Comparison of the Simplify D-dimer assay performed at the bedside with a laboratory-based quantitative D-dimer assay for the diagnosis of pulmonary embolism in a low prevalence emergency department population

M S Runyon,[1] D M Beam,[1] M C King,[1] E H Lipford,[2] J A Kline[1]

[1] Department of Emergency Medicine, Carolinas Medical Center, Charlotte, North Carolina, USA; [2] Department of Pathology, Carolinas Medical Center, Charlotte, North Carolina, USA

Correspondence to: Dr J A Kline, Emergency Medicine Research, Department of Emergency Medicine, Carolinas Medical Center, PO Box 32861, Charlotte, North Carolina 28323-2861, USA; jkline@carolinas.org

Accepted 24 July 2007

ABSTRACT

Background: The immunofiltration D-dimer assay could allow point-of-care testing for pulmonary embolism (PE). A study was undertaken to compare a clinician-performed qualitative D-dimer assay with the automated quantitative D-dimer test.

Methods: A prospective observational study was conducted from January to October 2005 at an urban academic emergency department (ED). 1193 patients of mean (SD) age 47 (16) years (66% female) were enrolled. The study protocol combined pretest probability estimation, D-dimer testing by both a qualitative immunochromatographic assay (Simplify) performed at the point of care by 192 different clinicians and a quantitative D-dimer test performed in a CLIA-certified laboratory. The criterion standard was image-proven PE or deep venous thrombosis within 45 days after enrolment. To test inter-observer agreement for the qualitative assay, two blinded observers independently read 841 Simplify cartridges.

Results: Of 1193 patients enrolled, 45 were PE+ (3.8%, 95% CI 2.8% to 5.0%). Qualitative results were available for 1169 (98%) and quantitative results were available for 1136 (95%). Comparison of the qualitative and quantitative D-dimer tests gave the following results: sensitivity 91% (95% CI 78% to 98%) vs 93% (95% CI 80% to 98%); specificity 57% (95% CI 54% to 60%) vs 57% (95% CI 54% to 60%); likelihood ratio negative 0.16 (95% CI 0.06 to 0.37) vs 0.13 (95% CI 0.05 to 0.35). The weighted Cohen's κ for interpretation of the qualitative assay was 0.69 (95% CI 0.63 to 0.76).

Conclusions: In this very low-risk ED population, a qualitative D-dimer assay performed at the point of care had similar diagnostic accuracy to the quantitative D-dimer test. Interobserver agreement for the qualitative test was good.

Our group has previously examined the diagnostic accuracy of the qualitative Simplify D-dimer assay (Agen Inc, Brisbane, Australia) in a cohort of 2302 patients evaluated in the emergency department (ED) for suspected pulmonary embolism (PE). We reported a moderate sensitivity (81%) and high specificity (73%).[1] This was comparable to the sensitivity of 82% and specificity of 74% found in an investigation performed in the UK by Hogg *et al*[2] who evaluated 417 patients presenting in the ED with pleuritic chest pain. Despite this moderate sensitivity, when combined with the physicians' overall clinical impression (unstructured estimate) of low risk for PE, patients with a negative qualitative test had a 0.7% post-test probability of PE, suggesting that the test could be used to exclude PE in a subset of patients in the ED. However, several operational characteristics of the qualitative D-dimer assay remain untested.

The principle of operation employs immunochromatography and requires an observer visually to determine whether the chromatography strip shows one (test negative) or two (test positive) purple lines. In our previous study we trained a small group of respiratory therapists to perform the assay. These therapists had relatively limited knowledge of the healthcare team's clinical suspicion for PE. We found occasional variations in the clarity of the chromatography results owing to inadequate sample loading, streaking or staining of the chromatography paper, and the more frequent and problematic finding of a very faint second line leading to ambiguity regarding the interpretation of the test as positive or negative. These observations suggest the possibility that two observers could interpret the same test differently. These differences could be either exaggerated or attenuated if the observer was a clinician with knowledge of the patient's pretest probability for PE. In contrast, quantitative D-dimer assays rely on optical measurement of light absorbance and therefore may be less vulnerable to interobserver differences. In addition, several meta-analyses have confirmed that the sensitivity of quantitative D-dimer assays (both enzyme-linked and turbidimetric) is significantly higher, but with a lower specificity than we observed with the qualitative assay.[3–5]

We therefore performed this study in a new population of patients in the ED selected for objective testing for possible PE. We trained a large number of clinicians (including ED nurses, nursing assistants and physicians) to perform the qualitative assay at the bedside, followed by a quantitative D-dimer assay on the same blood sample in our hospital's central laboratory. Our specific aims were (1) to measure and compare the diagnostic accuracy of an algorithm, combining pretest probability assessment along with the qualitative D-dimer assay, with the quantitative assay for the diagnosis of PE in this low prevalence population; (2) to compare the diagnostic accuracies of the D-dimer tests; and (3) to measure the interobserver agreement on the results of the qualitative D-dimer assay.

