Trauma care does not discriminate: The association of race and health insurance with mortality following traumatic injury

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BACKGROUND: Previous studies have reported that black race and lack of health insurance coverage are associated with increased mortality following traumatic injury. However, the association of race and insurance status with trauma outcomes has not been examined using contemporary, national, population-based data.

METHODS: We used data from the National Inpatient Sample on 215,615 patients admitted to 1 of 836 hospitals following traumatic injury in 2010. We examined the effects of race and insurance coverage on mortality using two logistic regression models, one for patients younger than 65 years and the other for older patients.

RESULTS: Unadjusted mortality was low for white (2.71%), black (2.54%), and Hispanic (2.03%) patients. We found no difference in adjusted survival for nonelderly black patients compared with white patients (adjusted odds ratio [AOR], 1.04; 95% confidence interval [CI], 0.90–1.19; $p = 0.550$). Elderly black patients had a 25% lower odds of mortality compared with elderly white patients (AOR, 0.75; 95% CI, 0.63–0.90; $p = 0.002$). After accounting for survivor bias, insurance coverage was not associated with improved survival in younger patients (AOR, 0.91; 95% CI, 0.77–1.07; $p = 0.233$).

CONCLUSION: Black race is not associated with higher mortality following injury. Health insurance coverage is associated with lower mortality, but this may be the result of hospitals' inability to quickly obtain insurance coverage for uninsured patients who die early in their hospital stay. Increasing insurance coverage may not improve survival for patients hospitalized following injury. (*J Trauma Acute Care Surg*. 2015;78: 1026–1033. Copyright © 2015 Wolters Kluwer Health, Inc. All rights reserved.)

LEVEL OF EVIDENCE: Epidemiologic and prognostic study, level III.

KEY WORDS: Race; health insurance; mortality; survivor treatment assignment bias.

Racial disparities in health care outcomes in the United States have been extensively reported for many conditions, including lung cancer,[1] head and neck cancer,[2] and following cardiac arrest.[3] A recent meta-analysis[4] concluded that black patients had substantially worse adjusted survival than whites following traumatic injury. Overall, blacks have a life expectancy that is 6 years shorter than that of whites, and trauma accounts for nearly as much of this disparity as ischemic heart disease, stroke, and cancer combined.[5] The relationship between race and survival following trauma is complex, however, because white patients are much more likely to have health insurance than black or Hispanic patients,[6] and health insurance has been associated with improved survival for trauma patients.[4]

Previous studies examining black-white disparities in trauma mortality are nearly all based on a single convenience sample of trauma centers, the National Trauma Data Bank (NTDB). No studies are based on contemporary national population-based data. Furthermore, none of these studies accounts for the possibility that the association between insurance coverage and apparently improved outcomes is caused by the inability of hospitals to obtain insurance coverage for uninsured trauma patients who die early in their hospital course. Our goal was to examine the association between race, insurance coverage, and mortality in injured patients using a national population-based sample. Our findings may help policy makers better understand the potential impact on outcomes of expanding health care coverage to uninsured injured patients.

PATIENTS AND METHODS

Data

The study is based on the Healthcare Cost and Utilization Project Nationwide Inpatient Sample (NIS), a 20% stratified sample of patients from nonfederal hospitals. The NIS includes information on patient demographics, race, insurance, admission source, DRG International Classification of Diseases—9th Rev.—Clinical Modification (ICD-9-CM) diagnostic and injury codes, Agency for Healthcare Research and Quality comorbidity measures, in-hospital mortality, hospital characteristics, and hospital identifiers.

The study population consists of patients admitted with a principal ICD-9-CM diagnosis of trauma (800–959.9), excluding patients with late effects of injury, foreign bodies, burns, or complications of trauma. ICD-9 Ecodes were used to create seven clinically relevant injury mechanisms (gunshot wound, self-inflicted gunshot wound, low fall, motor vehicle crash, pedestrian injury, other blunt injuries, and stab wound). We excluded 53,955 patients with missing information on race as well as 6,776 patients whose survival status could not be determined because they were transferred to another hospital. The final study cohort consisted of 108,178 nonelderly (15 years < age < 65 years) and 107,437 elderly patients (age ≥ 65 years) admitted to 836 hospitals.

