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Impact of Relative Contraindications to Home Management in Emergency Department Patients with Low-Risk Pulmonary Embolism

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Abstract

Rationale: Studies of adults presenting to the emergency department (ED) with acute pulmonary embolism (PE) suggest that those who are low risk on the PE Severity Index (classes I and II) can be managed safely without hospitalization. However, the impact of relative contraindications to home management on outcomes has not been described.

Objectives: To compare 5-day and 30-day adverse event rates among low-risk ED patients with acute PE without and with outpatient ineligibility criteria.

Methods: We conducted a retrospective multicenter cohort study of adults presenting to the ED with acute low-risk PE between 2010 and 2012. We evaluated the association between outpatient treatment eligibility criteria based on a comprehensive list of relative contraindications and 5-day adverse events and 30-day outcomes, including major hemorrhage, recurrent venous thromboembolism, and all-cause mortality.

Measurements and Main Results: Of 423 adults with acute low-risk PE, 271 (64.1%) had no relative contraindications to outpatient treatment (outpatient eligible), whereas 152 (35.9%) had at least one contraindication (outpatient ineligible). Relative contraindications were categorized as PE-related factors (n = 112; 26.5%), comorbid illness (n = 42; 9.9%), and psychosocial barriers (n = 19; 4.5%). There were no 5-day events in the outpatient-eligible group (95% upper confidence limit, 1.7%) and two events (1.3%; 95% confidence interval [CI], 0.1–5.0%) in the outpatient-ineligible group ($P = 0.13$). At 30 days, there were five events (two recurrent venous thromboemboli and three major bleeding events) in the outpatient-eligible group (1.8%; 95% CI, 0.7–4.4%) compared with nine in the ineligible group (5.9%; 95% CI, 2.7–10.9%; $P < 0.05$). This difference remained significant when controlling for PE severity class.

Conclusions: Nearly two-thirds of adults presenting to the ED with low-risk PE were potentially eligible for outpatient therapy. Relative contraindications to outpatient management were associated with an increased frequency of adverse events at 30 days among adults with low-risk PE.

Keywords: pulmonary embolism; risk assessment; ambulatory care

Risk stratification tools for emergency department (ED) patients with acute pulmonary embolism (PE) can be used to identify patients at low risk for complications (1). Many of these low-risk patients are eligible for outpatient management (2, 3). Among the several prognostic tools used to identify a low-risk population, the PE Severity Index is the most extensively studied and is recommended by professional societies internationally (1, 4–7). It was derived to identify patients at low risk for 30-day all-cause mortality and has demonstrated excellent discrimination in thousands of

patients across multiple settings in Europe and North America.

Although the PE Severity Index shows reliable predictive performance for 30-day mortality, predicting other adverse events in a shorter-term interval (e.g., 5 d) may be of equal importance for physicians making the initial site-of-care decisions for low-risk PE (8). Two single-center retrospective case series tested the PE Severity Index in this capacity but failed to account for relative contraindications to outpatient care (9, 10). Contraindications, however, are commonly used in various combinations throughout the prospective outpatient PE literature as well as in outpatient management protocols (2, 3, 11, 12).

No consensus of relative contraindications to outpatient PE care has been established, nor has their contribution to clinical outcomes been examined. We undertook this multicenter retrospective cohort study to compare 5-day and 30-day major outcomes between low-risk patients with PE (PE Severity Index classes I and II) with and without relative outpatient contraindications. We hypothesized that low-risk patients with acute PE who were potentially eligible for outpatient care (by virtue of lacking relative contraindications) would have a lower incidence of both 5-day adverse events and 30-day major outcomes compared with those who were ineligible for ambulatory management.

Some of the results of this study have been previously reported in the form of an abstract (13).

Methods

Study Design and Setting
This retrospective cohort study included adult ED patients who were diagnosed with acute PE from 2010 through 2012 in four community EDs within Kaiser Permanente Northern California, an integrated healthcare delivery system. Patients receive nearly all their medical care within the health plan, which is served by one integrated electronic health record linking 21 medical centers and 160 medical offices. The number of cases during the study period determined the sample size. The study was approved by the Kaiser Permanente Northern California Health Services Institutional Review Board.