 Emerg Med J 2008;**25**:70–75. doi:10.1136/emj.2007.048918

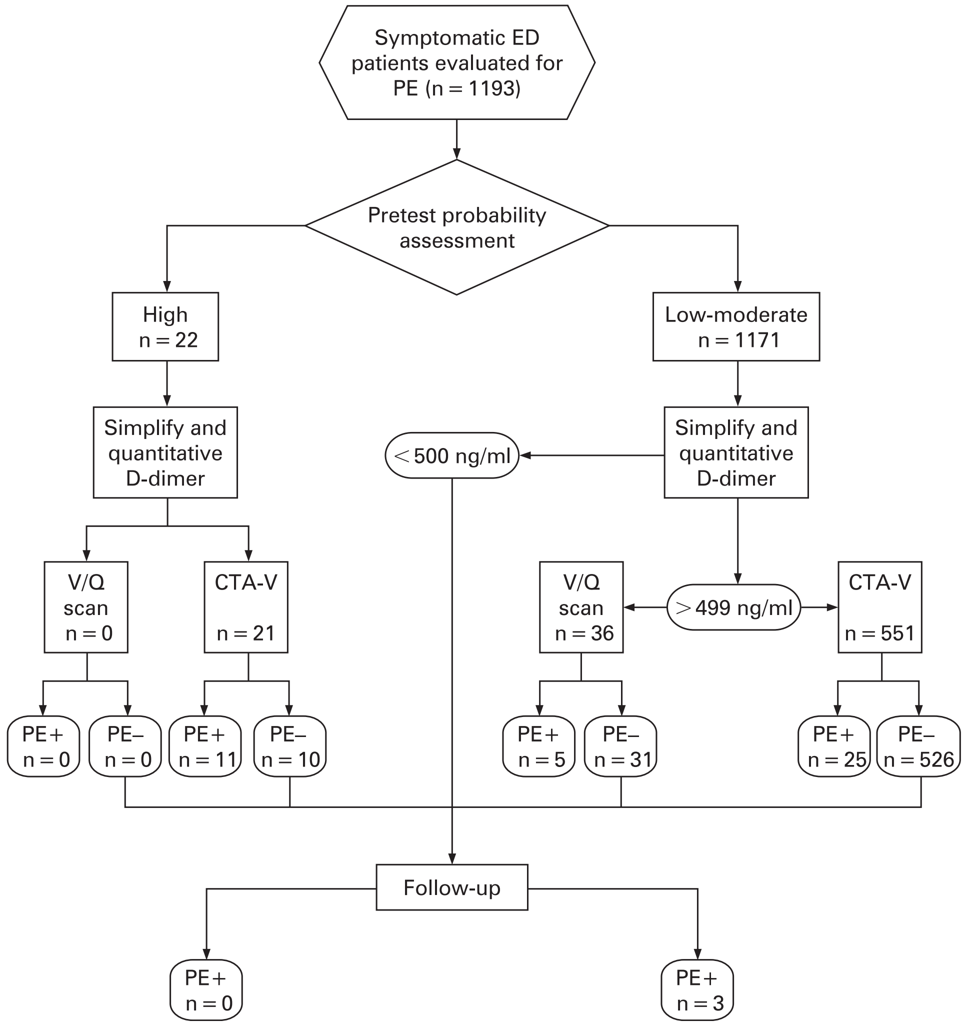

Figure 1 Flow diagram of diagnostic imaging performed in all patients with suspected pulmonary embolism (PE). One patient with clinical features suggesting PE met the criterion standard definition by ultrasound-proven deep vein thrombosis and did not undergo pulmonary vascular imaging. ED, emergency department; V/Q, ventilation-perfusion; CTA-V, computed tomography-angiography of the chest with indirect venography of the legs.

