The American Journal of Surgery 217 (2019) 1060–1064

Contents lists available at ScienceDirect

The American Journal of Surgery

journal homepage: www.americanjournalofsurgery.com

The paralyzing effect of insurance status on throughput of acute spinal cord patients

Mary Lindemuth*, Tabitha Garwe, Kiran Venincasa, Tyler Zander, Cullen McCarthy, Morgan Bonds, Zoona Sarwar, Roxie Albrecht, Jason Lees, Aaron Scifres, Alisa Cross

The University of Oklahoma Health Science Center, 800 Stanton L. Young Blvd, Suite 9000, Oklahoma City, OK, 73104, USA

ARTICLE INFO

Article history:
Received 16 March 2018
Accepted 9 October 2018

ABSTRACT

Objective: To determine whether lack of insurance is a predictor of poor outcomes and increased healthcare expenditure for SCI patients.
Methods: Retrospective cohort study of trauma patients admitted with an acute, severe (AIS ≥ 3) SCI and admission score of ASIA-A to a Level 1 trauma center (2012–2016). Patient characteristics and outcomes (LOS, complications) were compared between insured and uninsured patients. Multivariable adjustment was performed using linear regression.
Results: Of 76 patients who met eligibility, 44 had insurance and 32 were uninsured (NOINSUR). Despite having similar ventilator days (13 vs. 12.1) and ICU LOS (20.1 vs. 16.8), the NOINSUR group had more ventilator-free days (22.3 vs 6.6; $p < 0.0001$), longer Stepdown Unit length of stay (10.2 vs 2.3; $p = 0.0036$), and a longer hospital length of stay (35.3 vs 18.7; $p = 0.0062$).
Conclusion: Uninsured SCI patients face longer hospital LOS due to their insurance status and lack of funding for timely rehabilitation placement. This utilizes valuable hospital resources and puts them at risk for hospital related complications and further increased healthcare expenditures.
Published by Elsevier Inc.

Background

Despite the U.S. Government's statute that all Americans acquire healthcare insurance under the *Patient Protection and Affordable Care Act* of 2010, the 2016 U.S. Census calculated 28.1 million, or 8.8% of the population, as uninsured.[1] Of the overall 8.8% who are uninsured, Hispanics had the highest uninsured rate at 16%, followed by African-Americans at 10.5% and Asians at 7.6%. Healthcare disparities, including lack of insurance and ethnicity, have been highlighted when evaluating access to primary and preventative care, but there is a paucity of research focusing on the overall impact that uninsured status has on both patients with traumatic spinal cord injuries, and the acute care centers that treat them.

Haider et al.[2] and Rosen et al.[3] found a significant correlation between lack of insurance and overall trauma mortality, which is particularly interesting given the well-established and standardized treatment protocols used in Level 1 trauma centers. Greene et al.[4] confirmed this finding in both penetrating and blunt trauma patients in 2010. A recent study of adult spine trauma patients[5] found insurance status, along with ethnicity, to be associated with increased mortality after spine trauma. Traumatic spinal cord injuries (SCI) result in a range of devastating disabilities, with the most severe being complete quadriplegia with need for full time care. The economic and social strains caused by SCIs are amplified by disparities in access to care once out of the acute period of injury. Krause et al.[6] highlighted the importance of socioeconomic status on individuals with traumatic SCI, as patients with a lower socioeconomic status face more hospitalizations and obstacles regarding education and employment after their injuries.

The purpose of this investigation was to test the hypothesis that uninsured SCI patients have longer length of hospital stay (LOS) and higher rates of complications as compared to those with insurance when admitted to a Level 1 trauma center.

Methods

Study design and setting

This was a retrospective cohort study of trauma patients with an acute, severe SCI admitted to a Level 1 trauma center between

* Corresponding author.
E-mail address: Mary-Lindemuth@ouhsc.edu (M. Lindemuth).

https://doi.org/10.1016/j.amjsurg.2018.10.049
0002-9610/Published by Elsevier Inc.

