Identification, diagnosis, treatment, and in-hospital outcomes of acute pulmonary embolism: Results from a single integrated health system

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Background Although the high-risk acute pulmonary embolism (PE) population has been described, little is known about the contemporary inpatient experience and practice patterns of the PE population as a whole.

Methods All patients with a diagnosis of acute PE from January 1, 2016, to June 30, 2017 within our academic, multihospital health system were retrospectively identified using *International Classification of Diseases, 10th Revision,* codes, and data were manually abstracted by 2 clinical investigators. Descriptive analyses were performed according to clinical risk stratification categories from the European Society of Cardiology.

Results Of 829 total patients, 372 (44.8%) patients had intermediate or high-risk PE. Mean age was 62.1 years old, and 42.1% of patients had a history of malignancy. One hundred fifty-three (18.5%) patients had an acute PE during a hospitalization for another indication. A total of 6.0% underwent invasive PE therapies, 26.1% required intensive care unit admission, and 9.0% experienced in-hospital death or hospice discharge. In a subgroup description, patients who developed acute PE during a hospitalization for another indication had a higher incidence of incomplete risk stratification and a higher mortality (9.8%) than the primary cohort. Mortality was attributed to PE in 48.4% of cases.

Conclusions This contemporary description of acute PE managed at a single large, multihospital academic health system highlights substantial health care utilization and high mortality despite the available of advanced therapeutics. Additional work is needed to standardize care for the heterogeneous PE population to ensure appropriate allocation of resources and improved outcomes for all PE patients. (Am Heart J 2019;216:136-142.)

Venous thromboembolism, including deep vein thrombosis and pulmonary embolism (PE), affects approximately 900,000 Americans annually and frequently complicates care following surgical procedures, myocardial infarction, and stroke.[1,2] Acute PE is one of the most preventable causes of death in hospitalized patients in the United States,[3,4] yet it is estimated to be responsible for 100,000 deaths in hospitalized patients annually.[3] In studies up to 2010, the incidence of acute PE has steadily risen despite a notable decrease in PE-related inpatient mortality.[5]

Unfortunately, little is known about the contemporary clinical landscape of all patients with acute PE since many studies are older,[5-7] focus on various high-risk groups,[8,9] or evaluate the management of patients in the pulmonary embolism response team system.[10,11] The patient characteristics, treatments, and outcomes of this heterogeneous population as a whole remain poorly understood. In light of this, we describe a contemporary cohort of all patients with acute PE managed within our large, multihospital academic health system as stratified by current European Society of Cardiology (ESC) clinical guidelines.

Methods

Patient identification

The Duke University Health System is comprised of approximately 1,500 inpatient beds distributed between 2 community hospitals and 1 academic health center. Data on inpatient encounters are stored in a data warehouse called the *Decision Support Repository*, which can be queried using the Duke Enterprise Data Unified Content Explorer. Using *International Classification of Diseases, 10th Revision,* codes for PE (I26,

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I26.0, I26.02, I26.09, I26.9, I26.92, I26.99), an initial cohort of patients who presented from January 1, 2016, through June 30, 2017, was identified and extracted into the study database. Body mass index, tobacco use (defined as both former and active), coded comorbid conditions, as well as the exact time of hospital admission, hospital discharge, intensive care unit (ICU) admission, and ICU discharge were queried from the warehouse database for the identified cohort.

Inclusion/exclusion criteria

To be included, patients had to be more than 18 years of age, with imaging-confirmed acute PE, as defined by a radiology report specifying definitive acute PE on computed tomography (CT) scan, high probability ventilation-perfusion (V/Q) scan, echocardiography, pulmonary artery (PA) angiogram, or visualization on extracorpuscular membrane oxygenation (ECMO) cannulation. Patients with any other thromboembolic event, including but not limited to fat embolism, air embolism, septic embolism, and chronic thromboembolic pulmonary hypertension, were excluded. Patients without imaging-diagnosed PE were excluded even if there was a high clinical suspicion for acute PE.