No standard policy for PE risk assessment or site-of-care management was in place throughout the study period. Treating physicians commonly used the standard Kaiser Permanente Northern California discharge order set for thromboembolism, which recommended warfarin with concomitant bridging therapy using enoxaparin. Alternative oral anticoagulants approved for the treatment of PE were not often prescribed, as the formulary restricted their use to patients who had failed or were unable to adhere to warfarin. Outpatient warfarin dosing was managed by each facility's pharmacy-led anticoagulation service following a standardized nomogram. Percent time spent with therapeutic international normalized ratios at these facilities during the study period ranged from 72 to 74%. Conventional practice for patients with PE discharged home directly from the ED or after a short observational stay was outpatient follow-up within 7 days (14).

Selection of Participants
The process of patient selection is detailed in Figure 1. The three risk stratification instruments we used to identify patients to be examined for eligibility were the PE Severity Index (7), the simplified PE Severity Index (15), and the PE Triage Score (16). Our final cohort consisted of adult patients who received an objectively confirmed diagnosis of acute PE in the ED, were categorized as low risk by the PE Severity Index (classes I and II; ≤85 points) (see Table E1 in the online supplement) (7), and had complete 30-day outcome data. Radiographic diagnosis was based on a new contrast filling defect on spiral computed tomography or pulmonary angiography or a new high-probability ventilation–perfusion lung scan (6).

Data Collection and Definitions
We extracted demographic and clinical variables from patients' electronic health records (17). Investigators undertook manual review of these records to both confirm extracted data and supplement them as needed. We entered our findings directly into a standardized electronic data collection tool that was prepopulated with the electronically extracted data, which were used to facilitate the abstractors' identification of study variables. All abstractors received training on data collection methods. Abstractors were not blinded to the study hypothesis. The principal investigator (D.R.V.) monitored

data collection activities and answered and arbitrated coding questions.

We systematically reviewed the electronic health records pertaining to the index visit as well as healthcare encounters in the prior 90 days and subsequent 30 days. Our manual calculation of the PE Severity Index scores used the definitions from the original derivation and validation study (Table E1) (7). In keeping with the Index's design, we used the worst, not the first, vital signs from the ED stay. We also included abnormal clinical findings from the immediate prearrival assessment (emergency medical services and outpatient clinic) if they were documented by the emergency physician or consulting hospitalist, because these were known to the site-of-care decision maker(s) and could influence the patient's disposition. Missing vital signs were assumed to be normal for calculation purposes. We also identified presenting symptoms, disposition at ED discharge, and total length of stay.

Patients who were low risk on the PE Severity Index were considered candidates for outpatient management in the absence of relative contraindications. The contraindications were adopted from the literature on outpatient PE management and predictors of adverse outcomes in patients with acute PE (6, 11, 12, 18–41). We defined these relative contraindications *a priori* and selected them to reflect a conservative approach to outpatient management. Relative contraindications were deemed present only if they were available to the physicians making the initial site-of-care decision.

We adopted and adapted the definitions of major 5-day inpatient adverse events from researchers at Massachusetts General Hospital (8, 9, 19). These included clot extraction or lysis (local or systemic), respiratory support (a non-rebreather mask or more), new cardiac dysrhythmia requiring treatment, use of intravenous vasopressors or inotropics, use of defibrillation or cardiopulmonary resuscitation, recurrent PE, major hemorrhage (defined below), and death.

