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Education

A NOVEL TOOL FOR ASSESSMENT OF EMERGENCY MEDICINE RESIDENT SKILL IN DETERMINING DIAGNOSIS AND MANAGEMENT FOR EMERGENT ELECTROCARDIOGRAMS: A MULTICENTER STUDY

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☐ **Abstract—Background: Reading emergent electrocardiograms (ECGs) is one of the emergency physician's most crucial tasks, yet no well-validated tool exists to measure resident competence in this skill. Objectives: To assess validity of a novel tool measuring emergency medicine resident competency for interpreting, and responding to, critical ECGs. In addition, we aim to observe trends in this skill for resident physicians at different levels of training. Methods: This is a multi-center, prospective study of postgraduate year (PGY) 1–4 residents at five emergency medicine (EM) residency programs in the United States. An assessment tool was created that asks the physician to identify either the ECG diagnosis or the best immediate management. Results: One hundred thirteen EM residents from five EM residency programs submitted completed assessment surveys, including 43 PGY-1s, 33 PGY-2s, and 37 PGY-3/4s. PGY-3/4s averaged 74.6% correct (95% confidence interval [CI] 70.9–78.4) and performed significantly better than PGY-1s, who averaged 63.2% correct (95% CI 58.0–68.3). PGY-2s averaged 69.0% (95% CI 62.2–73.7). Year-to-year differences were more pronounced in management than in diagnosis. Conclusions: Residency training in EM seems to be associated with improved ability to interpret "critical" ECGs as measured by our assessment tool. This lends validity evidence for the tool by correlating with a previously observed association between residency training and improved ECG interpretation. Resident skill in ECG interpretation remains less than ideal. Creation of this sort of tool may allow programs to assess resident performance as well as evaluate interventions designed to improve competency.**

☐ **Keywords—emergency electrocardiography; residency education; educational assessments**

INTRODUCTION

Each year, approximately 8 million patients seek emergency department (ED) care for the chief complaint of chest pain (1). In addition, many other common chief complaints, including syncope and dyspnea, also require electrocardiograms (ECGs) for immediate diagnosis of life-threatening illness. Electrocardiography has thus developed into one of the most frequently obtained diagnostic tools in today's medical practice (2).

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Timely and accurate recognition of high-risk ECGs is an essential skill for emergency physicians, as is taking the most appropriate action in response. Training aimed at achieving competence in the interpretation of high-risk ECGs has traditionally been approached through the apprenticeship model of real-world ED experience, combined with lectures and small group sessions (3). Although emergency medicine residency training seems to improve ECG interpretation, the diagnosis of life-threatening pathology evident on ECG still remains suboptimal among resident physicians (4–8). Despite these known deficiencies, a significant percentage of residency programs, as high as 35% of programs in one study, lack a formal ECG curriculum (9). The majority have no method to assess ECG competency, with only about one in four having a formal mechanism in place, according to one survey (3). To our knowledge, no tool designed to assess emergency physicians' ability to interpret and respond to critical ECGs has been evaluated in a multicenter trial.

To begin addressing this need, the study authors created a tool to assess the interpretation of critical ECGs by emergency medicine (EM) residents. The purpose of this study was to conduct a multicenter trial to assess validity of this tool, originally developed at a single center, and to estimate resident physician skill at interpreting and responding to emergent ECGs.

METHODS

This is a multicenter, prospective study of postgraduate year (PGY) 1–4 residents at five EM residency programs in the United States. Because no agreed-upon standard for "critical" ECG diagnoses has been established for EM, we attempted to define one. "Critical" ECG diagnoses were defined as those for which emergency physicians must take immediate action to treat or avoid a life threat, such as myocardial infarction or unstable dysrhythmia. The scope of "critical" ECG diagnoses was first agreed upon by study authors, and then tested against agreement of two nationally recognized experts in emergency electrocardiography to establish content validity. Critical diagnoses included: ventricular fibrillation, ventricular tachycardia, atrial fibrillation with rapid ventricular response, atrial flutter with rapid ventricular response, atrioventricular nodal re-entrant tachycardia or atrioventricular re-entrant tachycardia, anterior ST-elevation myocardial infarction, inferior ST-elevation myocardial infarction, posterior ST–elevation myocardial infarction, Wolff-Parkinson-White syndrome, second-degree atrioventricular block type II, third-degree atrioventricular block, ST depressions, hyperkalemia pattern, left-bundle branch block-associated myocardial infarction, and Brugada syndrome. Examples of these ECGs were identified from chart review and Internet search, each of which was assessed for validity by unanimous agreement of a panel of three emergency physicians. An assessment tool was then created, which asks the physician to identify either the best ECG diagnosis or the best immediate management of the condition reflected on the ECG. The question bank for this tool included three representative ECGs from each "critical" category, as well as three examples of an entirely normal ECG, designated "normal sinus rhythm" for testing purposes. These normal ECGs were included to prevent the learner from automatically assuming a critical diagnosis was present on a given question. Each representative ECG was assigned to one diagnosis question and one management question. Thus, three diagnosis questions and three management questions were generated for each critical diagnosis and for normal sinus rhythm. The resulting question bank included 96 questions (six for each of 15 critical diagnoses plus six for normal sinus rhythm). To mimic actual EM practice, all major ECG diagnoses and most possible responses to important ECG findings were provided as possible answers to every question in a multiple choice format. Figure 1 contains an example question.

Prior to the resident assessment, an Angoff estimate of a minimum passing score was determined. The Angoff method is an accepted way to generate an initial passing standard for a test intended to measure competence. To create a passing standard, a panel of experts is asked to estimate the likelihood that a borderline-competent, graduating trainee would answer a given question correctly (10). Six board-certified emergency physicians were polled using the tool, and their collective responses yielded an estimated passing score of 73%.

The tool was first piloted at a single EM residency program among PGY 1–4 residents. The pilot resulted in an average of 65% of questions answered correctly. After the pilot, questions and ECGs were again reviewed for accuracy, including the input of residents who had taken the assessment, to ensure that their response process matched the intent of the test. After institutional review board approval at each of the five sites, each resident was given the assessment tool, consisting of 25 randomly selected ECG questions from the total pool of 96. Because normal ECGs (those considered "normal sinus rhythm" for testing purposes) represented six of the 96 possible questions, residents received, on average, 93.75% critical ECGs and 6.25% normal ECGs. An illustration of the composition of the question bank from which the assessment was sampled is given in Figure 2. Testing was conducted on Qualtrics© (Qualtrics, Provo UT, copyright 2015), an Internet-based survey program. All active residents at each site were solicited for participation via