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Socioeconomic Status and Hospitalization Costs for Children with Brain and Spinal Cord Injury

Mark R. Zonfrillo, MD, MSCE^{1,2}, Isabella Zaniletti, PhD³, Matthew Hall, PhD⁴, Evan S. Fieldston, MD, MBA, MSHP^{2,5}, Jeffrey D. Colvin, MD, JD⁶, Jessica L. Bettenhausen, MD⁶, Michelle L. Macy, MD, MS⁷, Elizabeth R. Alpern, MD, MSCE⁸, Gretchen J. Cutler, PhD, MPH⁹, Jean L. Raphael, MD, MPH¹⁰, Rustin B. Morse, MD, MMM¹¹, Marion R. Sills, MD, MPH¹², and Samir S. Shah, MD, MSCE¹³

¹Department of Emergency Medicine and Injury Prevention Center, Hasbro Children's Hospital, Providence, RI;

²Alpert Medical School of Brown University, Providence, RI;

³Department of Statistics, University of Missouri, Columbia, MO;

⁴Children's Hospital Association, Overland Park, KS;

⁵Department of Pediatrics, The Children's Hospital of Philadelphia, Philadelphia, PA;

⁶Department of Pediatrics, Children's Mercy Hospitals and Clinics, University of Missouri-Kansas City School of Medicine, Kansas City, MO;

⁷Department of Emergency Medicine, Child Health Evaluation and Research Unit, Division of General Pediatrics, C.S. Mott Children's Hospital, University of Michigan Medical School, Ann Arbor, MI;

⁸Department of Pediatrics, Ann and Robert H. Lurie Children's Hospital of Chicago, Northwestern University Feinberg School of Medicine, Chicago, IL;

⁹Department of Pediatric Emergency Medicine, Children's Hospitals and Clinics of Minnesota, Minneapolis, MN;

¹⁰Department of Pediatrics, Section on Academic General Pediatrics, Baylor College of Medicine, Houston, TX;

¹¹Children's Health System of Texas, Dallas, TX;

¹²Children's Hospital Colorado, Aurora, CO;

¹³Department of Pediatrics, Cincinnati Children's Hospital Medical Center, University of Cincinnati College of Medicine, Cincinnati, OH

Abstract

Objective—To determine if household income is associated with hospitalization costs for severe traumatic brain injury (TBI) and spinal cord injury (SCI).

Study design—Retrospective cohort study of inpatient, nonrehabilitation hospitalizations at 43 freestanding children's hospitals for patients <19 years old with unintentional severe TBI and SCI from 2009–2012. Standardized cost of care for hospitalizations was modeled using mixed-effects methods, adjusting for age, sex, race/ethnicity, primary payer, presence of chronic medical condition, mechanism of injury, injury severity, distance from residence to hospital, and trauma center level. Main exposure was zip code level median annual household income.

Results—There were 1061 patients that met inclusion criteria, 833 with TBI only, 227 with SCI only, and 1 with TBI and SCI. Compared with those with the lowest-income zip codes, patients from the highest-income zip codes were more likely to be older, white (76.7% vs 50.4%), have private insurance (68.9% vs 27.9%), and live closer to the hospital (median distance 26.7 miles vs 81.2 miles). In adjusted models, there was no significant association between zip code level household income and hospitalization costs.

Conclusions—Children hospitalized with unintentional, severe TBI and SCI showed no difference in standardized hospital costs relative to a patient's home zip code level median annual household income. The association between household income and hospitalization costs may vary by primary diagnosis.

Lower community-level household income is associated with higher inpatient costs of care for common medical conditions in children, such as asthma, diabetes, and bronchiolitis.¹ In the US, patients from lower-resource backgrounds may consume more health care-related resources when they do seek care because of several factors including the lack of primary, secondary, and tertiary prevention measures; lack of timely access to care; higher risk of exposure to health-impairing environmental and behavioral issues; and lower adherence to treatments.^{1,2} Diagnoses associated with higher cost of hospitalizations, including acute trauma care, may be ideal targets for cost-mitigation strategies, such as case management.^{3,4} Efficient allocation of intensive and finite resources can be realized through identification of subgroups most likely to benefit from these services. Provision of acute trauma care is expensive, and injury is the leading cause of death and acquired disability in children.^{5,6} Because severe injuries result in high hospitalization costs, there is great potential for savings in the area of acute trauma care.

