Racial Differences in 30-Day Mortality for Pulmonary Embolism

Said A. Ibrahim, MD, MPH, Roslyn A. Stone, PhD, D. Scott Obrosky, MSc, Jennifer Sartorius, MSc, Michael J. Fine, MD, MSc, and Drahomir Aujesky, MD, MSc

Objectives. Previous studies reported a higher incidence of in-hospital mortality for Black patients who had pulmonary embolism than for White patients. We used a large statewide database to compare 30-day mortality (defined as death within 30 days from the date of latest hospital admission) for Black and White patients who were hospitalized because of pulmonary embolism.

Methods. The study cohort consisted of 15531 discharged patients who had been treated for pulmonary embolism at 186 Pennsylvania hospitals between January 2000 and November 2002. We used random-effects logistic regression to model 30-day mortality for Black and White patients, and adjusted for patient demographic and clinical characteristics.

Results. The unadjusted 30-day mortality rates were 9.0% for White patients, 10.3% for Blacks, and 10.9% for patients of other or unknown race. When adjusted for severity of disease using a validated clinical prognostic model for pulmonary embolism, Black patients had 30% higher odds of 30-day mortality compared with White patients at the same site (adjusted odds ratio = 1.3; 95% confidence interval, 1.1,1.6). Neither insurance status nor hospital volume was a significant predictor of 30-day mortality.

Conclusion. Black patients who had pulmonary embolism had significantly higher odds of 30-day mortality compared with White patients. (*Am J Public Health.* 2006;96:2161–2164. doi:10.2105/AJPH.2005.078618)

Pulmonary embolism is a common disease associated with substantial morbidity and mortality.[1,2] Black patients are reported to have a higher incidence of venous thromboembolism (VTE) and VTE-related mortality than White patients[3–8] However, because these studies did not adjust for potential differences in patient or hospital factors, it is unclear whether the higher observed death rates among Black patients represent a true disparity or are a result of confounding. We used a large statewide database to compare 30-day mortality (defined as death within 30 days from the date of latest hospital admission) between Black and White patients who had pulmonary embolism; we adjusted for severity of disease, insurance status, and hospital volume.

METHODS

We identified our study cohort from the Pennsylvania Health Care Cost Containment Council PHC4 Database, which includes demographic data for all patients discharged from nongovernmental (i.e., non-Veterans Administration) acute care hospitals in Pennsylvania. The database also includes a measure of hospital volume, the number of beds per site. During the admission process, a patient's race was either self-reported or determined by administrative staff. Race was coded as White, Black, or other/unknown. The cohort consisted of all patients aged 18 years or older who were discharged with a primary diagnosis of pulmonary embolism from January 2000 to November 2002 on the basis of the following codes according to the *International Classification of Diseases, 9th Revision, Clinical Modification*[9]: 415.1, 415.11, 415.19, and 673.20–673.24. We also included patients who had a secondary diagnosis of pulmonary embolism and one of the following primary diagnoses that represent likely complications or treatments for pulmonary embolism: 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/mechanical ventilation (96.04, 96.05, 96.70–96.72). Because patients who have recurrent pulmonary embolism may have a higher incidence of mortality than patients who have a first episode, we included all episodes of pulmonary embolism within the study period.[10] We excluded discharged patients who did not have patient identifiers or whose mortality status was unknown.

Patient baseline clinical variables were obtained by linking study patients to the Atlas Database (MediQual, Marlborough, Mass), which includes detailed clinical findings at presentation for all inpatients treated at nongovernmental acute care hospitals in Pennsylvania.[11] These variables include insurance status, comorbid conditions, and physical examination findings as shown in Table 1.

Severity of disease was quantified using a validated prognostic model for patients who have pulmonary embolism.[12,13] The prognostic model consists of 11 routinely available predictors of mortality: age, male gender, 3 comorbid conditions (cancer, chronic lung disease, and heart failure), and 6 clinical factors (pulse ≥110 beats per minute, systolic blood pressure <100 mm Hg, respiratory rate ≥30/min, body temperature <36°C, altered mental status, and oxygen saturation <90%) shown in Table 1. On the basis of a simple point score, each patient is classified into 1 of 5 classes (I–V) of increasing risk of 30-day mortality and other adverse medical outcomes (cardiogenic shock, cardiorespiratory arrest, recurrent VTE, and major bleeding).