Event ascertainment was undertaken by combining electronic data extraction and manual chart review by physician-investigators. The programming methods used to raise "red flags" of possible events for the abstractors are detailed in Table E2. Abstractors systematically reviewed the integrated electronic health records from
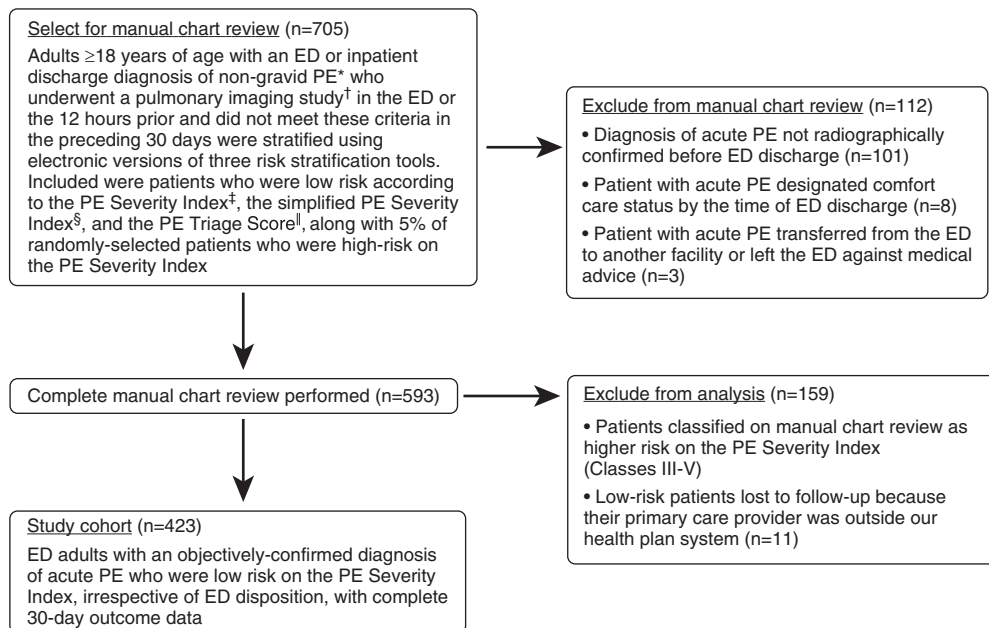
Figure 1. Cohort assembly. *International Classification of Diseases, Ninth Revision codes 415.11, 415.13, 415.19, 673.20, 673.21, 673.22, and 673.24. †Spiral computed tomography (Current Procedural Terminology [CPT] codes 71275, 71260, and 71270), pulmonary angiogram (CPT codes 75743 and 75746), a ventilation–perfusion lung scan (CPT codes 78579, 78580, 78582, 78584, 78585, 78586, 78587, 78588, 78591, 78593, and 78594), or a magnetic resonance angiogram (CPT code 71555). ‡Low risk on the Pulmonary Embolism (PE) Severity Index equates to a score of 85 points or less (classes I and II). §Low risk on the simplified PE Severity Index equates to a score of 0. ‖Low risk on the PE Triage Score equates to a score of 0. ED = emergency department; PE = pulmonary embolism.

the index ED stay and inpatient, ED, and outpatient visits in the preceding 90 days and following 30 days to confirm and supplement the extracted data. We reviewed physician notes, nursing flow sheets (for evidence of respiratory support and red blood cell transfusion), and radiology reports (for recurrent venous thromboembolic events). We also examined our claims database for medical care of study patients during the study period rendered outside the health plan.

Inpatient adverse events were restricted to outcomes and interventions not diagnosed or initiated during the initial ED stay. We included events that occurred during the index inpatient stay as well as during any postdischarge return ED visit or hospitalization. The 5-day and 30-day intervals were measured from the time of ED registration.

Thirty-day outcomes included major hemorrhage, recurrent venous thromboembolism, and all-cause mortality (2, 6, 42). Major hemorrhage was defined in keeping with the International Society on Thrombosis and Haemostasis as bleeding at high-risk anatomic locations (intracranial, intraspinal, intraocular, retroperitoneal, intraarticular, pericardial, or intramuscular

with compartment syndrome) or overt bleeding with either a reduction of hemoglobin greater than or equal to 2 g/dl or a transfusion of two or more units of red blood cells (42). Recurrent venous thromboembolism was defined by a new or expanded abnormality on imaging. Deaths were identified using a system mortality database that links to the Social Security death master file and the California State Department of Vital Statistics to identify both in-system and out-of-system deaths.

We randomly selected 10% of cases (n = 43) to undergo an additional abstraction of the electronic health record by a second investigator to measure interrater reliability as a marker of misclassification bias. We compared the results of five variables: PE Severity Index class (low risk vs. high risk), relative contraindications (absent vs. present), disposition (home or admission), 5-day adverse event (absent vs. present), and 30-day major outcome (absent vs. present). Percent agreement between investigators ranged between 98 and 100%.