Socioeconomic disparities exist for many trauma-related outcomes in children. Minority and impoverished children have higher injury incidence, severity, and mortality rates, and have poorer functional outcomes after injuries.^{7–9} The etiology of the disparities in functional outcomes is multifactorial, and reflects differences in insurance status, access to acute and rehabilitation care, and social support systems.¹⁰ From a policy standpoint, it is important to determine if injured patients coming from areas with lower median household incomes experience higher hospitalization costs. Specifically, if economically disadvantaged patients cost more to care for, hospitals that treated these patients could be disproportionately underpaid or even penalized by reimbursement policies, when these disparities are not considered in evaluation of these practices.^{11,12} However, research exploring hospitalization costs among injured children with varying household income is lacking. This study focused on severe traumatic brain injury (TBI) and spinal cord injury (SCI) because these are subcategories of unintentional injury that lead to more disability^{13,14} and higher societal cost¹⁵ than any other injuries in children.

The primary goal of this study was to examine the association between zip code-level median annual household income and costs of hospitalization among severely injured children. We hypothesized that patients from areas with lower median annual household income would have higher inpatient costs for severe TBIs and SCIs.

Methods

Data for this multicenter retrospective cohort study were obtained from the Pediatric Health Information System (PHIS), which contains administrative data from 43 free-standing children's hospitals. PHIS includes patient demographics, patient's home zip code, up to 41 International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnoses, up to 41 ICD-9-CM procedure codes, and hospital costs for services.

Data are deidentified prior to inclusion in the database, but unique identifiers allow for longitudinal analyses across visits for a single patient. Data quality and reliability are assured jointly by the Children's Hospital Association (formerly Child Health Corporation of America, Overland Park, Kansas), participating hospitals, and Truven Health Analytics (formerly Thomson Reuters Healthcare, New York, New York).^{16–19} In accordance with the Common Rule (45 CFR 46.102[f]) and the policies of The Children's Hospital of Philadelphia Institutional Review Board, this study using a deidentified dataset was not considered human subjects research.

Data from 43 hospitals were included. Inpatient-status and observation-status hospitalizations during the calendar years 2009–2012 were included in analyses.^{20,21} For the purposes of this study, severe TBIs and SCIs were identified by selecting ICD-9-CM coded diagnoses that represented abbreviated injury scale (AIS) scores of 4, 5, or 6 (on an ordinal scale of 1–6; 6 indicating highest severity) for the body region of the head and/or the spinal cord.²² The AIS is an anatomically based severity scoring system that is considered a global standard for injury data collection and analysis.²³ There were 134 possible ICD-9-CM TBI codes (109 AIS = 4, 14 AIS = 5, 11 AIS = 6) and 48 ICD-9-CM SCI codes (36 AIS = 4, 9 AIS = 5, 3 AIS = 6) that met eligibility criteria, and patients were included if they had 1 or more of these codes as a diagnosis for their hospital visit. Any admissions associated with a patient older than 18 years of age, intentional injury, death in the emergency department or during the hospitalization, categorized as a readmission encounter (ie, subsequent admissions for the same injuries), or inpatient rehabilitation were excluded.

Outcome Variable

The primary outcome variable was the overall standardized hospital costs and categorized costs for children diagnosed with severe TBIs or SCIs. Within PHIS, each service or activity is assigned a standardized cost, derived from the median cost across all PHIS hospitals for that service.^{24,25} This approach allows for cost comparisons across hospitals without biases arising from using charges or from deriving costs using hospitals' ratios of costs to charges. Standardized costs were categorized into total, laboratory, imaging, pharmacy, and other.

