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Does Health Insurance Affect the Care of Trauma Patients in Emergency Departments?

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Introduction

The topic of unequal health insurance status has received a great amount of attention over the past few years. This includes broad legislative efforts to provide greater insurance coverage through the Patient Protection and Affordable Care Act (PPACA) and extensive media coverage on this issue. Those with no or poor insurance encounter inequalities within many levels of the United States healthcare system. This includes disparate rates of healthcare access, differing ability to see specialists, and discrepancies in coverage of prescription medications or elective procedures.

The emergency department is likely the medical area most resistant to disparities in health insurance coverage. This is not simply based on ideology but ensured by long-standing federal law to see all presenting patients. For this reason, the emergency department has become a major point of access for many Americans marginalized by the healthcare system. Within emergency care, one of the most acute and standardized disease entities is trauma. Trauma care is dictated by a highly algorithmic series of surveys taught to providers by the American College of Surgeons as part of Advanced Trauma Life Support (ATLS). By this nature, traumas should represent a disease process with a large degree of consistency in care across different subgroups of patients. Every analysis into this area has shown that even in this highly specialized circumstance of patient care, health insurance differences lead to large variances in mortality rate.

The purpose of this paper is to determine the association of insurance status or lack of coverage with the quality of care that trauma patients receive when seen in the emergency department. The primary goal is to determine where in the system statistically

significant differences arise, as prior analyses have not explored any identifiable risk factors for this phenomenon. The goal of this research is to identify shortcomings within the emergency response system model that are allowing for health insurance discrepancies to influence patient outcomes. Data for analysis was obtained from the 2013 version of the National Trauma Data Bank (NTDB), compiled annually by the American College of Surgeons.

Background

In 2012, the last full year before the implementation of the PPACA, the number of uninsured Americans was estimated by the US Census Bureau to be 48.0 million or 15.4% of the national population.[1] These figures were similar to previous years. In 2011, the same US Census report identified 48.6 million uninsured individuals or 15.7% of the population.[1] With the help of the PPACA, these numbers decreased sharply to 42.0 million and 13.4% in the most recently published data from 2013.[2] This is a promising step in the right direction, but the uninsured population in America remains very large. For comparison, 42.0 million currently exceeds the total population of 86% of the world's nations.[3] This figure further excludes a large proportion of Americans who are underinsured, with high deductibles, high coinsurance and limited coverage. Despite the measures taken by the PPACA and other initiatives, disparities in health insurance will likely continue to persist for a considerable time secondary to the immense size and scale of the problem.

In order to analyze the uninsured and underinsured population, it is first necessary to identify who is involved. Within the uninsured population, there are strong tendencies

clustered around age, race and nativity. In 2013 only 7.6% of minors under the age of 19 and 1.6% of senior citizens did not have any health insurance, compared to 18.4% of people between the ages of 19 and 65. The proportion of uninsured individuals within the 19-34 age range was especially large, at 23.1%.[2] Hispanics had the highest uninsured rate with 24.3%, followed by Blacks with 15.9%, Asians with 14.5% and lastly non-Hispanic whites at 9.8%. However, non-Hispanic whites remain the largest portion of the uninsured population when accounting for population sizes.[2] Foreign-born residents were also much more likely to be uninsured, with a prevalence of 27.7% compared to 11.2% for native-born Americans.[2] Other associations have been shown with income and employment status. The highest uninsured prevalence is among people below the poverty line, and 15% of the nonelderly uninsured populace is unemployed compared to a national unemployment rate of 5.8%.[5, 6]

The most frequently cited obstacle to obtaining adequate health insurance is cost. In a recent survey asking uninsured Americans why they are not covered by health insurance, the most frequent responses were insurance being unaffordable, losing a job, and coverage not being offered by an employer. Only 1.7% of participants stated that they did not have health insurance because they had no need for it.[5] There are many economic factors to consider when examining health insurance coverage, especially in the wake of a deep recession. The current insurance model has several different modalities. There are different options for insurance in the private and public spheres. Private options consist of employer-based coverage and self-purchase, while public options include Medicare, Medicaid and military care.[2] A majority of Americans (169.0 million) receive health insurance from their employers. Medicaid (54.1 million),

