Turbidimetric D-Dimer Test in the Diagnosis of Pulmonary Embolism: A Metaanalysis

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Background: Clinicians in outpatient clinics and emergency departments desire an accurate quantitative D-dimer assay. The study objective was to evaluate the diagnostic performance characteristics of the latex turbidimetric D-dimer test in the diagnosis of pulmonary embolism (PE) in the emergency department population.

Methods: We conducted a search of MEDLINE, EMBASE, and bibliographies of previous systematic reviews with no language restriction. Experts in the field of PE research were contacted to identify unpublished studies. Prospective investigations involving predominately outpatient populations with suspected PE that used a turbidimetric D-dimer test were included. Two authors extracted data independently and assessed study quality based on the composition of the patient spectrum and the reference standard used. Consensus was reached by conference. The analysis was based on a summary ROC curve and combining sensitivity and specificity independently across studies using a random-effects model.

Results: The search yielded 264 publications and 2 unpublished studies. Nine studies met the inclusion criteria and provided a sample of 1901 individuals. Eight of the nine studies were homogeneous in terms of both sensitivity and specificity. One study had similar sensitivity but higher specificity. Combining the studies yielded an overall sensitivity of 0.93 (95% confidence interval, 0.89–0.96) and an overall specificity of 0.51 (95% confidence interval, 0.42–0.59).

Conclusions: The turbidimetric D-dimer test is sensitive but nonspecific for the detection of PE in the emergency department setting. D-Dimer tests using latex turbidimetric methods appear to have test characteristics comparable to those for ELISA methods.

D-Dimer testing in the emergency department (ED) setting has been recommended as a strategy for screening patients with a low pretest probability for pulmonary embolism (PE) (1). The rapid qualitative latex tests and bedside assays have not been demonstrated to have sensitivity adequate to rule out a life-threatening condition such as PE (2, 3). However, quantitative D-dimer methods have recently become available and may have test characteristics similar to those of the D-dimer ELISA (1). A previous systematic review evaluated the accuracy of the D-dimer ELISA in the diagnosis of PE and found that the test has excellent sensitivity but only moderate specificity (4). Using the same methods, this metaanalysis evaluates the test characteristics of quantitative latex turbidimetric D-dimer tests in the diagnosis of PE in outpatient acute-care settings.

Materials and Methods

Research Question
The research question was: What is the accuracy (e.g., sensitivity, specificity, likelihood ratios) of the D-dimer test using latex turbidimetric methods in the diagnosis of PE in the adult patient presenting to the ED with a suspected PE?

Search Techniques
MEDLINE (January 1982 to November 2002) was searched for clinical studies assessing the utility of a turbidimetric latex D-dimer test in the diagnosis of PE. The electronic search used the following terms or MeSH

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cases of PE were also excluded.

not address humans and studies that did not examine any

Reviews and editorials were excluded. Studies that did

criteria, reviewers attempted to contact the author to

online version of this article at http://www.clinchem.

form is available as a Data Supplement accompanying the

meeting the inclusion criteria (a copy of the data collection

was used to abstract data from each study

ment, consensus was reached by conference. A data

there was any discordance. Where there was disagree-

Following the relevance search, two reviewers (M.D.B.,

intervention presenting with symptoms and signs

To be included in the metaanalysis, the study must have

been an investigation involving a predominately outpa-

tient population presenting with symptoms and signs

were not identified in the

The search strategy used for the

Reference Update query included “D-dimer” AND “Pul-

monary Embolism OR Thromboembolism OR Venous

Thromboembolism”. The reference list of the articles

chosen for inclusion in the metaanalysis and the reference

list of previous systematic reviews were screened to

identify further studies for inclusion (4, 6–8).

Experts in the area of PE diagnosis and all companies

that manufacture or market the turbidimetric D-dimer

test cleared for human use by the US Food and Drug

Administration were contacted either by telephone or

e-mail in an attempt to identify any unpublished work

that would quality for inclusion.

STUDY SELECTION

Two reviewers (M.D.B., J.A.K.) independently examined

the titles and abstracts of the references identified in the

initial MEDLINE search to determine whether the study

was relevant to the clinical question (relevance search) (5).

Reviews and editorials were excluded. Studies that did

not address humans and studies that did not examine any

cases of PE were also excluded.

