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Association Between Insurance Status and Hospital Length of Stay Following Trauma

BRIAN R. ENGLUM, M.D.*, XUAN HUI, M.D., SCM.†, CHERYL K. ZOGG, M.S.P.H., M.H.S.‡, MUHAMMAD ALI CHAUDHARY, M.D.‡, CASSANDRA VILLEGAS, M.P.H.†, OLUWASEYI B. BOLORUNDURO, M.D., M.P.H.§, KENT A. STEVENS, M.D., M.P.H.§, ELLIOTT R. HAUT, M.D., Ph.D.†, EDWARD E. CORNWELL III, M.D.§, DAVID T. EFRON, M.D.†, and ADIL H. HAIDER, M.D., M.P.H.‡

*Duke University School of Medicine, Durham, North California †Department of Surgery, The Johns Hopkins University School of Medicine, Baltimore, Maryland ‡Department of Surgery, Center for Surgery and Public Health, Harvard Medical School & Harvard T.H. Chan School of Public Health, Brigham and Women's Hospital, Boston, Massachusetts §Department of Surgery, Howard University College of Medicine, Washington, DC

Abstract

Previous research has demonstrated that nonclinical factors are associated with differences in clinical care, with uninsured patients receiving decreased resource use. Studies on trauma populations have also shown unclear relationships between insurance status and hospital length of stay (LOS), a commonly used metric for evaluating quality of care. The objective of this study is to define the relationship between insurance status and LOS after trauma using the largest available national trauma dataset and controlling for significant confounders. Data from 2007 to 2010 National Trauma Data Bank were used to compare differences in LOS among three insurance groups: privately insured, publically insured, and uninsured trauma patients. Multivariable regression models adjusted for potential confounding due to baseline differences in injury severity and demographic and clinical factors. A total of 884,493 patients met the inclusion criteria. After adjusting for the influence of covariates, uninsured patients had significantly shorter hospital stays (0.3 days) relative to privately insured patients. Publicly insured patients had longer risk-adjusted LOS (0.9 days). Stratified differences in discharge disposition and injury severity significantly altered the relationship between insurance status and LOS. In conclusion, this study elucidates the association between insurance status and hospital LOS, demonstrating that a patient's ability to pay could alter LOS in acute trauma patients. Additional research is needed to examine causes and outcomes from these differences to increase efficiency in the health care system, decrease costs, and shrink disparities in health outcomes.

Research has consistently demonstrated that many nonclinical factors significantly affect health care including race, ^{1, 2} sex, ³ education, ¹ and socioeconomic status. ¹ Insurance status

has also been shown to alter access to and quality of medical care, leading to decreased resource utilization^{4, 5} and worse morbidity^{6, 7} and mortality⁸ for patients lacking insurance. Uninsured patients in the hospital are known to receive fewer physical therapy sessions⁹ and undergo fewer procedures such as upper endoscopy,⁸ colonoscopy,⁸ coronary angiography,^{8, 10} and coronary artery bypass graft surgery.^{8, 10} Uninsured patients are also hypothesized to receive inferior quality of care that leads them to suffer higher rates of ruptured appendices⁶ and be diagnosed with more advanced stages of breast cancer.⁷ Hospital length of stay (LOS), a commonly applied measure of resource use and quality of care, has been shown to be decreased among uninsured medical patients, which further points toward worse quality of care for the uninsured.^{5, 8}

The relationship of the medical care given to publicly insured patients (Medicare and Medicaid) compared with privately insured patients is less clear. Some studies suggest a trend toward decreased procedural use^{5, 9, 10} and worse morbidity^{6, 7} for publicly insured patients. LOS is thought to be longer in publicly insured patients,⁵ although some studies do suggest that no differences in LOS are present between those with publicly funded insurance and those with private insurance.^{11, 12} Similarly, research comparing mortality in those with public insurance to patients with private insurance has been incongruous.

