

## Original Contribution

# Emergency physician focused cardiac ultrasound improves diagnosis of ascending aortic dissection<sup>☆,☆☆</sup>



Joseph R. Pare, MD<sup>a,\*</sup>, Rachel Liu, MD<sup>a</sup>, Christopher L. Moore, MD<sup>a</sup>, Tyler Sherban, BA<sup>b</sup>, Michael S. Kelleher Jr., MD<sup>c</sup>, Sheeja Thomas, MD<sup>a</sup>, R. Andrew Taylor, MD, MHS<sup>a</sup>

<sup>a</sup> Department of Emergency Medicine, Yale University, Yale–New Haven Hospital, New Haven, CT

<sup>b</sup> Frank H. Netter, MD School of Medicine, North Haven, CT

<sup>c</sup> Department of Radiology, Yale–New Haven Hospital, New Haven, CT

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## ABSTRACT

**Study Objective:** Ascending aortic dissection (AAD) is an uncommon, time-sensitive, and deadly diagnosis with a nonspecific presentation. Ascending aortic dissection is associated with aortic dilation, which can be determined by emergency physician focused cardiac ultrasound (EP FOCUS). We seek to determine if patients who receive EP FOCUS have reduced time to diagnosis for AAD.

**Methods:** We performed a retrospective review of patients treated at 1 of 3 affiliated emergency departments, March 1, 2013, to May 1, 2015, diagnosed as having AAD. All autopsies were reviewed for missed cases. Primary outcome measure was time to diagnosis. Secondary outcomes were time to disposition, misdiagnosis rate, and mortality.

**Results:** Of 386 547 ED visits, targeted review of 123 medical records and 194 autopsy reports identified 32 patients for inclusion. Sixteen patients received EP FOCUS and 16 did not. Median time to diagnosis in the EP FOCUS group was 80 (interquartile range [IQR], 46–157) minutes vs 226 (IQR, 109–1449) minutes in the non-EP FOCUS group ( $P = .023$ ). Misdiagnosis was 0% (0/16) in the EP FOCUS group vs 43.8% (7/16) in the non-EP FOCUS group ( $P = .028$ ). Mortality, adjusted for do-not-resuscitate status, for EP FOCUS vs non-EP FOCUS was 15.4% vs 37.5% ( $P = .24$ ). Median rooming time to disposition was 134 (IQR, 101–195) minutes for EP FOCUS vs 205 (IQR, 114–342) minutes for non-EP FOCUS ( $P = .27$ ).

**Conclusions:** Patients who receive EP FOCUS are diagnosed faster and misdiagnosed less compared with patients who do not receive EP FOCUS. We recommend assessment of the thoracic aorta be performed routinely during cardiac ultrasound in the emergency department.

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## 1. Introduction

Ascending aortic dissection (AAD) is an uncommon, potentially treatable disease with mortality increasing ~1% to 2% per hour from symptom onset to diagnosis and therapy [1–3]. With a prevalence of 2.5 to 3.5 cases per 100 000 patient-years, AAD is often misdiagnosed in the emergency department (ED) due to nonspecific signs and symptoms and has been described as “the great masquerader” [3–5]. Although contrast-enhanced computed tomography angiography (CTA) is the most frequent definitive diagnostic test for AAD, it is not feasible to

perform CTA on all ED patients with symptoms of chest or back pain [5,6]. Point-of-care focused cardiac ultrasound (FOCUS) is increasingly used in the ED setting for patients with thoracic complaints; however, current American College of Emergency Physician recommendations for FOCUS do not include routine assessment of the ascending thoracic aorta [5,7]. In 2010, based on cases at our institution where aortic dissection was missed but thoracic aortic pathology was appreciated on quality assurance review, we started to perform routine measurement of the thoracic aortic root.

Aneurysmal dilation of the aorta is frequently present in AAD, with approximately 90% of AAD patients having dilation of the aorta greater than 4 cm at the time of diagnosis [6,8–10]. Emergency physician FOCUS (EP FOCUS) measurements for proximal aortic size have been shown to agree with CTA measurements [11,12]. In addition, ascending aortic dilation identified by FOCUS is approximately 70% sensitive for AAD [13].