January 2012 and December 2016. The American Spinal Injury Association (ASIA) Impairment Scale defines extent of spinal cord injury based on five classifications A-E, taking into account how much sensation a patient feels at multiple points on the body, as well as tests of motor function. Grade A is the most severe and reflects complete lack of motor and sensory function below the level of injury and; Grade E is the least severe and reflects normal sensory and motor functions. Patients were identified from the hospital trauma registry and were eligible for the study if they were 18 years and older, had ASIA A SCI injury, and were either privately insured (commercial insurance or workers compensation) or self-paying. Electronic medical records were reviewed to obtain supplemental information not readily available in the trauma registry. Medicaid/Medicare patients, deaths within 24 h of emergency department (ED) arrival, and patients with pre-existing spinal cord injuries were all excluded from the study. Medicaid/Medicare patients were excluded secondary to this payer source acting as a hybrid between insured and uninsured. Two study groups were defined based on insurance status, insured (INSUR) versus self-paying (NOINSUR). This study was approved by the University of Oklahoma Health Sciences Center Institutional Review Board.

Variables and data analysis

A number of variables were considered for univariate and multivariable analyses. Demographic and etiologic characteristics of interest included age, sex, race, and mechanism of injury. Clinical factors of interest considered included initial emergency department (ED) vital signs (Glasgow Coma Scale [GCS], systolic blood pressure [SBP], heart rate [HR], and respiratory rate [RR]), initial hematologic profile (complete blood count), spinal level of injury (C,T,L), overall injury severity score (ISS), serious (AIS > = 3) injury by body region (head, chest and abdomen) and whether patient's mean arterial pressure (MAP) was monitored based on the MAP protocol.

The primary outcome of interest was hospital length of stay. Other secondary outcomes evaluated included incidence of in-hospital complications, intensive care unit (ICU) and ICU-free days, ventilator and ventilator-free days, stepdown unit length of stay, re-admission to ICU, and hospital discharge destination. Complications recorded included surgical site infections (SSI), pneumonia, urinary tract infections (UTI), pressure ulcers and deep venous thrombosis (DVT). Unadjusted comparisons between the two insurance groups were performed using the independent Student's T test or Mann–Whitney–Wilcoxon test for continuous variables; for categorical variables, the chi-square statistic and Fisher's exact tests were used. Multiple linear regression was used to evaluate the association between insurance status and hospital length of stay while adjusting for potentially confounding variables. Covariates were considered for multivariable adjustment if they were deemed *a priori* to be clinically important and potentially confounding (e.g., age ISS, initial emergency department [ED] vital signs, etc.), or had p-value of 0.25 based on unadjusted comparisons. A p-value of 0.05 was considered to represent statistical significance. All analyses were performed using SAS software version 9.4 (SAS 9.4, SAS Institute, Cary, NC).

Results

A total of 436 patients with spinal cord injuries were admitted to our Level I trauma center between 2012 and 2016. Of these, 76 (17.4%) had ASIA A SCI and met study eligibility. Of the included patients, 44 (58%) had insurance (INSUR) and 32 (42%) were uninsured (NOINSUR). Tables 1 and 2 summarize patient and clinical characteristics by insurance status. Over the 5-year study period, there was a trend towards more private insurance coverage for ASIA A SCI patients ($p = 0.0804$). There were no noted significant differences between the two insurance groups in the distribution of demographic characteristics. However, NOINSUR SCI patients were more likely to have a penetrating injury (21.9% vs 9.1%) and were on average not as severely injured (ISS 13.5 vs 20.3, $p = 0.0628$). The NOINSUR SCI patients spent significantly ($p < 0.05$) less time on the MAP protocol, were less likely to have C-spine level injuries (34.4% vs 56.8%), and more likely to be T-spine level injuries (56% vs 43%).

Comparisons of outcomes

Unadjusted comparisons of outcomes for the two insurance groups showed significant differences ($p < 0.05$) in the distribution of stepdown length of stay, ventilator free days, ICU free days, hospital length of stay, and disposition (Table 3). Despite having similar ventilator days (13 vs. 12.1; $p = 0.8214$) and ICU LOS (20.1 vs. 16.8; $p = 0.4275$), the NOINSUR group had more ventilator-free days (22.3 vs 6.6; $p < 0.0001$), longer stepdown unit length of stay (10.2 vs 2.3; $p = 0.0036$), and a longer hospital length of stay (35.3 vs 18.7; $p = 0.0062$). Furthermore, NOINSUR patients were more likely to be readmitted to the ICU (15.6% vs 4.6%, $p = 0.1244$), had a higher incidence of complications, in particular a higher rate of DVT (44.3% vs 6.8%; $p = 0.0002$), and were less likely to be discharged to a rehabilitation facility (65.6% vs 75.0%) and more likely to be discharged home (15.6% vs 0%; $p = 0.0075$). Overall crude in-hospital mortality was not significantly different between the two insurance groups ($p = 0.7143$). Upon multivariable analysis adjusting for age, overall injury severity, MAP protocol and spinal level of injury, the noted longer hospital length of stay in NOINSUR patients remained statistically significant with an r^2 (amount of variability of the outcome explained by the model) of 0.18 (Table 4). Additionally, C-spine level of injury was associated with increased hospital length of stay, independent of insurance status. A multivariable model including only significant predictors (insurance status and spine level of injury) yielded an r^2 of 0.16.