In contrast to patients with chronic conditions, patients with acute traumatic injury were previously thought to be immune from disparities based on insurance due to the emergent nature and perceived universal access to trauma care. Studies have not examined long-term outcome variation among trauma patients by insurance status; however, several recent studies have demonstrated worse in-patient mortality for uninsured trauma victims.^{2, 13} Examining resource usage, uninsured patients with acute trauma are less likely to receive physical therapy, and both uninsured and publicly insured patients receive fewer operative procedures.⁹ The uninsured also have less costly hospital stays.¹⁴

LOS has long been used as a measure of health care quality due to its availability and objective nature. ^{11, 14} LOS has been widely linked to health outcomes, such as readmission rates. ^{15–18} Looking specifically at LOS and its relationship to insurance status in trauma patients, the research has been discordant. The objective of this study is to define the relationship between insurance status and LOS after trauma using the largest available national trauma dataset and controlling for significant confounders.

Methods

Patient Population

This study analyzed patients included in the National Trauma Data Bank (NTDB) from 2007 to 2010. The NTDB is the largest database of trauma patients in the United States, collecting information from about 900 trauma centers and hospitals that treat trauma patients. It is maintained by the American College of Surgeons. Complete information on the NTDB has been published elsewhere. ¹⁹

Trauma patients, aged 18 to 64 years, were included in the analysis. Pediatric (age 17 years) and elderly (age 65 years) patients were excluded due to differing effects of trauma

on these age groups²⁰ and due to the high rate of publicly funded insurance and very low rate of uninsured patients among these age groups. The analysis excluded burn patients and patients lacking information for LOS. Patients with LOS in the highest 0.4 per cent of the sample (LOS >60 days) were considered extreme outliers and were excluded to prevent their extended LOS from artificially inflating the mean LOS of our study population. A sensitivity analysis including all patients regardless of LOS was performed to demonstrate that this exclusion did not appreciably change our results.

Patients were categorized into one of three insurance groups for analysis based on primary payer status: 1) private insurance (Blue Cross/Blue Shield, private/commercial, workers compensation, no fault automobile, and other government plans), 2) publicly funded insurance (Medicaid and Medicare), and 3) uninsured (self-pay). Privately insured patients were used as the reference group for all analyses. The main outcome measure for the study was hospital LOS.

To control for differences in injury severity and case mix between insurance groups, factors considered potential confounders for LOS were included as covariates in the risk-adjusted analyses. Considered covariates included: age, sex, race/ethnicity, Injury Severity Score (ISS), Glasgow Coma Scale-motor score, presence of shock (systolic blood pressure < 90) on emergency department arrival, mechanism of injury (motor vehicle collision, fall, gunshot wound, etc.), type of injury (blunt *vs* penetrating), intention of injury, presence of severe head/extremity injury, trauma center designation (level I–IV), and year of admission. Subset analysis was also performed in which patients were stratified by discharge disposition including to home (home and home health), rehabilitation facility, nursing facility (nursing home and skilled nursing facility), and hospital transfer.

Statistical Analysis

Differences in demographic and clinical covariates were compared by insurance status using descriptive statistics. Unadjusted and risk-adjusted differences in LOS were then compared by insurance status using generalized linear models with generalized estimating equations and robust standard errors to account for clustering of patients within hospitals.

Missing data were handled in two ways: 1) by complete case analysis (removing patients with missing information) and 2) via multiple imputation techniques²¹ to fill in missing values with information provided by the other variables. Imputed values were used as part of a sensitivity analysis to demonstrate that missing data did not lead to different conclusions. Presented tables/figures were produced using complete case analysis set.

All data analyses were completed using Stata Statistical Software: Release 12 (College Station, TX). Two-sided *P* values were considered significant. The Johns Hopkins University School of Medicine Institutional Review Board approved the study.

Results

Approximately 1.45 million patients in the NTDB met the inclusion criteria, of whom 884,493 had data for complete case analysis. Multiple imputations allowed for recovery of

an additional 561,139 patients with missing insurance and covariate data (Fig. 1), included in the sensitivity analysis (total population for sensitivity analysis: 1,445,632 patients). Among patients included in the complete case analysis set, 53.0 per cent (n = 469,107) were privately insured. An additional 17.6 per cent (n = 155,827) and 29.4 per cent (n = 259,559) had public insurance and were uninsured. Relative to privately insured patients, patients who were publically insured tended to be older, be racial minorities, suffer intentional and penetrating injuries, and be discharged to a nursing facility among other significant covariate differences (P < 0.05) (Table 1). Patients on Medicaid accounted for 57.3 per cent and patients on Medicare accounted for 42.7 per cent. In contrast, uninsured patients tended to be younger, be racial minorities, suffer intentional and penetrating injuries, and be discharged home, among other significant covariates relative to privately insured patients (P < 0.05) (Table 1). Complete data on demographic and injury severity characteristics are presented by insurance status in Table 1.

