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Electrocardiogram interpretation: Emergency medicine residents on the front lines

Electrocardiogram (ECG) interpretation skills represent an important diagnostic tool we impart to new generations of trainees. It is essential to patient care, diagnostic treatment plans and national hospital quality metrics [1,2]. This burden lies heavily on emergency medicine (EM) physicians, thus, ECG interpretation skills are an essential component of EM residency education.

The American College of Cardiology (ACC) and American Heart Association (AHA) have developed curricula regarding ECG competency within cardiology [3]. Although the Accreditation Council for Graduate Medical Education (ACGME) and American Board of Emergency Medicine (ABEM) created twenty-three EM subcompetencies, none of these specifically refer to ECG interpretation requirements [4]. The EM Council of Residency Directors (CORD) includes ECG interpretation as part of its curricular model but without specific metrics [5].

While efforts have been made to improve ECG interpretation training, EM literature provides little guidance regarding the optimization of ECG curricula [6-9]. We sought to profile the current ECG interpretation curricula and clinical practice patterns, specifically the role of the resident as ECG interpreter.

At the time of survey initiation, there were 166 allopathic EM residency programs within the United States. Program directors (PD) were asked to complete a de-identified questionnaire via a secure application called Research Electronic Data Capture (REDCap; Vanderbilt University, TN). REDCap allowed for response tracking and three additional reminder emails were sent. Participants provided program demographics, geographic location as defined by the Society of Academic Emergency Medicine (SAEM) Regions, and additional information regarding their ECG curriculum and primary rapid ECG interpreter. Per
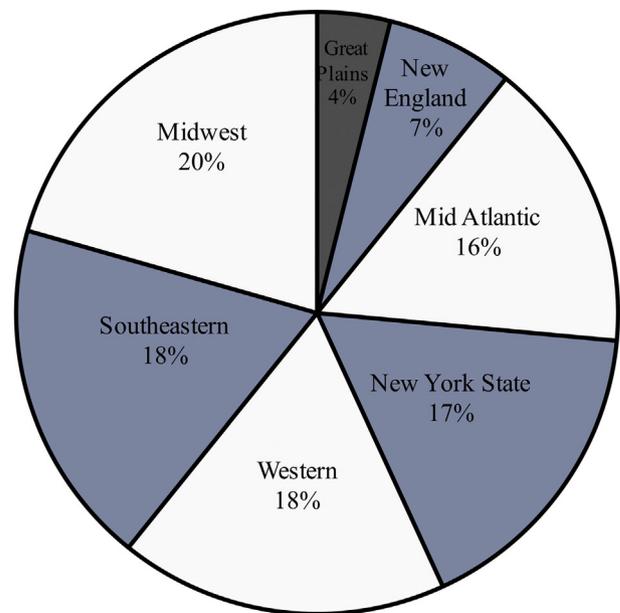

Fig. 1. Geographical distribution of participating emergency medicine residencies as defined by SAEM Regions.

ACC and AHA guidelines, rapid ECGs are performed within 10 min of presentation concerning for acute coronary syndrome [10]. Four senior faculty members, two junior faculty members and one second-year EM resident internally validated the survey questions at our academic institution. The study met exempteion criteria per the Institutional Review Board.

Frequencies and proportions were calculated to determine the most common responses. Fisher's exact tests were performed to assess associations between variables. All analyses were two-sided, with a significant level of ≤0.05. SAS version 9.4 (SAS Institute, Cary, NC) was used for analyses.

Of 166 programs, 102 (61%) participated from various regions of the United States (Fig. 1). Of the responding programs, 71 (70%) are three-year programs and 30 (30%) are four-year programs. Eighty-nine programs (87%) reported an attending as primary ECG interpreter, while only thirteen institutions (13%) allowed the senior resident to perform primary interpretation. Of these thirteen programs, nine (69%) require attending interpretation within 11–30 min and the other four programs (31%) state the attending will review the ECG interpretation at another time during the shift.

Seventy-one programs (70%) provided information regarding required and elective ECG curriculum models (Fig. 2). We found that most programs utilize mandatory didactic lectures, while a smaller portion use innovative teaching modalities such as the flipped classroom model in which learners prepare at home for in-class problem solving [11].