Medical record review

Manual medical record abstraction was subsequently performed by 2 physicians (T. H. and A. E. S.) to confirm the diagnosis of acute PE via clinical review of radiology reports. Subsequently, the following clinical information was abstracted: PE risk factors (major surgery or trauma within 3 months of PE diagnosis, hypercoagulable states, hormonal therapy, pregnancy, tobacco use), presenting symptoms (chest pain, shortness of breath, syncope, presyncope, cough, hemoptysis, leg swelling), vital signs, initial cardiac markers (troponin, brain natriuretic peptide [BNP]), imaging results (CT, echocardiogram, V/Q scan), use of invasive therapy (catheter directed therapy, systemic thrombolysis, etc), discharge location (home, skilled nursing facility, etc), and discharge anticoagulation (direct oral anticoagulant, enoxaparin, warfarin, etc).

Presenting symptoms and vital signs were collected from the initial H&P or from documentation within 24 hours of confirmatory imaging for patients diagnosed with acute PE while hospitalized for another indication (termed *in-hospital PE*). *Hypotension* was defined as a systolic blood pressure <90 mm Hg or the requirement of vasopressor support within 24 hours of admission or diagnosis of acute PE. Markers of myocardial necrosis (troponin and BNP) were recorded if measured within 24 hours of acute PE diagnosis. Troponin-T, Troponin-I, BNP, and proBNP are all used within our health system and were recorded as positive if greater than the upper limit of normal or previously established baseline. Laterality and PE location as well as right ventricular (RV) to left ventricular (LV) ratio (RV/LV) were taken from CT reports. V/Q scans were considered positive if reported as high probability only. RV hypokinesis, enlargement, right atrial enlargement, and right ventricular systolic pressure were abstracted from echocardiographic reports. Use of advance therapies, discharge location, and discharge anticoagulation were manually abstracted into the study database. On medical record review, all hospice discharges were deceased. The timing of death following discharge was not available in the data warehouse and is therefore a study limitation.

Statistical analysis

All descriptive analysis was performed with SAS version 9.4 (SAS Institute Inc, Cary, NC). Patients were grouped based on ESC clinical stratification[12] of low risk (LR), intermediate low risk (ILR), intermediate high risk (IHR), and high risk (HR) and subsequently described, with continuous variables presented as the mean with SD or median with (25th, 75th) interquartile range (IQR) and categorical variables presented as the frequency with percentage for nonmissing data.