Statistical Analysis

The outcome variable of interest was in-hospital mortality. Because elderly (age > 64 years) and nonelderly (age < 65 years) trauma patients have very different risk and injury profiles, we fit separate logistic regression models for each age group. We controlled for age, sex, traumatic shock (ICD-9 958.4), extent of anatomic injury (expressed as the logit of the probability of death computed using the Trauma Mortality Prediction Model[7]), mechanism of injury, 12 comorbidities, as well as the predictor of interest, race (white, black, and Hispanic). Although we explored the role of insurance status in the nonelderly cohort, for reasons outlined later, we excluded insurance status from our final models. We did not control for insurance status in the elderly patients since more than 99% of the elderly patients were insured. Because four states provided no information on race and were excluded from our analysis, we estimated all models without sample weighting. However, including sample weights changed our results minimally. We used clustered sandwich estimators[8] to adjust for the correlation of outcomes within individual hospitals.

Our initial model for the young patient cohort indicated an improbably large effect of health insurance coverage on survival. We therefore explored the possibility of survivor treatment assignment bias (STAB),[9] a well-recognized but often overlooked[10]problem that can arise when a time-dependent treatment is specified as if it is fixed at baseline. Considering insurance coverage as a treatment, time dependency is introduced by the efforts of hospital administrators to obtain insurance coverage for uninsured patients following hospital admission. As a result of such efforts, patients who die without insurance may die uninsured simply because early death prevented them from becoming insured. The risk for STAB for young trauma patients is substantial because both death and change in insurance status usually occur very early in patients' hospital stays: in our sample, two thirds of deaths occurred by the third hospital day, and almost all patients who would ultimately be insured had been insured (Fig. 1).

To minimize survivor bias inherent to insurance status, we imputed the insurance status of uninsured patients with hospital stays less than 1 day. Our imputation model predicted the probability of having health insurance at any time after the first hospital day using only predictors fixed before hospital admission (Appendix, Supplemental Digital Content 1, http://links.lww.com/TA/A543). We used this model to impute insurance status for the 4,409 patients (4%) with length of stay less than 1 day, the group with the highest risk of STAB. We then included this imputed insurance status in our final mortality model to account for hospitals' frequent failure to find insurance coverage for initially uninsured patients within the first hospital day. In effect, this procedure assigned these patients the insurance status they would have had if they had stayed in the hospital longer than a single day, thus controlling for STAB. All statistical analysis was performed using Stata/MP version 13.1. The institutional review board of the University of Vermont judged this research not to require review because it did not constitute human subject research.

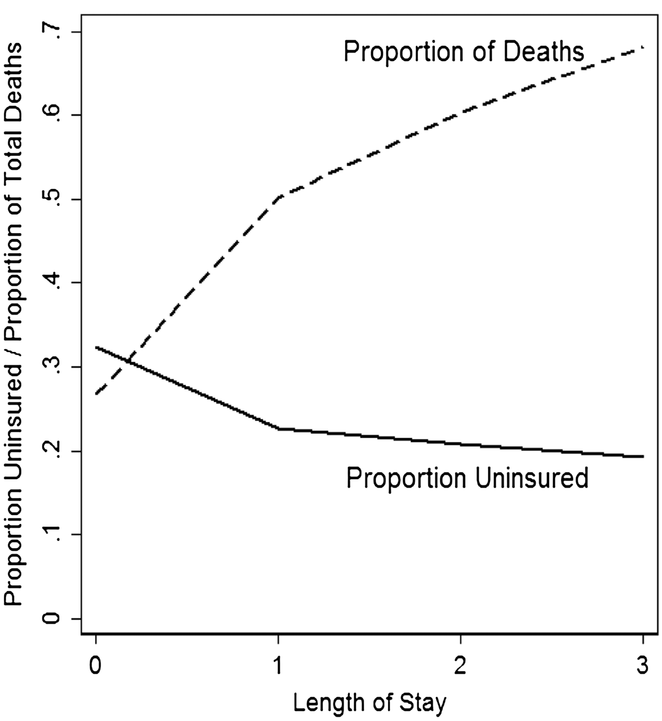

Figure 1. Proportion of patients who are uninsured (*solid line*) and proportion of total deaths (*dashed line*) as functions of length of hospital stay, until death or discharge.

RESULTS

Nonelderly black patients had a higher mortality (2.39%) than did nonelderly white patients (1.73%); this relationship was reversed in the elderly where that black race had a lower mortality (3.07%) than did the white race (3.46%) (Tables 1 and 2). Nonelderly black patients were more likely to be uninsured than whites (29% vs. 16%). Less than 1% of elderly were uninsured. White patients were more likely to be admitted to small and to rural hospitals, while black patients were more commonly admitted to urban hospitals and to teaching hospitals (Table 3).