INCLUSION CRITERIA

To be included in the metaanalysis, the study must have

been an investigation involving a predominately outpa-

tient population presenting with symptoms and signs

suspicious for PE. If a study included any inpatients, the

study population must have been composed of at least

80% outpatients or data must have been available to

calculate sensitivity and specificity for the outpatient

component of the study population.

FINAL INCLUSION

Following the relevance search, two reviewers (M.D.B.,

J.A.K.) compared exclusion logs to determine whether

there was any discordance. Where there was disagree-

ment, consensus was reached by conference. A data

collection form was used to abstract data from each study

meeting the inclusion criteria (a copy of the data collection

form is available as a Data Supplement accompanying the

online version of this article at http://www.clinchem.

org/content/vol49/issue11/). If a study met the inclusion

criteria, reviewers attempted to contact the author to

identify additional papers, confirm data extraction/esti-

mation for correctness and completeness, and obtain

missing data. Two reviewers (M.D.B., J.A.K.) indepen-
dently confirmed numeric calculations and graphic ex-

trapolations.

REFERENCE STANDARDS

Although a positive angiogram or autopsy is considered

the reference standard for the diagnosis of PE, we consid-
ered any one of the following as acceptable surrogate

reference standards: (a) high probability ventilation-per-

fusion scan, (b) computed tomography scan positive for

PE, or (c) positive lower extremity imaging study (ultra-
sound, impedance plethysmography, venogram, or com-

puted tomography venogram). A negative angiogram

was considered the reference standard for ruling out PE.

Acceptable surrogate reference standards for a negative
diagnosis were as follows: (a) normal or very low proba-

bility ventilation-perfusion scan, or (b) clinical follow-up

documenting the absence of a thromboembolic event over

a minimum of 3 months (9).

QUALITY ASSESSMENT

The rigorous inclusion criteria served as the primary

quality filter. The metaanalysis focused the appraisal of

study quality on the potential for differential reference

standard bias (10) and spectrum bias (11). The reference

standard and patient spectrum for each study was graded

in regard to quality parameters (A, excellent; B, suscepti-

ble to some bias; C, indeterminate or poor) (4) as outlined

below:

Reference standard. Grade A included those studies using

the same reference standard regardless of the turbidimet-

ric D-dimer result. Grade B included those studies using

different reference standards depending on the results of

the turbidimetric D-dimer test. Grade C included those

studies indeterminate or not meeting the study protocol
definition of an appropriate reference standard.

Patient spectrum. For grade A, the patient spectrum would

be expected to include a consecutive or random sampling

of a typical outpatient population presenting with symp-

toms and signs suspicious for PE. Grade B included

studies that selected only a small subgroup of individuals

with suspected PE. Grade C included studies that were

indeterminate or not meeting the study protocol defini-
tion of an appropriate patient spectrum.

There is potential for interpretation bias if the radiolo-
gist performing the reference standard was not blind to

the turbidimetric D-dimer result (11). This information

was obtained from the manuscript or by author query. To

provide the most conservative estimate of test character-

istics, after each study was scored for quality, grade C

studies were excluded from the analysis.
STATISTICAL ANALYSES
The analysis was based on a summary ROC (SROC) curve (12, 13). The sensitivity and specificity for the single test threshold identified for each study were used to plot an unweighted SROC curve (13, 14). A correction factor of one-half was added to each cell to avoid calculation problems by having a value of zero in the 2 x 2 table (13). This correction has not been found to significantly alter the results of the SROC curve (13). The SROC curve analysis was based on a regression analysis of logit transformation of the data, which plots the difference between the logit of the true-positive (TPR) and the logit of the false-positive (FPR) rates (D = logit TPR - logit FPR) on the y axis and the sum (S = logit TPR + logit FPR) on the x axis. The y axis (D) is equivalent to the log diagnostic odds ratio, and the x axis (S) is a measure of how the test characteristics vary with the test threshold. A regression equation (D = α + β * S) derived from the SROC curve analysis can be used to assess the heterogeneity among study results. If the β coefficient is near zero and not statistically significant, then evidence of significant heterogeneity is not present. When there is little variability of both the test sensitivity and specificity among studies, the SROC curve does not provide additional information over averaged sensitivity or specificity values (14). A random-effects model was used to calculate the average sensitivity and specificity across studies (14–16). The random-effects model accounts for between-study variability and provides a more conservative estimation compared with the fixed-effects model (12). Spurious SROC curves may result when individual study results are homogeneous because regression analysis on data with small variations in both the independent and dependent variables could be misleading. In this case, an overall diagnostic odds ratio may be calculated by combining the diagnostic odds ratios of individual studies, using a random-effects model to construct the SROC curve (17). This method assumes that the β is zero and produces a symmetric SROC curve. Statistical tests related to the SROC curve were performed using MetaTest (Ver. 0.6, Boston, MA) and MathCAD (Ver. 2001i Professional; © 1986–2001 MathSoft Engineering & Education, Inc.). All other statistical tests were performed using the SAS statistical application program (Ver. 8.0; Cary, NC).