The overall median LOS for all included patients was 3 (interquartile range: 1–6) days. Risk-adjusted differences by payer status are presented in Figures 2 and 3. As demonstrated in Figure 3, publically insured patients were significantly more likely than privately insured patients to have a longer LOS by an overall risk-adjusted average of 0.9 [95% confidence interval (CI) 0.8–1.0] days. Restricted to more severely injured patients, the association became even more pronounced. Publically insured patients with an ISS 9 stayed in the hospital for an additional 1.4 (95% CI: 1.1–1.6) days relative to privately insured patients, whereas patients with an ISS 15 stayed in the hospital for an additional 1.9 (95% CI: 1.6–2.3) days. Contrastingly, uninsured patients were significantly more likely to have shorter LOS when compared with privately insured patients (Figs. 2 and 3). They had risk-adjusted mean LOS that were shorter by 0.3 (95% CI 0.1–0.4) days overall, 0.5 (95% CI 0.3–0.6) days among patients with an ISS 9, and 0.5 (95% CI 0.2–0.8) days among patients with an ISS 15 (Fig. 3). Sensitivity analysis to include multiple imputation values did not alter the direction or magnitude of these results, regardless of injury-severity level.

Table 2 presents risk-adjusted results stratified by discharge disposition. No differences were found between uninsured and privately insured patients discharged home. However, relative to privately insured patients, uninsured patients who were sent to a rehabilitation facility and who were sent to a nursing facility had significantly longer lengths of initial hospital stay with relative values of 0.9 (95% CI 0.3–1.6) and 1.7 (95% CI 1.1–2.3), respectively. Uninsured patients transferred to another hospital for continuing care had significantly shorter LOS (0.3 days; 95% CI 0.8–0.1 days). Publically insured patients had significantly longer LOS across the board (P<0.05) (Table 2). Baseline unadjusted mean LOS for privately insured patients discharged to home, a rehabilitation facility, a nursing facility, and to another hospital were 4.5, 13.5, 14.1, and 6.3 days, respectively.

Secondary sensitivity analyses for the models shown in Figures 2 and 3 with the 0.4 per cent of patients with outlying LOS (>60 days) included revealed differences in LOS between publically and privately insured patients that were even more pronounced. Differences between privately insured and uninsured patients did not appreciably change.

Discussion

This study used the largest available trauma dataset in the United States to analyze the relationship between insurance status and hospital LOS, although controlling for known confounders. The results demonstrate significant differences inhospital LOS by insurance status in patients suffering traumatic injury. Overall, uninsured patients remained in the hospital fewer days than their privately insured counterparts, whereas publicly insured patients remained in the hospital longer. These findings suggest that uninsured patients may be discharged prematurely, whereas publicly insured patients may be kept in the hospital too long.

These results speak to the potential for decreased resource use among uninsured patients, a finding which, if true, could contribute to worse health outcomes within this population. Differences in insurance status have been linked to disparities in quality of health care and health outcomes in other population. ^{5–8, 10, 12} Analogous to work by Hass and Goldman in Massachusetts and Doyle in automobile accidents, our findings demonstrate among all trauma patients on a national scale similar disparities for uninsured trauma patients. ^{9, 14}

LOS has consistently been measured as an indicator of health care quality due to its availability, objective nature, ^{11, 14} and close association with outcomes. ^{15, 16, 22} Previous research has linked decreased LOS to worse patient outcomes, such as higher rates of hospital readmissions in a wide variety of patient populations. ^{15, 16} For example, a recent study on the outcomes of more than 1.5 million Medicare patients undergoing total hip arthroplasty showed that from 1991 to 2008 there was a significant decline in mean hospital LOS of approximately 5 days and an increase of 30 day readmission from 5.9 to 8.5 per cent of patients. ¹⁸ Bueno et al. found similar trends in a study of Medicare patients hospitalized for heart failure from 1993 to 2006, with mean LOS decreasing from 8.8 to 6.3 days, whereas 30 day readmission rates increased from 17.2 20.1 percent. ¹⁷