Our study outcome was death from any cause within 30 days of hospital admission for pulmonary embolism. We obtained mortality data by linking study patients to the National Death Index.[14] We used 30-day mortality rather than in-hospital mortality as our primary outcome because racial differences for in-hospital mortality may be biased by racial differences in length of stay across hospitals.

TABLE 1—Race-Specific Baseline Patient Characteristics (n = 15 531)

	White (n = 12 554)	Black (n = 1701)	Other/Unknown (n = 1276)	P
Demographic variables				
Age, mean	64.8	57.7	62.8	<.001
Male gender, %	40.3	37.6	41.1	.07
Insurance status, %				<.001
No insurance	1.1	2.4	0.6	
Government insurance	56.9	44.6	51.4	
Medicaid	5.0	24.7	10.0	
Private insurance	36.8	27.9	37.4	
Unknown	0.3	0.5	0.6	
Comorbid disease, %				
Cancer	19.7	13.8	26.3	<.001
Lung disease	18.9	17.5	15.2	.003
Heart failure	15.4	19.6	15.2	<.001
Physical examination findings, %				
Pulse ≥ 110/min	17.3	20.5	17.8	.005
Systolic blood pressure < 100 mm Hg	10.3	11.1	11.1	.46
Respiratory rate ≥ 30/min	14.2	18.2	13.2	<.001
Oral temperature < 36°C	16.6	15.8	17.2	.57
Altered mental status	6.8	10.3	7.6	<.001
Oxygen saturation < 90%	8.0	7.8	7.8	.94
Risk classification, %				<.001
Class I	18.3	28.2	17.7	
Class II	21.9	18.8	20.3	
Class III	22.0	20.6	21.6	
Class IV	16.8	12.0	15.7	
Class V	21.1	20.4	22.7	

We compared patient baseline characteristics between Whites, Blacks, and patients of other/unknown race using a Kruskal–Wallis test for continuous variables and χ^2 tests for categorical variables. Pair-wise comparisons of racial groups were conducted when an overall test was significant (P=.05). We modeled 30-day mortality using random-effects logistic regression models with hospital site as the random effect, and adjusted for risk class, insurance status, and hospital volume (log number of beds). We also assessed the potential interaction between race and risk class.

RESULTS

Of the 16 467 discharged patients who met all eligibility criteria in the PHC4 database, we excluded 90 (0.5%) patients who did not have patient identifiers, 70 (0.4%) patients whose mortality status was unknown, and 776 (4.7%) patients who did not have key clinical findings. The study cohort comprised 15 531 discharged patients who had pulmonary embolism and were treated at 186 Pennsylvania hospitals. Of the 15 531, 80.8% were White, 11.0% were Black, and 8.2% were of another or unknown race; the vast majority (91.6%) of this latter group was of unknown race. The number of hospital discharges actually represented 14 672 individual patients who had pulmonary embolism. There were 859 (5.5%) discharges (612 patients) attributable to recurrent pulmonary embolism. Thrombolytic therapy was received by 284 White patients (2.3%), 45 Black patients (2.7%), and 27 patients of other or unknown race (2.1%) (P=.56 for differences by race). There were only 3 cases of embolectomy

Black patients were younger and more likely to be covered by Medicaid insurance (P<.001 for each; Table 1). Although heart failure and physical examination abnormalities (pulse, respiratory rate, and altered mental status) were more prevalent among Blacks than among either Whites or patients of other or unknown race, relatively more Blacks were classified as very low risk (risk class I).

The crude 30-day mortality rates were 9.0% for White patients (1125 deaths), 10.3% for Black patients (175 deaths), and 10.9% for patients of other or unknown race (139 deaths; P=.02). Race-specific mortality is shown by risk class in Figure 1. Within risk class I (P=.03), 30-day mortality was higher for Blacks (2.5%; 12 deaths) relative to Whites (1.1%; 25 deaths) and patients of other or unknown race (0.8% (2 deaths). The incidence of mortality did not differ significantly by race for patients in risk classes II (P=.10), III (P=.93), or IV (P=.82). Within risk class V (P=.006), mortality was higher for Blacks (29.1%; 101 deaths) and patients of other or unknown race (29.3%; 85 deaths) relative to Whites (23.1%; 611 deaths).