Results
The comprehensive search yielded a total of 266 studies. A total of 258 references were identified in the initial search of MEDLINE. After review of the abstracts, 220 were immediately deemed ineligible for full review (Table 1). The relevance search had moderate agreement between the two reviewers, with a simple agreement of 89% and κ of 0.54 [95% confidence interval (95% CI), 0.39–0.69]. The EMBASE and Institute for Scientific Information search yielded an additional five references eligible for full review (Fig. 1). The search for the “gray literature” (18) identified one article that was missed (19) and two unpublished studies. Both of the unpublished studies were of substantial size and appeared to qualify for full review. One of the unpublished studies was the product of research done by one of the authors (J.A.K.) of this metaanalysis. The second unpublished study was done at the University of Virginia, and a draft of the manuscript has been submitted for publication (Dr. David E. Bruns, personal communication).5 Representatives of six manufacturers responded to inquiries regarding unpublished data. The companies contacted included Kamiya Biomedical Company, BioPool International Inc (acquired by Trinity USA), Roche Diagnostics, Dade Behring, Stago Diagnostica, and Instrumentation Laboratories. None of these sources provided any undisclosed literature. One company, bioMerieux Inc, parent company of Organon Teknika Corp, the manufacturer of the MDA® assay, indicated the need for a Confidentiality Agreement before unpublished data would be released. We declined this option.

Table 1. Primary reasons for exclusion (n = 257).

<table>
<thead>
<tr>
<th>Reason for author contact</th>
<th>No. of reports</th>
</tr>
</thead>
<tbody>
<tr>
<td>After relevance screen of MEDLINE</td>
<td></td>
</tr>
<tr>
<td>Review</td>
<td>46</td>
</tr>
<tr>
<td>Letter to editor</td>
<td>18</td>
</tr>
<tr>
<td>Patients evaluated only for DVT</td>
<td>98</td>
</tr>
<tr>
<td>Nonturbidimetric D-dimer</td>
<td>34</td>
</tr>
<tr>
<td>Other</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td>220</td>
</tr>
<tr>
<td>After full manuscript review</td>
<td></td>
</tr>
<tr>
<td>Review paper</td>
<td>3</td>
</tr>
<tr>
<td>Duplicate publication</td>
<td>3</td>
</tr>
<tr>
<td>Nonturbidimetric method</td>
<td>18</td>
</tr>
<tr>
<td>Grade C patient spectrum</td>
<td>4</td>
</tr>
<tr>
<td>Grade C reference standard</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>34</td>
</tr>
<tr>
<td>After attempt at author contact</td>
<td></td>
</tr>
<tr>
<td>Reber et al., 2002 (19)</td>
<td>Duplicate*</td>
</tr>
<tr>
<td>Houbouyan-Reveillard et al., 2000 (32)</td>
<td>Data missing</td>
</tr>
<tr>
<td>de Monye et al., 1999 (33)</td>
<td>Data missing</td>
</tr>
</tbody>
</table>

* DVT, deep vein thrombosis.
| b Patient spectrum: grade C, indeterminate or not meeting protocol definition for adequate patient spectrum.
| c Reference standard: grade C, indeterminate or not meeting protocol definition for adequate reference standard.
| d After correspondence with author.

5 Note Added in Proof: This study has since been published (34).
important missing information and confirm data extraction, an attempt was made to contact the authors of the 12 remaining studies. Authors of 8 of the 12 studies (67%) responded in some form to these queries. After attempts at author contact, an additional three studies were excluded (Table 1). Nine studies therefore met the inclusion criteria and provided a total study population of 1901 individuals [20–26]. A summary of the major characteristics of each study is provided in Table 2.