Among nonelderly patients, after adjusting for covariates, black patients (adjusted odds ratio [AOR], 1.105; 95% confidence interval [CI], 0.90–1.22; p = 0.56) and Hispanic patients (AOR 0.93; 95% CI, 0.73–1.19; p = 0.55) had similar risk of mortality compared with white patients. In patients 65 years or older, black patients had a 25% lower odds of mortality compared with white patients (AOR, 0.75; 95% CI, 0.63–0.90; p = 0.002), whereas Hispanic patients had similar risk of mortality compared with white patients (Table 3).

We found that insurance status had no effect survival when we imputed insurance status for the 4,409 patients died or were discharged during the first 24 hours of their hospital stay (AOR, 0.91; 95% CI, 0.77–1.07; p = 0.233). By contrast, insurance status was associated with better survival in our initial baseline model, which did not account for survivor bias (AOR, 0.81; 95% CI, 0.68–0.93; p = 0.005) (Tables 4 and 5).

Because our use of multiple imputation to control for STAB is novel, we performed two confirmatory analyses. In the first, we excluded the 4% of patients with a length of stay less than 1 day from our analysis because these patients were the most likely to be affected by STAB. A second confirmatory analysis examined the effect of insurance status at the time of admission rather than on discharge, thus allowing us to treat the time-varying nature of insurance status as a measurement error problem. The results of both of these confirmatory analyses support our imputation analysis finding that the apparent effect of insurance on survival is largely or entirely caused by STAB (Appendix, Supplemental Digital Content 1, http://links.lww.com/TA/A543).

DISCUSSION

In this nationally representative sample of US hospitals, we did not find evidence that either black race or Hispanic ethnicity was associated with worse outcomes in patients hospitalized with traumatic injuries. We also found no evidence that patients with health insurance were more likely to survive after accounting for the effects of survivor bias.

Our study is the first population-based national study with comprehensive risk adjustment to examine the association between race and mortality in injured patients. This result contradicts a number of previous studies reporting that blacks are more likely than whites to die following traumatic injuries.[11–17] However, since most of these studies are based on a single data

TABLE 1. Characteristics of Patients Aged 16 Years to 65 Years

	White	Black	Hispanic	Total
n	73,975 (68.4%)	18,277 (16.9%)	15,926 (14.7%)	108,178
Female	27,553 (37.3%)	4,908 (26.9%)	3,779 (23.7%)	36,240 (33.5%)
Age, mean, y	43.2	37.2	36.3	41.2
Length of stay	4.94	5.88	5.19	5.14
Uninsured	11,584 (15.6%)	5,208 (28.5%)	4,835 (30.4%)	21,591 (20.0%)
Payer				
Medicare	7,287 (9.9%)	1,458 (8.0%)	643 (4.0%)	9,398 (8.7%)
Medicaid	8,738 (11.8%)	4,416 (24.2%)	3,217 (20.2%)	16,371 (15.1%)
Private	38,149 (51.6%)	5,404 (29.6%)	4,031 (25.3%)	47,584 (44.0%)
Self-pay	10,858 (14.3%)	4,872 (26.7%)	4,461 (28.0%)	19,918 (18.4%)
No charge	936 (1.3%)	336 (1.8%)	374 (2.4%)	1,673 (1.6%)
Other	8,253 (11.2%)	1,781 (9.7%)	3,200 (20.1%)	13,234 (12.2%)
Comorbidity				
AIDS	121 (0.16%)	119 (0.65%)	50 (0.13%)	290 (0.27%)
Congestive heart failure	1,129 (1.53%)	309 (1.69%)	93 (0.58%)	1,531 (1.42%)
Chronic lung disease	7,460 (10.08%)	1,644 (8.99%)	733 (4.60%)	9,837 (9.09%)
Coagulopathy	2,193 (2.96%)	466 (2.55%)	375 (2.35%)	3,034 (2.80%)
Liver disease	1,707 (2.31%)	249 (1.36%)	283 (1.78%)	2,239 (2.07%)
Electrolyte disorder	8,545 (11.55%)	2,032 (11.12%)	1,468 (9.22%)	12,045 (11.13%)
Metastatic cancer	242 (0.33%)	32 (0.18%)	21 (0.13%)	295 (0.27%)
Perivascular disease	1,064 (1.44%)	209 (1.14%)	125 (0.78%)	1,398 (1.29%)
Pulmonary circulatory disease	564 (0.76%)	142 (0.78%)	86 (0.54%)	792 (0.73%)
Renal failure	1,439 (1.95%)	519 (2.84%)	247 (1.55%)	2,205 (2.04%)
Tumor without metastasis	281 (0.38%)	43 (0.24%)	19 (0.12%)	343 (0.32%)
Weight loss	1,747 (2.36%)	492 (2.69%)	237 (1.49%)	2,487 (2.29%)
Mechanism				
Blunt	38,574 (52.1%)	8,373 (45.8%)	8,406 (52.8%)	55,353 (51.2%)
Gunshot wound	1,095 (1.5%)	2,909 (15.9%)	944 (5.9%)	4,948 (4.6%)
Gunshot wound (self-inflicted)	394 (0.5%)	182 (1.0%)	49 (0.3%)	625 (0.6%)
Low fall	10,643 (14.4%)	1,602 (8.8%)	1,447 (9.1%)	13,692 (12.7%)
Motor vehicle crash	14,367 (19.4%)	3,214 (17.6%)	3,037 (19.1%)	20,618 (19.1%)
Pedestrian trauma	7,836 (10.6%)	1,654 (9.1%)	1,542 (9.7%)	1,910 (1.8%)
Stab wound	1,066 (1.4%)	343 (1.9%)	501 (3.2%)	1,910 (1.8%)