After adjusting for severity of disease using the pulmonary embolism prognostic model, insurance status and log bed size, Black patients had 30% higher odds of mortality (OR=1.3; 95% confidence interval=1.1, 1.6; Table 2) relative to White patients. Neither insurance status nor hospital volume were significantly associated with mortality (P>.22 for each). The effect of race did not vary significantly by risk class (P=.36).

DISCUSSION

In our cohort of over 15 000 patients identified using a statewide database, Black patients had a 30% higher risk of 30-day mortality than White patients. Although our finding is consistent with previous studies,[3,4,6–8] our adjustments for severity of disease using a validated prognostic model, insurance status, and hospital volume rendered potential confounding by these factors unlikely. Identifying a cohort from a single US state reduces the potential for confounding caused by regional variation in VTE management.[12,13]

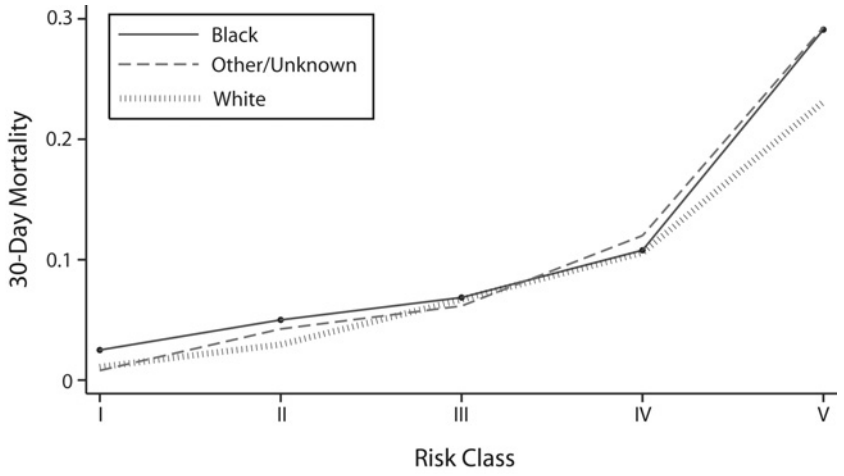

FIGURE 1–Race-specific 30-day mortality, by risk classification.

TABLE 2–Adjusted Odds Ratios and 95% Confidence Intervals for 30-Day Mortality on the Basis of a Random-Effect Logistic Model

	Adjusted Odds Ratio (95% Confidence Interval)	*P*
Race		
White	Reference	Reference
Black	1.3 (1.1, 1.5)	.01
Other/unknown	1.2 (1.0, 1.5)	.05
Insurance		
Private	Reference	Reference
None/unknown	0.4 (0.2, 1.0)	.06
Government	1 (0.9, 1.2)	.56
Medicaid	1.1 (0.8, 1.4)	.59
Log number of beds	1.1 (1.0, 1.2)	.29
Risk classification		
Class 1	Reference	Reference
Class 2	2.6 (1.8, 3.7)	<.001
Class 3	5.4 (3.8, 7.7)	<.001
Class 4	9.1 (6.4, 13.0)	<.001
Class 5	24.2 (17.2, 34.0)	<.001

The reason why Black patients have relatively higher mortality rates from pulmonary embolism remains unexplained. The pattern of thrombosis may put Black patients at higher risk of pulmonary embolism mortality. One preliminary study reported that Black patients were more likely than White patients to have proximal deep venous thrombosis (68% vs 59%), which is associated with higher clot burden and possibly higher risk of VTE recurrence and death.[15] Although we did not examine treatment for pulmonary embolism in our study, differences in management of acute pulmonary embolism during the hospital course could explain the higher observed pulmonary embolism mortality among Black patients. Because the risk of recurrent pulmonary embolism is greatest early after a pulmonary embolism episode, suboptimal anticoagulation during the hospital course may contribute to a higher risk of death after pulmonary embolism. Several studies have reported racial variation in VTE management and use of anticoagulation therapy.[16–18] Finally, differences in mortality rates for Blacks and Whites after an acute pulmonary embolism episode could be attributed to an as yet undefined physiologically mediated difference in response to standard drugs used to treat pulmonary embolism. Current literature assumes that heparin and warfarin are equally efficacious in Black and White patients who have VTE. A recent study of racial differences in nitric oxide–mediated physiology of congestive heart failure leading to differences in response to common drugs used in the treatment of heart disease,[19] challenges this assumption. Although one study reported racial/ethnic variation in warfarin responses, comparative studies of the efficacy of heparin and warfarin in pulmonary embolism management for Black and White patients have not yet been done.[20]