Uninsured patients are known to have worse outcomes, including mortality^{2, 9, 13, 14} and decreased access to health care resources. The shorter LOS among the uninsured in this study provides additional evidence of the decreased resource use within this population. Although the decrease in LOS was small, 0.3 to 0.5 fewer days in the hospital for this population represents a relative 5 to 7 per cent decrease in LOS. Because the NTDB does not measure partial days, such a finding could reasonably be extrapolated to imply that up to 30 to 50 per cent of patients are being discharged an entire day early. In the setting of worse outcomes, the results call for further study of the reasons that lead to earlier discharge among the uninsured and any differences in tests, procedures, or rehabilitation therapies that could result in outcome disparities.

This study also indicates that publicly insured patients tend to fall on the other end of the LOS spectrum, experiencing extended stays that are potentially both dangerous and costly. Shorter LOS has been associated with hospitals and physicians that maintain better quality of care ratings, evidenced by improved patient satisfaction and decreased mortality.²² Research has also demonstrated that extended hospitalization carries a number of risks, particularly as patients age.^{23, 24} Decreasing unnecessary days in the hospital has the

potential to decrease the risk of deep vein thrombosis, nosocomial infection, renal failure, adverse drug reactions, delirium, and depression. Additionally, extended hospital LOS has an adverse effect on the medical costs being intensely debated in the current health care climate. 12, 14 While 0.9 or 1.9 days may seem insignificant, these stays represent nearly a 20 per cent relative increase in the total LOS for this population. Given that the previous research has shown no clear evidence of improved outcomes among publicly insured trauma patients, 9, 13 this study raises the possibility that the extended LOS among publicly insured patients may be adding unnecessary costs to trauma hospitalizations and putting trauma patients at increased risk for complications. Addressing this inefficiency could both decrease public health care spending and improve patient outcomes.

Differences in LOS by insurance status were exaggerated as injury severity increased, with publicly insured patients staying 1.9 days longer and uninsured patients 0.5 days shorter relative to privately insured patients (ISS 15). This finding indicates that these results were not being driven by the mildly injured patients whose single day in the hospital may have been left to patient discretion. Instead, the most severely injured patients, who often have the least choice in their care and are the most resource intensive, bear the heaviest burden of this disparity in resource usage.

Discharge disposition has a strong association with LOS, ¹¹ and the results of this study clearly reinforce this. First, privately insured and uninsured patients showed no difference in LOS when only patients discharged to home were analyzed. This decreased difference may have been due to decreased rates of uninsured patients discharged to rehabilitation and nursing facilities. ²⁵ When uninsured patients were unable to be placed in these facilities, they may have remained in the hospital for an extended period, artificially inflating the average LOS for those eventually discharged to home.

Among patients discharged to rehabilitation, a reversal of the LOS trends was noted, with the uninsured remaining in the hospital longer than those with private insurance. Both the uninsured and publicly insured experienced an increased LOS. This trend remained among patients discharged to nursing homes and was exaggerated in uninsured patients. These trends resonated with the experience of our trauma group, who has found the placement of uninsured and publicly insured patients in health care facilities to be significantly more difficult and time-consuming than for privately insured patients.

Several researchers have suggested that differences in health care quality and outcomes among different insurance groups are due to reimbursement considerations, whether coming directly from physicians or from pressure exerted by hospitals and payers. ^{4, 5, 12} While these data reinforce that theory, the complex relationship between discharge needs, access to post-hospitalization care, and physician or systemic decision-making remains unclear. Rehabilitation and nursing facility needs certainly affected LOS. The increased LOS among uninsured patients discharged to these facilities is likely in part due to administrative and financial clearance issues that delay placement of such patients into post-hospitalization care. Similarly, we found publicly insured patients to have a longer adjusted LOS.

