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How Physicians Evaluate Patients with Dementia who Present with Shortness of Breath

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Abstract

Background—Whether the presence of dementia in patients makes it difficult for physicians to assess the risk such patients might have for serious conditions such as pulmonary embolism (PE) is unknown. Our objective was to examine the differential association of four clinical factors (DVT/PE, malignancy, recent surgery, tachycardia) with PE testing for patients with dementia compared to patients without dementia.

Methods—We performed a cross-sectional study of emergency department (ED) visits to 104 VA hospitals from 2011-2018 by patients 60 and over presenting with shortness of breath (SOB). Our outcomes were PE testing (CT scan and/or D-dimer) and subsequently diagnosed acute PE.

Results—The sample included 593,001 patient visits for SOB across 7,124 ED physicians. 5.6% of the sample had dementia. 10.6% received PE testing. Three of the four clinical factors examined had a lower association with PE testing for patients with dementia. For example, after taking into account that at baseline physicians were 0.9 percentage points less likely to test patients with dementia than patients without dementia for PE, physicians were an additional 2.6 percentage points less likely to test patients with dementia who had tachycardia than patients without dementia who had tachycardia. We failed to find evidence that any clinical factor examined had a differentially lower association with a subsequently diagnosed acute PE for patients with dementia.

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Conclusions—Clinical factors known to be predictive of PE risk had a lower association with PE testing for patients with dementia compared to patients without dementia. These results may be consistent with physicians missing these clinical factors more often when evaluating patients with dementia, but also with physicians recognizing such factors but not using them in the decision-making process. Further understanding how physicians evaluate patients with dementia presenting with common acute symptoms may help improve the care delivered to such patients.

Introduction

When evaluating patients, physicians integrate information from multiple sources, including from the electronic health record (EHR) and from patients themselves. This evaluation may be more challenging when patients have dementia due to such patients having potential problems with memory or communication. Such patients may have difficulty conveying what brought them to the hospital.[1] Little is known about how physicians evaluate patients with dementia compared to patients without dementia for common acute presentations such as shortness of breath (SOB).

Patient evaluation often involves assessing disease risk, such as the risk of pulmonary embolism (PE) in patients with SOB. PE, if left untreated, is associated with an overall mortality of up to 30 percent (compared to 2 to 11 percent when treated with anticoagulation).[2] In some scenarios, such as PE risk assessment, clinical prediction rules can help physicians process large amounts of clinical information by highlighting a subset of clinical factors that are validated to correlate with disease risk.[3,4] Several of these factors, such as past deep venous thrombosis (DVT)/PE and tachycardia, can be found in the EHR. How physicians assess highlighted clinical factors available in the EHR for patients with dementia is unknown and may provide insights into the care of such patients.

In this study, we used national Veterans Affairs (VA) EHR data from 2011 to 2018 to examine how physicians in the emergency department (ED) evaluate patients with SOB for the risk of PE. We first examined whether clinical factors known to be predictive of PE risk had an association with PE testing for patients with SOB. We then examined whether these clinical factors had a lower association with PE testing for patients with dementia compared to patients without dementia. Finally, we examined whether these clinical factors were less predictive of PE for patients with dementia relative to patients without dementia.

Methods

Data Sources and Study Population

We used national EHR data from the VA Corporate Data Warehouse, which includes patient demographics, vital signs, diagnosis codes, tests ordered, and surgeries performed. We used ED visit data collected in VA Emergency Department Integration Software (EDIS).[5] We identified patients aged 60 and over who visited a VA ED with a presenting complaint of SOB between 2011 and 2018. We excluded ED visits for patients on hospice or who had electronic documentation of being “comfort measures only.” We included and controlled for having electronic documentation of being “do not resuscitate/do not intubate (DNR/DNI),”

a possible proxy for desired intensity of care, although we excluded such patients in a sensitivity analysis.