METHODS

This prospective observational investigation was conducted at Carolinas Medical Center, an urban academic centre with an annual ED census during the study period of approximately 115 000. The study protocol was reviewed and approved by the Carolinas Healthcare System Institutional Review Board. All patients selected by the treating emergency physician for evaluation of possible PE were eligible for enrolment in the study. Eligibility did not require any predefined symptom or sign. Exclusion criteria were prior failed venipuncture >2 times on the same day, the study associate's impression that follow-up would not be possible, or patient desire not to participate in the study. Before testing, the treating physician populated a HIPAA-compliant web-based data collection form using a secure personal computer in the ED. The methodology and contents of this form have been previously published.[6] Briefly, the form first asks the physician's unstructured estimate of the likelihood of PE, categorised as "low" (<15%), "moderate" (15–40%) or "high" (>40%). In previous work we have found the unstructured estimate to be preferred by emergency physicians and to produce equivalent results to structured decision rules.[7 8] The study was designed according to the guidelines set out in the standards for reporting studies of diagnostic accuracy (STARD). Patients were evaluated for PE according to the algorithm shown in fig 1, which included both qualitative and quantitative D-dimer testing for all patients.

D-dimer testing

Blood for D-dimer testing was obtained by venipuncture by a nurse or qualified phlebotomist. Both the qualitative and quantitative D-dimer assays were performed on the same blood specimens (0.11 mM sodium citrate Vacutainer Tubes; Becton Dickinson, Franklin Lakes, NJ, USA). The qualitative D-dimer testing was performed in the ED by one of 52 physicians, 125 nurses or 15 certified nursing assistants who attended a standardised training session conducted by one of the study authors to learn how to perform and interpret the qualitative assay in accordance with the manufacturer's recommendations. To minimise bias, the assay was completed and the result documented before the quantitative result was reported. Our instructions were for the user to inspect the chromatogram to ensure complete saturation and then to hold the cartridge at arm's length, under standard fluorescent lighting in a designated area with ambient light intensity of approximately 4000 lux, and to view the reading window to the count of two, and to ask "Do I see one line or two lines?" If the observer believed he or she saw one line, the test was recorded as negative. To measure interobserver agreement, two authors independently used the same technique and interpreted the same test cartridges on the same day and documented their results in a written log, blinded to each other's interpretation. These observers were blinded to the quantitative D-dimer result, the clinical outcome and the other author's interpretation. Quantitative D-dimer testing was performed simultaneously on the same blood sample used for the qualitative assay in a CLIA-certified central clinical laboratory using either the VIDAS automated ELISA or the MDA immunoturbidimetric assay (bioMerieux Inc, Durham, NC, USA). A positive D-dimer result was defined as a level >500 ng/ml for both assays.

Pulmonary vascular imaging

The primary pulmonary vascular imaging (PVI) modality at our institution is contrast-enhanced CT angiography of the chest vasculature immediately followed by venous contrast phase imaging from the popliteal fossae to the level of the inferior vena cava to evaluate for deep venous thrombosis.[9] Each study is interpreted by a board-certified radiologist with fellowship training in chest radiology. In the case of documented allergy to iodinated contrast material, baseline creatinine >1.5 mg/dl or in patients exceeding the weight limit of the CT table (440 pounds), ventilation-perfusion (V/Q) scintillation lung scanning was performed and interpreted by board-certified radiologists with fellowship training in nuclear medicine radiology in accordance with the Prospective Investigation of Pulmonary Embolism Diagnosis study criteria.[10] The radiologists were unaware of the D-dimer results. Non-high risk patients with negative D-dimer results were not required to undergo PVI. In these cases the final decision regarding PVI was made at the discretion of the treating emergency physician.

Algorithm for evaluating PE

Patients were evaluated for PE using the combination of pretest probability and D-dimer testing with selective use of PVI. In patients with a low or moderate unstructured clinical pretest probability for PE, a negative qualitative assay and a quantitative D-dimer test <500 ng/ml, PE was considered to be ruled out. Patients with either a positive qualitative test or a quantitative D-dimer >499 ng/ml and all patients with a high pretest probability had mandatory PVI while still in the ED. All patients had clinical follow-up at 45 days.[11] The criterion standard for the diagnosis of PE required imaging (CT angiography or venography, V/Q scanning or venous ultrasonography) that demonstrated new acute PE or new acute deep venous thrombosis and the decision of the clinical team to initiate anticoagulation or vena caval filtering within 45 days of enrolment. We also considered any patient who died from image- or necropsy-proven PE to be criterion standard positive for PE.