Statistical Analysis
Continuous variables were analyzed using Student t test. Categorical variables were

analyzed using Fisher exact tests. Confidence intervals (CIs) were calculated using the modified Wald method. We also conducted a bivariate logistic regression to estimate the odds ratio associated with outpatient ineligibility criteria, adjusting for patients' PE severity class (I or II). We used a type I error level of 0.05 (two-tailed) as the threshold for statistical significance. We used Stata version 11.2 (StataCorp, College Station, TX) for our analyses.

Results

During the 3-year study period we identified 423 individual ED patients with acute objectively confirmed PE who were low risk on the PE Severity Index and met study criteria (Figure 1). Six patients (1.4%) were missing documentation of an ED temperature, which we assumed was greater than 36.0°C for the calculation of the PE Severity Index score. The cohort's risk factors for venous thromboembolism are enumerated in Table E3.

Two hundred seventy-one patients (64.1%) were deemed outpatient eligible, whereas 152 patients (35.9%) had one or

Table 1. Characteristics of emergency department patients with acute pulmonary embolism who were low risk on the Pulmonary Embolism Severity Index

Patient Characteristics	Eligible for Outpatient Management		P Value
	Yes (*N* = 271) (%)	No (*N* = 152) (%)	
Demographics			
Age, mean (SD), yr	52.6 (15.6)	49.4 (15.6)	0.04
Sex, male	156 (57.2)	95 (60.1)	0.47
Race/ethnicity			0.56
White	197 (72.7)	104 (68.4)	
African American	34 (12.5)	26 (17.1)	
Hispanic or Latino	23 (8.5)	10 (6.6)	
Asian or Pacific Islanders	13 (4.8)	9 (5.9)	
Other	4 (1.5)	3 (2.0)	
Venous thromboembolism risk factors*			0.13
None	34 (12.5)	10 (6.6)	
One	73 (26.9)	40 (26.3)	
Two or more	164 (60.5)	102 (67.1)	
Primary PE-related complaint			<0.01
Chest or thoracic back pain	156 (57.6)	68 (44.7)	
Shortness of breath, dyspnea on exertion, or wheezing	92 (33.9)	55 (36.2)	
Extremity pain or swelling consistent with deep vein thrombosis	16 (5.9)	11 (7.2)	
Syncope or presyncope	0 (0.0)	17 (11.2)	
Cough or hemoptysis	7 (2.6)	1 (0.7)	
PE Severity Index Risk Class			0.02
Class I (⩽65 points)	138 (50.9)	59 (38.8)	
Class II (66–85 points)	133 (49.1)	93 (61.2)	
Disposition from the ED			<0.01
Discharged home	27 (10.0)	4 (2.6)	
Clinical decision area	31 (11.4)	14 (9.2)	
Hospital floor	210 (77.5)	120 (78.9)	
Intensive care unit	1 (0.4)	13 (8.6)	
Labor and delivery	1 (0.4)	1 (0.7)	
Skilled nursing facility	1 (0.4)	0 (0)	
Total length of stay†			
Median (IQR), h	37.0 (22.8, 54.1)	59.5 (35.7, 98.0)	<0.01
Short stay (<24h)	81 (29.9)	21 (13.8)	<0.01
Long stay (⩾5d)	20 (7.4)	29 (19.1)	<0.01

Definition of abbreviations: ED = emergency department; IQR = interquartile range; PE = pulmonary embolism.
Data presented as no. (%) unless otherwise noted. *P* values based on Student *t* test (mean), Chi-square test (frequency), or Mann-Whitney test (median).
*See Table E3 in the online supplement.
†Measured from the time of ED registration.

more contraindications to outpatient management (outpatient ineligible). Patient characteristics of the study cohort, stratified by outpatient eligibility, are reported in Table 1. The outpatient-eligible patients were similar in sex and race/ethnicity to the contraindications group but were on average a few years older and had a higher proportion of patients categorized as class I on the PE Severity Index. The two groups also differed significantly in terms of resource use, particularly disposition at ED discharge and total length of stay (Table 1).