### Study Descriptions

The prevalence of disease among outpatients suspected of PE ranged from 9% to 62% with a mean of 26%. In all studies where information on gender was available, females were represented slightly more than males. The mean age of the patients ranged from 55 to 66 years. Seven studies used a D-dimer concentration \( \geq 500 \mu g/L \) as normal, one used \( < 200 \mu g/L \) (27), and one used [190] \( \mu g/L \), a value determined by the authors on post hoc analysis (22).

### Quality Assessment

Seven studies were assigned grade A with respect to the key quality parameters, patient spectrum, and reference standard (Table 1) (20,22,24–26). Two of these studies included 20% inpatients, which is the maximum percentage of inpatients a study could have and still meet the inclusion criteria as defined in the research protocol.

### Table 2: Nine studies of turbidimetric D-dimer in the diagnosis of PE: study characteristics and diagnostic test performance.

<table>
<thead>
<tr>
<th>Study</th>
<th>Prevalence of PE, %</th>
<th>n( ^a ) (% outpatient)</th>
<th>Mean age,( ^b ) years</th>
<th>Male sex,( ^b ) %</th>
<th>Test (threshold)</th>
<th>Sensitivity (95% CI), %</th>
<th>Specificity (95% CI), %</th>
<th>Reference standard( ^c )</th>
<th>Patient spectrum( ^d )</th>
<th>Radiologist blinded to assay results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bruns, 2003( ^{e,h} )</td>
<td>9</td>
<td>234 (100)</td>
<td>58</td>
<td>34</td>
<td>Liatest (500 \mu g/L)</td>
<td>90 (67–98)</td>
<td>48 (41–55)</td>
<td>A</td>
<td>B</td>
<td>Yes</td>
</tr>
<tr>
<td>Kline, 2003( ^{e} )</td>
<td>11</td>
<td>127 (100)</td>
<td>44</td>
<td>35</td>
<td>MDA (500 \mu g/L)</td>
<td>93 (64–100)</td>
<td>53 (44–62)</td>
<td>A</td>
<td>A</td>
<td>Yes</td>
</tr>
<tr>
<td>Bates et al., 2001 (20)</td>
<td>17</td>
<td>278 (100)</td>
<td>57</td>
<td>37</td>
<td>MDA (500 \mu g/L)</td>
<td>94 (82–98)</td>
<td>42 (36–49)</td>
<td>A</td>
<td>A</td>
<td>Yes</td>
</tr>
<tr>
<td>Kovacs et al., 2001 (21)</td>
<td>10</td>
<td>366 (100)</td>
<td>NA</td>
<td>NA( ^f )</td>
<td>IL-test (200 \mu g/L)</td>
<td>91 (76–98)</td>
<td>74 (69–79)</td>
<td>A</td>
<td>A</td>
<td>Yes</td>
</tr>
<tr>
<td>Reber et al., 2001 (22)</td>
<td>28</td>
<td>166 (100)</td>
<td>61</td>
<td>47</td>
<td>Plus (190 \mu g/L)</td>
<td>98 (87–100)</td>
<td>46 (37–55)</td>
<td>A</td>
<td>A</td>
<td>No</td>
</tr>
<tr>
<td>Heit et al., 1999 (23)</td>
<td>31</td>
<td>61 (100)</td>
<td>63</td>
<td>44</td>
<td>Minutex (500 \mu g/L)</td>
<td>88 (61–98)</td>
<td>51 (36–66)</td>
<td>A</td>
<td>B</td>
<td>Yes</td>
</tr>
<tr>
<td>Meyer et al., 1998 (24)</td>
<td>40</td>
<td>142 (80)</td>
<td>55</td>
<td>42</td>
<td>Liatest (500 \mu g/L)</td>
<td>93 (82–98)</td>
<td>44 (33–55)</td>
<td>A</td>
<td>A</td>
<td>Yes</td>
</tr>
<tr>
<td>Reber et al., 1998 (25)</td>
<td>50</td>
<td>501 (100)</td>
<td>62</td>
<td>NA</td>
<td>Liatest (500 \mu g/L)</td>
<td>99 (96–100)</td>
<td>44 (38–49)</td>
<td>A</td>
<td>A</td>
<td>No</td>
</tr>
<tr>
<td>Knecht et al., 1997 (26)</td>
<td>62</td>
<td>26 (80)</td>
<td>66</td>
<td>38</td>
<td>Tinaq (500 \mu g/L)</td>
<td>100 (79–100)</td>
<td>50 (20–80)</td>
<td>A</td>
<td>A</td>
<td>Yes</td>
</tr>
</tbody>
</table>