AIDS, acquired immunodeficiency syndrome.

set, the NTDB and rely on a single technique, logistic regression, their findings might be better thought of as replications of a single study. One study based on the NIS reported a black-white disparity in trauma outcomes, but this study[12] was based on data two decades old and had limited risk adjustment. More recently, Glance et al.[18] used regional data limited to 28 trauma centers in Pennsylvania to examine the association of race and mortality, but their findings may not be generalizable outside of Pennsylvania or to nontrauma centers.

Our finding that elderly black trauma patients were more likely to survive compared with white patients was unexpected. Although this observation is based on only 5,024 black patients only 147 of whom died, the effect is highly significant and possibly large enough to be clinically important. This finding persisted after controlling for hospital effects, suggesting that this surprising finding is not the result of elderly black patients receiving care at hospitals with better outcomes. A recent study of the NIS using a different model reported a similar survival advantage of elderly black trauma patients over white patients[19] and proposed a number of possible explanations, among them a reduction in treatment biases in older patients or possibly a healthy survivor bias.

The association between health insurance coverage and improved survival following injury has been widely reported. In our baseline analysis, we also found that health insurance was associated with improved survival. However, we believe that this finding is an epiphenomenon, the result of an overlooked quirk of our health care system: Patients' insurance status is actually not fixed on admission but is instead recorded at discharge. To improve reimbursement, most hospitals help uninsured patients become insured,[20] a process that can take several days. As a result, patients who die early in their hospital course are more likely to die uninsured than are patients who survive longer *simply because it takes time to insure the initially uninsured*. This effect is particularly important in young patients hospitalized following injury who, if they are to die at all, usually die early in their hospital course. Thus, it is early mortality that increases a patient's likelihood of being uninsured rather than the usual narrative that being