Primary Independent Variable

Median annual household income for the child's home zip code was obtained from 2012 US Census Bureau data. Zip code-based median household income has been previously demonstrated to be a useful proxy for patient socioeconomic status when individual level data are unavailable.^{26–28} House hold incomes were divided into 4 categories based on the US federal poverty level (FPL) for a family of 4.²⁹ These categories were household income-1, less than 1.5 times the FPL (\$34 575 or less); household income-2, 1.5–2 times the FPL (\$34 576–\$46 100); household income-3, 2–3 times the FPL (\$46 101–\$69 150), and household income-4, greater than 3 times the FPL (\$69 151 or more). These categories were the same or similar to categories reported in other studies.^{30,31}

Covariates

Injury severity score (ISS), a standardized summary of injury severity, were calculated by summing the squares of the AIS severity scores (1–6) of the 3 most severely injured body regions,²² which were mapped from all ICD-9-CM injury codes for the patient's visit. ISS ranges from 3–75, and a maximum AIS severity 6 in any body region defaulted to an ISS of 75.^{22,32,33} Intent and mechanism of injury were determined using the Centers for Disease Control and Prevention Matrix of E-Code Groupings.² E-codes supplement the primary ICD-9-CM diagnosis codes and categorize the external cause and intent of the injury.

Patient demographic variables included age, sex, race/ethnicity, primary payer, and the presence of a complex chronic medical condition. Race/ethnicity categories included white, black or African American, Hispanic or Latino, American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander, and other. The “other” category included unreported or missing data or any category not previously mentioned. The primary payer variable of “public” included Medicaid, Medicaid managed care, and Title V. “Commercial” payer included employer-based (including Tricare) and privately purchased health insurance. “Uninsured” included “self-pay” and “charity.” “Other” payer indicated Medicare, worker's compensation, other governmental insurance, missing payer information, and no-charge. The distance between the geographic centers of the patient's home zip code and the hospital's zip code was calculated. The hospitals' American College of Surgeons trauma center level designation as determined by a Children's Hospital Association survey included: level 1/ pediatric level 1 (with the most comprehensive, tertiary care trauma treatment capabilities), level 2/pediatric level 2, level 3, and none. Complex chronic conditions included pediatric neurologic, cardiac, respiratory, renal, gastrointestinal, hematologicimmunologic, metabolic, malignancy, or “other” diagnoses that: (1) were expected to last longer than 12 months; and (2) involved either several different organ systems or one organ system severely enough to require specialty pediatric care and hospitalization.³⁴

Data Analyses

The sample was described by median annual household income categories using frequencies and percentages for categorical variables, and median and IQR for continuous variables.

Comparisons were made across categories of household income using χ^2 tests for categorical variables and Wilcoxon rank sum tests for continuous variables. Z-scores for the distance

travelled by patients were computed using the mean and the SD of the entire population of inpatient and observation-status patients within each hospital. Unadjusted costs by hospital were then compared with z-score categories using Wilcoxon rank sum test. Standardized costs were successively modeled using linear mixed-effects methods allowing for repeated measurements on hospitals and adjusted for covariates including severity of illness (based on patient-level ISS), cause of injury, age, sex, race/ethnicity, primary payer, presence of chronic medical condition, distance traveled, and trauma center level. The logarithm transformation of the standardized costs was used to adjust for skewness of the distributions.^{35–37} Post hoc tests were used to compare the adjusted standardized costs of patients within household income groups. All statistical analyses were performed using SAS v 9.3 (SAS Institute, Cary, North Carolina). P values of <.05 were considered statistically significant.

Results

Of all patients admitted to participating hospitals during the study period, 1061 patients met inclusion criteria, representing 0.06% of all patients and 80% of all severe TBIs/SCIs (with the remaining 20% being intentional injuries; Table I). The majority of the sample was school age (68.4% 5–18 years), male (66.5%), white (60.1%), and insured (82.2%). There were significant differences between median annual household income groups related to age, race/ethnicity, insurance, and distance from residence to hospital. Patients from the highest-income zip codes (household income-4) were more likely to be older, white (76.7% vs 50.4%), have private insurance (68.9% vs 27.9%), and live the closest to the hospital (median distance 26.7 miles [IQR 20.5, 38.5] vs 81.2 miles [IQR 11.6, 157.1]) when compared with those from the lowest-income zip codes (household income-1). There were no differences between median annual household income groups related to the presence of complex chronic medical conditions, the hospital trauma center level, or the median ISS.