We report the rates of relative contraindications to outpatient management in Table 2. Among the outpatient-ineligible group, the median number of contraindications was one (interquartile range, one to two). The most common contraindications were PE-related factors, each present in 5% or more of the population: right heart dysfunction or strain, hypotension, and syncope/presyncope.

There were no 5-day events in the outpatient-eligible group (95% upper confidence limit, 1.7%) and two 5-day events (1.3%; 95% CI, 0.1–5.0%) in the outpatient-ineligible group ($P = 0.13$) (Table 3). One patient presented with active heavy menses and syncope and was found to have a saddle embolus. After admission

to telemetry, the patient again syncopized and was treated with systemic thrombolytics. When the bleeding worsened, she received a two-unit transfusion of red blood cells. The other patient had multiple significant comorbidities and presented with syncope. On hospital Day 3, unstable vital signs precipitated a transfer to the intensive care unit, where the patient developed septic shock that required mechanical ventilation and vasopressors.

There were 14 major outcomes (3.2%) at 30 days: 5 (1.8%; 95% CI, 0.7–4.4%) in the outpatient-eligible group and 9 (5.9%; 95% CI, 2.7–10.9%) in the contraindications group ($P < 0.05$) (Table 3). After adjusting for severity class, the presence of relative contraindications for outpatient management was associated with an odds ratio of 3.0 (95% CI, 1.0–9.7; $P = 0.05$) for 30-day major outcomes.

Discussion

In this multicenter retrospective cohort study, we confirmed that patients with PE with low-risk characteristics (PE Severity Index classes I and II) overall had a low rate of adverse events at 30 days. Importantly, we also found that supplementing the Index with relative contraindications could further identify patients with PE with an even lower risk of short- and medium-term adverse outcomes. For example, there were no 5-day inpatient adverse events among low-risk patients with PE who also lacked relative contraindications for outpatient management. At 30 days after presentation, none of the outpatient-eligible patients had died; they also had significantly fewer major outcomes when compared with low-risk patients with coexisting relative contraindications to outpatient treatment.

Home management of select ED patients with acute PE is a widely recommended, evidence-based practice (2, 4, 5). Because inpatient care accounts for nearly one-third of all U.S. healthcare expenditures, minimizing avoidable admissions of ED patients is a key target of efforts to optimize the value of our healthcare system (43). The success of shifting the traditional site of care for PE, however, depends on identifying those for whom outpatient care is appropriate. The PE Severity Index can help identify which patients may safely forego hospitalization, assuming they lack other indications for

Table 2. Relative contraindications to outpatient management of emergency department patients with acute low-risk pulmonary embolism

	(N = 423) No. (%)
PE-related factors	112 (26.5)*
Right heart dysfunction or strain[†]	51 (12.1)
Hypotension (systolic blood pressure < 100 mm Hg)	25 (5.9)
Syncope or presyncope	22 (5.2)
Saddle embolus	14 (3.3)
Hypoxemia (oxygen saturation < 90%)	13 (3.1)
Coexisting major deep vein thrombosis[‡]	12 (2.8)
International normalized ratio ≥ 2.0 or on anticoagulation	7 (1.7)
Inferior vena cava filter planned for inpatient stay	5 (1.2)
Anticoagulation allergy/intolerance or heparin-induced thrombocytopenia	1 (0.2)
Clot lysis or extraction performed in the ED or planned as inpatient	1 (0.2)
Comorbidities	42 (9.9)
Diagnosis other than PE that required inpatient care[§]	17 (4.0)
Active bleeding or severe anemia requiring transfusion	7 (1.7)
Cirrhosis or partial thromboplastin time > 35 s	6 (1.4)
Major surgery within the preceding 14 d[‖]	5 (1.2)
Renal insufficiency or failure[¶]	4 (0.9)
Pregnancy	3 (0.7)
History of intracranial hemorrhage	2 (0.5)
Significant gastrointestinal hemorrhage within the preceding 14 d	2 (0.5)
Ischemic stroke within the preceding 10 d	1 (0.2)
Thrombocytopenia (platelet count < 75,000/μl)	1 (0.2)
Known bleeding disorder**	0
Barriers to treatment adherence or follow up	19 (4.5)
Worrisome alcohol or illicit drug use	11 (2.6)
Psychosis, dementia, or other psychiatric condition	7 (1.7)
Social issues (e.g., lack of home, phone, transport, support, or patient's home is geographically inaccessible)	6 (1.4)

Definition of abbreviations: ED = emergency department; PE = pulmonary embolism.

