Length of Hospital Stay and Postdischarge Mortality in Patients With Pulmonary Embolism

A Statewide Perspective

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Background: The optimal length of stay (LOS) for patients with pulmonary embolism (PE) is unknown. Although reducing LOS is likely to save costs, the effects on patient safety are unclear. We sought to identify patient and hospital factors associated with LOS and assess whether LOS was associated with postdischarge mortality.

Methods: We evaluated patients discharged with a primary diagnosis of PE from 186 acute care hospitals in Pennsylvania (January 2000 through November 2002). We used discrete survival models to examine the association between (1) patient and hospital factors and the time to discharge and (2) LOS and postdischarge mortality within 30 days of presentation, adjusting for patient and hospital factors.

Results: Among 15 531 patient discharges with PE, the median LOS was 6 days, and postdischarge mortality rate was 3.3%. In multivariate analysis, patients from Philadelphia were less likely to be discharged on a given day (odds ratio [OR], 0.82; 95% confidence interval [CI], 0.73-0.93), as were black patients (OR, 0.88; 95% CI, 0.82-0.94). The odds of discharge decreased notably with greater patient severity of illness and in patients without private health insurance. Adjusted postdischarge mortality was significantly higher for patients with an LOS of 4 days or less (OR, 1.55; 95% CI, 1.21-2.00) relative to those with an LOS of 5 to 6 days.

Conclusions: Several hospital and patient factors were independently associated with LOS. Patients with a very short LOS had greater postdischarge mortality relative to patients with a typical LOS, suggesting that physicians may inappropriately select patients with PE for early discharge who are at increased risk of complications.

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Over 122 000 patients with a primary diagnosis of pulmonary embolism (PE) were discharged from US hospitals in 2004, and the mean length of hospital stay (LOS) was 6 days.[1] Although clear trends toward shorter hospital stays after PE have been apparent during the past decade, the optimal timing of discharge is unclear because of the potential health consequences of earlier hospital discharge. Although the LOS of patients with PE is shortened by the use of low-molecular-weight heparin (LMWH) rather than unfractionated heparin (UFH)[2,3] and the early achievement of therapeutic anticoagulation,[4,5] little is known about the variation in LOS within and between hospitals or the associations between patient and hospital factors and LOS following hospitalization for PE.

Early hospital discharge policies in patients with nonmassive PE have been supported by data from prospective studies[6-8] that suggested that early hospital discharge, or even treatment entirely on an outpatient basis, may be safe in selected low-risk patients. Although the potential cost savings associated with a reduction in LOS are substantial,[9] early hospital discharge after PE may preclude the timely detection and treatment of early and potentially fatal complications such as recurrent PE or anticoagulation-related bleeding. Given the declining trend in LOS for patients hospitalized with PE, our goal was to examine whether a shorter LOS is associated with postdischarge mortality in patients with this illness. Using a statewide database of 15 531 patients discharged with PE, we sought to (1) describe intrahospital and interhospital variation in LOS among patients with similar severity of illness, (2) identify patient and hospital factors associated with LOS and

For editorial comment see page 683

in-hospital mortality, and (3) explore whether patients with a shorter LOS have a higher postdischarge mortality within 30 days of presentation than those with a longer hospital stay.

METHODS

PATIENT IDENTIFICATION AND ELIGIBILITY

We identified patients discharged with PE from January 2000 through November 2002 using the Pennsylvania Health Care Cost Containment Council (PHC4) database. This database contains information on demographic characteristics, insurance status, source of admission, hospital region and number of beds, *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) discharge diagnosis and procedure codes, and admission and discharge dates for all patients discharged from 186 nongovernmental acute care hospitals in Pennsylvania.

We included inpatients 18 years or older who were discharged with a primary diagnosis of PE based on *ICD-9-CM* codes 415.1, 415.11, 415.19, and 673.20-24. To ensure that we identified the most severely ill patients with PE as the primary reason for hospitalization, we also included inpatients with a secondary diagnosis code for PE and one of the following primary diagnosis codes that may represent complications or treatments of this condition: respiratory failure (518.81), cardiogenic shock (785.51), cardiac arrest (427.5), secondary pulmonary hypertension (416.8), syncope (780.2), thrombolysis (99.10), and intubation or mechanical ventilation (96.04, 96.05, 96.70-96.72). Because the unit of analysis was the hospitalization, we included all hospitalizations for PE for these patients at the study sites within the study period.