Table 1 Clinical characteristics of the study cohort (N = 1193)

Characteristics	N	%
Female gender	790	66.2
Age >50 years	477	40.0
Heart rate >100	388	32.5
Immobilisation or surgery within 4 weeks	153	12.8
Alternative diagnosis less likely than PE	115	9.6
Previous PE or DVT	107	9.0
Shock index (HR/SBP) >1.0	83	7.0
Unexplained hypoxaemia	80	6.7
Suspected DVT	79	6.6
Active malignancy	62	5.2
Recent surgery	58	4.9
Unilateral leg swelling	52	4.4
Haemoptysis	29	2.4

DVT, deep venous thrombosis; PE, pulmonary embolism; HR, heart rate; SBP, systolic blood pressure.

Statistical analysis

Descriptive statistics including means, percentages and 95% confidence intervals (CIs) were calculated. Test characteristics for each assay were computed from the 2×2 diagnostic tables. The confidence intervals for the likelihood ratios were constructed using the likelihood-based approach to binomial proportions of Koopman. The confidence intervals for all other statistics are exact binomial confidence intervals constructed using the method of Clopper and Pearson. Interobserver agreement for the result of the qualitative assay was measured by Cohen's kappa. All analyses were performed using the StatsDirect statistical software Version 2.5.8 (Cheshire, UK).

Sample size

We estimated the sample size at 1000 using the assumptions of the same prevalence of PE and diagnostic results reported previously and our predefined intention to narrow the top limit of the 95% CI of the post-test prevalence of PE for patients with a low clinical probability and a negative qualitative D-dimer to <2.0%.[12]

RESULTS

We enrolled 1193 patients from 1 January 2005 to 30 October 2005. The mean (SD) age of the study population was 47.4 (16.4) years and 790 (66%) were female. Before knowing the results of diagnostic testing, the physicians recorded their unstructured estimate of the pretest probability of PE to be low (<15%) in 1007 (84%), moderate (15–40%) in 164 (14%) and high (>40%) in 22 (2%). The clinical characteristics of the study population are shown in table 1. Forty-five (3.8%, 95% CI 2.8% to 5.0%) met the criterion standard for the diagnosis of PE.

Figure 2 shows the disease prevalence stratified by the physicians' unstructured estimate of the pretest probability of PE. The prevalence of PE was 2.3%, 6.7% and 50% for the low, moderate and high pretest probability groups respectively.

Qualitative D-dimer assay

One hundred and ninety-two individual clinicians (physicians, nurses and nursing assistants) performed and documented a qualitative assay on a unique study participant. Table 2 shows the test results of both D-dimer assays for the entire cohort.

The overall sensitivity of the qualitative assay was 91% (95% CI 78 to 98%) with a specificity of 57% (95% CI 54 to 60%) and

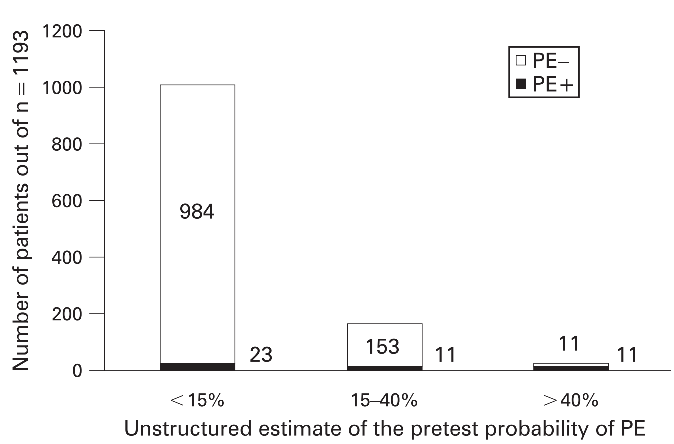

Figure 2 Distribution of the treating physician's unstructured estimate of the pretest probability of pulmonary embolism (PE). The bars show the total number of patients in each subcategory divided into patients without PE (open area) and patients with PE (filled area).