\( ^a \) Number of patients with suspected PE.
\( ^b \) Demographics are close approximations based on the information available.
\( ^c \) Reference standard: grade A, same reference standard regardless of the turbidimetric D-dimer test.
\( ^d \) Patient spectrum: grade A, consecutive or random sampling of a typical outpatient population presenting with symptoms suspicious for PE; grade B, potential for spectrum bias.
\( ^e \) Unpublished study.
\( ^f \) NA, adequate data not available after author contact.
\( ^g \) Test threshold determined post hoc.
\( ^h \) Note Added in Proof: This study has since been published (34).
None of the studies used the results of the turbidimetric test to determine which reference standard was applied and were, therefore, not suspected of differential reference standard bias. Two studies were rated grade B with respect to the patient spectrum. The radiologist was blind to the D-dimer results and any other clinical information in the majority (seven of nine) of studies.

**ANALYSES**

After the addition of the correction factor (adding 0.5 to each cell), the sensitivity and specificity of each included study were calculated with the 95% CI displayed (Fig. 2 and Table 2). The pooled summary estimate using a random-effects model produced a sensitivity of 0.93 (95% CI, 0.89–0.96), and a specificity of 0.51 (95% CI, 0.42–0.59). The SROC curve analysis demonstrated evidence of statistically significant heterogeneity with $\gamma = 0.51$ (95% CI, 0.01–1.02). However, the visual display provided by the SROC curve showed minimal variability in the results (Fig. 3). Deriving the SROC curve using the overall diagnostic odds ratio of 13.9 (95% CI, 8.3–23.4) provided a symmetric curve that covered a larger area.

**SENSITIVITY ANALYSES**

The sensitivity analysis based on the key quality parameters and subgroups defined a priori was performed, and none were significant. All studies formed a cluster except for the study by Kovacs et al. (21), which was the only truly heterogeneous study in the group. When the unpublished studies were excluded, there was essentially no change in the overall estimates.

**Discussion**

This systematic review attempted to identify the current published and unpublished literature regarding the use of turbidimetric D-dimer in the diagnosis of PE in the acute-care setting. After an exhaustive search, the application of stringent inclusion/exclusion criteria, and rigorous selection methodology, we included nine studies involving 1901 patients. The results demonstrate that D-dimer tests using the turbidimetric technique are highly sensitive (93%), but only moderately specific (51%). This equates to a likelihood ratio positive of 1.9 and a likelihood ratio negative of 0.14. Previous work focused on use of the rapid ELISA (4), and our data show approximate equivalence to the D-dimer ELISA. It is important to have quantitative data as background data to devise clinical decision rules and clinical pathways. Clinical relevance includes that the turbidimetric test can be expected to offer a likelihood ratio negative of $\approx 0.1$ to 0.15. Thus, the turbidimetric test could be used to reduce the posttest probability of PE to $<1\%$, as suggested by Kline and Wells, if used in a patient population with a pretest probability $<10\%$ (1). This level of pretest probability may be achieved with the use of appropriate clinical decision rules or possibly with the use of clinician suspicion of low-risk for PE.

In recent studies of ED outpatients who were evaluated for possible pulmonary embolism with D-dimer testing,
the pretest prevalence of PE was <10% even without the use of a decision rule or physician suspicion to select for low-risk individuals (27, 28). Indeed, over the past 5 years, published studies of outpatients evaluated for PE with the D-dimer have demonstrated a steady reduction in the overall prevalence of PE, which suggests that physicians are becoming more comfortable with the D-dimer and are expanding its use in patients who might not be evaluated with an objective test if the only option for testing were the use of pulmonary vascular imaging. We used strict criteria to select studies involving predominantly outpatients. The mean prevalence of PE in the present study was 26%, which we believe is somewhat higher than will be encountered when the test is implemented in daily practice. Thus, it can be speculated that because of spectrum bias, the diagnostic indexes derived in this metaanalysis will be slightly different from those that will be observed in real practice. One possibility is that the specificity of the test will increase and the sensitivity will decrease.