We excluded patients who had only a secondary *ICD-9-CM* code for PE and/or those who were transferred from another health care facility because such patients are more likely to have PE as a complication of hospitalization. We also excluded patients who subsequently were transferred to other hospitals, patients without the identifiers required for linkage to the necessary clinical data, and those for whom mortality information was not available. The institutional review board approved this study.

DATA COLLECTION

Patient demographic characteristics, insurance status, LOS, and hospital region and number of beds were abstracted from the PHC4 database. Hospital teaching status was ascertained from a list developed by the Council of Teaching Hospitals of the Association of American Medical Colleges. Baseline clinical variables were obtained by linking eligible patients to the Atlas Database (MediQual, Malborough, Massachusetts), which includes detailed clinical findings at presentation for all inpatients treated at nongovernmental acute care hospitals in Pennsylvania. Severity of illness was quantified using the Pulmonary Embolism Severity Index (PESI), a validated prognostic model for patients with PE that was developed and validated using these data from the PHC4 and Atlas databases.[10,11] Based on the PESI, each patient is categorized according to 1 of 5 classes (I-V) of increasing risk of 30-day mortality: class I, 1.1%; class II, 3.1%; class III, 6.5%; class IV, 10.4%; and class V, 24.5%.[10] To ascertain whether patients received thrombolysis while in the hospital, we used *ICD-9-CM* procedure codes (99.10) from the PHC4 and Atlas databases. We obtained all-cause mortality data at 30 days after presentation by linking patients to the National Death Index.[12] Most deaths caused by PE occur within this duration of follow-up.[13]

STATISTICAL ANALYSES

To describe between-site variation in LOS of patients with comparable severity of illness, we graphed the site-specific quartiles of LOS vs the number of beds in each hospital site, separately for patients in each PESI risk class. The variability of LOS within a given hospital site is described in terms of the interquartile range. To summarize mortality patterns by LOS, we graphed the proportions of patients who died in and out of the hospital within 30 days by day of discharge.

We used the discrete proportional odds model to examine the association between hospital and patient characteristics and time to discharge; a lower odds ratio (OR) of discharge correspond to a longer LOS. To account for the correlation between hospitalizations at the same site, we treated hospital site as a random effect.[14] We controlled for hospital region, teaching status, the number of hospital beds, patient race, insurance, and severity of illness using the PESI. Because 76% of teaching hospitals but only 12% of nonteaching hospitals had at least 350 hospital beds, we created a composite hospital-level variable for our statistical modeling (ie, small nonteaching hospitals with fewer than 350 beds, large nonteaching hospitals with at least 350 beds, and teaching hospitals). We modeled time to discharge censoring in-hospital deaths on the day of death, and modeled in-hospital death censoring those patients discharged alive on the day of discharge. We also conducted a sensitivity analysis by deleting in-hospital deaths from the analysis of LOS.

We used a discrete survival approach to examine the association between LOS and postdischarge mortality within 30 days of presentation. Patients who died in the hospital were excluded from this analysis. We adjusted for previously described patient and hospital factors as well as treatment with thrombolysis. Preliminary analyses indicated notable nonlinearity in LOS, so we modeled LOS as a categorical variable defined by quartiles across all hospitalizations (≤4 days, 5-6 days, 7-8 days, and >8 days). In all analyses, patients who were still in the hospital were censored on day 30. In sensitivity analyses, we deleted the 1591 multiple hospitalizations for PE; we also assessed trends with calendar time for all outcomes.

RESULTS

Of the 17 733 patient discharges that met our inclusion criteria, we excluded 323 with only a secondary code indicative of PE (1.8%), 767 transfers in from another hospital (4.3%), 265 subsequent transfers (1.5%), 777 who could not be matched to key clinical findings (4.4%), and 70 who could not be linked to the National Death Index (0.4%). The study cohort comprised 15 531 patient discharges with a diagnosis of PE from 186 Pennsylvania hospitals (**Table 1**). Almost half of the study sites were located in urban areas (Pittsburgh, Philadelphia, and surrounding areas), and most patients were hospitalized at small nonteaching hospitals.