Table II shows the unadjusted standardized median costs for hospitalization. For all median annual household income groups, the overall unadjusted median standardized cost was \$19 860 (IQR \$8890, \$51 795). We found no statistically significant differences across the zip code-based income categories in unadjusted standardized median total costs or any subcategory of inpatients costs. There were still no significant differences in standardized costs of hospitalization across zip code-based income categories after adjusting for potential confounders (Table III).

Discussion

We found no evidence that lower household income groups incurred higher medical costs per inpatient encounter among children with severe TBI and SCI. This finding differs from prior evidence of higher costs for common medical condition hospitalizations based on household income.¹ A potential explanation for this difference may be that our findings reflect a select group of severely injured patients, and there may be associations between household income and hospital costs of care for less profound and disabling injuries. Given the severity of the injuries in our study, there may be no discernable differences in care of this patient population or small differences may be overwhelmed by the high overall cost for treatment. Future studies may consider analyses on less severely injured hospitalized

patients, where the magnitude of costs may approximate costs of other medical conditions for which differences have been reported.¹

Our findings also differ from prior studies of pediatric trauma and socioeconomic status. Previous research of pediatric trauma patients has shown significant associations between mortality and ethnicity, race, and insurance type.⁷⁻⁹ Associations between insurance type and pediatric trauma hospitalization rates, as well as race and trauma center quality, have also been demonstrated.^{38,39} However, the focus of our study was on costs, and we included race/ethnicity and payer in our model in addition to household income.

Another potential reason for the lack of differences in hospital costs of care across household income level in our study may be that zip code-level median annual household income data may only approximate the income of a patient or family.⁴⁰ Furthermore, examination of socioeconomic status was limited to 1 domain (income), and results may differ when other dimensions of socioeconomic status are considered, such as patient or family educational level or occupation.⁴¹

Previous research has primarily examined demographic differences in admission rates to the acute care setting and discharge rates to rehabilitation facilities, where racial and ethnic minority trauma patients have shorter postacute care stays and are less likely to be referred to a rehabilitation center after discharge.^{8,42} In contrast, our study considered the acute care, in-hospital setting only and did not consider disposition and postacute care costs. Standardization in acute trauma care may in part explain our finding consistencies in costs of acute hospitalization across household income levels. Differences in hospital costs for nontrauma pediatric admissions may be a result of less standardized treatment protocols,¹ and this possibility deserves further research.

The study was limited to patients cared for at freestanding children's hospitals. It is possible that the disparities identified in previous trauma research are related to hospital-level rather than patient-level differences. Inclusion of different settings may influence length of stay and overall costs, although it is difficult to determine if this would be associated with a patient's median household income rather than hospital level factors.

Similarly, including only zip code-level income data may result in misclassification at an individual household level. In addition, we could not reliably determine which patients were transferred from the hospitals in the PHIS database to another acute care hospital, which could have created misclassification or bias in the costs calculated. However, because these are children's hospitals and trauma centers, they are less likely to have transfers out to another acute care setting. Finally, there were no patient outcomes measured (eg, disability, functionality), and variation in cost does not necessarily relate to variation in outcomes.

In summary, we found that children treated for unintentional severe TBI and SCI showed no difference in per-episode standardized costs for acute hospital care relative to a patient's community-level income. This study contributes to a growing body of literature describing the effects of social determinants on health care resource utilization and suggests that the association of median household income and hospitalization costs varies by primary diagnosis.