TABLE 2. Characteristics of Patients Older Than 64 Years

	White	Black	Hispanic	Total
n	96,750 (90.1%)	5,180 (4.8%)	5,507 (5.1%)	107,437
Female	67,130 (69.4%)	3,327 (64.2%)	3,596 (65.3%)	74,053 (68.9%)
Age, mean, y	81.39	79.06	79.37	81.18
Length of stay	5.27	6.28	5.75	5.35
Uninsured	485 (0.5%)	85 (1.6%)	185 (2.9%)	728 (0.68%)
Payer				
Medicare	85,422 (88.3%)	4,285 (82.7%)	4,253 (77.2%)	93,960 (87.5%)
Medicaid	707 (0.7%)	112 (2.2%)	372 (6.8%)	1,191 (1.1%)
Private	8,883 (9.2%)	635 (12.3%)	613 (11.1%)	10,131 (9.4%)
Self-pay	437 (0.5%)	79 (1.5%)	147 (2.7%)	663 (0.6%)
No charge	48 (0.05%)	6 (0.12%)	11 (0.20)	65 (0.06%)
Other	1,253 (1.3%)	63 (1.22%)	111 (2.02%)	1,427 (1.33%)
Comorbidity				
AIDS	18 (0.02%)	6 (0.12%)	2 (0.04%)	26 (0.02%)
Congestive heart failure	13,883 (14.3%)	720 (13.9%)	621 (11.3%)	15,224 (14.2%)
Chronic lung disease	18,776 (19.4%)	795 (15.4)	836 (15.2%)	20,407 (19.0%)
Coagulopathy	5,230 (5.4%)	285 (5.5%)	308 (5.6%)	5,823 (5.4%)
Liver disease	932 (1.0%)	72 (1.4%)	124 (2.3%)	1,128 (1.1%)
Electrolyte disorder	24,127 (25.0%)	1,282 (24.8)	1,314 (23.9)	26,723 (24.9)
Metastatic cancer	985 (1.0%)	51 (1.0%)	54 (1.0%)	1,090 (1.0%)
Perivascular disease	6,122 (6.33%)	359 (6.9%)	299 (5.4%)	6,780 (6.3)
Pulmonary circulatory disease	3,553 (3.7%)	191 (3.7%)	140 (2.5%)	3,884 (3.6%)
Renal failure	11,701 (12.0%)	1,072 (20.7%)	746 (13.6%)	13,519 (12.6%)
Tumor without metastasis	1,575 (1.6%)	112 (2.2%)	70 (1.3%)	1,757 (1.6%)
Weight loss	4,101 (4.2%)	285 (5.5%)	195 (3.5%)	4,581 (4.3%)
Mechanism				
Blunt	50,680 (52.4)	2,781 (53.7)	2,787 (50.3)	55,353 (51.2%)
Gunshot wound	75 (0.08%)	26 (0.50)	5 90.09%)	106 (0.10)
Gunshot wound (self-inflicted)	74 (0.08%)	8 (0.15%)	3 (0.05%)	85 (0.08%)
Low fall	40,618 (42.0%)	1,912 (36.9%)	2,262 (41.1%)	44,792 (41.7%)
Motor vehicle crash	4,144 (4.3%)	321 (6.2%)	305 (5.5%)	4,770 (4.4%)
Pedestrian trauma	996 (1.0%)	118 (2.3%)	150 (2.7%)	1,264 (1.2%)
Stab wound	163 (0.2%)	14 (0.3%)	14 (0.3%)	191 (0.2%)

AIDS, acquired immunodeficiency syndrome.

uninsured increases mortality through some unspecified mechanism. The effect of this STAB is most appropriately addressed by including a time-varying covariate in the prediction model.[21] However, the hospital day on which insurance is obtained is not available in the NIS; only the patient's insurance status at the time of discharge or death is provided. It is not straightforward to compute the importance of STAB, but our novel use of imputation suggests that the efforts of hospitals to find insurance for initially uninsured patients may entirely account for the apparent survival advantage conferred by insurance reported by other investigators.

It may surprise some readers that our analysis of the NIS concludes that neither race nor insurance coverage affects survival following injury, a conclusion diametrically opposed to several previous analyses of the same questions in the NTDB. To such readers, we offer two observations. First, the NIS is a stratified random sample of hospitals, which allows inferences to be made to trauma care in the United States overall. The NTDB, by contrast, is a convenience sample that allows inferences only to be made to care at hospitals that contribute data to the NTDB. Because our interest centers on the effect of race and insurance coverage on trauma outcomes in the United States as a whole, we believe that the NIS is the appropriate data set for our analysis. A second observation we would offer is that we believe our conclusion that neither race nor insurance is associated with survival is actually not the result of using a different *data set* (the NIS rather than of the NTDB), but rather the result of using a different statistical *model*. While the details of statistical models are often not reported by researchers, the many seemingly small decisions that statisticians make in the course of analyzing a data set can profoundly affect and even reverse the ultimate conclusions offered. Our analysis of the NIS is a case in point. Our model differs in several important respects from those used in previous studies, but perhaps most importantly, our models explicitly controlled for gunshot wound as a mechanism of injury and for shock on admission as a physiologic predictor of outcome. In an article analyzing the NTDB, Millham et al.[18] modeled the