BASELINE PATIENT CHARACTERISTICS BY LOS

Compared with other patients, those in the fourth LOS quartile (>8 days) were older and were more likely to be black or lack private health insurance and to have had more comorbid diseases and abnormal findings from physical examination (**Table 2**). Overall, 53.2% of patients hospitalized for 4 days or less were higher-risk patients (PESI risk classes III-V); the proportion of

Table 1. Hospital Site and Patients by Site Characteristics

Hospital Site Characteristic	No. (%) Sites (n=186)	No. (%) Patient Discharges (n=15 531)
Hospital region, Pennsylvania		
Pittsburgh and surrounding area	39 (21.0)	3614 (23.3)
Northwest Pennsylvania	24 (12.9)	1091 (7.0)
Southern Laurel Highlands	12 (6.5)	789 (5.1)
North Central Pennsylvania	14 (7.5)	1037 (6.7)
South Central Pennsylvania	18 (9.7)	2445 (15.7)
Northeast Pennsylvania	18 (9.7)	936 (6.0)
Eastern Pennsylvania	13 (7.0)	1527 (9.8)
Area surrounding Philadelphia	25 (13.4)	2215 (14.3)
Philadelphia	23 (12.4)	1877 (12.1)
Size and teaching status		
Large nonteaching (≥350 beds)	19 (10.2)	3028 (19.5)
Small nonteaching (<350 beds)	142 (76.3)	8458 (54.5)
Teaching	25 (13.4)	4045 (26.0)
Mean annual number of pulmonary embolism (quartiles)		
<10	52 (28.0)	829 (5.3)
10-20	41 (22.0)	1745 (11.2)
>20-42	45 (24.2)	3976 (25.6)
>42	48 (25.8)	8981 (57.8)

patients classified in risk classes III to V generally increased with increasing LOS quartile.

VARIATION IN LOS

The median LOS across all hospitals was 6 days (interquartile range, 4-8 days) and increased from 5 days in PESI risk class I, to 6 days in risk classes II to IV, to 7 days in risk class V. Only 781 hospitalizations (5.0%) were longer than 14 days. Among patients within the same PESI risk class, the LOS varied considerably across and within sites, as shown by the broad shaded areas denoting the 25th and 75th percentiles of site- and risk class–specific LOS in **Figure 1**.

IN-HOSPITAL AND POSTDISCHARGE MORTALITY PATTERNS ACCORDING TO LOS

Of the 15 531 patients, 1439 patients (9.3%) died within 30 days of presentation. Of those who died, 926 (64.4%) died in the hospital, and 513 (35.6%) died after hospital discharge. Among the in-hospital deaths, 552 (59.6%) died within 4 or fewer days, 101 (10.9%) died within 5 or 6 days, 66 (7.1%) died within 7 or 8 days, and 207 (22.5%) died after day 8. Among the 552 in-hospital deaths occurring within 4 or fewer days, the risk class distribution was 3.3% in class I; 6.3% in class II; 4.9% in class III; 16.5% in class IV; and 59.1% in class V. Among the 513 postdischarge deaths, 149 (29.0%) died after an LOS of 4 or fewer days, 111 (21.6%) died after an LOS of 5 or 6 days, 84 (16.4%) died after an LOS of 7 or 8 days, and 168 (32.9%) died after an LOS of more than 8 days.

As shown in **Figure 2**, a striking proportion of patients with an LOS of 4 or fewer days died in the hospital rather than following hospital discharge. The proportion of discharged patients on a given day who died in the hospital increased again after an LOS of about 8 days, whereas the extreme variability after 21 days is attributable to small denominators. Among patients discharged alive, the proportion who died after discharge within 30 days of presentation was somewhat higher for patients with very short stays than for patients hospitalized for 4 to 8 days and tended to be highest for those with an LOS longer than 8 days.