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Glossary

AIS	Abbreviated injury scale
FPL	Federal poverty level
ICD-9-CM	<i>International Classification of Diseases, Ninth Revision, Clinical Modification</i>
ISS	Injury severity score
PHIS	Pediatric Health Information System
SCI	Spinal cord injury
TBI	Traumatic brain injury

References

- Fieldston ES, Zaniletti I, Hall M, Colvin JD, Gottlieb L, Macy ML, et al. Community household income and resource utilization for common inpatient pediatric conditions. *Pediatrics* 2013;132: e1592–601. [PubMed: 24276839]
- Jonas J, Eder J, Noonan K, Rubin D, Fieldston E. Shifting the Care and Payment Paradigm for Vulnerable Children, http://policylab.chop.edu/sites/default/files/pdf/publications/PolicyLab_EtoA_ShiftingCarePaymentParadigm_2015.pdf; 2015 Accessed July 15, 2015.
- Zatzick D, Roy-Byrne P, Russo J, Rivara F, Driesch R, Wagner A, et al. A randomized effectiveness trial of stepped collaborative care for acutely injured trauma survivors. *Arch Gen Psychiatry* 2004;61:498–506. [PubMed: 15123495]
- Aboutanos MB, Jordan A, Cohen R, Foster RL, Goodman K, Halfond RW, et al. Brief violence interventions with community case management services are effective for high-risk trauma patients. *J Trauma* 2011;71:228–36. discussion 36–7. [PubMed: 21818029]
- Centers for Disease Control-National Center for Injury Prevention and Control. Web-based Injury Statistics Query and Reporting System (WISQARS). <http://www.cdc.gov/injury/wisqars/>. Accessed January 30, 2012.
- Peden MM, UNICEF, World Health Organization. World report on child injury prevention. Geneva: World Health Organization; 2008.
- Cassidy LD, Lambropoulos D, Enters J, Gourlay D, Farahzad M, Lal DR. Health disparities analysis of critically ill pediatric trauma patients in Milwaukee, Wisconsin. *J Am Coll Surg* 2013;217:233–9. [PubMed: 23664140]
- Haider AH, Weygandt PL, Bentley JM, Monn MF, Rehman KA, Zarzaur BL, et al. Disparities in trauma care and outcomes in the United States: a systematic review and meta-analysis. *J Trauma Acute Care Surg* 2013;74:1195–205. [PubMed: 23609267]
- Hakmeh W, Barker J, Szpunar SM, Fox JM, Irvin CB. Effect of race and insurance on outcome of pediatric trauma. *Acad Emerg Med* 2010;17: 809–12. [PubMed: 20670317]
- Brown RL. Epidemiology of injury and the impact of health disparities. *Curr Opin Pediatr* 2010;22:321–5. [PubMed: 20375897]
- Bierman AS, Clark JP. Performance measurement and equity. *BMJ* 2007; 334:1333–4. [PubMed: 17599980]