There were important trends in the relationship between [1] geographic location or [2] ECG curriculum and the primary ECG interpreter (Table 1). Midwest programs were more likely to have an attending as primary ECG interpreter (22%, p-value = 0.01). Southeastern and Western programs were more likely to have a resident as primary interpreter (31% for each region, p-value = 0.01). Programs that allowed resident as primary interpreter were more likely to have implemented elective one-on-one training (75% versus 38%, p-value = 0.03).

Our findings expand on previous studies that highlighted ECG curricula as an area for improvement. Over ten years ago, a similar study of EM PDs demonstrated that only half of the residencies queried had a formal ECG curriculum and even fewer had a way to assess competency [12,13]. Since that time, there remains no standardization of the ECG interpretation curricula within EM graduate medical education nor has an optimal teaching method been identified [14].
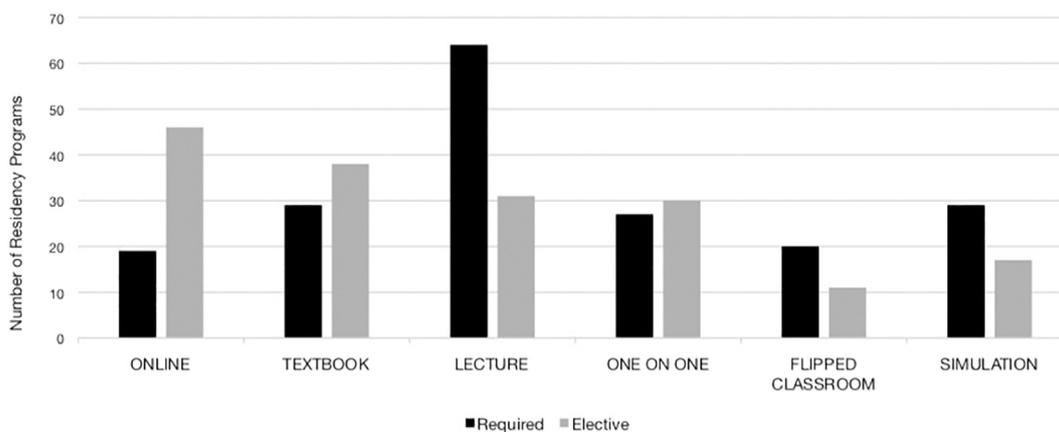
Fig. 2. Required versus elective teaching modalities.

Table 1
Associations between the primary ECG interpreter and other variables.

N (%)	Primary ECG interpreter		P-value
	Attending	Resident	
Geographic location			0.01
Great Plains	2 (2%)	2 (15%)	
New England	6 (7%)	2 (15%)	
Mid Atlantic	16 (18%)	0 (0%)	
New York State	16 (18%)	1 (8%)	
Western	14 (16%)	4 (31%)	
Southeastern	15 (17%)	4 (31%)	
Midwest	20 (22%)	0 (0%)	
Elective One-on-One Teaching			0.03
Yes	22 (38%)	9 (75%)	
No	36 (62%)	3 (25%)	

Unlike previous publications, our study explicitly investigated the role of the resident in clinical ECG interpretation. Our survey demonstrated that attending physicians are the primary interpreters of ECGs at the majority of programs. Only 13% of the participants utilize senior residents as the primary interpreter. Our institution's educational model allows senior residents (post-graduate year three) to perform primary ECG interpretation. This deliberate practice (DP) model allows for performance of repetitive skills followed by assessment and constructive feedback [15]. DP has been demonstrated to be a powerful method to improve clinical skills and to have a positive impact on patient care [16,17].

While we cannot definitively ascertain the optimal ECG teaching method, our study highlights areas for potential growth such as an emphasis on innovative educational methods and deliberate practice in the clinical setting. Limitations include the 61% response rate as well as possible reporting bias due to PD discretion in choosing whether to participate in the survey. Additional research is required to determine the optimal method by which to teach and assess ECG interpretation skills.

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