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Results

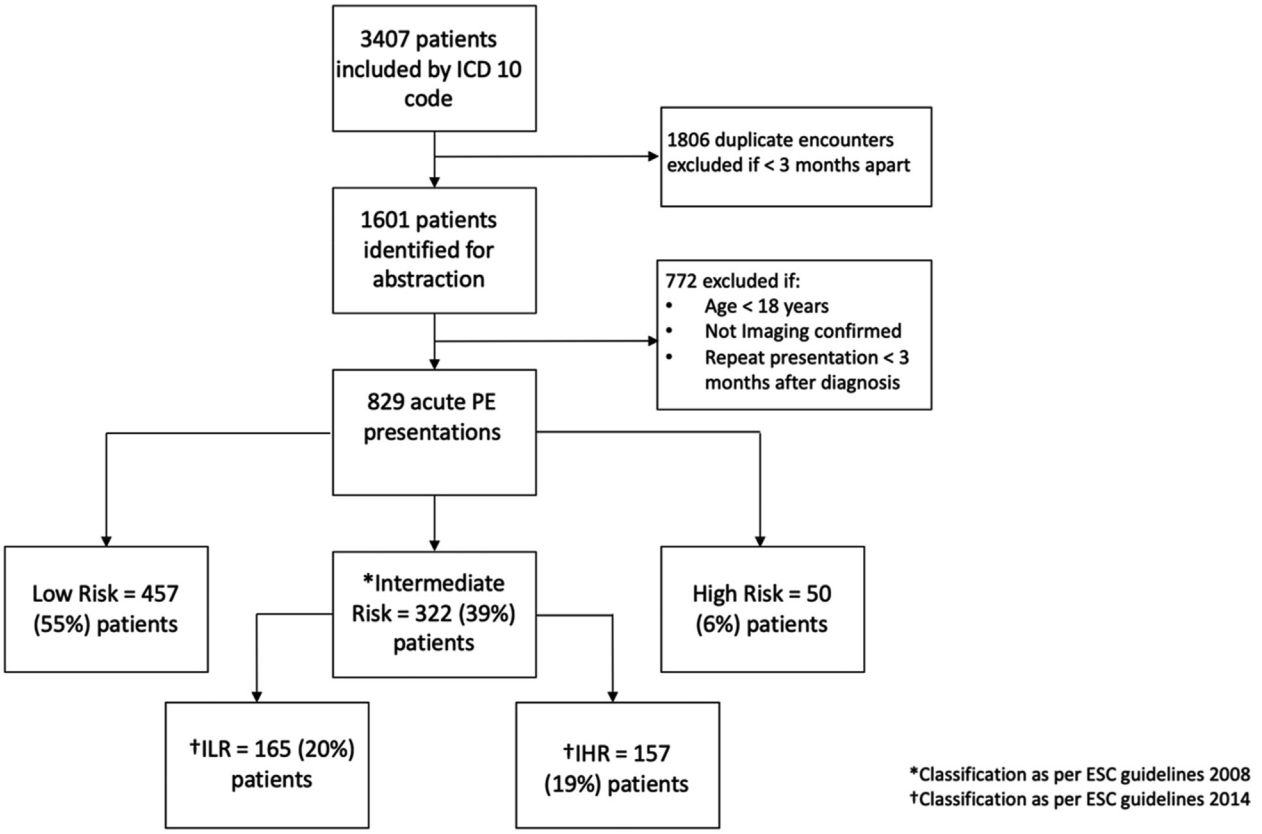
Patient demographics

A cohort of 3,407 patients was initially identified after data extraction, of which 1,601 index events were eligible for review after filtering for exclusion criteria, and 829 patients met inclusion criteria to be eligible for data abstraction (Figure 1). Within the cohort, 444 (53.6%) were women, 400 (48.3%) were ≥65 years of age (mean 62.1 years; SD 17.0 years), and 319 (38.5%) identified as African American. Demographic and clinical characteristics are shown based on ESC stratification[12] in Table I. Patients with acute PE had a high degree of comorbidity including hypertension (56.0%), coronary artery disease (10.5%), heart failure (10.1%), and chronic obstructive pulmonary disease (10.0%). Notable PE risk factors included tobacco use (54.8%), history of cancer (42.1%), and surgery or trauma within the last 3 months (24.8%). More than 70% of patients presented via the emergency department, whereas 18.5% of patients with acute PE occurred during an in-hospital admission for another indication.

Presenting symptoms

Dyspnea (n = 458, 55.2%) and chest pain (n = 232, 28.0%) were the most common presenting symptoms. Syncope or presyncope was only noted in 69 patients

Figure 1



Flow diagram of the 3,407 initially identified in the Duke Enterprise Data Unified Content Explorer data extraction and subsequent exclusion and risk stratification.

(8.3%), although this was more common in patients within higher-risk groups, including IHR (n = 30 19.1%) and HR (n = 8, 16.0%). Approximately 60% of patients presented with tachycardia and tachypnea, and 50% with hypoxia.

Diagnostic testing and risk stratification

Imaging and laboratory findings are shown in Table II. Acute PE was diagnosed by CT in 761 (91.7%) patients, whereas V/Q scan was used in 63 (7.6%) patients, and 5 (0.6%) patients were diagnosed via echocardiography, PA angiogram, or direct visualization on ECMO cannulation. *Saddle PE*, defined as the presence of thrombus that straddles the main pulmonary artery, was noted in 37 (4.9%) patients, whereas left and/or right main-stem PE was seen in 198 (26.0%) patients. Notably, saddle or main-stem PE was more common among IHR (14.0% and 51.0%, respectively) and HR (12.5% and 60.0%, respectively) patients. Assessment of RV dysfunction via CT and echocardiograpy was available for 18.0% and 65.9% of patients, respectively. Approximately 90% of intermediate and high-risk patients had RV dysfunction assessed by echocardiography. RV enlargement was noted in 244 (29.4%) patients, whereas RV hypokinesis was seen in 213 (25.7%) patients. Overall, troponin elevations were positive in 89 (10.7%) patients, whereas 244 (29.4%) had elevated BNP. When stratified according to current ESC PE risk assessment guidelines, the number (%) of patients in each risk category was LR = 457 (55%), ILR = 165 (20%), IHR = 157 (19%), and HR = 50 (5%) (Figure 1, Table I). Deep vein thrombosis was confirmed in 31% of patients.