*Patients could have one or more factors.

[†]Dysfunction detected on computed tomography pulmonary angiogram or echocardiogram; strain defined by serum troponin > 0.09 ng/ml or brain (b-type) natriuretic peptide > 500 pg/ml. Only 69.0% (n = 292) received a cardiac troponin test in the emergency department, and 27.2% (n = 115) received a brain natriuretic peptide test.

[‡]High segment femoral or iliac, phlegmasia cerulea dolens, alba dolens, or bilateral deep vein thrombosis. Overall, 27.4% (n = 116) of our cohort underwent compression sonography.

[§]Examples in this population include sepsis, pneumonia, diabetic ketoacidosis, hematemesis, preeclampsia, and accelerated cancer work-up.

[‖]Major surgery included general abdominal surgery (e.g., cholecystectomy), neurosurgery, and airway surgery.

[¶]Stage 4 or stage 5 chronic kidney disease (International Classification of Diseases, Ninth Revision codes 585.4–585.6), dialysis, or a serum creatinine clearance in the emergency department < 30 ml/min.

**In our population this includes congenital and acquired coagulation and qualitative platelet defects, like factor VIII and IX disorders and von Willebrand disease.

inpatient observation or intervention. The PE Severity Index was derived and validated to identify a population of patients with acute PE who were at low risk for 30-day all-cause mortality (7). The incidence of 30-day mortality in our study was concordant with the literature, providing external validation of the PE Severity Index in a U.S. community-based population of patients. However, the Index was designed to evaluate 30-day mortality estimates rather than shorter-term

outcomes. The latter, however, could strongly influence decision making about hospitalizing patients or assigning them to immediate ambulatory care (19).

Two single-center retrospective studies have tested the performance characteristics of the PE Severity Index with a novel application: to predict the risk of short-term inpatient decompensation (9, 10). These studies found an inpatient adverse event rate up to 8% for their low-risk PE populations. They failed, however, to

discriminate between patients with and without contraindications to outpatient care. Although the PE Severity Index was not constructed specifically to predict 5-day inpatient decompensation, it has performed very well on this measure when augmented by supplemental outpatient eligibility criteria (6). ED patients with low-risk PE lacking relative contraindications to outpatient therapy who were randomized to home management had a very low incidence of major adverse events at 14 days (1.2%), which suggests their adverse event rate at 5 days was similarly very low.

In this study, we adopted a conservative approach to outpatient eligibility and found that relative contraindications to immediate outpatient management were common in our population. Ours is one of the few studies to report the rate of outpatient contraindications among patients classified as low risk on the PE Severity Index. Our contraindications for outpatient management overlap extensively with those used by Aujesky and colleagues in their randomized controlled trial (6). Their candidates for home care were low risk on the PE Severity Index and lacked the following contraindications, which parallel our own: hypoxemia, hypotension, active bleeding, high risk of bleeding, pregnancy, severe renal failure, barriers to adherence and follow up, and non-PE diagnoses requiring inpatient care. We drew from other studies of PE risk assessment and outpatient management to expand our list of relative contraindications to include right ventricular dysfunction (18, 26, 30, 32, 33) and syncope (20, 41), two of the most common contraindications in our cohort.

All of the prospective studies of the management of ED patients with acute PE use some combination of contraindications to outpatient management (2). Although several criteria are used uniformly in nearly all of these studies, wide variation exists. Which variables should count as relative contraindications to outpatient management has not been definitively established, but this question is critical to standardizing practices across hospitals.