In a similar study using the NTDB, Brasel et al.¹¹ demonstrated that both uninsured and Medicaid patients had an increased relative risk for an extended LOS, whereas Medicare patients had a decreased relative risk.¹¹ The current study differed in two significant ways. First, our study excluded patients over the age of 64 years due to the high percentage of those patients with public insurance, which made this population a confounding factor that our regression modeling would not be able to adequately control. Second, our study used generalized linear models to estimate absolute LOS and demonstrate both statistically and clinically significant differences in LOS in an attempt to show the magnitude of the current disparities.

Our study had a number of limitations. First, missing data on pre-existing comorbidities and hospital complications in the NTDB made it impossible to control for these important confounders 16; however, this concern was minimized by exclusion of elderly patients and adjusting for age, which likely accounted for much of these differences. Due to our exclusion of elderly patients, the results of this study can only be generalized to the patients aged 18 to 64 years. Sensitivity analysis using multiple imputations to fill in missing data revealed similar trends. Such an application of multiple imputations is becoming a common tool for sensitivity analysis in large datasets, aiding researchers' ability to draw conclusions from these databases. ²⁶ Additional considerations stem from reliance on a retrospective analysis of existing data. While use of a research database like the NTDB helps to ally many of the traditional concerns related to administrative data, it is still subject to the potential for errors in reporting and a fixed set of variables available on clinical and demographic data. Moreover, no "ideal" LOS has been established for trauma or surgical patients, despite strong associations with clinical outcomes and quality of care. We chose to use privately insured patients as the reference group due to considerable evidence that this group holds a privileged place in the United States health care system, seen in lower rates of morbidity^{6, 7} and mortality, ^{2, 13} and increased use of medical services. ^{8–10} As the largest insurance group, they also offered the greatest amount of statistical power. However, in analyzing payer status in the manner that we did, differences between publically insured and uninsured patients could not be directly explored.

In conclusion, this study demonstrates that insurance status strongly associates with hospital LOS after trauma, even after adjusting for the influence of known covariates. Publicly insured patients remained in the hospital longer by a risk-adjusted average of nearly one day. Existing evidence from the literature suggests that this difference is without apparent mortality benefit. Uninsured patients, in contrast, were being discharged earlier, leading to worse health outcomes that have been well established by previous literature. Trends became even more pronounced among severely insured patients and varied, to some extent, by the discharge dispositions of the respective patients. Recognition and correction of this resource utilization gap in trauma holds enormous potential for improving the efficiency of the American health care system, decreasing health care costs, and shrinking disparities in health outcomes and care among patients with varied payer status.

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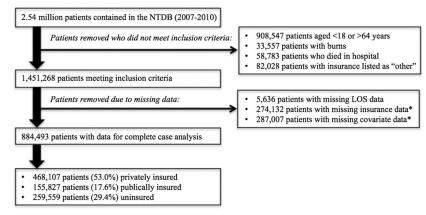
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*Patients later recovered in sensitivity analysis using multiple imputation

Fig. 1. Study inclusion and exclusion criteria.

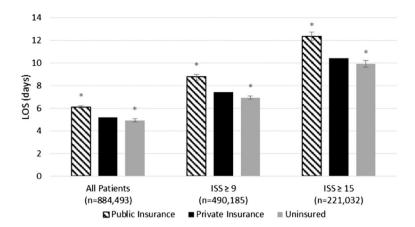


Fig. 2. Length of hospital stay by payer status, overall and stratified by ISS 9 and 15. *Indicates a significant risk-adjusted difference with a 2-sided P < 0.05 (reference: private insurance). Models were adjusted for: age, sex, race/ethnicity, ISS, shock, mechanism, type, intention of injury, treating facility trauma level, and year of admission.

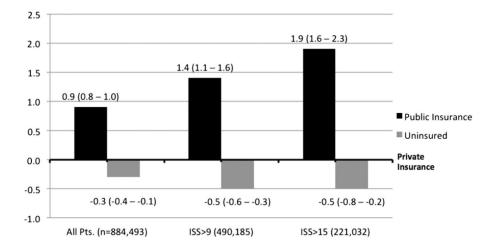


Fig. 3.Risk-adjusted difference (95% CI) in length of hospital stay by payer status (reference private insurance), overall and stratified by ISS 9 and 15. Models were adjusted for: age, sex, race/ethnicity, ISS, shock, mechanism, type, and intention of injury, treating facility trauma level, and year of admission.