Our finding of racial differences in mortalities as a result of pulmonary embolism confirms a previously suspected but unproven disparity involving a common, treatable clinical condition. Unlike other health disparities for which solutions may not always lie within the health care system, variation in VTE management, if proven to be the cause, could potentially be remedied through quality of care improvements within the health care system. Marked variation and underutilization of commonly accepted standards of care for VTE have been shown for all patients, regardless of race.[12,13,21–23]

There are limitations to consider when interpreting our results. First, we examined data from a single state in the United States. It is conceivable that comparable studies in other regions may show different results. Second, we could not examine the potential affect of pulmonary embolism treatment on mortality, which could explain our observed differences in mortality rates between Blacks and Whites. However, if it existed, differential treatment would be another manifestation of inequity. Third, our data do not address other causes of differences in 30-day mortality for Black and White patients after pulmonary embolism admission. Such a study would require more in-depth information about the processes of care within and outside the hospital. Fourth, we excluded patient discharges with missing vital status, key clinical findings, or patient identifiers, potentially limiting the ability to generalize.

Black patients who have pulmonary embolism have significantly higher odds of 30-day mortality compared with White patients. Further studies are needed to examine the processes of care among Black and White patients who are hospitalized for pulmonary embolism, to ascertain whether differences in these processes could account for the observed differences in mortality. ■

About the Authors

Said A. Ibrahim, Michael J. Fine, Roslyn A. Stone, D. Scott Obrosky, and Jennifer Sartorius are with the Veterans Administration Center for Health Equity Research and Promotion, Pittsburgh Healthcare System, Pittsburgh, Pa. Said A. Ibrahim, Michael J. Fine, and D. Scott Obrosky are also with the Division of General Internal

Medicine, Department of Medicine, University of Pittsburgh, Pittsburgh. Roslyn A. Stone is also with the Department of Biostatistics, Graduate School of Public Health, University of Pittsburgh. Drahomir Aujesky is with the Division of Internal Medicine, the Clinical Epidemiology Center, and the University Outpatient Clinic, University of Lausanne, Lausanne, Switzerland.

Requests for reprints should be sent to Said A. Ibrahim, MD, MPH, Veterans Administration Center for Health Equity Research and Promotion, Pittsburgh Healthcare System, University Drive C (151C-U), Pittsburgh, PA 15240 (e-mail: said.ibrahim2@va.gov).

This article was accepted February 27, 2006.

Contributors

D. Aujesky, S.A. Ibrahim, and M.J. Fine designed the study, interpreted the data, and wrote the article. R.A. Stone, D.S. Obrosky, and J. Sartorius conducted data cleaning, analysis, and assisted with writing and data interpretation.

Acknowledgments

This study was partially funded by the National Heart, Lung, and Blood Institute (grant 1 R21 HL075521–01A1). Drahomir Aujesky was partially supported by the Clinical Epidemiology Center, University of Lausanne. Said A. Ibrahim received a career development award from the Veterans Administration Health Services Research and Development Office and the Robert Wood Johnson Foundation's Harold Amos Faculty Development Award. Michael J. Fine was supported in part by a K24 Mid-Career Development Award from the National Institute of Allergy and Infectious Diseases.

The authors thank Kimberly Hansen for her editorial assistance.

Human Participant Protection

This study was approved by the University of Pittsburgh institutional review board.

References

1. Anderson FA, Jr., Wheeler HB, Goldberg RJ, et al. A population-based perspective of the hospital incidence and case-fatality rates of deep vein thrombosis and pulmonary embolism. The Worcester DVT Study. *Arch Intern Med.* 1991;151:933–938.