12. Chien AT, Chin MH, Davis AM, Casalino LP. Pay for performance, public reporting, and racial disparities in health care: how are programs being designed? *Med Care Res Rev* 2007;64:283S–304S. [PubMed: 17881629]
13. Zonfrillo MR, Durbin DR, Winston FK, Zhang X, Stineman MG. Residual cognitive disability after completion of inpatient rehabilitation among injured children. *J Pediatr* 2014;164:130–5. [PubMed: 24268846]
14. Zonfrillo MR, Durbin DR, Winston FK, Zhao H, Stineman MG. Physical disability after injury-related inpatient rehabilitation in children. *Pediatrics* 2013;131:e206–13. [PubMed: 23248228]
15. Langlois JA, Rutland-Brown W, Wald MM. The epidemiology and impact of traumatic brain injury: a brief overview. *J Head Trauma Rehabil* 2006;21:375–8. [PubMed: 16983222]
16. Berry JG, Hall DE, Kuo DZ, Cohen E, Agrawal R, Feudtner C, et al. Hospital utilization and characteristics of patients experiencing recurrent re-admissions within children's hospitals. *JAMA* 2011;305:682–90. [PubMed: 21325184]
17. Mongelluzzo J, Mohamad Z, Ten Have TR, Shah SS. Corticosteroids and mortality in children with bacterial meningitis. *JAMA* 2008;299: 2048–55. [PubMed: 18460665]
18. Morse RB, Hall M, Fieldston ES, McGwire G, Anspacher M, Sills MR, et al. Hospital-level compliance with asthma care quality measures at children's hospitals and subsequent asthma-related outcomes. *JAMA* 2011;306:1454–60. [PubMed: 21972307]
19. Shah SS, Hall M, Srivastava R, Subramony A, Levin JE. Intravenous immunoglobulin in children with streptococcal toxic shock syndrome. *Clin Infect Dis* 2009;49:1369–76. [PubMed: 19788359]
20. Fieldston ES, Shah SS, Hall M, Hain PD, Alpern ER, Del Beccaro MA, et al. Resource utilization for observation-status stays at children's hospitals. *Pediatrics* 2013;131:1050–8. [PubMed: 23669520]
21. Macy ML, Hall M, Shah SS, Hronek C, Del Beccaro MA, Hain PD, et al. Differences in designations of observation care in US free-standing children's hospitals: are they virtual or real? *J Hosp Med* 2012;7:287–93. [PubMed: 22031487]
22. Association for the Advancement of Automotive Medicine (AAAM). The Abbreviated Injury Scale (AIS) 2005—Update 2008. Barrington, IL: AAAM; 2008.
23. Association for the Advancement of Automotive Medicine (AAAM). The Abbreviated Injury Scale. <http://aaam.org/about-ais.html>. Accessed August 15, 2014.
24. Pediatric Health Information System Cost Master Index, <https://extranet.chca.com/CHCAForums/PerformanceImprovement>; 2012 Accessed April 2, 2012.
25. Keren R, Luan X, Localio R, Hall M, McLeod L, Dai D, et al. Prioritization of comparative effectiveness research topics in hospital pediatrics. *Arch Pediatr Adolesc Med* 2012;166:1155–64. [PubMed: 23027409]
26. 3M APR DRG Software, http://solutions.3m.com/wps/portal/3M/en_US/Health-Information-Systems/HIS/Products-and-Services/Products-List-A-Z/APR-DRG-Software; 2009 Accessed April 1, 2015.
27. Averill RF, Goldfield N, Hughes JS. All Patient Refined Diagnosis Related Groups (APR DRGs), Version 24.0—Methodology Overview. Wallingford, CT: 3M Health Information Systems; 2007.
28. Krieger N, Chen JT, Waterman PD, Soobader MJ, Subramanian SV, Carson R. Choosing area based socioeconomic measures to monitor social inequalities in low birth weight and childhood lead poisoning: the Public Health Disparities Geocoding Project (US). *J Epidemiol Community Health* 2003;57:186–99. [PubMed: 12594195]
29. Department of Health and Human Services. Poverty Guidelines for the Remainder of 2010. *Fed Regist* 2010;75:45628–9.
30. Larson K, Halfon N. Family income gradients in the health and health care access of US children. *Matern Child Health J* 2010;14:332–42. [PubMed: 19499315]
31. Simpson L, Owens PL, Zodet MW, Chevarley FM, Dougherty D, Elixhauser A, et al. Health care for children and youth in the United States: annual report on patterns of coverage, utilization, quality, and expenditures by income. *Ambul Pediatr* 2005;5:6–44. [PubMed: 15656707]
32. MacKenzie EJ, Steinwachs DM, Shankar B. Classifying trauma severity based on hospital discharge diagnoses. Validation of an ICD-9CM to AIS-85 conversion table. *Med Care* 1989;27:412–22. [PubMed: 2649755]