Discussion

Access to healthcare is consistently at the forefront of political debate, but this study spotlights a variable that affects access to post-hospitalization care. This retrospective analysis demonstrates that despite having a lower injury severity score, lack of insurance significantly impacts throughput of SCI patients in an acute care facility. Interestingly, our finding that insurance status does not impact the number of ICU days suggests that provider-driven decisions are not influenced by payer sources.

Uninsured SCI patients spend more ventilator-free days within the hospital and have an overall longer hospital stay when compared with patients who have a payer source. Furthermore, we found that these uninsured patients are ultimately not receiving the post-acute rehabilitation care needed for their acute injury because they are more likely to be discharged home after their prolonged inpatient stay. Englum et al.[7] demonstrated that racial disparities, regardless of insurance status, affects trauma patients access to post hospitalization care; all in spite of the fact that optimal post hospitalization care has been shown as vital to providing SCI patients the best chance of regaining an acceptable quality of life. Several studies[8–10] have analyzed the post-acute care access for traumatic brain injury patients, and the overarching consensus is that insurance acts as a gateway, to the much-needed rehabilitation after acute care is completed. While lives may be physically saved within the acute care system, post hospitalization care augments the quality of life and potential of trauma patients.

Table 1
Demographic and injury characteristics by health insurance status.

Variable	INSUR (Private/Worker Compensation) (n = 44)	NOINSUR (Self-Pay) (n = 32)	p-value
Injury Year, n (%)			
2012	6(13.6)	11(34.4)	0.0804
2013	7(15.9)	8(25.0)	
2014	6(13.6)	1(3.1)	
2015	14(31.8)	8(25.0)	
2016	11(25.0)	4(12.5)	
Age, Mean (SD)	35.8(15.3)	39.6(13.4)	0.2669+
Age (groups), n (%)			
18-34	26(59.1)	12(37.5)	0.1431*
35-54	10(22.7)	14(43.8)	
55-64	7(15.9)	6(18.8)	
≥65	1(2.3)	0	
Gender, n (%)			
Male	34(77.3)	24(75)	0.8180
Female	10(22.7)	8(25.0)	
Race, n (%)			
White	16(36.4)	16(50.0)	0.7709*
Black	3(6.8)	2(6.3)	
AI/AN/PI	21(47.7)	11(34.4)	
Asian	2(4.6)	1(3.1)	
Other	2(4.6)	2(6.3)	
MOI, n (%)			
Traffic	22(50.0)	11(34.4)	0.1718
GSW/Stabbing	4(9.1)	7(21.9)	
Falls	6(13.6)	8(25)	
Other/Unspecified	12(27.3)	6(18.8)	
Penetrating Injury, n (%)	4(9.1)	7(21.9)	

*p-value for Fishers exact test.

Not only does lack of insurance impede access to preventative care and treatment of chronic, preexisting medical conditions, lack of a payer source can also affect outcomes within a system that provides emergency care regardless of insurance status. This association between outcomes post trauma and lack of insurance status may be more complex secondary to lack of insurance being a proxy for other socioeconomic factors, including but not limited to, chronic medical comorbidities, past and present substance use, mental illness, and ethnic disparities that ultimately result in educational and communication barriers.[11] Despite these potential

Table 2
Patients' clinical characteristics by health insurance status.