Our objective was to determine whether patients who received EP FOCUS including evaluation of the thoracic aorta had at least a 1-hour reduction in time to diagnosis for AAD compared with patients who did not receive EP FOCUS and were ultimately diagnosed as having AAD. Secondary objectives were to determine if EP FOCUS reduces mortality, misdiagnosis, and time to disposition. It is expected that an

**Abbreviations:** AAD, ascending aortic dissection; CTA, computed tomography angiography; EP FOCUS, emergency physician focused cardiac ultrasound.

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\* Corresponding author. Joseph R. Pare, MD, Department of Emergency Medicine, Yale University, Yale–New Haven Hospital, 464 Congress Ave, Suite 260, New Haven, CT, 06519. Tel.: +1 203 785 4058; fax: +1 203 785 4580.

E-mail address: [joseph.pare@yale.edu](mailto:joseph.pare@yale.edu) (J.R. Pare).

abnormal aorta identified on EP FOCUS when used as an early diagnostic tool should improve our study outcome measures.

## 2. Methods

### 2.1. Study design

This was a retrospective cohort analysis of patients treated within a multihospital health care system who were found to have AAD. We adhered to guidelines for retrospective medical record reviews as delineated by Gilbert et al [14] and Kaji et al [15]. To be eligible for enrollment, patients must have been treated in the ED at 1 of 3 affiliated hospitals during a 26-month study period, March 1, 2013, to May 1, 2015. March 1, 2013 was chosen as the starting point because this was when our electronic health record (EHR) was initiated, allowing us to identify reliably patients with AAD across our hospital system. Patients identified with AAD were analyzed based on those who received EP FOCUS in the ED and those who did not.

### 2.2. Study setting and population

Hospital 1 is a large urban, nonprofit, level 1 trauma academic tertiary medical center. It is the flagship hospital for this health care system, and its ED has an annual census of approximately 90 000 adult patient visits per year. Hospital 2 is a small suburban, nonprofit, community-based freestanding ED. This location has an annual census of approximately 30 000 visits per year. Hospital 3 is a large urban, nonprofit, academic community-based hospital and has an annual census of approximately 70 000 ED visits. Each of these facilities is a 24-hour health care facility with CTA available for the diagnosis of aortic dissection.

These 3 affiliated sites were selected for inclusion because a single academic emergency ultrasound section is responsible for physician point-of-care ultrasound education and quality assurance. The physicians at these study locations are encouraged to use the “5Es” approach to EP FOCUS with regard to measurement of the proximal aorta on a parasternal long-axis view (Fig. 1) [16]. The 5Es approach is a rapid protocol recommended to assess for pericardial *Effusion*, ventricular *Ejection* function, ventricular *Equality* (eg, right heart enlargement seen with pulmonary embolus), *Exit* (proximal aortic size), and *Entrance* (inferior vena cava size and collapsibility). Evaluation of the aorta using the 5Es protocol is a simple measure using the leading edge technique to obtain a single measure at the most dilated portion of the visualized proximal aorta. All FOCUS examinations including DICOM images are required to

be added to the EHR. Emergency medicine attendings are responsible for all FOCUS examinations and final interpretations. Templated worksheets for EP FOCUS on our ultrasound documentation and quality assurance system, Q-path (Telexy Healthcare, Port Coquitlam, BC, Canada) require classification of proximal aortic size as normal (<4 cm), aneurysmal dilation (4–4.5 cm), or aneurysmal (>4.5 cm). Each study site is also equipped with the same ultrasound machines and probes, the Phillips Sparq (Bothell, Washington). A phased-array S4-2 ultrasound probe is used for cardiac imaging at these facilities with a frequency of 2 to 4 MHz. Point-of-care ultrasound machines are readily available for use at all times at the study site facilities.