Table 2 Comparison of test results for the entire cohort

	Qualitative D-dimer*		Quantitative D-dimer†	
Test result	PE+	PE−	PE+	PE−
+	40	488	37	468
–	4	637	3	628
Sensitivity (95% CI)	90.9% (78.3% to 97.5%)		92.5% (79.6% to 98.4%)	
Specificity (95% CI)	56.6% (53.7% to 59.5%)		57.3% (54.3% to 60.3%)	
LR(–) (95% CI)	0.16 (0.06 to 0.37)		0.13 (0.05 to 0.35)	
NPV (95% CI)	99.4% (98.4% to 99.8%)		99.5% (98.6% to 99.9%)	
Post-test probability (–) (95% CI)	0.62% (0.17% to 1.59%)		0.48% (0.1% to 1.38%)	

LR, likelihood ratio; NPV, negative predictive value.
*Results of the Simplify assay were not available for 24 subjects (2.1%), including one who was PE+.
†Results of the quantitative assay were not available for 57 subjects (4.8%), including five who were PE+.

a likelihood ratio negative of 0.16 (95% CI 0.06 to 0.37). Table 3 shows the results of both D-dimer assays according to the physician's unstructured pretest probability estimate.

Among patients with a low pretest probability (n = 1007, 23 PE+), the qualitative D-dimer test demonstrated sensitivity equal to 82.6% and specificity equal to 60.5%. Among the patients categorised with a moderate or high pretest probability (n = 164, 22 PE+), the qualitative assay demonstrated sensitivity equal to 100% and specificity equal to 34% and 27%, respectively.

Quantitative D-dimer assay

As shown in table 2, the quantitative assay demonstrated an overall sensitivity of 93% (95% CI 80% to 98%) with a specificity of 57% (95% CI 54% to 60%) and a likelihood ratio negative of 0.13 (95% CI 0.05 to 0.35). Table 3 shows that, in patients categorised as low pretest probability, the quantitative D-dimer assay demonstrated test sensitivity equal to 90.5% and specificity equal to 60.7%; in patients with a moderate pretest probability the quantitative D-dimer assay demonstrated sensitivity equal to 90% and specificity equal to 36%; and in patients with a high pretest probability the quantitative D-dimer demonstrated sensitivity equal to 100% and specificity equal to 46%.

Interobserver agreement for the qualitative D-dimer assay at the point of care

The interobserver agreement for the result of the qualitative assay is shown in table 4. Because the interobserver agreement required the presence of two study authors on the day of testing, the 841 patients represented in table 4 were obtained from a convenience sample. The observed agreement was 84% with a weighted Cohen's κ of 0.69 (95% CI 0.63 to 0.76).

DISCUSSION

In this investigation we directly compared the diagnostic accuracy of a commercially available qualitative D-dimer assay (Simplify) with a quantitative automated D-dimer assay using the manufacturer's suggested threshold of 500 ng/ml as a cut-off value. The main advantage of the Simplify assay over the various laboratory-based quantitative techniques is that it can be performed and interpreted rapidly at the bedside without a machine. Moreover, the test cartridges and reagents are compact and can be stored at room temperature, allowing for easy portability and testing in locations remote from the hospital or clinical laboratory or at times when laboratory resources are not readily available.

We found that the two assays had similar sensitivity and specificity. In this study the qualitative D-dimer assay had a lower specificity than in our previous study (57% (95% CI 54% to 60%) vs 72.5% (95% CI 71% to 74%)) and there was a trend towards a higher sensitivity (91% (95% CI 78% to 98%) vs 81% (95% CI 72% to 88%)). In addition to performing two D-dimer assays in real time, the present study has several other design differences from our previous work. First, this study mandated a D-dimer assay to be performed for all patients undergoing any objective diagnostic test for PE, regardless of clinical suspicion for PE, whereas in our previous work clinicians could omit the D-dimer assay in patients with a high pretest probability of PE. As shown in table 3, the sensitivity of the Simplify assay was 100% in both the moderate and high pretest probability groups. Removing the high-risk patients would therefore be expected to shift the sensitivity towards the lower value seen in the low-risk group (83%). As the current work included all patients regardless of pretest probability, we feel it is a more accurate demonstration of the overall test performance. Despite the inclusion of patients with high pretest probability, the there was a downward trend for the prevalence in the present study compared with our previous report (3.8% vs 4.7%).