Medicare (49.0 million) and self-purchase (34.5 million) represent the major alternatives.[2, 5] Trends in recent years show many employers refusing to provide health benefits particularly if they are small businesses or moving to plans with higher individual premiums. Over the past 10 years premiums for individual contributions have risen 81%, making many full-time low-wage workers effectively uninsured.[5]

For minors and senior citizens, Medicaid and Medicare have historically filled in many gaps and account for the low uninsured prevalence in these age groups. For people between 19 and 64, Medicare is not an option and it is very difficult to obtain Medicaid eligibility especially without any dependent children.[5] Thirty-one percent of uninsured Americans report being denied Medicaid coverage within the past five years.[7] Many people are left with expensive self-purchase non-group insurance as their only remaining option. Twenty-two percent of uninsured individuals have looked into buying their own insurance but they were unable to afford it.[7] The combination of low wages or unemployment, no employer insurance offered or those scaled back with large premiums, and the high cost of buying individual plans creates a difficult environment that can perpetuate lack of coverage for chronic periods. Forty-seven percent of uninsured individuals report having no coverage for the past five years.[7]

The effect of having poor or no insurance coverage on medical outcomes is consistent. Medical literature has shown a connection between lack of health insurance coverage and poor clinical outcomes compared to well-insured peers. Differences in care exist across the spectrum of patient encounters, from access to care to treatment outcomes. Uninsured people are much less likely to seek care for their illnesses than their

peers. They are half as likely to have a regular physician compared to those with insurance, and 41% report having no healthcare visits over the past year in contrast to 13% for those with employer-based insurance and 10% for those with Medicaid.[7] Many of those who do have access to care feel that they have limited choice in providers.[7] In terms of illness and treatment, individuals without health insurance have the same likelihood of having a chronic illness as the general population. However, 49% of them choose to postpone required treatment whereas the same is true for 28% of people with employer-based insurance.[7] It has been estimated that there are 45,000 preventable deaths every year attributed solely to patients being uninsured.[8] This figure is unique to the United States among industrialized countries. The European Union, Canada, Australia, Japan, and portions of South America all have universal health insurance coverage.[8]

The combination of inadequate preventative care and deferred clinical attention has led to the use of emergency departments as a health access point for the uninsured. As recently as 2011, 61.6% of uninsured patients presenting to the emergency department stated they had no other healthcare options.[9] The legal standard of care in emergency departments includes the Emergency Medical Treatment and Active Labor Act (EMTALA, 1986), which renders illegal any direct discrimination between patients on payer status.[10] This federal mandate was specifically aimed to make emergency departments independent of any influences from a patient's ability to provide compensation, shifting the priority to delivering care according to need. In practice, this is still not the case almost 30 years later. Even in trauma cases, one of the most acute medical events with standardized protocols for providing care, being uninsured is a significant predictor of an individual's chances of survival.

The field of traumatic injuries treated within the emergency department presents as standardized a subject as possible to best isolate and interpret the impact of health disparities, independent of differences within medical physiology and pathology. Trauma care within the United States is taught universally by the American College of Surgeons as part of Advanced Trauma Life Support (ATLS) protocols. Every general surgery, emergency medicine, and anesthesia provider starting their medical residency must be certified by the same course and re-certified every four years.[11] ATLS enforces a methodology of the "primary survey," with the acronym "ABCDE," and a subsequent secondary survey. The primary survey takes priority at the initial presentation of every case and progresses in order of lettering. A stands for determining the patency of the patient's airway. B represents appropriate breathing, followed by C for adequate circulation to all organs and extremities.[12] D indicates disability, a frequent stand-in for neurologic impairment including pupillary and other reflexes, ability to follow commands, and orientation to the surrounding environment. A way to indicate neurologic impairment is the Glasgow Coma Score (GCS). Specifically developed as a standardized method of assessing neurologic status in trauma victims, GCS is a combination of 15 points on three different graded scales. One scale assesses ocular (eye) response up to four maximum points, another is meant for verbal response up to five maximum points, and the last is used to interpret motor response up to six maximum points. Summing the total of each of the three categories gives a maximum of 15 (completely normal) and minimum of three (completely nonreactive).[13] The GCS is also further differentiated into mild traumatic brain injury (TBI, 13-15), moderate TBI (9-12), and severe TBI (eight or below). Several studies have shown that these categories are strongly correlated with

mortality, and the ATLS process strictly recommends that any patient with severe TBI be intubated to protect their airway during their hospital stay regardless of their initial clinical status.[14] Finally, E represents exposure, in this case completely undressing and visualizing every surface.[12]