We found that a sizable number of ED patients who were low risk on the PE Severity Index have relative contraindications to outpatient

Table 3. Outcomes of emergency department patients with low-risk acute pulmonary embolism stratified according to outpatient eligibility

	Eligible for Outpatient Management		P Value
	Yes (n = 271)	No (n = 152)	
Adverse events* (<5 d)[†]	0	2 (1.3)	0.13
Clot extraction or lysis (local or systemic)	0	1 (0.7)[‡]	
Respiratory support	0	1 (0.7)[§]	
New cardiac dysrhythmia requiring treatment	0	0	
Reception of intravenous vasopressors or inotropics	0	1 (0.7)[§]	
Reception of defibrillation or cardiopulmonary resuscitation	0	0	
Recurrent PE	0	0	
Major hemorrhage	0	1 (0.7)[‡]	
Death	0	0	
Major 30-d outcomes	5 (1.8)	9 (5.9)	<0.05
Recurrent venous thromboembolism	2	3	
Major bleeding	3	4	
All-cause mortality	0	2	

Definition of abbreviations: ED = emergency department; PE = pulmonary embolism.
Data are presented as no. (%).
*Includes events during index hospitalization as well as during return visits to ED or hospital for patients initially discharged <120 h from index ED registration.
[†]Measured from the time of ED registration.
[‡]These two events occurred in one patient.
[§]These two events occurred in one patient.

management. Similar findings have been reported by Aujesky and colleagues regarding ED patients with acute pneumonia (44). They found that 37% of low-risk patients were hospitalized. The most commonly reported reasons physicians gave for requiring inpatient management were the presence of a comorbid illness or a laboratory value, vital sign, or symptom that precluded ED discharge.

Our outpatient-eligible population, that is, those who were both low risk on the PE Severity Index and free of relative contraindications, had low rates of 5-day adverse events and 30-day major outcomes. Yet 70% of these patients were observed in the hospital for more than 24 hours. Our results suggest that many of these patients may have been candidates for short-term observation or exclusive outpatient management. It could be that the physicians making the initial site-of-care decisions were uncertain how to identify the outpatient-eligible population. Incorporating the PE Severity Index, appropriately augmented by a sensible list of relative contraindications, into an electronic clinical decision support tool available at the point of care may help facilitate identification of the low-risk population. Such a strategy may prove useful in matching healthcare resources to patient needs without compromising medical care or patient safety.

As this study shows, not all patients categorized as "low risk" are identical, nor should they be treated the same. Many are eligible to go home, but a sizable minority may not be candidates for immediate ambulatory care. The PE Severity Index functions best when all other clinical and social factors are taken into account. The Index, like any risk stratification tool, is optimally used as an assistive, not a directive, tool. This study reminds us that prognostic instruments are meant to serve, not supersede, clinical judgment. The designation of our contraindications as "relative" and not absolute acknowledges the role of clinical judgment in assessing the most appropriate initial site of care for each patient.

This study suffers from the biases and data collection limitations that accompany a retrospective design. These are mitigated, however, by the redundancy of our data collection and chart review methods, the robustness of our administrative databases, and by our high interrater reliability. Abstractors were not blinded to the study hypothesis, however, which may have minimally biased their interpretation of the electronic health record in favor of the hypothesis. Eleven cases (2.5%) were lost to follow-up and were removed from analysis: five from the outpatient-eligible group and six from the ineligible group.

Our list of relative contraindications could be faulted for being overly sensitive, on the one hand, or incomplete, on the other. Some variables, like a need for hospitalization based on non-PE diagnoses, are highly facility specific, and the rates vary widely between studies (27, 30). Another contraindication to immediate outpatient management whose definition lacks consensus is an elevated brain (or b-type) natriuretic peptide. Even when used as a reason to hospitalize a patient with acute PE, it is not clear which serum level is the best cut-off to forestall outpatient management (18, 26, 32, 33, 36). We were unable to include variables that were difficult to ascertain reliably on manual chart review. The rare event rate of 5-day inpatient adversities (<1%) left the study underpowered to detect a significant difference between the two groups on this measure. Although our population reflects the geographic areas served, it might not represent other regions (45, 46). The study was conducted in community EDs, however, which enhances its generalizability (47).

In conclusion, we found that the addition of relative contraindications to the low-risk classification on the PE Severity Index may enhance its ability to identify patients who are eligible for home management and are at low risk for 30-day major outcomes. Implementation of the PE Severity Index in clinical practice to assist in site-of-care decision making should incorporate a supplemental assessment of outpatient eligibility in keeping with the best evidence on this topic. ∎

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