Advanced therapies

Fifty (6.0%) patients received advanced therapies. A total of 15 patients (1 ILR, 4 IHR, and 10 HR) received systemic thrombolysis. Catheter-directed thrombolysis was used in 32 patients (3.8%) (3 ILR, 22 IHR, and 7 HR). Surgical embolectomy was done in 6 (3 IHR and 3 HR) patients. In the HR group, ECMO was used in 5 (10.0%) patients (Table III).

Table I. Baseline characteristics and admitting location, stratified by ESC risk classification

	LR	ILR	IHR	HR	Total
Demographics					
n	457	165	157	50	829
Age (y)	60.0 ± 17.2	62.8 ± 17.7	66.6 ± 15.1	64.2 ± 15.0	62.1 ± 17.0
Age > 65 y	197 (43.1%)	85 (51.5%)	91 (58.0%)	27 (54.0%)	400 (48.3%)
Sex (M/F)	200/257	97/68	61/96	27/23	385/444
BMI (kg/m^2)	30.4 ± 8.2	30.6 ± 9.5	33.1 ± 9.6	30.8 ± 7.2	31.0 ± 8.7
Race/ethnicity					
White	254 (55.6%)	97 (58.8%)	83 (52.9%)	29 (58.0%)	463 (55.9%)
Black	169 (37.0%)	59 (35.8%)	70 (44.6%)	21 (42.0%)	319 (38.5%)
Other	34 (7.4%)	9 (5.5%)	4 (2.5%)	0 (0.0%)	47 (5.7%)
Comorbidities					
Hypertension	230 (50.3%)	102 (61.8%)	102 (65.0%)	30 (60.0%)	464 (56.0%)
Hyperlipidemia	106 (23.2%)	35 (21.2%)	42 (26.8%)	9 (18.0%)	192 (23.2%)
CAD	46 (10.1%)	23 (13.9%)	14 (8.9%)	4 (8.0%)	87 (10.5%)
CHF	37 (8.1%)	22 (13.3%)	19 (12.1%)	6 (12.0%)	84 (10.1%)
COPD	48 (10.5%)	18 (10.9%)	16 (10.2%)	1 (2.0%)	83 (10.0%)
Diabetes	78 (17.1%)	31 (18.8%)	28 (17.8%)	11 (22.0%)	148 (17.9%)
CVA	10 (2.2%)	2 (1.2%)	4 (2.5%)	1 (2.0%)	17 (2.1%)
Kidney disease	39 (8.5%)	16 (9.7%)	22 (14.0%)	2 (4.0%)	79 (9.5%)
PE risk factors					
Surgery/trauma	133 (29.1%)	36 (21.8%)	22 (14.0%)	15 (30.0%)	206 (24.8%)
Cancer history	205 (44.9%)	71 (43.0%)	56 (35.7%)	17 (34.0%)	349 (42.1%)
Hypercoagulable	30 (6.6%)	7 (4.2%)	5 (3.2%)	0 (0%)	42 (5.1%)
Hormone therapy	15 (3.3%)	8 (4.8%)	7 (4.5%)	3 (6.0%)	33 (4.0%)
Pregnancy	8 (1.8%)	2 (1.2%)	1 (0.6%)	0 (0%)	11 (1.3%)
Tobacco use	249 (55.5%)	88 (54.3%)	78 (52.0%)	26 (59.1%)	441 (54.8%)
Presenting symptoms					
Dyspnea	223 (48.8%)	98 (59.4%)	118 (75.2%)	19 (38.0%)	458 (55.2%)
Chest pain	129 (28.2%)	51 (30.9%)	42 (26.8%)	10 (20.0%)	232 (28.0%)
Syncope/presyncope	18 (3.9%)	13 (7.9%)	30 (19.1%)	8 (16.0%)	69 (8.3%)
Limb pain	43 (9.4%)	9 (5.5%)	18 (11.5%)	3 (6.0%)	73 (8.8%)
Limb swelling	40 (8.8%)	23 (13.9%)	28 (17.8%)	3 (6.0%)	94 (11.3%)
Hemoptysis	10 (2.2%)	7 (4.2%)	2 (1.3%)	0 (0%)	19 (2.3%)
Cough	49 (10.7%)	27 (16.4%)	25 (15.9%)	0 (0%)	101 (12.2%)
Fatigue	23 (5.0%)	12 (7.3%)	34 (21.7%)	5 (10.0%)	74 (8.9%)
Hemodynamics					
SBP <90	26 (5.7%)	0 (0%)	0 (0%)	50 (100%)	76 (9.2%)
HR >100	235 (51.4%)	107 (64.8%)	114 (72.6%)	48 (96%)	504 (60.8%)
Spo_2 < 90%	171 (37.4%)	92 (55.8%)	108 (68.8%)	48 (96.0%)	419 (50.5%)
RR >18	227 (49.7%)	108 (65.5%)	122 (77.7%)	47 (94.0%)	504 (60.8%)
Initial encounter location					
Emergency department	323 (70.7%)	121 (73.3%)	114 (72.6%)	24 (48.0%)	582 (70.2%)
In-hospital service	96 (21.0%)	28 (17.0%)	12 (7.6%)	17 (34.0%)	153 (18.5%)
Transfer	21 (4.6%)	10 (6.1%)	28 (17.8%)	9 (18.0%)	68 (8.2%)
Clinic	17 (3.7%)	6 (3.6%)	3 (1.9%)	0 (0%)	26 (3.1%)