2. Silverstein MD, Heit JA, Mohr DN, Petterson TM, O'Fallon WM, Melton LJ, 3rd. Trends in the incidence of deep vein thrombosis and pulmonary embolism: a 25-year population-based study. *Arch Intern Med.* 1998; 158:585–593.

3. Lilienfeld DE. Decreasing mortality from pulmonary embolism in the United States, 1979–1996. *Int J Epidemiol.* 2000;29:465–469.

4. White RH, Zhou H, Murin S, Harvey D. Effect of ethnicity and gender on the incidence of venous thromboembolism in a diverse population in California in 1996. *Thromb Haemost.* 2005;93:298–305.

5. Stein PD, Hull RD, Patel KC, et al. Venous thromboembolic disease: comparison of the diagnostic process in Blacks and Whites. *Arch Intern Med.* 2003;163: 1843–1848.

6. Siddique RM, Siddique MI, Connors AF, Jr., Rimm AA. Thirty-day case-fatality rates for pulmonary embolism in the elderly. *Arch Intern Med.* 1996;156: 2343–2347.

7. Stein PD, Kayali F, Olson RE. Estimated case fatality rate of pulmonary embolism, 1979 to 1998. *AM J Cardiol.* 2004;93:1197–1199.

8. Horlander KT, Mannino DM, Leeper KV. Pulmonary embolism mortality in the United States, 1979–1998: an analysis using multiple-cause mortality data. *Arch Intern Med.* 2003;163:1711–1717.

9. *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM), 6th ed. Available at: http://www.cdc.gov/nchs/products/elec_prods/subject/icd96ed.htm. Accessed August 8, 2006.

10. Douketis JD, Foster GA, Crowther MA, Prins MH, Ginsberg JS. Clinical risk factors and timing of recurrent venous thromboembolism during the initial 3 months of anticoagulant therapy. *Arch Intern Med.* 2000;160:3431–3436.

11. Auble TE, Hsieh M, Gardner W, et al. A prediction rule to identify low-risk patients with heart failure. *Acad Emerg Med.* 2005;12:514–521.

12. Aujesky D, Obrosky DS, Stone RA, et al. Derivation and Validation of a Prognostic Model for Pulmonary Embolism. *Am J Respir Crit Care Med.* 2005; 172:1041–1046.

13. Aujesky D, Roy PM, Le Manach CP, et al. Validation of a model to predict adverse outcomes in patients with pulmonary embolism. *Eur Heart J.* 2006;27: 476–481.

14. MacMahon B. The national death index. *Am J Public Health.* 1983;73:1247–1248.

15. Patel RK, Lambie J, Bonner L, Arya R. Venous thromboembolism in the Black population. *Arch Intern Med.* 2004;164:1348–1349.

16. Ganz DA, Glynn RJ, Morun H, Knight EL, Bohn RL, Avorn J. Adherence to guidelines for oral anticoagulation after venous thrombosis and pulmonary embolism. *J Gen Intern Med.* 2000;15:776–781.

17. Ibrahim SA, Kwoh CK, Harper DL, Baker DW. Racial differences in the utilization of oral anticoagulation therapy in heart failure: a study of elderly hospitalized patients. *J Gen Intern Med.* 2000;15:134–137.

18. Ibrahim SA, Kwoh CK. Underutilization of oral anticoagulation therapy for stroke prevention in elderly patients with heart failure. *Am Heart J.* 2000;140: 219–220.

19. Taylor AL, Ziesche S, Yancy C, et al. Combination of isosorbide dinitrate and hydralazine in Blacks with heart failure. *N Engl J Med.* 2004;351:2049–2057.

20. El Rouby S, Mestres CA, LaDuca FM, Zucker ML. Racial and ethnic differences in warfarin response. *J Heart Valve Dis.* 2004;13:15–21.

21. Aujesky D, Cornuz J, Bossum JL, et al. Uptake of new treatment strategies for deep vein thrombosis: an international audit. *Int J Qual Health Care.* 2004;16: 193–200.

22. Whittle J, Johnson P, Localio AR. Anticoagulation therapy in patients with venous thromboembolic disease. *J Gen Intern Med.* 1998;13:373–378.

23. Hylek EM, Regan S, Henault LE, et al. Challenges to the effective use of unfractionated heparin in the hospitalized management of acute thrombosis. *Arch Intern Med.* 2003;163:621–627.