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Table 1
Patient Demographic and Injury Severity Characteristics

	All Patients	Private Insurance	Public Insurance	Uninsured
Number (%)	884,493	469,107 (53.0)	155,827 (17.6)	259,559 (29.4)
Median LOS in days (IQR)	3 (1–6)	3 (2–6)	4 (2–7)	2 (1–5)
Female (%)	28.4	30.8	35.0*	20.1*
Age (%)				
18–24	22.3	20.9	19.5*	26.6*
25–34	22.0	19.3	18.8*	28.8*
35–44	19.0	18.7	17.8*	20.2*
45–54	20.9	22.2	23.1*	17.0*
55–64	15.8	18.9	20.8*	7.4*
Race (%)				
White	64.0	73.8	58.5 *	49.6*
Black	17.7	11.2	24.1*	25.6*
Hispanic	12.8	9.7	11.8*	19.1*
Other	5.5	5.3	5.7*	5.7*
Type of injury (%)				
Blunt	86.2	92.7	82.5*	76.9*
Penetrating	13.8	7.3	17.5 *	23.2*
Mechanism of injury (%)				
Motor-vehicle collision (MVC)	44.5	52.5	31.3*	38.1*
Fall	23.9	24.1	32.7*	18.1*
Struck	9.6	7.1	11.1*	13.2*
Stab	7.5	4.3	9.2*	12.3*
Gunshot wound (GSW)	6.3	3.1	8.3*	10.8*
Other	8.3	9.0	7.5*	7.5*
Intentional injury (%)	18.4	9.0	25.2*	31.3*
Region of body injury (%)				
Head	14.9	15.0	16.7*	13.8*
Thorax	16.7	18.0	15.5*	15.1*
Abdomen	4.6	4.4	5.1*	4.6*
Extremity	17.0	18.2	18.6*	13.7*
Shock (SBP < 90 mm Hg) (%)	2.6	2.3	3.3*	2.6*
Injury severity (%)			5.5	2.0
Mild (ISS 8)	49.3	47.1	47.1	54.4*
Moderate (ISS 9-14)	30.4	31.4	31.4	28.2*

	All Patients	Private Insurance	Public Insurance	Uninsured
Severe (ISS 15-24)	13.3	14.1	13.6*	11.7*
Extremely severe (ISS 25)	7.0	7.5	7.9*	5.7*
Discharge disposition (%)				
Home	84.3	83.4	76.7 *	91.1*
Rehabilitation facility	6.8	7.9	8.9*	3.4*
Nursing facility	5.8	5.8	11.3*	2.3*
Hospital transfer	1.9	2.3	1.5*	1.3*
Other	1.2	0.6	1.7*	2.0*

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IQR = interquartile range; SBP, systolic blood pressure.

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^{*} Indicates values that showed significant differences compared with private insurance with a 2-sided P< 0.05.

Table 2

Risk-adjusted Differences in LOS (95% CI) for Uninsured and Publicly Insured Patients Compared with Privately Insured Patients (reference group) by Discharge Status

Discharge Status							
Insurance status	Home $(n = 644,855)$	Rehabilitation Facility (n = 52,095)	Nursing Facility (n = 44,486)	Hospital Transfer (n = 14,152)			
Public insurance	0.6 (0.5–0.7)*	1.2 (0.9–1.6)*	0.9 (0.6–1.2)*	1.4 (0.7–2.0)*			
Uninsured	0.0 (-0.1 to 0.2)	0.9 (0.3–1.6)*	1.7 (1.1–2.3)*	-0.3 (-0.8 to -0.1)*			

Models were adjusted for: age, sex, race/ethnicity, ISS, shock, mechanism, type, and intention of injury, treating facility trauma level, and year of admission.

^{*}Indicates values that showed significant differences compared with private insurance with a 2-sided P< 0.05.