BMI, Body mass index; *CAD*, coronary artery disease; *CHF*, congestive heart failure; *COPD*, chronic obstructive pulmonary disease; *CVA*, cerebral vascular accident; *SBP*, systolic blood pressure; *HR*, heart rate; *Spo_2*, oxygen saturation; *RR*, respiratory rate.

Hospital utilization, discharge destination, and discharge medications

Table IV demonstrates hospital utilization, discharge destination, and discharge medication data. Two hundred sixteen (26.1%) patients were admitted to the ICU, including 64 (14.0%) LR, 41 (24.8%) ILR, 66 (42.0%) IHR, and 45 (90.0%) HR patients. Seventy-four (8.9%) patients were intubated, which included 46.0% of HR patients. Median hospital length of stay (LOS) in the cohort was 5.0 days (IQR: 3.0, 9.0), but notably, HR patients had a median LOS of 9.0 days (IQR: 5.0, 17.0).

In the cohort, 75.2% of patients were discharged home, 13.6% to acute rehabilitation, 5.3% to hospice, 0.7% to long-term acute care facilities, and 1.3% were transferred to another hospital. Of patients alive at hospital discharge,

Table II. Results of risk stratification imaging and laboratory testing, stratified by ESC risk classification

	LR	ILR	IHR	HR	Total
CT characteristics					
Total	426 (93.2%)	152 (92.1%)	143 (91.1%)	40 (80.0%)	761 (91.7%)
Saddle	7 (1.6%)	5 (3.3%)	20 (14.0%)	5 (12.5%)	37 (4.9%)
Main PA	63 (14.8%)	38 (25.0%)	73 (51.0%)	24 (60.0%)	198 (26.0%)
Lobar	176 (41.3%)	79 (52.0%)	85 (59.4%)	28 (70.0%)	368 (48.4%)
Sub/segmental	298 (70.0%)	105 (69.1%)	97 (67.8%)	27 (67.5%)	527 (69.3%)
RV/LV ratio (+/−/missing)	0/25/401	21/11/120	53/8/82	18/1/21	92/45/624
NM characteristics					
Total	31 (6.8%)	13 (7.9%)	14 (8.9%)	5 (5.0%)	63 (7.6%)
Echo characteristics					
Total	210 (45.9%)	135 (81.8%)	154 (98.0%)	47 (94.0%)	546 (65.9%)
RV enlargement	0 (0%)	67 (40.6%)	134 (85.4%)	43 (86.0%)	244 (29.4%)
RV hypokinesis	0 (0%)	48 (29.1%)	126 (80.3%)	39 (78.0%)	213 (25.7%)
Cardiac biomarkers					
Total troponins ordered	230 (50.3%)	131 (79.4%)	152 (96.8%)	42 (84.0%)	555(66.9%)
Positive	3 (0.7%)	13 (7.9%)	48 (30.6%)	25 (50.0%)	89 (10.7%)
Total BNP/pro-BNP ordered	134 (29.3%)	117 (70.9%)	151 (96.2%)	35 (70.0%)	437 (52.7%)
Positive	8 (1.8%)	71 (43.0%)	140 (89.2%)	25 (50.0%)	244 (29.4%)