Second, in the present study the Simplify assays were performed in the ED using citrate-anticoagulated venous blood by 192 different registered nurses, nursing assistants and physicians. We also found good interobserver agreement as measured by the weighted Cohen's κ of 0.69 (95% CI 0.63 to 0.76).[13] However, the interpretation was discordant among the

Table 3 Comparison of test results based on pretest probability assessment

Pretest probability	Diagnostic index	Qualitative D-dimer	Quantitative D-dimer
Low (n = 1007)	Sensitivity (95% CI)	82.6% (61.2% to 95.1%)	90.5% (69.6% to 98.8%)
	Specificity (95% CI)	60.5% (57.3% to 63.6%)	60.7% (57.5% to 63.8%)
Moderate (n = 164)	Sensitivity (95% CI)	100% (71.5% to 100%)	90% (55.5% to 99.8%)
	Specificity (95% CI))	34.0% (26.5% to 42.2%)	35.9% (28.0% to 44.4%)
High (n = 22)	Sensitivity (95% CI)	100% (69.2% to 100%)	100% (66.4% to 100%)
	Specificity (95% CI)	27.3% (6.0% to 61.0%)	45.5% (16.8% to 76.6%)

Table 4 Interobserver agreement for the interpretation of the Simplify assay (n = 841)

	Observer 2	
Observer 1	Negative	Positive
Negative	361	12
Positive	119	349
	Observed agreement: 84%	
	κ = 0.69 (95% CI 0.63 to 0.76)	

observers in 16% of tests. As this is the first study to measure the interobserver agreement for this assay, the significance of these findings remains unclear. Certainly, as with any diagnostic test, clinical protocols incorporating the Simplify D-dimer assay require adequate initial training, periodic reassessment of testing competency and a structured quality assurance programme to maximise patient safety. In our previous work a small group of respiratory therapists performed the Simplify assay on heparin-anticoagulated arterial blood and, in that study, we did not measure interobserver agreement.

During the study period the clinical laboratory at our institution changed from the MDA immunoturbidimetric D-dimer assay to the VIDAS automated ELISA. Overall, the MDA and VIDAS assay were performed in 859 and 277 patients, respectively. While the assay methods differ, meta-analyses have shown that they possess similar test characteristics.[3–5] Furthermore, subgroup analysis of our data revealed no significant differences in diagnostic accuracy between the assays (data not shown). As our primary aim was to compare the relative performances of the qualitative and quantitative tests, we felt it prudent to combine the data for the two quantitative assays.

Another important point is that our study protocol did not mandate PVI for non-high risk patients with negative results on both D-dimer assays. It is possible that a subset of these patients had PE at the index visit with natural resolution of their symptoms by 45 days. While unlikely, this incorporation bias may have caused the D-dimer tests to "overperform". Requiring all patients to undergo PVI regardless of pretest probability would have been logistically and ethically problematic.

We and others have postulated that diagnostic strategies to exclude PE should result in a posterior probability of PE of <1%.[12] This goal was accomplished by both the qualitative and quantitative D-dimer assays (when negative) in all patients deemed low risk by the physician's unstructured estimate of the pretest probability of PE. We observe that the qualitative assay had 100% sensitivity in patients judged to have a moderate or high pretest probability for PE and it is possible that this test may be used to safely exclude PE even in these non-low risk patients. However, given that our study was conducted in a low prevalence population with a limited number of non-low risk patients and that the observed lower limits of the 95% confidence intervals for these sensitivities were 72% and 69%, we believe that further study is needed before this strategy can be advocated for the exclusion of PE in non-low risk patients.

The remarkably low prevalence of venous thromboembolism in our study population may be explained in part by the clinicians' unimpeded access to the Simplify qualitative assay and its results in the ED during the study. We attempted to control overuse of the qualitative test by requiring the formal quantitative D-dimer assay to be performed and by publishing the protocol requirement that PVI could not be withheld solely on the basis of a negative qualitative D-dimer test. The prevalence of PE in published diagnostic studies performed in North America has steadily declined over the past several years, possibly as a consequence of the physicians' perceived risk of medical malpractice.[14] Additional socioeconomic factors probably contribute to this trend, including lack of adequate outpatient clinic care in the urban ED population.[15 16] Within this setting, the D-dimer assay is an attractive—if imperfect—screening test that avoids the significant cost and exposure to ionising radiation associated with current PVI modalities.