TABLE 3. Hospital Characteristics

	White	Black	Hispanic	Total
Location				
Rural	21,597 (12.7)	970 (4.1)	1,099 (5.1)	23,666 (11.0)
Urban	145,027 (85.0)	21,776 (92.8)	19,999(93.3)	186,802 (86.6)
Unknown	4,101 (2.4)	711 (3.0%)	335 1.6%)	5,147 (2.4)
Hospital size				
Small	17,563 (10.3)	1,088 (4.6)	1,389 (6.5)	20,040 (9.3)
Medium	37,017 (21.7)	4,346 (18.5)	3,906(18.2)	45,269 (21.0)
Large	112,044 (65.6)	17,312 (73.8)	15,803(73.7)	145,159 (67.3)
Unknown	4,101 (2.4)	711 (3.0)	335 (1.6)	5,147 (2.4)
Teaching status				
Teaching	82,592 (48.4)	17,659 (75.3)	12,781(59.6)	113,032 (52.4)
Nonteaching	84,032 (49.2)	5,087 (21.7)	8,317(38.8)	97,436 (45.2)
Geographic region				
Northeast	36,509 (21.4)	6,653 (28.4)	3,664(17.1)	46,826 (21.7)
South	70,268 (41.2)	11,324 (48.3)	7,551(35.2)	89,161 (41.4)
Mid-West	31,143 (18.2)	3,546 (15.1)	1,365 (6.4)	36,054 (16.7)
West	32,787 (19.2%)	1,934 (8.2)	8,853(41.3)	43,574 (20.2)

NTDB controlling explicitly for shock as a physiologic predictor and gunshot wound as a mechanism of injury and using this model conclude, as we do, that race is not a predictor of subsequent mortality in the NTDB. This suggests that it is the model, not the data set, which is driving the difference in results. A second article by Hicks et al.[20] models survival following injury in the *NIS without* explicitly controlling for gunshot wound or shock as predictors and concludes that black race *is* associated with higher mortality in patients younger than 65 years. Again, this finding points to a difference in models rather than a difference in data set, causing disparate results. Taken together, these two articles make the case that it is a difference in statistical modeling rather than data sets that leads us to conclude that neither race nor insurance coverage is associated with survival following injury in the United States today.

Our study has several strengths. Because our analysis is based on a random sample of hospitals from almost all states, our results are more likely to be representative of the country as a whole than the convenience samples used in earlier work, and because we used contemporary data, we believe our results reflect the current relationship between race, insurance status, and survival. In addition, the models that we developed for this study had outstanding discrimination and very good calibration (Appendix, Supplemental Digital Content 1, http://links.lww.com/TA/A543).

TABLE 4. Logistic Mortality Model for Young Patients (Age 15–64 Years)

Died	Coefficient	SE	z	$p > z$	95% CI
Race					
black	0.044215	0.078467	0.56	0.573	−0.10958 to 0.198006
Hispanic	−0.07135	0.127728	−0.56	0.576	−0.32169 to 0.178994
tmpm	1.093017	0.023319	46.87	0	1.047313 to 1.138721
age_cubed	0.003405	0.000388	8.78	0	0.002645 to 0.004165
female	−0.1701	0.052703	−3.23	0.001	−0.27339 to −0.0668
shock	1.267253	0.119979	10.56	0	1.032099 to 1.502406
Mechanism					
gsw	1.00004	0.109899	9.1	0	0.784642 to 1.215439
gsw_suicide	2.301176	0.131011	17.56	0	2.0444 to 2.557953
low_fall	−0.25369	0.130667	−1.94	0.052	−0.50979 to 0.002414
mvc	0.033061	0.078994	0.42	0.676	−0.12177 to 0.187886
ped	0.330151	0.081035	4.07	0	0.171326 to 0.488976
stab	−1.50146	1.023311	−1.47	0.142	−3.50711 to 0.504195
Comorbidity					
CM_AIDS	1.143439	0.282672	4.05	0	0.589411 to 1.697466
CM_CHF	0.883181	0.176471	5	0	0.537305 to 1.229058
CM_CHRNLUNG	−0.34719	0.130588	−2.66	0.008	−0.60313 to −0.09124
CM_COAG	1.084424	0.099851	10.86	0	0.888719 to 1.280128
CM_LIVER	0.897533	0.128884	6.96	0	0.644925 to 1.150141
CM_LYTES	0.428118	0.077048	5.56	0	0.277107 to 0.579129
CM_METS	1.815436	0.251919	7.21	0	1.321684 to 2.309189
CM_PERIVASC	0.393444	0.169066	2.33	0.02	0.062081 to 0.724807
CM_PULMCIRC	0.467698	0.227137	2.06	0.039	0.022518 to 0.912878
CM_RENLFAIL	0.861067	0.147915	5.82	0	0.57116 to 1.150974
CM_TUMOR	0.948488	0.369524	2.57	0.01	0.224235 to 1.672742
CM_WGHTLOSS	−0.76369	0.148471	−5.14	0	−1.05468 to −0.47269
_cons	−1.31034	0.078589	−16.67	0	−1.46438 to −1.15631

Note that neither black nor Hispanic ethnicity is significantly associated with mortality ($p > 0.05$) compared with the reference group, white patients.