Table III. Advanced therapies done during index hospitalization, stratified by ESC risk classification

	LR	ILR	IHR	HR	Total
Total number of patients*	0 (0.0%)	4 (2.4%)	26 (16.6%)	20 (40.0%)	50 (6.0%)
Advanced therapies					
Systemic tPA	0 (0%)	1 (0.6%)	4 (2.5%)	10 (20%)	15 (1.8%)
U/CDT	0 (0%)	3 (1.8%)	22 (14.0%)	7 (14.0%)	32 (3.8%)
Embolectomy	0 (0%)	0 (0%)	3 (1 .9%)	3 (6.0%)	6 (0.7%)
ECMO	0 (0%)	0 (0%)	0 (0%)	5 (10%)	5 (0.6%)

tPA, tissue plasminogen activator; U/CDT, ultrasound-assisted catheter-directed therapy and catheter-directed therapy.
* Indicates the total number of patients who underwent advanced therapies taking into account that some patients underwent multiple therapies during hospitalization.

395 (48%) were on a direct oral anticoagulants, 221 (27%) on heparin derivative, 134 (16%) on warfarin, and 78 (9%) on no anticoagulation.

Mortality

Thirty-one (3.7%) patients died during the hospitalization, including 13 (2.8%) LR, 7 (4.2%) ILR, 4 (2.5%) IHR, and 7 (14.0%) HR patients. Forty-four (5.3%) patients were discharged to hospice, including 24 (5.3%) LR, 7 (4.2%) ILR, 8 (5.1%) IHR, and 5 (10.0%) HR patients. All hospice patients died after hospital discharge. Most in-hospital deaths were related to PE (48.4%), whereas most hospice discharges were due to malignancy (52.3%) (Supp. 2).

In-hospital PE

A total of 153 patients were diagnosed with acute PE while hospitalized for another indication. Of these patients with in-hospital PE, 59.5% had recently undergone a surgical procedure or been involved in a trauma. CT was the primary method of diagnosis, but CT RV/LV ratio, troponins, BNPs, and echocardiograms were not pursued in 79.2%, 51.0%, 68.0%, and 45.1% of patients, respectively. Approximately 47% required ICU admission and 28% required intubation. Median ICU LOS was 5.9 days (IQR: 2.8, 11.4), and median hospital LOS was 12.0 days (IQR: 7.0, 21.0). Inpatient mortality in this subgroup was 6.5%, whereas 3.3% of patients were discharged to hospice.

Discussion

This heterogeneous cohort of 829 patients with acute PE reflects the contemporary clinical experience within our hospital system stratified by recent ESC guidelines.[12] There are several key points from this descriptive analysis. First, although many reports focus on high-risk groups and patients receiving advanced therapies, this cohort study includes all patients with acute PE and demonstrates that 75% of patients have low or intermediate-low risk. Second, an important strength of this analysis is that clinical

Table IV. Mortality, hospital utilization, and discharge anticoagulation, stratified by ESC risk classification.

	LR	ILR	IHR	HR	Total
Discharge status					
Alive	443 (96.9%)	158 (95.8%)	153 (97.5%)	43 (86.0%)	797 (96.1%)
Deceased	13 (2.8%)	7 (4.2%)	4 (2.5%)	7 (14.0%)	31 (3.7%)
Hospice	24 (5.3%)	7 (4.2%)	8 (5.1%)	5 (10.0%)	44 (5.3%)
ICU utilization					
n	64 (14.0%)	41 (24.8%)	66 (42.0%)	45 (90.0%)	216 (26.1%)
Median LOS (d)	4.8 (1.4, 10.7)	2.7 (1.0, 4.5)	2.0 (1.2, 3.5)	4.7 (2.2, 8.2)	2.9 (1.3, 6.9)
Intubation	33 (7.2%)	12 (7.3%)	6 (3.8%)	23 (46.0%)	74 (8.9%)
Hospital utilization					
Mean hospital LOS	7.3 ± 12.5	6.9 ± 6.1	7.1 ± 6.5	12.8 ± 11	7.5 ± 10.5
Median hospital LOS	4.0 (2.0, 8.0)	5.0 (3.0, 9.0)	5.0 (3.0, 9.0)	9.0 (5.0, 17.0)	5.0 (3.0, 9.0)
Discharge anticoagulation					
Heparin derivative	130 (28.4%)	41 (24.8%)	40 (25.5%)	10 (20.0%)	221 (26.7%)
Warfarin	62 (13.6%)	32 (19.4%)	31 (19.7%)	9 (18.0%)	134 (16.2%)
DOAC	227 (49.7%)	74 (44.8%)	75 (47.8%)	19 (38.0%)	395 (47.6%)
None	37 (8.1%)	18 (10.9%)	11 (7.0%)	12 (24.0%)	78 (9.4%)