FACTORS ASSOCIATED WITH LOS AND IN-HOSPITAL MORTALITY

In multivariate discrete survival analysis, black patients and patients without private health insurance were less likely to be discharged on a given day than other patients (**Table 3**). Low odds of discharge correspond to a longer LOS. The odds of discharge decreased with increasing severity of illness, with the OR of discharge for a PESI risk class V patient being 0.57 (95% confidence interval [CI], 0.53-0.61) relative to a risk class I patient. Patients from North Central Pennsylvania were significantly more likely (OR, 1.45; 95% CI, 1.25-1.69), and patients from Philadelphia significantly less likely (OR, 0.82; 95% CI, 0.73-0.93), to be discharged on a given hospital day than patients in other geographic regions. These results were not sensitive to the exclusion of in-hospital deaths.

The odds of in-hospital mortality increased with increasing PESI risk class (OR, 13.62; 95% CI, 9.08-20.44) for a risk class V patient relative to a risk class I patient (Table 3). The odds of in-hospital mortality did not vary by region.

FACTORS ASSOCIATED WITH POSTDISCHARGE MORTALITY

When adjusted for hospital and patient factors, postdischarge mortality increased significantly with increasing PESI risk class (OR, 26.00; 95% CI, 14.25-47.43) for risk class V compared with risk class I (Table 3). Among patients discharged alive, those who received thrombolysis in the hospital had significantly reduced odds of mortality (OR, 0.32; 95% CI, 0.12-0.85) compared with patients who did not receive this therapy. Postdischarge mortality was significantly higher in Philadelphia relative to Pittsburgh (OR, 1.61; 95% CI, 1.18-2.19).

The LOS was significantly associated with postdischarge mortality within 30 days. Relative to patients hospitalized for 5 or 6 days, the odds of postdischarge mortality were significantly higher for patients hospitalized for 4 or fewer days (OR, 1.55; 95% CI, 1.21-2.00) and for patients hospitalized for more than 8 days (OR, 2.39; 95% CI, 1.87-3.06). The odds of postdischarge mortality were also higher for patients with an LOS of 4 or fewer days relative to an LOS of 7 or 8 days (OR, 1.32; 95% CI, 1.00-1.74). None of the analyses in Table 3 was sensitive to the exclusion of subsequent hospitalizations for PE or adjustment for time trends.

COMMENT

We found that the LOS for PE varied markedly both within and between hospitals in Pennsylvania and that several

Table 2. Baseline Characteristics by Quartiles of LOS for 15 531 Patients

Characteristic	No. (%)					*P* Value
	Overall	Quartile 1 (≤4 d)	Quartile 2 (5-6 d)	Quartile 3 (7-8 d)	Quartile 4 (>8 d)	
Demographics						
Age ≥65 y	8506 (54.8)	2264 (48.3)	2485 (53.8)	1696 (58.0)	2061 (62.6)	<.001
Male sex	6227 (40.1)	1897 (40.4)	1857 (40.2)	1187 (40.6)	1286 (39.0)	.56
Race						<.001
White	12 553 (80.8)	3854 (82.2)	3837 (83.1)	2326 (79.5)	2536 (77.0)	
Black	1700 (10.9)	486 (10.4)	433 (9.4)	315 (10.8)	466 (14.2)	
Other or unknown	1278 (8.2)	351 (7.5)	350 (7.6)	285 (9.7)	292 (8.9)	
Insurance status						<.001
Government	8556 (55.1)	2289 (48.8)	2464 (53.3)	1716 (58.7)	2087 (63.4)	
Medicaid	1174 (7.6)	404 (8.6)	312 (6.8)	198 (6.8)	260 (7.9)	
Private	5564 (35.8)	1917 (40.9)	1777 (38.4)	965 (33.0)	905 (27.5)	
None or unknown	237 (1.5)	81 (1.7)	67 (1.5)	47 (1.6)	42 (1.3)	
Comorbid diseases						
History of cancer	3046 (19.6)	904 (19.3)	876 (19.0)	568 (19.4)	698 (21.2)	.08
Chronic lung disease	2868 (18.5)	702 (15.0)	772 (16.7)	581 (19.9)	813 (24.7)	<.001
Heart failure	2459 (15.8)	602 (12.8)	620 (13.4)	514 (17.6)	723 (22.0)	<.001
Physical examination findings						
Pulse ≥110/min	4575 (29.5)	1279 (27.3)	1278 (27.7)	861 (29.4)	1157 (35.1)	<.001
SBP <100 mm Hg	1624 (10.5)	508 (10.8)	373 (8.10)	288 (9.8)	455 (13.8)	<.001
Respiratory rate ≥30/min	2261 (14.6)	590 (12.6)	599 (13.0)	429 (14.7)	643 (19.5)	<.001
Body temperature <36°C	2575 (16.6)	774 (16.5)	775 (16.8)	462 (15.8)	564 (17.1)	.54
Altered mental status[a]	1131 (7.3)	357 (7.6)	238 (5.2)	178 (6.1)	358 (10.9)	<.001
Oxygen saturation <90%[b]	1235 (8.0)	302 (6.4)	333 (7.2)	246 (8.4)	354 (10.8)	<.001
PESI risk class						<.001
I	3027 (19.5)	1204 (25.7)	972 (21.0)	486 (16.6)	365 (11.1)	
II	3322 (21.4)	991 (21.1)	1089 (23.6)	662 (22.6)	580 (17.6)	
III	3389 (21.8)	967 (20.6)	974 (21.1)	694 (23.7)	754 (22.9)	
IV	2512 (16.2)	643 (13.7)	776 (16.8)	478 (16.3)	615 (18.7)	
V	3281 (21.1)	886 (18.9)	809 (17.5)	606 (20.7)	980 (29.8)	