Study Measures

Our primary covariates of interest were clinical factors found in a validated clinical prediction rule that was commonly-taught during the examined time period: Wells' score for PE (Table S1).[3,4,6] Using EHR data, we are able to observe 4 of the 7 clinical factors in the Wells' score: prior DVT or PE, a diagnosis of cancer within the prior 6 months, a surgery within the prior 4 weeks, and heart rate greater than 100. For heart rate, we chose the first heart rate recorded after ED arrival. We also a priori included 4 other clinical covariates. The first was oxygen saturation less than 90%. We chose the first oxygen saturation recorded after ED arrival. The other 3 clinical factors were the presence of chronic conditions whose exacerbation may provide a possible alternative diagnosis for shortness of breath: ischemic heart disease, congestive heart failure, and chronic obstructive pulmonary disease. For these diagnoses and the diagnosis of dementia, we a priori chose a 2-year window prior to ED arrival. Other patient covariates included age, sex, and race and ethnicity. Finally, we included DNR/DNI status.

Our main outcome of interest was whether patients received a test intended to diagnose or exclude PE either within 8 hours of ED arrival or by ED departure, whichever came first. In a sensitivity analysis we removed the 8-hour restriction. There are two main recommended tests for PE: D-dimer blood test and CT scan of the chest with contrast (CT pulmonary angiogram). Because we are missing 3 of the 7 clinical factors in the Wells' score that may make either a D-dimer test or a CT scan more appropriate, our outcome of interest was a binary composite measure of either or both tests. We did not include ventilation/perfusion (V/Q) scans or lower extremity ultrasounds because these were uncommonly ordered from the ED (0.30% and 0.50%, respectively, of ED visits for SOB), but we included such tests in a sensitivity analysis.

To examine whether clinical factors found in the Wells' score may have a lower association with PE testing for patients with dementia because they are less predictive of PE in such patients, our second outcome of interest was a diagnosis of acute PE within 30 days of ED departure. This outcome was formed under the assumption that a PE will continue to cause the SOB for which patients presented to the ED until discovered.

Statistical Analysis

In the first specification, we performed a multivariable regression using a linear probability model of our binary testing outcome as a function of the four clinical factors in the Wells' score observable in the EHR ("abbreviated Wells' score"). We modeled these clinical factors both as a single score and as separate binary variables. For the single score, we assigned 1.5 points for tachycardia, 1.5 points for recent surgery, 1.5 points for prior DVT/PE, and 1 point for a recent malignancy diagnosis.[7] The score was entered categorically as 0, 1, 1.5, 2.5, and 3+. We included oxygen saturation because the finding of a low oxygen saturation may contribute to the likelihood of a PE. We controlled for the other clinical and demographic covariates listed above. We included physician fixed effects to control for differences across

physicians, including differences in testing thresholds and in specialty training. We also included weekend (versus weekday) fixed effects, month fixed effects, and year fixed effects to control for temporal trends. We clustered our standard errors at the hospital level.

In the second specification, to examine whether there was a lower association of these clinical factors with PE testing for patients with dementia compared to patients without dementia, we included a covariate for dementia and the interaction of this covariate either with the categorical score or with the separate binary variables for these four factors. We defined the baseline testing difference for patients with dementia as the testing difference between those with and without dementia among those with an abbreviated Wells' score of 0. The dementia covariate controls for this baseline testing difference to account for the possibility that patients with dementia on average are tested less. The coefficients on the interaction terms, therefore, help examine whether these clinical factors had a differential association with PE testing for patients with dementia compared to patients without dementia. The inclusion of physician fixed effects effectively compares differences in the association of these clinical factors with PE testing by the same physician between patients with dementia and patients without dementia.

In the third specification, we replaced the testing outcome with our outcome of an acute PE diagnosis within 30 days of ED departure. All p-values were from 2-sided tests and results were deemed statistically significant at the $p<0.05$ level. Data were prepared using Microsoft SQL Server and analyzed using Stata version 15.1. The VA Boston Healthcare System IRB approved the study.

Results

Our sample included 7,124 ED physicians who had 593,001 patient visits for SOB across 104 VA hospitals. 5.6 percent of the sample had dementia (Table 1). Patients with dementia were more likely to have a past DVT/PE and less likely to have a recent malignancy diagnosis, a recent surgery, or tachycardia. Patients with dementia were more likely to have a low oxygen saturation and to be DNR/DNI.

In adjusted analyses among all patients, each clinical factor in the abbreviated Wells' score was associated with increased testing for PE, and higher abbreviated Wells' scores were associated with more testing (Figure S1 and Table S2). For example, in absolute differences, physicians were 10.0 percentage points more likely to test those with a score of 3 or more points than those with a score of 0. Similarly, physicians were 5.1 percentage points more likely to test those with tachycardia than those without tachycardia.