Relevant to this discussion is evidence that PE can be excluded solely based on information gathered at the bedside. Our group has previously derived and validated an eight-variable block rule that uses information from the history, physical examination and pulse oximetry measurement to identify very low risk patients (pretest probability <2%) in whom PE can be excluded clinically without further testing.[17] Applying this rule to the current study cohort would have decreased D-dimer testing by 322 patients at the cost of missing 2 cases of PE (posterior probability 0.62%, 95% CI 0.08% to 2.23%).

In conclusion, we found no significant difference in the diagnostic accuracy of the bedside Simplify D-dimer assay compared with the laboratory-based quantitative test in a low prevalence population in the ED. When negative, both tests resulted in a posterior probability of PE of <1%. The interobserver agreement on the results of the Simplify D-dimer assay was good, based on a Cohen's κ of 0.69. These data support further investigation of the Simplify D-dimer assay as part of a management strategy to exclude PE at the point of care.

Acknowledgements: Agen Inc, Brisbane, Australia provided the Simplify cartridges used for the study at no cost, but had no role in patient enrolment, data collection and interpretation, or the preparation or revision of the manuscript.

Competing interests: JAK owns stock in BreathQuant Medical LLC and Pretest Consult LLC. The other authors have no competing interests.

REFERENCES

1. **Kline JA,** Runyon MS, Webb WB, *et al*. Prospective study of the diagnostic accuracy of the simplify D-dimer assay for pulmonary embolism in emergency department patients. *Chest* 2006;**129**:1417–23.
2. **Hogg K,** Dawson D, Mackway-Jones K, *et al*. The emergency department utility of Simplify D-dimer to exclude pulmonary embolism in patients with pleuritic chest pain. *Ann Emerg Med* 2005;**46**:305–10.
3. **Stein PD,** Hull RD, Patel KC, *et al*. D-dimer for the exclusion of acute venous thrombosis and pulmonary embolism. *Ann Intern Med* 2004;**140**:589–602.
4. **Brown MD,** Lau J, Nelson RD, Kline JA. Turbidimetric D-dimer in the diagnosis of pulmonary embolism: a meta-analysis. *Clin Chem* 2003;**49**:1846–53.
5. **Brown MD,** Rowe BH, Reeves MJ, *et al*. The accuracy of the enzyme-linked immunoabsorbent assay D-dimer test in the diagnosis of pulmonary embolism: a meta-analysis. *Ann Emerg Med* 2002;**40**:133–44.
6. **Kline JA,** Johnson CL, Webb WB, *et al*. Prospective study of clinician-entered research data in the emergency department using an Internet-based system after the HIPAA Privacy Rule. *BMC Med Inform Decis Mak* 2004;**4**:17.
7. **Runyon MS,** Webb WB, Jones AE, *et al*. Comparison of the unstructured clinician estimate of pretest probability for pulmonary embolism to the Canadian score and the Charlotte rule: a prospective observational study. *Acad Emerg Med* 2005;**12**:587–93.
8. **Runyon MS,** Richman PB, Kline JA, Pulmonary Embolism Research Consortium Study Group. Emergency medicine practitioner knowledge and use of decision rules for the evaluation of patients with suspected pulmonary embolism: variations by practice setting and training level. *Acad Emerg Med* 2007;**14**:53–7.
9. **Richman PB,** Wood J, Kasper DM, *et al*. Contribution of indirect computed tomography venography to computed tomography angiography of the chest for the diagnosis of thromboembolic disease in two United States emergency departments. *J Thromb Haemost* 2003;**1**:652–7.
10. **PIOPED Investigators**. Value of the ventilation/perfusion scan in acute pulmonary embolism. *JAMA* 1990;**263**:2753–9.
11. **Kline JA,** Mitchell AM, Runyon MS, *et al*. Electronic medical record review as a surrogate to telephone follow-up to establish outcome for diagnostic research studies in the emergency department. *Acad Emerg Med* 2005;**12**:1127–33.
12. **Kline JA,** Wells PS. Methodology for a rapid protocol to rule out pulmonary embolism in the emergency department. *Ann Emerg Med* 2003;**42**:266–75.