Abbreviations: LOS, length of stay; PESI, Pulmonary Embolism Severity Index; SBP, systolic blood pressure.
[a] Defined as disorientation, lethargy, stupor, or coma.
[b] With or without supplemental oxygen.

patient and hospital factors were independently associated with LOS. Moreover, patients with a short LOS (≤4 days) had a notably increased postdischarge mortality relative to patients hospitalized 5 to 8 days.

Variation in LOS seems to be similar among patients with comparable severity of illness in hospitals of different size. We offer 4 possible explanations for this observed variation. First, prior studies[2,3] linking processes of care with LOS in patients with PE showed that the use of LMWH rather than UFH, and early achievement of therapeutic oral anticoagulation by starting warfarin on the same day as heparin, could contribute to a shorter LOS without compromising patient safety.[4,5] Differences in the use of these processes of care with proven impact on LOS may explain the variability in LOS between and within hospitals. Prior studies[15,16] showed that the use of recommended practices of care and the achievement of treatment goals for patients with venous thromboembolism are highly variable. Second, the great variability seen in LOS for PE may reflect physicians' uncertainty in assessing prognosis and the perceived benefits of hospital care. Third, physicians from different hospitals may use different criteria to determine whether a patient with PE is sufficiently stable for safe discharge. Fourth, the local availability of outpatient treatment facilities, which would allow treatment of low-risk patients with nonmassive PE partly in the outpatient setting, may vary across hospitals.

Although the observed association between increasing severity of illness and LOS seems obvious, we cannot entirely explain why black individuals and patients without private health insurance had a longer LOS. One explanation is that patients of lower socioeconomic status may be overrepresented in these patient groups and may have higher rates of homelessness and other conditions that may represent obstacles to outpatient treatment with LMWH.

That patients with a short LOS (≤4 days) had a higher postdischarge mortality suggests that an abbreviated LOS may be potentially harmful. Limited evidence from a retrospective study[16] suggests that an overlap of heparin and warfarin of fewer than 4 days before stopping heparin is associated with worse outcomes in patients with venous thromboembolism. However, because we could not examine anticoagulation-related processes of care in this study, we cannot say whether a brief hospital stay interfered with a 4-day heparin-warfarin overlap or other relevant processes of care. In another study,[17] a shorter LOS in patients with deep venous thrombosis was not associated with a higher rate of recurrent venous thromboembolism.