DOAC, Direct oral anticoagulant.

abstraction and adjudication were performed to ensure clinical integrity and data completeness. In addition, physician-reviewed mortality analysis revealed that 48% of in-hospital deaths were attributable to PE-related complications. Finally, in-hospital PE is rarely described in the literature. In this analysis, nearly 6.5% of in-hospital PEs were fatal, and 22.1% of patients experienced hemodynamic compromise requiring higher levels of clinical care (eg, ICU stay, mechanical ventilation).

Through this critical review of acute PE patients within our health system, we were able to make several key observations. The most important one is a lack of consistent risk stratification among in-hospital PE as evident by the high rates of missing biomarkers and RV imaging in the LR group. Acute PE is managed by an array of health care personnel across many subspecialties, which contributes to the wide variability in stratification and management of these heterogeneous patients and subsequently makes risk stratification difficult to standardize. In fact, in-hospital PE accounted for one-third of all deaths in this cohort, all of which are classified as low risk. This likely indicates poor recognition and risk assessment by in-hospital providers and represents an important opportunity for advancement in PE management.

Nearly all IHR and HR patients were completely risk stratified (including BNP, troponin, and assessment of RV dysfunction), whereas approximately 20% of ILR patients did not have cardiac biomarkers or RV assessment with echocardiography. This raises the possibility that incompletely stratified patients may have benefited from higher levels of care and advanced therapies if identified. These observations highlight an opportunity to standardize care across health systems and the need for real-time electronic medical record–based identification of acute PE to ensure that all patients are considered for risk stratification, diagnostic testing, and pulmonary embolism response team consultation.

The observed mortality rates of the present cohort are comparable to previous studies. Both our study and the EMPEROR study included a large proportion of low-risk PE, and our 3.7% (31 patients) in-hospital mortality rate is similar to the 3.4% overall mortality rate of EMPEROR.[13] In HR patients, mortality was 14.0% even with use of invasive therapies. Despite the substantial mortality associated with acute PE, few have described if mortality is associated with PE-related complications or underlying comorbid conditions. We conducted a mortality analysis and found that 35.5% of in-hospital deaths after diagnosis of acute PE are completely unrelated to the PE and rather are due to complications from underlying malignancy or sepsis. Malignancy accounted for 22.6% of inpatient deaths and 52.3% of hospice discharges. Notably, more HR and IHR patients died from PE-related complications, whereas ILR and LR patients more often succumbed to malignancy-related complications. In this chronically ill population, acute PE was often a final complication that led to hospice discharge.

Ultimately, acute PE management remains a developing field with novel therapeutics emerging to replace previously high-risk interventions.[15-17] In recent years, many have proposed transitioning to a multidisciplinary team-based approach, similar to that used for the management of ST-elevation myocardial infarction.[18,19] Moving forward, it will be important to consider that, even with new therapies and strategies emerging to care for these complex patients, identification and stratification will be paramount. Electronic medical record–based informatics to identify at risk patients has already shown

promise in the management of sepsis[20] and may represent a unique opportunity to identify high-risk patients, provide real-time assessment of patient risk, and create a signal to mobilize multidisciplinary teams capable of delivering high-quality value-based care across a hospital system.

Conclusion

This description of a large, heterogeneous cohort of patients with acute PE highlights the contemporary demographics and risk factors as well as the diagnostic and management patterns at a large, academic medical center. The consistently high mortality of 14% in the HR group despite advanced therapies and inadequate risk stratification of acute PE highlight an important opportunity to improve and standardize care of patients with acute pulmonary embolism.

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Appendix A. Supplementary data

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