In a recent survey of 30 academic medical centers, 87% of academic emergency physicians indicated that they had 24-h access to the D-dimer assay for the purpose of evaluating for PE (29). We postulate that the number of clinicians who are ordering the quantitative D-dimer and using the result to make decisions in the ED is increasing each year. Moreover, our experience suggests that many laboratory directors are currently in the process of reevaluating the D-dimer assays that they use in their hospital laboratories. For these reasons, we thought that it was important to aggregate the available data in this systematic review to help clinicians and laboratory directors decide which D-dimer assay format to use. Clinicians are generally aware that the ELISA format provides quantitative D-dimer results and that a negative D-dimer ELISA result (<500 μg/L) significantly lowers the probability of PE. However, our experience indicates that clinicians are less well informed of the diagnostic accuracy of the qualitative latex immunoturbidimetric D-dimer assay. Some have confused the immunoturbidimetric D-dimer with the latex fixation assay. The immunoturbidimetric test assay uses spectrophotometry to measure the rate of precipitation of latex particles that are coated with antibody directed against the D-dimer peptide. When a plasma sample is introduced to a sample cuvette containing the latex particles, the particles begin to aggregate. As the particles aggregate, the amount of light transmitted across the cuvette increases at a rate that is proportional to the D-dimer concentration in the plasma sample. In contrast, the qualitative latex fixation D-dimer assay relies on visual inspection to detect flocculation of latex particles. The interpretation of latex fixation assays is therefore intrinsically subjective. This subjective component may be one reason that the qualitative latex fixation D-dimer assay has not uniformly demonstrated good sensitivity for PE in published studies.

A precedent metaanalysis that used methods similar to those in the present report found that the D-dimer ELISA had a pooled sensitivity of 94% and specificity of 45% in outpatients with suspected PE (4). The ELISA metaanalysis pooled the data from 2126 patients in 11 studies, but included only 2 studies (n = 639) (30, 31) that used the rapid ELISA method. The standard ELISA method has limited value in the outpatient setting, inasmuch as the test requires at least 3 h to perform and is generally not designed for single-sample use. Manufacturers indicate that commercially available rapid ELISA tests can be performed within 30 min (VIDAS®). Likewise, the immunoturbidimetric D-dimer test can be completed within 15 min (MDA). We found very similar diagnostic performance of the immunoturbidimetric assay compared with the standard ELISA assay.

In this study, we used the cutoff for a normal D-dimer concentration that was suggested by the authors. Seven of nine studies in Table 2 used 500 μg/L as the upper limit of normal. Among the seven studies that used 500 μg/L, the prevalence of PE ranged from 9% to 62%, but the cluster of summary diagnostic indexes from these seven studies was very tight when plotted on the SROC in Fig. 3. This finding suggests that a threshold of 500 μg/L will
yield very similar diagnostic results when applied to different outpatient populations.

Two studies that used lower cutoffs warrant specific comment. One study that used 190 μg/L (22) performed similarly to studies that used 500 μg/L (Table 2). However, it was somewhat counterintuitive that the specificity in the study that used a threshold of 200 μg/L (21) was unusually high (74%) compared with studies that used 500 μg/L. One possible reason for this finding was that patients in that particular study population, for whom the prevalence of PE was 10%, may have been relatively young and devoid of comorbidity that would cause false-positive D-dimer test results. Thus, if the hypothesis that expanding use of the D-dimer to screen for PE leads to testing in younger patients with less comorbidity is true, then it remains possible that a lower concentration threshold can be used without sacrificing test specificity. This discussion must be interpreted with caution, and we emphasize that we do not have data for all D-dimer concentrations from all 1901 patients, which precludes us from recommending an optimal cutoff for a normal D-dimer concentration.

In conclusion, this metaanalysis found that the immunoturbidimetric D-dimer assay has reasonably high sensitivity and moderate specificity for the detection of PE in outpatients. The diagnostic indexes compare favorably with those found in a predicate metaanalysis of the D-dimer ELISA assay (4). On the basis of diagnostic accuracy, our data suggest that the test characteristics of the immunoturbidimetric D-dimer assay are similar to those of the ELISA D-dimer assay.

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References