At baseline, physicians were 0.9 percentage points less likely to test their patients with dementia than their patients without dementia (Table S3). After controlling for this baseline testing difference, physicians were an additional 2.2 percentage points less likely to test their patients with dementia with an abbreviated Wells' score of 1.5 than their patients without dementia with an abbreviated Wells' score of 1.5, and they were an additional 4.8 percentage points less likely to test their patients with dementia with an abbreviated Wells' score of 3 or more than those without dementia with an abbreviated Wells' score of 3 or more (Figure

1 and Table S3). This additional 4.8 percentage point difference is almost half of the testing difference of 10.4 percentage points among patients without dementia between those with an abbreviated Wells' score of 3 or more and those with an abbreviated Wells' score of 0.

Patterns were similar when examining by individual clinical factors, with recent malignancy diagnosis, past DVT/PE, and tachycardia having a lower association with PE testing for patients with dementia than for patients without dementia (Table S3). For example, for patients without dementia, tachycardia was associated with a 5.2 percentage point higher likelihood of testing relative to those without tachycardia. After accounting for the baseline 0.9 percentage point lower likelihood of testing for patients with dementia, physicians were an additional 2.6 percentage points less likely to test their patients with dementia who had tachycardia than those without dementia who had tachycardia.

Results were unchanged when not limiting PE testing to the first 8 hours (Table S4), excluding patients who were DNR/DNI (Table S5), or including V/Q scans and lower extremity ultrasounds in the testing outcome (Table S6).

When examining by abbreviated Wells' score, higher scores were not differentially associated with a subsequently diagnosed acute PE for patients with dementia (Figure 2 and Table S7). That is, we failed to find evidence of a difference in association of, for example, an abbreviated Wells' score of 3 or more with a subsequently diagnosed PE between patients with dementia and patients without dementia. When examining by individual clinical factors, recent surgery had a higher association with PE for patients with dementia than for patients without dementia (Table S7).

Discussion

Using a national sample of almost 600,000 ED visits for SOB, this study found that, after controlling for the baseline lower level of testing for patients with dementia, clinical factors known to be predictive of PE risk had a lower association with PE testing for patients with dementia compared to patients without dementia. These factors did not have a lower association with a subsequently diagnosed PE for patients with dementia. Our results suggest that for every 100 patients without dementia seen in the ED for SOB who have an abbreviated Wells' score of 3 or more, 3 of them will have PE and 19 will be tested for PE. Conversely, for every 100 patients with dementia seen in the ED for SOB who have an abbreviated Wells' score of 3 or more, 4 of them will have PE and 14 (5 fewer) will be tested for PE.

Although there is literature on treatment decisions and, to a much lesser extent, testing decisions for patients with mild cognitive impairment and dementia when examining particular diagnoses like acute myocardial infarction and stroke,[8–12] little is known about differential associations of particular clinical factors with testing for patients with dementia when examining from the perspective of clinical presentations like SOB. We find evidence consistent with physicians taking into account factors highlighted in a commonly-used clinical prediction rule. Physicians, though, appear implicitly to place lower weights on such factors or appear more likely to miss such factors when evaluating patients with

dementia. Patients with dementia may be challenging to evaluate because they may not be able to convey important information about their present illness or their medical history. It is unclear, however, why physicians appear more often to miss clinical factors that can be found in the EHR or place a lower weight on them for such patients.

There are several possible explanations. One explanation is that the Wells' score is less predictive of PE for patients with dementia. However, our results were inconsistent with this explanation. Another explanation is that the reluctance of patients with dementia, the reluctance of their health care proxies, or the reluctance of physicians evaluating such patients to test for PE grows as the risk for PE increases. We cannot rule out this explanation, although our results controlled for a possible proxy for desired intensity of care (DNR/DNI status) and were unchanged when excluding such patients. Our results are consistent with the possibility that physicians are less able to identify important clinical factors in patients with dementia, and by not identifying the possibility of PE, are unable to discuss testing and treatment options with patients and their caregivers consistent with their care preferences. However, there are other explanations for our results that our study design and data cannot explore, such as physicians down-weighting factors in the EHR that they cannot directly verify with patients.