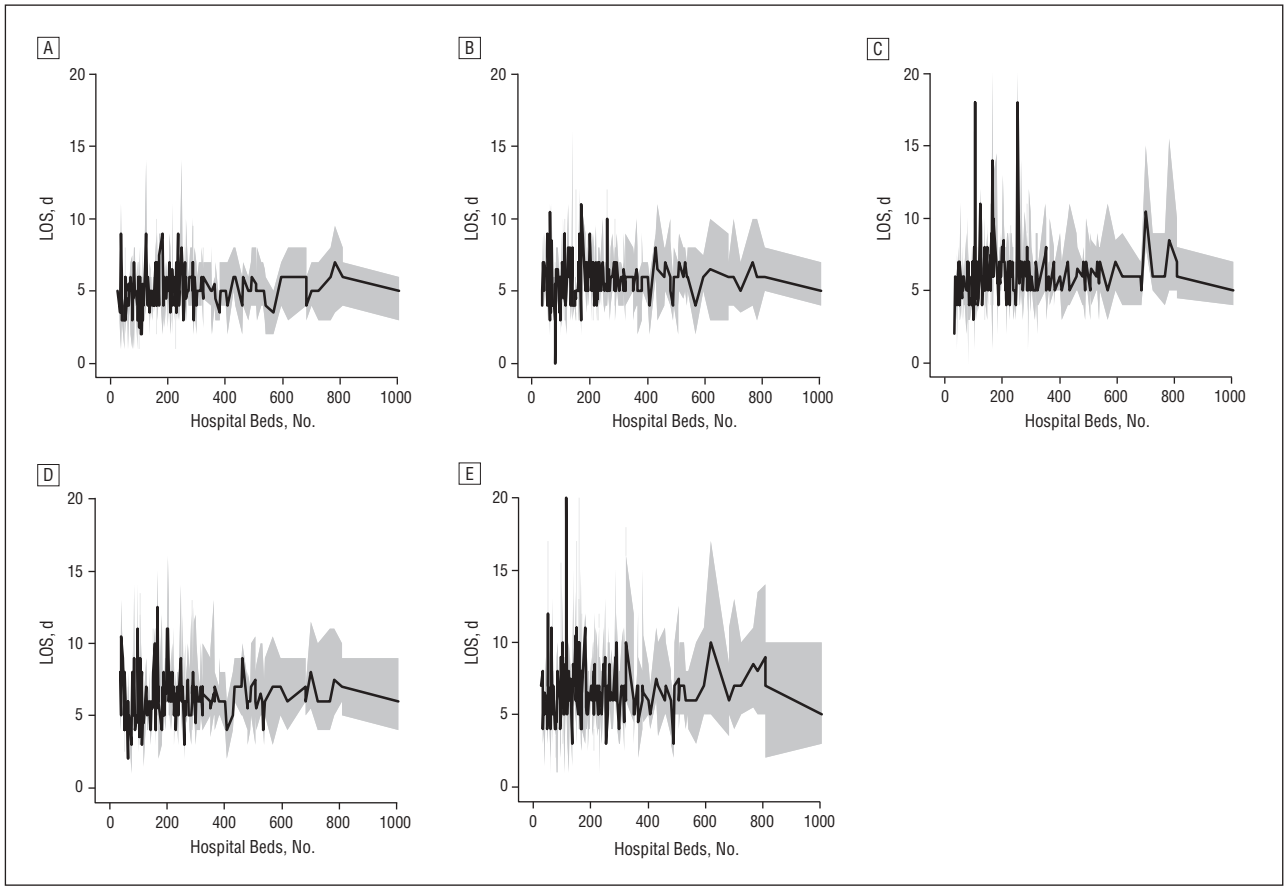

Figure 1. Variability in length of stay (LOS) by severity of illness and number of hospital beds, according to Pulmonary Embolism Severity Index (PESI) risk class. The black lines correspond to the site-specific median lengths of stay; the gray zones represent the site-specific interquartile ranges (between the 25th and 75th percentiles). A, PESI class I; B, PESI class II; C, PESI class III; D, PESI class IV; E, PESI class V.