Only when these areas have been thoroughly addressed can care proceed to the "secondary survey," which represents other more subjective elements of caring for patients. The secondary survey involves more detailed history taking, subsequent physical examination, and greater reliance on prior provider experience and knowledge. In this sense, trauma care follows this identical process regardless of mechanism, severity, prior medical history, demographics, type of institution, or location. Regardless of the etiology of a patient's presentation to the emergency department, once they become a "trauma activation," they will undergo the same process every time.[11]

A systematic review of the research literature shows that the uninsured have higher morbidity and mortality in traumas in all age groups.[4] Data from the National Trauma Data Bank (NTDB) shows that this health discrepancy remains even after controlling for age, sex, race, injury severity and mechanism of injury.[4,15-22] Uninsured patients have a 50% increased relative risk of dying following a gunshot wound compared to those with insurance, despite identical injury severity and patient demographics.[17] Mortality rates have been reported as more than twice as high for uninsured patients compared to insured controls after all types of penetrating trauma (5% death rate insured vs. 11% uninsured) and blunt trauma (2% death rate insured vs. 4% uninsured).[18] This discrepancy in trauma survival extended to the pediatric population as

well, where uninsured children and teenagers had a 3.32 odds ratio for dying following blunt or penetrating trauma compared to insured patients.[19] Multiple studies also found statistically significant differences in outcome between Medicaid and private insurance.[16,19,20]

This association has been supported with a large number of suggested explanations. The most common explanations are that the uninsured are more prone to preexisting disease and undiagnosed comorbidities, higher sustained injury severity, receive fewer important diagnostic tests, delay in receiving necessary treatment, and social determinants of health, such as poor health literacy, chronic stress and poor support networks.[15,17-23] Other factors that have been considered include geographic clustering of uninsured patients at urban emergency care settings where resources may be spread thin, different rates of hospital admissions from the emergency department, unequal disposition to post-hospital rehabilitation facilities, and poor patient adherence to prescribed medication regimens.[15,24,25] These influences entail population-level inequalities present prior to any incident, inconsistencies in the treatment of an acute illness, and differences in post-encounter disposition.

Many of these causes have been observed within our healthcare system, but the degree of their contribution to current therapeutic inequalities is unclear. Certainly, there is a consistency in the literature that insurance status is a strong determinant of patient outcomes even in trauma cases that are routinely guided by strict protocols and algorithms. However, there is very limited research into whether any of the

aforementioned factors could be a precise mechanism in which the current healthcare system is failing Americans.

In order to establish such an association, there must be a two-step process. It is first necessary to determine whether there is significant variation between the patient encounters of the uninsured and those with different types of health insurance. Then, it is important to identify which of these factors are contributing to the observed association between insurance status and clinical outcomes. The current literature is of limited use to providers, administrators and public health officials. Despite identifying an undesired influence of insurance inequalities, there are very few details to help neutralize or control for it. With more information, emergency departments, as one of the most common sources of care for uninsured individuals, can be better prepared to ensure all patients have a positive health outcome appropriately influenced only by their physiologic condition.

The primary focus of this study was on the sequence of events that unfold once a trauma is underway, from mobilization of emergency medical services (EMS) to emergency department diagnosis and treatment. Upon leaving the emergency department or hospital, it was hypothesized that mortality rates would be confirmed as higher in uninsured and publicly insured populations given the existing literature on this subject. The study was separated into pre-hospital, hospital and post-hospital environments in order to further narrow etiologies for this association. It was hypothesized that the uninsured and underinsured may be more likely to suffer more severe traumatic injuries given less robust preventative healthcare, however this effect would be masked once