Variable	INSUR (Private/Worker Compensation) (n = 44)	NOINSUR (Self-Pay) (n = 32)	p-value
Initial ED, Mean (SD)			
SBP	129.2(26.5)	121.9(31.4)	0.2766+
GCS	12.0(4.8)	13.3(3.6)	0.2246+
HR	85.4(24.7)	83.9(21.7)	0.7794+
CBC, Mean (SD)			
WBC	13.6(7.3)	13.0(6.4)	0.6677+
Platelet	227.5(67.7)	225.2(59.1)	0.8789+
HCT	38.6 (5.8)	39.1(5.1)	0.7097+
Hb	13.0(2.1)	13.2(1.8)	0.5323+
Spine level of Injury, n (%)			
C-Spine	25(56.8)	11(34.4)	**0.0304***
T-Spine	19(43.2)	18(56.3)	
L-Spine	0	3(9.4)	
Tracheostomy, n (%)	20(45.5)	9(28.1)	0.1247
PEG, n (%)	18(40.9)	9(28.1)	0.2503*
Spinal Fixation, n (%)	36(81.8)	25(78.1)	0.6896
TBI (GCS < 9), n (%)	11(25.0)	4(12.5)	0.5666*
ISS, Mean (SD)	20.3(17.2)	13.5(12.8)	**0.0628**+
ISS Group, n (%)			
0-8	9 (20.45)	10 (31.3)	0.1452
9-15	12 (27.3)	13(40.6)	
16-24	8 (18.2)	5 (15.6)	
>=25	15 (34.1)	4 (12.5)	
Severe Injury (AIS ≥ 3), n (%)			
Head	16(36.4)	12(37.5)	0.9192
Chest	26(59.1)	17(53.1)	0.6044
Abdomen	8(18.2)	6(18.8)	0.9497
MAP Protocol, n (%)	37 (84.1)	21 (66)	0.1274*
Days on MAP Protocol, Mean (SD)	6.6(1.9)	5.2(3.3)	**0.0443**+

*p-value for Fishers exact test.
+p-value for Student's T-test.

Table 3
Unadjusted outcomes by health insurance status.

Variable	INSUR (Private/Worker Compensation) (n = 44)	NOINSUR (Self-Pay) (n = 32)	p-value
Ventilator Days, Mean (SD)	12.1(12.8)	13.0(9.9)	0.8214+
Vent-free Days, Mean (SD)	6.6(7.7)	22.3(17.5)	<**0.0001**+
ICU length of stay, Mean (SD)	16.8(12.1)	20.1(21.5)	0.4275+
ICU Free days, Mean (SD)	2.0(5.4)	15.2(16.5)	**0.0001**+
Re admission to ICU, n (%)	2(4.6)	5(15.6)	0.1244*
Stepdown length of stay, Mean (SD)	2.3(5.1)	10.1(13.5)	**0.0036**+
Hospital length of stay, Mean (SD)	18.7(13.5)	35.3(30.3)	**0.0062**+
In-hospital Mortality, n (%)	4(12.5)	4(9.1)	0.7143*
Overall Complications, n (%)	26(59.1)	21(65.6)	0.5626
Frequency of Complications			0.1008*
1	18(40.9)	7(21.9)	
2	5(11.4)	8(25)	
3	3(6.8)	4(12.5)	
4	0	2(6.3)	
Surgical Site Infection	1(5.3)	2(7.4)	0.5531*
Pneumonia	22(50.0)	14(46.8)	0.7782
UTI	8(18.2)	10(35.7)	0.0940*
Pressure Ulcer	3(7.0)	4(15.4)	0.4126*
DVT	3(6.8)	13(44.3)	**0.0002**
Disposition, n (%)			
Home	0	5(15.6)	**0.0075***
Rehab	33(75.0)	21 (65.6)	
LTAC	2 (4.6)	0	
SNF	1(2.3)	2 (6.3)	
Other	5(11.4)	0	
Morgue	4(12.5)	3(6.8)	

*p-value for Fishers exact test.
+p-value for Student's T-test.

Table 4
Association of Insurance Status with Hospital length of Stay Adjusted for age, spinal level of injury, ISS and Map Protocol (Full Model).

Variable	Estimate	Standard Error	p-value
Age	0.06	0.18	0.7198
Insurance Groups			
INSUR (Private/Worker Compensation)	*Reference*		
NOINSUR (Self-Pay)	17.2	5.5	**0.0026**
Spine level of Injury			
T and L −Spine	*Reference*		
C-Spine	10.3	5.2	**0.0532**
ISS	−0.06	0.17	0.7149
Map Protocol			
No	Reference		
Yes	−5.5	6.1	0.3774

$r^2 = 0.176418$.

associated socioeconomic factors, we found that there is no statistical significance in crude in-hospital mortality between the two groups. However, what we did find is that lack of a payer source results in a significant lengthier hospital stay, despite uninsured patients having a lower injury severity score. A longer hospital stay not only resulted in greater chance of an in-hospital complication, but is also taxing to the very system tasked with providing the acute care.