TABLE 5. Logistic Mortality Model for Patients 65 Years and Older

	Coefficient	SE	z	$p > z$	95% CI
Race					
black	−0.28991	0.089722	−3.23	0.001	−0.46577 to −0.11406
Hispanic	−0.08506	0.084584	−1.01	0.315	−0.25085 to 0.080718
tmpm	0.964038	0.016399	58.78	0	0.931896 to 0.996181
age_ln	3.462618	0.191101	18.12	0	3.088067 to 3.837169
female	−0.59761	0.037164	−16.08	0	−0.67045 to −0.52477
shock	1.863622	0.133345	13.98	0	1.60227 to 2.124973
Mechanism					
gsw	0.828997	0.353678	2.34	0.019	0.135801 to 1.522192
gsw_suicide	1.773806	0.282302	6.28	0	1.220504 to 2.327108
low_fall	−0.24002	0.039483	−6.08	0	−0.31741 to −0.16264
mvc	0.008207	0.076642	0.11	0.915	−0.14201 to 0.158422
ped	0.174122	0.129817	1.34	0.18	−0.08032 to 0.428559
Comorbidity					
CM_AIDS	0.363656	1.047107	0.35	0.728	−1.68864 to 2.415947
CM_CHF	0.617823	0.043758	14.12	0	0.532059 to 0.703586
CM_CHRNLUNG	0.297296	0.04385	6.78	0	0.211353 to 0.38324
CM_COAG	0.36039	0.061155	5.89	0	0.240527 to 0.480252
CM_LIVER	0.776638	0.131465	5.91	0	0.518971 to 1.034305
CM_LYTES	0.369904	0.038397	9.63	0	0.294648 to 0.44516
CM_METS	0.965557	0.117581	8.21	0	0.735103 to 1.196011
CM_PERIVASC	0.116318	0.066314	1.75	0.079	−0.01365 to 0.246291
CM_PULMCIRC	0.642636	0.070194	9.16	0	0.505057 to 0.780214
CM_RENLFAIL	0.292098	0.048183	6.06	0	0.197661 to 0.386534
CM_TUMOR	0.262524	0.119354	2.2	0.028	0.028594 to 0.496453
CM_WGHTLOSS	0.457513	0.063302	7.23	0	0.333443 to 0.581583
_cons	0.164293	0.061206	2.68	0.007	0.044331 to 0.284254

Note that black race is significantly ($p < 0.001$) associated with lower mortality (negative coefficient) compared with white patients, the reference group.

Our study also has several potential limitations. Administrative data sets are subject to miscoding and undercoding, errors that may result in incorrect estimates of injury severity. In addition, administrative data sets lack important clinical predictors of mortality (e.g., admission systolic blood pressure). Although we were able to approximate this particular clinical predictor using an ICD-9 code (traumatic shock, 958.4), actual clinical data would have been preferable. In addition, four states (Minnesota, Ohio, Washington, West Virginia) did not provide information about race to the NIS, so our conclusions my not apply to these states. Finally, the NIS data set did not allow us to address insurance status as the time-varying covariate that it is. While we believe our use of imputed insurance status is a better solution to this problem than the more usual approach of treating insurance status as though it were fixed on admission, we acknowledge that an analysis based on the actual date of insurance coverage might reach a conclusion different from ours.

In summary, we did not find evidence that black race is associated with higher mortality in a large nationally representative sample of patients hospitalized following injury. We also found no evidence that uninsured patients are more likely to die compared with insured patients after adjusting for the effects of survivor bias. This latter result suggests that efforts to increase insurance coverage in young injured patients will not lead to improved survival. While there are many compelling reasons to provide health insurance for our citizens, improved survival following injury is not among them.