33. Durbin DR, Localio AR, MacKenzie EJ. Validation of the ICD/AIS MAP for pediatric use. *Inj Prev* 2001;7:96–9. [PubMed: 11428572]
34. Feudtner C, Silveira MJ, Christakis DA. Where do children with complex chronic conditions die? Patterns in Washington State, 1980–1998. *Pediatrics* 2002;109:656–60. [PubMed: 11927711]
35. Schaeffer AJ, Johnson EK, Logvinenko T, Graham DA, Borer JG, Nelson CP. Practice patterns and resource utilization for infants with bladder exstrophy: a national perspective. *J Urol* 2014;191:1381–8. [PubMed: 24300484]
36. Turney CM, Wang W, Seiber E, Lo W. Acute pediatric stroke: contributors to institutional cost. *Stroke* 2011;42:3219–25. [PubMed: 21868726]
37. Wall S, Scudamore D, Chin J, Rannie M, Tong S, Reese J, et al. The evolving role of the pediatric nurse practitioner in hospital medicine. *J Hosp Med* 2014;9:261–5. [PubMed: 24616251]
38. McCarthy ML, Serpi T, Kufera JA, Demeter LA, Paidas C. Factors influencing admission among children with a traumatic brain injury. *Acad Emerg Med* 2002;9:684–93. [PubMed: 12093708]
39. Glance LG, Osler TM, Mukamel DB, Meredith JW, Li Y, Qian F, et al. Trends in racial disparities for injured patients admitted to trauma centers. *Health Serv Res* 2013;48:1684–703. [PubMed: 23662602]
40. Geronimus AT, Bound J. Use of census-based aggregate variables to proxy for socioeconomic group: evidence from national samples. *Am J Epidemiol* 1998;148:475–86. [PubMed: 9737560]
41. Braveman PA, Cubbin C, Egerter S, Chideya S, Marchi KS, Metzler M, et al. Socioeconomic status in health research: one size does not fit all. *JAMA* 2005;294:2879–88. [PubMed: 16352796]
42. Shafi S, de la Plata CM, Diaz-Arrastia R, Bransky A, Frankel H, Elliott AC, et al. Ethnic disparities exist in trauma care. *J Trauma* 2007;63:1138–42. [PubMed: 17993963]

Table 1.

Study sample characteristics overall and based on household income category

	Overall ^a	Median annual household income categories				P
		Household income-1	Household income-2	Household income-3	Household income-4	
N	1061	401 (37.79)	296 (27.9)	261 (24.60)	103 (9.71)	
Age (y)						.004
<1	52 (4.90)	16 (3.99)	21 (7.09)	11 (4.21)	4 (3.88)	
1–4	283 (26.67)	117 (29.18)	96 (32.43)	53 (20.31)	17 (16.50)	
5–12	439 (41.38)	161 (40.15)	113 (38.18)	118 (45.21)	47 (45.63)	
13–18	287 (27.05)	107 (26.68)	66 (22.30)	79 (30.27)	35 (33.98)	
Male	706 (66.54)	278 (69.33)	175 (59.12)	183 (70.11)	70 (67.96)	.58
Race						<.0001
White	643 (60.60)	202 (50.37)	196 (66.22)	166 (63.60)	79 (76.70)	
African American	164 (15.46)	100 (24.94)	35 (11.82)	26 (9.96)	3 (2.91)	
Hispanic or Latino	143 (13.48)	63 (15.71)	41 (13.85)	37 (14.18)	2 (1.94)	
Asian	15 (1.41)	4 (1.00)	1 (0.34)	2 (0.77)	8 (7.77)	
American Indian/Alaskan Native	6 (0.57)	3 (0.75)	1 (0.34)	2 (0.77)	0 (0)	
Other	90 (8.48)	29 (7.23)	22 (7.43)	28 (10.73)	11 (10.68)	
Payer						<.0001
Public	441 (41.56)	211 (52.62)	127 (42.91)	91 (34.87)	12 (11.65)	
Commercial/private/employer-based	431 (40.62)	112 (27.93)	113 (38.18)	135 (51.72)	71 (68.93)	
Uninsured	64 (6.03)	32 (7.98)	17 (5.74)	10 (3.83)	5 (4.85)	
Other	125 (11.78)	46 (11.47)	39 (13.18)	25 (9.58)	15 (14.56)	
Complex chronic condition ³²	141 (13.29)	57 (14.21)	41 (13.85)	35 (13.41)	8 (7.77)	.38
Median distance from residence to hospital [IQR]	41.4 [18.4, 105.5]	81.2 [11.6, 157.1]	59.5 [22, 113.5]	30.2 [19.2, 55.5]	26.7 [20.5, 38.5]	<.0001
Hospital trauma center level						
Level 1	737 (69.46)	287 (71.57)	204 (68.92)	174 (66.67)	72 (69.90)	.09
Level 2	158 (14.89)	62 (15.46)	49 (16.55)	29 (11.11)	18 (17.48)	
Level 3	5 (0.47)	3 (0.75)	1 (0.34)	1 (0.38)	0 (0.00)	
None	15 (1.41)	7 (1.75)	4 (1.35)	4 (1.53)	0 (0.00)	
Missing	146 (13.76)	42 (10.47)	38 (12.84)	53 (20.31)	13 (12.62)	