13. **Landis JR,** Koch G. The measurement of observer agreement for categorical data. *Biometrics* 1977;**33**:159–74.
14. **Studdert DM,** Mello MM, Sage WM, *et al*. Defensive medicine among high-risk specialist physicians in a volatile malpractice environment. *JAMA* 2005;**293**:2609–17.
15. **Kline JA,** Runyon MS, Webb WB, *et al*. Simplify D-dimer to rule out pulmonary embolism. *Chest* 2007;**131**:633–4.
16. **Le Gal G,** Bounameaux H. Diagnosing pulmonary embolism: running after the decreasing prevalence of cases among suspected patients. *J Thromb Haemost* 2004;**2**:1244–6.
17. **Kline JA,** Mitchell AM, Kabrhel C, *et al*. Clinical criteria to prevent unnecessary diagnostic testing in emergency department patients with suspected pulmonary embolism. *J Thromb Haemost* 2004;**2**:1247–55.

Images in emergency medicine

Circumferential aortic dissection

A 30-year-old woman with clinical features of Marfan's disease was referred to our institution with acute chest pain and profound hypotension requiring inotropic and vasoactive support, together with mechanical ventilation. At admission she was haemodynamically unstable, and a grade 2/6 diastolic murmur was heard at the left parasternal area. Transthoracic and transoesophageal echocardiography showed an aneurysmatic ascending aorta with a DeBakey type I aortic dissection causing severe aortic regurgitation. The left ventricle was dilated and left ventricular systolic function severely depressed with an ejection fraction of 10%. Transverse sections of the ascending aorta showed that the dissection affected the 360° of the proximal aortic circumference (fig 1). A large horizontal intimal tear was found to be located 3 cm above the aortic valve plane, and the dissection extended to the distal thoracic descending aorta. Unfortunately, the patient had a cardiac arrest which could not be reversed and died shortly after admission.

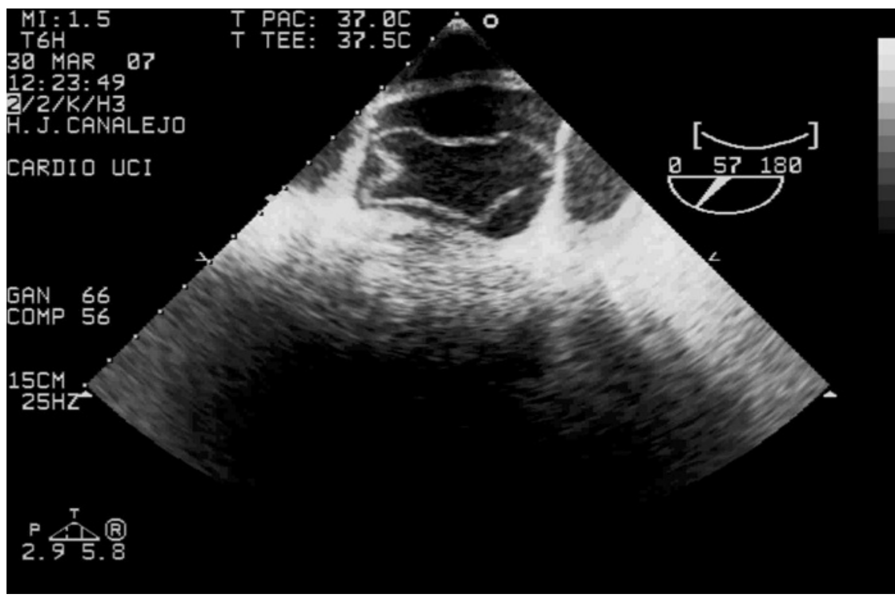

Figure 1 Transoesophageal echocardiography (transverse aortic section) showing a circumferential dissection of the ascending aorta.

A Bouzas-Mosquera,[1] M Solla-Buceta,[2] S Fojón-Polanco[2]

[1] Department of Cardiology, Juan Canalejo Hospital, A Coruña, Spain; [2] Intensive Care Unit, Juan Canalejo Hospital, A Coruña, Spain

Correspondence to: Dr A Bouzas-Mosquera, Department of Cardiology, Juan Canalejo Hospital, As Xubias, 84. 15006. A Coruña, Spain; aboumos@canalejo.org

Emerg Med J 2008;**25**:75. doi:10.1136/emj.2007.049908

Comparison of the Simplify D-dimer assay performed at the bedside with a laboratory-based quantitative D-dimer assay for the diagnosis of pulmonary embolism in a low prevalence emergency department population

M S Runyon, D M Beam, M C King, E H Lipford and J A Kline

Emerg Med J 2008 25: 70-75
doi: 10.1136/emj.2007.048918