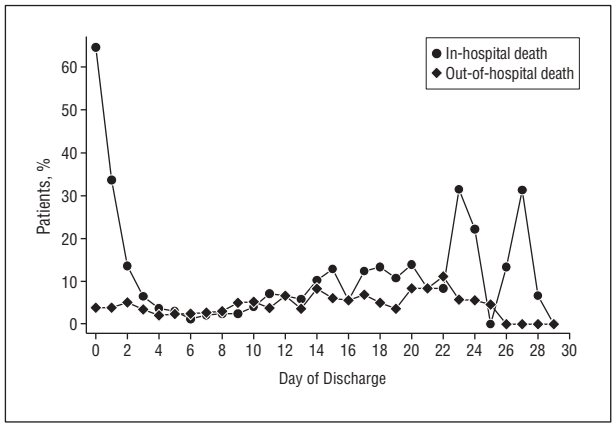

Figure 2. Percentages of in-hospital death and percentages of postdischarge mortality within 30 days of presentation among patients who left the hospital on a given day. Each day-specific denominator is the total number of patients who left the hospital that day, either discharged alive or dead.

Recently published practice guidelines[18] that recommend outpatient care for carefully selected patients with nonmassive PE fail to specify how these low-risk patients can be identified accurately. Our results demonstrating a higher postdischarge mortality in patients with a shorter LOS suggest that physicians may select patients with PE who are at increased risk of complications inappropriately for an abbreviated LOS. More than half of the patients in our data set who were discharged early (LOS of ≤4 days) were classified as high risk. To foster more appropriate use of hospitalization in the treatment of PE, use of clinical prognostic models for PE, such as the PESI, may be helpful. However, any risk stratification strategy identifying low-risk patients with PE who safely can be discharged early or treated in the outpatient setting must be assessed in clinical trials before it can be considered safe.

We found a statistically significant increase in postdischarge mortality associated with longer duration of hospitalization (>8 days) (see Table 3 for *P* values). This finding may be explained by confounding related to unmeasured severity of illness, failure to achieve therapeutic anticoagulation caused by suboptimal anticoagulation practices, resistance to oral anticoagulation therapy, or the occurrence of complications that make anticoagulation impossible (eg, major bleeding).[17]

Our study has limitations. First, identifying our patient sample using *ICD-9-CM* codes for PE rather than using accepted clinical criteria may lead to inaccuracies in diagnosis owing to biases or imperfections in hospital coding procedures. However, prior studies[17,19,20] demonstrated that 94% to 96% of patients with specific *ICD-9-CM* codes for PE had objectively documented disease based on medical chart review criteria. Second, we did not have other prognostic factors for PE (eg, markers of

Table 3. Estimated ORs for Hospital Discharge, In-hospital Mortality, and Postdischarge Mortality Within 30 Days by Hospital and Patient Characteristics