Median annual household income categories				
	Overall*	Household income-1	Household income-2	Household income-3
ISS median [IQR]	18 [16, 25]	18 [16, 25]	17 [16, 25]	18 [16, 25]
				18 [16, 25]
P				.24

* All reported number are n (%) except where indicated as a median (IQR).

Table II.

Unadjusted median standardized costs overall and based on household income category

Service costs	Overall	Median annual household income categories				P
		Household income-1	Household income-2	Household income-3	Household income-4	
Pharmacy costs	1089 [297, 3761]	1166 [314, 3805]	1090 [364, 4328]	1096 [266, 3545]	919 [137, 2403]	.204
Laboratory costs	794 [271, 3338]	804 [287, 3470]	753 [232, 2902]	873 [275, 3472]	611 [242, 2276]	.369
Imaging costs	1365 [494, 2989]	1458 [564, 2930]	1267 [474, 3220]	1163 [474, 2841]	1565 [415, 3293]	.643
Supply costs	2039 [289, 6438]	1916 [294, 5797]	1897 [322, 5750]	2211 [237, 6611]	2191 [243, 7761]	.955
Clinical costs	1912 [508, 6648]	1776 [428, 6593]	1827 [623, 7814]	1984 [550, 6472]	2175 [453, 6632]	.929
Other costs	5713 [1848, 10 876]	5288 [1701, 10 912]	5744 [1819, 11 202]	6364 [2388, 11 079]	5533 [1419, 9313]	.911
Room costs	5615 [2170, 15 572]	5321 [2170, 14 896]	6154 [2711, 16 816]	5632 [2215, 16 226]	5041 [2162, 15 195]	.604
Subtotal without room costs	13 881 [5943, 34 579]	14 365 [6015, 35 926]	13 658 [5769, 35 182]	13 700 [5832, 33 481]	13 415 [6159, 37 276]	.907
Total costs	19 860 [8890, 51 795]	20 078 [9503, 51 424]	19 684 [8572, 52 489]	19 323 [8461, 49 877]	19 389 [8499, 53 166]	.810

Median costs and IQR in US dollars.

Table III.

Adjusted standardized mean costs based on household income category

Costs	Median annual household income categories				P
	Household income-1	Household income-2	Household income-3	Household income-4	
Pharmacy costs	1267 (501)	1358 (540)	1338 (534)	884 (375)	.2105
Laboratory costs	1652 (513)	1582 (494)	1988 (622)	1517 (508)	.2197
Imaging costs	1709 (414)	1894 (463)	1949 (477)	2060 (538)	.3988
Supply costs	2038 (909)	2022 (909)	2337 (1051)	2279 (1093)	.8360
Clinical costs	2353 (911)	2798 (1091)	2917 (1146)	3477 (1435)	.1984
Other costs	6860 (1911)	6470 (1811)	6977 (1960)	7469 (2231)	.7581
Room costs	8061 (2151)	9470 (2553)	9561 (2560)	9332 (2662)	.2701
Subtotal without room costs	21 539 (5745)	20 720 (5558)	21 545 (5796)	23 456 (6706)	.8497
Total costs	34 103 (8367)	34 729 (8576)	35 713 (8825)	37 378 (9814)	.9054

Median costs and (SDs) in US dollars.

Mixed model clustered on hospitals with standardized mean and SD on the log scale, and adjusted for age, sex, race/ethnicity, payer, presence of chronic medical condition, trauma center level, distance from residence to hospital (using z-score), and ISS.