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DISCLOSURE

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REFERENCES

1. McCann J, Artinian V, Duhaime, Lewis JW Jr, Kvale PA, DiGiovine B. Evaluation of the causes for racial disparity in surgical treatment of early stage lung cancer. *Chest*. 2005;128:3440–3446.
2. Subramanian S, Chen A. Treatment patterns and survival among low-income Medicaid patients with head and neck cancer. *JAMA Otolaryngol Head Neck Surg*. 2013;139:489–495.
3. Chan PS, Nichol G, Krumholz HM, Spertus JA, Jones PG, Peterson ED, Rathore SS, Nallamothu BK. Racial differences in survival after in-hospital cardiac arrest. *JAMA*. 2009;302:1195–1201.
4. Haider AH, Weygandt PL, Bentley JM, Monn MF, Rehman KA, Zarzaur BL, Crandall ML, Cornwell EE, Cooper LA. Disparities in trauma care and outcomes in the United States: a systematic review and meta-analysis. *J Trauma Acute Care Surg*. 2013;74:1195–1205.

5. Wong MD, Shapiro MF, Boscardin WJ, Ettner SL. Contribution of major diseases to disparities in mortality. *N Engl J Med*. 2002;347:1585–1592.
6. *Income, Poverty and Health Insurance Coverage*. Washington, DC: United States Census Bureau; 2012. Available at: http://www.census.gov/hhes/www/hlthins/data/incpovhlth/2012/tables.html. Accessed May 9, 2014.
7. Glance LG, Osler T, Mukamel DB, Meredith W, Wagner J, Dick AW. TMPM-ICD9: a trauma mortality prediction model based on ICD-9-CM codes. *Ann Surg*. 2009;249:1032–1039.
8. Williams RL. A note on robust variance estimation for cluster-correlated data. *Biometrics*. 2000;56:645–646.
9. Austin PC, Mamdani MM, van Walraven C, Tu JV. Quantifying the impact of survivor treatment bias in observational studies. *J Eval Clin Pract*. 2006;12:601–612.
10. van Walraven C, Davis D, Forster AJ, Wells GA. Time-dependent bias was common in survival analyses published in leading clinical journals. *J Clin Epidemiol*. 2004;57:672–682.
11. Arthur M, Hedges JR, Newgard CD, Diggs BS, Mullins RJ. Racial disparities in mortality among adults hospitalized after injury. *Med Care*. 2008;46:192–199.
12. Falcone RA Jr, Martin C, Brown RL, Garcia VF. Despite overall low pediatric head injury mortality, disparities exist between races. *J Pediatr Surg*. 2008;43:1858–1864.
13. Greene WR, Oyetunji TA, Bowers U, Haider AH, Mellman TA, Cornwell EE, Siram SM, Chang DC. Insurance status is a potent predictor of outcomes in both blunt and penetrating trauma. *Am J Surg*. 2010;199:554–557.
14. Haider AH, Efron DT, Haut ER, DiRusso SM, Sullivan T, Cornewell EE 3rd. Black children experience worse clinical and functional outcomes after traumatic brain injury: an analysis of the National Pediatric Trauma Registry. *J Trauma*. 2007;62:1259–1262; discussion 1262—1263.
15. Martin CA, Care M, Rangel EL, Brown RL, Garcia VF, Falcone RA Jr. Severity of head computed tomography scan findings fail to explain racial differences in mortality following child abuse. *Am J Surg*. 2010;199:210–215.
16. Rosen H, Saleh F, Lipsitz SR, Meara JG, Rogers SO Jr. Lack of insurance negatively affects trauma mortality in US children. *J Pediatr Surg*. 2009;44:1952–1957.
17. Rosen H, Saleh F, Lipsitz S, Rogers SO Jr, Gawande AA. Downwardly mobile: the accidental cost of being uninsured. *Arch Surg*. 2009;144:1006–1011.
18. Millham F, Jain NB. Are there racial disparities in trauma care? *World J. Surg*. 2009;33:23–33.
19. Hicks CW, Hashmi ZG, Velopulos C, Efron DT, Schneider EB, Haut ER, Cornwell EE 3rd, Haider AH. Association between race and age in survival after trauma. *JAMA Surg*. 2014;149:642–647.
20. Barnett H, Maughan E, Pearce PF. Battling the uncompensated care spiral: outcomes from a single institution assisting uninsured hospitalized patients to obtain health insurance. *Prof Case Manag*. 2010;15:280–289.
21. Glesby MJ, Hoover DR. Survivor treatment selection bias in observational studies: examples from the AIDS literature. *Ann Intern Med*. 1996;124:999–1005.