It is worth noting that this study is limited it its retrospective nature and relatively low power. This study is meant to describe a single trauma center's experience with acute SCI patients' throughput. Medicaid/Medicare patients were excluded secondary to the government payer source acting as a hybrid. While Medicaid patients ultimately have a payer source to reimburse the acute care facility, the process to obtain this coverage can take weeks. During the processing time, this patient group falls under uninsured status, and then shifts to insured once coverage is obtained. With regards to Medicare, post-acute resources available to patients can be limited depending on the Medicare package/coverage. Future studies are needed to further understand the impact of government payer sources on the throughput of SCI patients.

Our findings highlight the need for future studies to investigate the role of insurance status on the throughput of other traumatic injury patterns. While the American healthcare system prides itself in every citizen having access to emergent care, the importance of post-hospitalization care cannot be overlooked, as well as the impact that lack of post-hospitalization access has on the acute care centers that ultimately provide long-term care to sub-acute patients.

Conclusion

This descriptive study of one trauma center's patient population suggests that insurance status has a direct correlation to hospital LOS and hospital related complications in acute SCI patients. These results show that lack of funding has a negative effect on timely rehabilitation placement and, from this, it can be extrapolated that the inability to place acute SCI patients strains acute care facilities. In a facility that has a finite number of stepdown beds and resources, the inability to discharge uninsured, acute SCI patients

hurts both the system and the patients; the system experiences an increased expenditures from misuse of acute care resources, the acute SCI patients are at risk of hospital related complications and potential setbacks from not receiving aggressive rehabilitation. In addition, other patients are at a potential disadvantage as full hospitals result in diversions to other facilities, which may not have the optimal level of care required for that patient. Further studies are needed to investigate the full impact that lack of insurance has on both acute SCI patients and on the acute care hospital caring for them.

Conflicts of interest

The Authors declare that there is no conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amjsurg.2018.10.049.

References

1. Barnett JC, Berchick ER. *Current Population Reports, P60-260, Health Insurance Coverage In the United States: 2016*. Washington, DC: U.S. Government Printing Office; 2017.
2. Haider AH, Chang DC, Efron DT, et al. Race and insurance status as risk factors for trauma mortality. *Arch Surg*. 2008;143(10):945–949.
3. Rosen H, Saleh F, Lipsitz S, et al. Downwardly mobile: the accidental cost of being uninsured. *Arch Surg*. 2009;144(11):1006–1012.
4. Greene WR, Oyetunji TA, Bowers U, et al. Insurance status is a potent predictor of outcomes in both blunt and penetrating trauma. *Am J Surg*. 2010;199:554–557.
5. Schoenfeld AJ, Belmont PJ, See AA, et al. Patient demographics, insurance status, race, and ethnicity as predictors of morbidity and mortality after spine trauma: a study using the National Trauma Data Bank. *Spine J*. 2013;13:1766–1773.
6. Krause JS, Broderick LE, Saladin LK, Broyles J. Racial disparities in Health outcomes after spinal cord injury: mediating effects of education and income. *J Spinal Cord Med*. 2006;29:17–25.
7. Englum BR, Villegas C, Bolorunduro O, et al. Racial, ethnic, and insurance status disparities in use of posthospitalization care after trauma. *J Am Coll Surg*. 2011;213(6):699–703.
8. Kane WG, Wright DA, Fu R, Carlson KF. Racial/ethnic and insurance status disparities in discharge to posthospitalization care for patients with traumatic brain injury. *J Head Trauma Rehabil*. 2014;29(6):E10–E17.
9. Asemota AO, George BP, Cumpsty-Fowler CJ, et al. Race and insurance disparities in discharge to rehabilitation for patients with traumatic brain injury. *J Neurotrauma*. 2013;30:2057–2065.
10. Bowman SM, Martin DP, Sharar SR, Zimmerman FJ. Racial disparities in outcomes of persons with moderate to severe traumatic brain injury. *Med Care*. 2007;45(7):686–690.
11. Salim A, Ottochian M, DuBose J, et al. Does insurance status matter at a public, level 1 trauma center? *J Trauma*. 2010;68(1):211–216.