a year that they spend in an intensive care unit. Instruction in electrocardiogram interpretation is also supplemented by didactic lectures and computer-based instruction.

Participants in this study included current internal medicine and emergency medicine residents. Each par-