	Hospital Discharge Within 30 Days (n=15 531)		In-hospital Mortality Within 30 Days (n=15 531)		Postdischarge Mortality Within 30 Days (n=14 505)	
Characteristic	Discharge OR (95% CI)[a]	*P* Value	In-Hospital Mortality OR (95% CI)	*P* Value	Postdischarge Mortality OR (95% CI)	*P* Value
Race		<.01		.13		.30
White	1 [Reference]		1 [Reference]		1 [Reference]	
Black	0.88 (0.82-0.94)		1.21 (0.96-1.51)		0.87 (0.63-1.20)	
Other or unknown	0.99 (0.91-1.07)		1.19 (0.93-1.52)		1.20 (0.88-1.63)	
Insurance type		<.001		.75		.28
Private	1 [Reference]		1 [Reference]		1 [Reference]	
Government	0.91 (0.87-0.95)		1.07 (0.90-1.27)		0.93 (0.75-1.15)	
Medicaid, none, or unknown	0.90 (0.84-0.96)		1.05 (0.77-1.42)		0.68 (0.43-1.10)	
PESI risk class		<.001		<.001		<.001
I	1 [Reference]		1 [Reference]		1 [Reference]	
II	0.78 (0.73-0.82)		1.80 (1.14-2.86)		3.79 (2.00-7.19)	
III	0.66 (0.62-0.70)		3.96 (2.60-6.03)		6.21 (3.34-11.54)	
IV	0.63 (0.59-0.68)		5.60 (3.67-8.55)		12.56 (6.82-23.15)	
V	0.57 (0.53-0.61)		13.62 (9.08-20.44)		26.00 (14.25-47.43)	
Thrombolysis	NR		NR		0.32 (0.12-0.85)	.02
LOS quartiles, d		NR		NR		<.001
≤4	NR		NR		1.55 (1.21-2.00)	
5-6	NR		NR		1 [Reference]	
7-8	NR		NR		1.18 (0.88-1.57)	
>8	NR		NR		2.39 (1.87-3.06)	
Hospital region		<.001		.59		.03
Pittsburgh and surrounding area	1 [Reference]		1 [Reference]		1 [Reference]	
Northwest Pennsylvania	1.09 (0.96-1.23)		1.00 (0.73-1.37)		0.89 (0.59-1.34)	
Southern Laurel Highlands	1.04 (0.89-1.23)		1.39 (1.00-1.95)		0.92 (0.56-1.50)	
North Central Pennsylvania	1.45 (1.25-1.69)		0.87 (0.60-1.25)		0.79 (0.50-1.23)	
South Central Pennsylvania	0.94 (0.83-1.06)		1.01 (0.79-1.29)		0.98 (0.71-1.35)	
Northeast Pennsylvania	1.01 (0.87-1.16)		0.99 (0.71-1.39)		1.13 (0.75-1.70)	
Eastern Pennsylvania	1.03 (0.89-1.19)		1.13 (0.86-1.49)		0.87 (0.60-1.27)	
Surrounding Philadelphia	0.93 (0.83-1.04)		1.01 (0.80-1.29)		0.98 (0.72-1.35)	
Philadelphia	0.82 (0.73-0.93)		0.94 (0.73-1.21)		1.61 (1.18-2.19)	
Size and teaching status		.07		.07		.33
Large nonteaching	1 [Reference]		1 [Reference]		1 [Reference]	
Small nonteaching	1.12 (1.01-1.24)		1.14 (0.93-1.39)		1.03 (0.79-1.33)	
Teaching	1.05 (0.93-1.19)		1.30 (1.04-1.64)		1.20 (0.90-1.62)	

Abbreviations: CI, confidence interval; LOS, length of stay; NR, not reported; OR, odds ratio; PESI, Pulmonary Embolism Severity Index.
[a]The OR for discharge on a given hospital day. A lower OR corresponds to a longer LOS.

right-ventricular dysfunction) in our databases because these parameters are not routinely assessed in patients with PE. Third, we had no information on clinical stability at the time of discharge or on processes of care potentially associated with LOS and postdischarge mortality, such as anticoagulation quality. Fourth, our data set lacked information on nonfatal complications that occurred in the hospital and socioeconomic factors associated with reduced adherence that may interfere with hospital discharge and anticoagulation quality. Prospective studies linking processes of care for PE and anticoagulation quality with patient outcomes are necessary to fill this knowledge gap. Fifth, although we had no information about specific causes of death in our sample, PE was the direct cause of death in 45% of patients who died following this illness.[21] Sixth, our analyses that focused on out-of-hospital mortality necessarily excluded deaths that occurred during the hospital stay because these deaths could not be attributable to premature discharge. Although there is no ideal way to handle in-hospital mortality in this type of analysis, we dealt with this methodologic issue in a manner consistent with numerous prior analyses[22-24] exploring LOS and postdischarge mortality. Seventh, although follow-up time is short for patients with a relatively long LOS, our analyses of postdischarge mortality within 30 days of presentation accounted for time at risk, and relatively few patients (5%) had an LOS longer than 2 weeks. Finally, because our study patients were hospitalized during the 2000-2002 period, we cannot exclude the possibility that changing practice patterns, such as earlier diagnosis of PE using spiral computed tomography or increasing use of LMWH, could have influenced our results. However, our results did not change when we adjusted for time trends.

In conclusion, we found considerable variation in LOS between and within hospitals in Pennsylvania and identified several hospital and patient factors that were independently associated with LOS. Patients with an LOS

of 4 days or fewer had a significantly higher postdischarge mortality than patients hospitalized for 5 to 8 days, suggesting that physicians may inappropriately select patients with PE for early discharge who are at increased risk of complications. Prognostic models and the development of explicit discharge criteria may be helpful to identify patients with PE who can be safely discharged early.

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