This study has several limitations. This study was observational and there is likely residual confounding. We were not able to observe every clinical factor in the Wells' score. We could not fully capture the clinically complexity of each case. However, our use of EHR data represents an improvement on prior data used, allowing us to include clinical data such as vital signs that physicians use when evaluating patients. Our data did not include information about clinical care wishes of patients or their caregivers beyond DNR/DNI status; we also could not tell from our data whether patients and their caregivers were given the option of PE testing and declined it. We do not have information regarding dementia severity. We do not have data on diagnoses and care received outside the VA. Our results are specific to the VA and may not generalize to non-VA physicians treating non-VA patient populations. These limitations, especially residual confounding, lack of patient or caregiver goals of care beyond DNR/DNI status, and lack of several elements of the Wells' score, could drive our results.

In conclusion, we find that clinical factors known to be predictive of PE risk have a lower association with PE testing for patients with dementia relative to patients without dementia. These results may be consistent with physicians being more likely to miss such factors in patients with dementia. With the number of people with dementia in the United States at over 6 million, given that a third of community-dwelling patients with dementia will visit the ED each year and half of nursing home residents of dementia will visit the ED each year,[13] understanding barriers to delivering quality care to patients with dementia will continue to grow in importance.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Key Points

Factors predictive of pulmonary embolism are less associated with PE testing for patients with versus without dementia

Factors are similarly associated with PE for those with dementia

Why Does this Paper Matter?

Doctors may miss or not act on factors predictive of PE for those with dementia

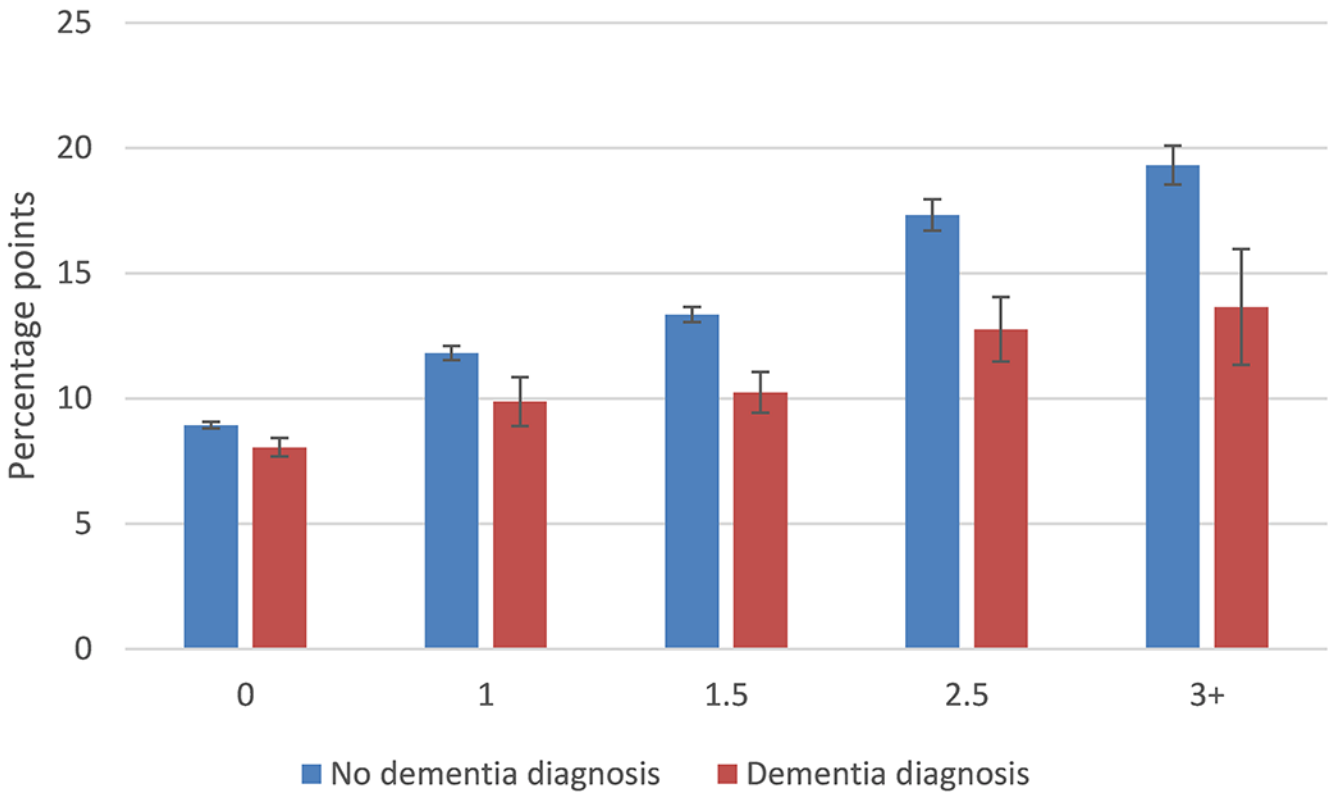

Figure 1:

Testing for Pulmonary Embolism for Patients with Dementia versus Patients without Dementia by Abbreviated Wells' Score, 2011-2018

Notes: Author's calculation using VA data from 2011-2018. Bars are 95 percent confidence intervals. For the abbreviated Wells' score, malignancy within 6 months was given 1 point, past deep venous thrombosis or pulmonary embolism was given 1.5 points, surgery within 4 weeks was given 1.5 points, and heart rate >100 was given 1.5 points. Adjusted probabilities were calculated using marginal standardization from linear probability models of testing (D-dimer and/or CT scan of the chest with contrast) as a function of Wells' score, dementia, and the interaction of the Wells' score with dementia; physician fixed effects were included to compare differences in testing within the same physician, controlling also for oxygen saturation below 90, past history of ischemic heart disease, past history of congestive heart failure, past history of chronic obstructive pulmonary disease, DNR/DNI status, age, female, race and ethnicity, year, month, and weekend. Standard errors were clustered at the hospital level.

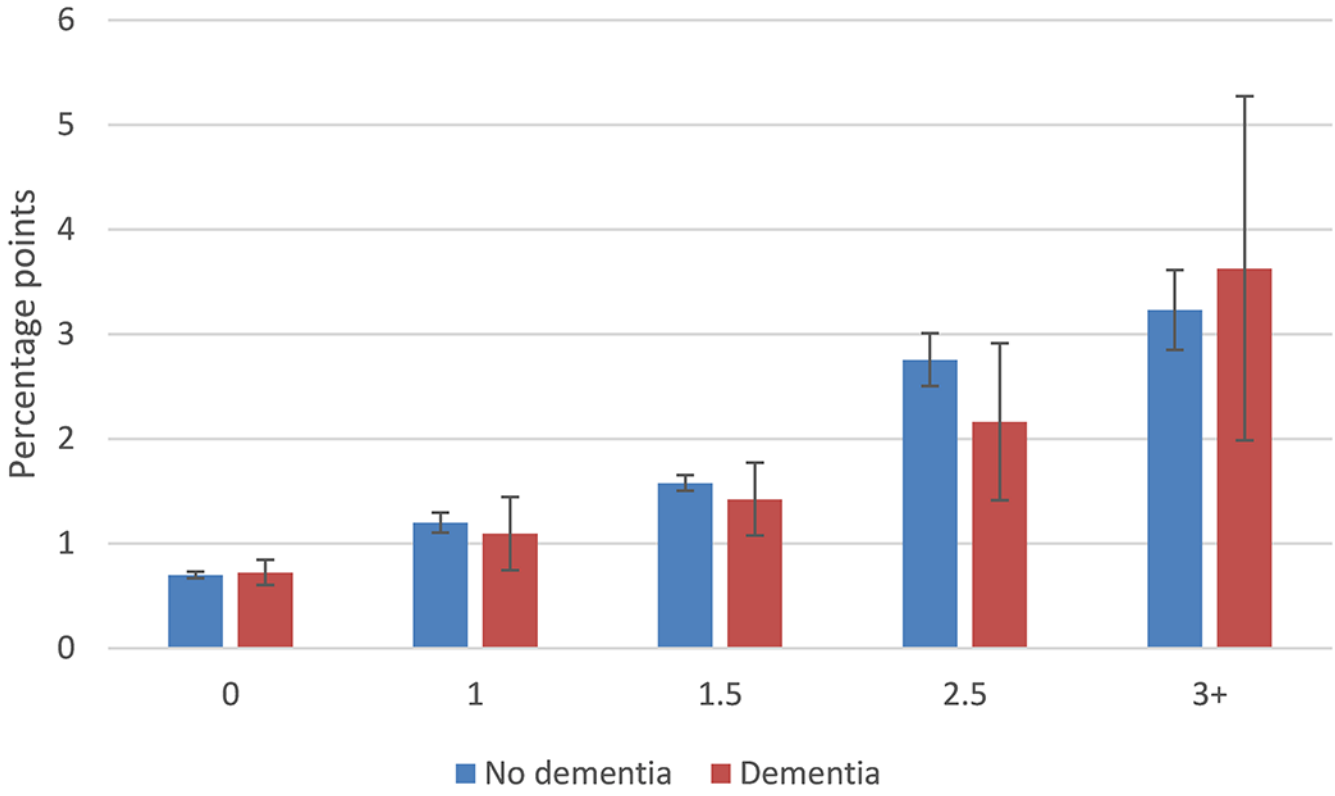

Figure 2:

Subsequent Diagnosis of Acute Pulmonary Embolism for Patients with Dementia versus Patients without Dementia by Abbreviated Wells' Score, 2011-2018

Notes: Author's calculation using VA data from 2011-2018. Bars are 95 percent confidence intervals. For the abbreviated Wells' score, malignancy within 6 months was given 1 point, past deep venous thrombosis or pulmonary embolism was given 1.5 points, surgery within 4 weeks was given 1.5 points, and heart rate >100 was given 1.5 points. Adjusted probabilities were calculated using marginal standardization from linear probability models of subsequent diagnosis of acute pulmonary embolism (within 30 days) as a function of Wells' score, dementia, and the interaction of Wells' score with dementia; controlling also for oxygen saturation below 90, past history of ischemic heart disease, past history of congestive heart failure, past history of chronic obstructive pulmonary disease, DNR/DNI status, age, female, race and ethnicity, year, month, and weekend. Standard errors were clustered at the hospital level.

Table 1:

Patient Visit Characteristics, 2011-2018

	All patient visits (n=593,001)	Patient visits with dementia diagnosis (n=33,419)	Patient visits without dementia diagnosis (n=559,582)	p-value for the difference
Age (years)	71.8	79.8	71.3	<0.001
60-69 (%)	52.6	19.5	54.6	<0.001
70-79 (%)	28.0	26.9	28.1	
80-89 (%)	15.7	39.1	14.3	
90+ (%)	3.7	14.6	3.0	
Female (%)	3.6	2.2	3.7	<0.001
Race				
American Indian or Alaska Native (%)	0.8	0.6	0.8	<0.001
Asian (%)	1.1	1.3	1.1	
Black (%)	19.8	18.3	19.9	
Hispanic (%)	5.8	11.6	5.4	
Other race or ethnicity (%)	4.3	4.4	4.3	
White (%)	68.3	63.8	68.5	
Dementia (%)	5.6	100	0	-
Malignancy within 6 months (%)	16.1	15.6	16.1	0.02
Past deep venous thrombosis or pulmonary embolism (%)	7.2	12.0	6.9	<0.001
Surgery within 4 weeks (%)	2.6	2.2	2.6	<0.001
Heart>100 (%)	18.2	17.3	18.2	<0.001
Abbreviated Wells' score (points)	0.58	0.63	0.58	<0.001
0 points (%)	63.5	60.8	63.6	<0.001
1 point (%)	10.7	10.6	10.7	
1.5 points (%)	19.0	21.2	18.9	
2.5 points (%)	4.8	4.5	4.8	
3+ points (%)	2.0	2.9	2.0	
Oxygen saturation<90% (%)	7.5	9.1	7.4	<0.001
Ischemic heart disease (%)	40.7	52.9	40.0	<0.001
Congestive heart failure (%)	26.9	41.3	26.0	<0.001
Chronic obstructive pulmonary disease (%)	52.4	55.8	52.2	<0.001
DNR/DNI (%)	6.5	18.6	5.8	<0.001
D-dimer (%)	7.8	7.2	7.8	<0.001
CT scan with contrast (%)	5.3	4.2	5.3	<0.001
D-dimer and/or CT scan with contrast (%)	10.6	9.4	10.7	<0.001
Acute pulmonary embolism diagnosed within 30 days of departure from emergency department (%)	1.0	1.1	1.0	0.10

Notes: Author's calculation using VA data from 2011-2018. For the abbreviated Wells' score, malignancy within 6 months was given 1 point, past deep venous thrombosis or pulmonary embolism was given 1.5 points, surgery within 4 weeks was given 1.5 points, and heart rate>100 was given 1.5 points. P-values were calculated using t-tests for means and chi-square tests for categories.