### 2.3. Study protocol

The EHR, EPIC ASAP (Verona, Wisconsin) used at all hospitals within this single health care system was queried for patients who had the diagnosis of aortic dissection (determined by *International Classification of Diseases, Ninth Revision* codes 441.0x and regular expression search using the terms “aorta,” “aortic,” “dissection”) either in the ED or as a discharge diagnosis after hospitalization between March 1, 2013, and May 1, 2015. This query was designed to find all cases of aortic dissection, both Stanford type A and type B, within a patient’s history of diagnoses. To identify cases of missed aortic dissection resulting in death, all hospital autopsy reports during this period were manually reviewed for the diagnosis of AAD as the cause of death. Patients were included if they were older than 18 years and were treated at 1 of 3 affiliated EDs within a month preceding diagnosis for a visit attributed to AAD or during the same hospital visit.

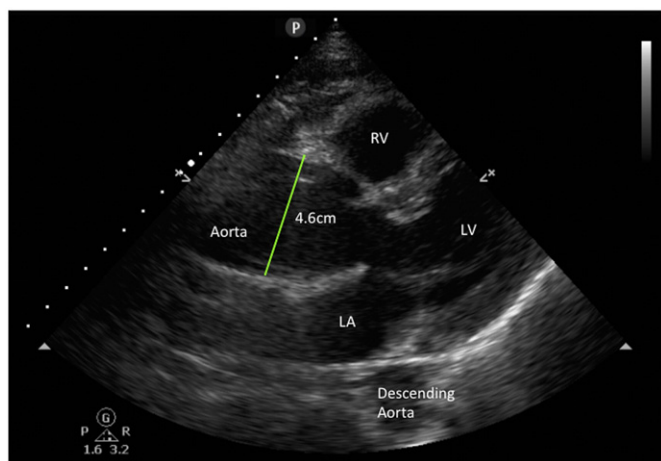
Patients were excluded if they were transferred from a referring facility with a known diagnosis of aortic dissection, if they had a history of acute trauma, if they were not treated in the ED, if medical record review did not support the patient having a diagnosis of AAD (eg, improper diagnosis being added to the patient’s medical record or diagnosis being added for a case of AAD that occurred prior to March 1, 2013), if they had a descending aortic dissection defined as distal to the left subclavian artery, or if they were treated at an alternative affiliated nonstudy site. Patients found to have AAD as a cause for death on autopsy were excluded if they arrived to the ED in cardiac arrest. Participants were selected for study enrollment after manual review of the medical record confirmed inclusion criteria and a lack of exclusions. Institutional review board approval was obtained for this study.

### 2.4. Key outcome measures

The primary outcome measure was time to diagnosis as defined by the difference between the time being roomed in an ED treatment area (time stamped in the EHR) to diagnosis of AAD. The time advanced imaging was performed and used as the diagnosis time. Advanced imaging was defined as CTA, magnetic resonance imaging, or transesophageal echocardiography. Secondary outcome measures included time to disposition, misdiagnosis rate (admitted or discharged with a diagnosis other than AAD), and mortality differences between cohorts. Mortality was adjusted for do-not-resuscitate (DNR) status by excluding patients with a DNR order; this included patients with a previous DNR order, or who were made DNR either prior to or after discovery of the diagnosis.

All information was obtained from study patients’ EHR. Data elements for hospitalizations associated with the visit for AAD were obtained from the enterprise data warehouse CLARITY (Epic, Verona, Wisconsin). Structured Query Language queries were written to identify and extract desired clinical and demographic information (eg, age, sex, race, and outpatient medications) based on a unique hospital visit number. Data that could not be abstracted using electronic methods were abstracted by manual medical record review (Appendix A: Variable by Abstraction Method).

Manual medical record abstractors included 3 emergency medicine residency-trained physicians (J.R.P., S.T., R.L.). A fourth medical record



**Fig. 1.** Focused cardiac ultrasound aorta measure. Obtained by a parasternal long-axis view, measure of the proximal aorta here shows abnormal aneurysmal dilation of 4.6 cm. Our institution performs echocardiography with the probe pointed to the right shoulder with the marker on the left of the screen [23]. Abbreviations: LA, left atrium; LV, left ventricle; RV, right ventricle.

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