injury severity was standardized. There was no expectation that EMS care such as response time or method of arrival to the emergency department would vary significantly amongst different insurance groups. Upon reaching the emergency department, there was also no expectation that disposition, number of ICU days, or other measures of treatment would be different between patients of differing insurance status once accounting for demographics and injury severity. The only prior attempt to define noteworthy comorbid illnesses in trauma cases identified alcohol and illicit drug use as the most likely to worsen outcomes.[26] However, this was also not thought to be particularly divergent among health insurance populations. It was hypothesized that there would be a significant discrepancy in access to short-term rehabilitation or intermediate care facilities based on insurance coverage. The post-hospital setting was identified as a source that could magnify the impact of health disparities on health outcomes and ultimately skew the results of prior standardized care.

Methods

Research Design

The aim of this research study was to further investigate first whether trauma patients encounter differences in experiences in the emergency department according to their insurance status. Secondarily, the study sought to determine whether any differences contributed to a disparity in mortality rates. The study was based on a secondary analysis of patient trauma encounters as described in prior trauma "activations." Cross-sectional data was used from the 2013 release of the NTDB published by the American College of Surgeons. The NTDB is the largest trauma registry in the country, with a 2013 case

volume of approximately 172,000 patients. The data are provided by 805 hospitals that include a mix of university, community and non-teaching institutions. Hospitals include a combination of Level I through Level IV trauma centers. Thirty-eight states report a greater than 66% hospital reporting rate.[27] The large, varied sample size has made the NTDB a rich resource for prior research investigations into the topic of trauma outcomes and health insurance status.

Variables

All statistical analysis was performed using SPSS 21.0. The initial sample size for the 2013 NTDB was 172,386 patients. Exclusion criteria for the analysis was missing information in key variables involving the independent variable, covariates, and dependent variables. These included insurance status, age, gender, race, ethnicity, injury severity, emergency department disposition, and hospital disposition. The only exception to this methodology included hospital disposition, when emergency department disposition involved death or discharge. In these cases, unrecorded hospital discharge information was treated as missing data given the prior inclusion of these patients within emergency department disposition. The sample size of eligible patient cases with all pertinent information present following this selection was 77,051 patients. The vast majority of data loss was due to missing demographic information which were often incomplete for many entries. In an effort to obtain as much standardization as possible for potential confounders, a choice was made to exclude any entry with unknown information rather than include incomplete values into the data analysis. The sample size was still overpowered for the required analysis despite data loss. Missing data for

remaining variables under study was initially programmed as negative entries. These values were reconfigured within SPSS to display as missing information, as per the suggestion of the NTDB. This resulted in certain analyses having sample sizes below the global figure of 77,051, especially in the EMS vitals and EMS GCS settings.

Patients were first grouped by their insurance status as either private/commercial, Medicare, Medicaid or self-pay/uninsured. Importantly, the self-pay category reflected an independent, non-insurance primary method of payment. This was not the same as self-purchase insurance coverage, which was included within private healthcare access as a means of payment. Given the inherent health discrepancies present within uninsured and underinsured populations, patients were standardized for age, sex, race and ethnicity for all analyses. Injury severity score was also included as a covariate. The NTDB defines severity of injury using the Injury Severity Score (ISS), which is another standardized tool that merits further explanation. Values have a range of 3-75, with a higher number indicating greater severity. Scores are obtained by separating the body into six categories – head/neck, face, chest, abdomen/pelvis, extremities, and external/other. Injuries to each body region are given an individual score from one (minor) to six (mortal). The ISS is calculated by taking the three most heavily injured regions, squaring each number for those three values, and adding the results. By definition, any area that has sustained a mortal injury (six) receives a score of 75 as part of the maximum value. Major traumas are defined as an ISS of 15 or above.[28]

String variables among covariates such as sex, race, and ethnicity were transformed to numeric counterparts. This was done to allow for adequate controlling of

confounders via the only possible options in SPSS, multinomial (multiple) logistic regression or ANCOVA. Sex was reprogrammed to one for male and two for female. Race was transformed to one for white, two for black, three for other, four for Asian, five for American Indian, and six for Native Hawaiian or Pacific Islander. These values were assigned in order of decreasing frequency from one to six. The "other race" category was retained since removal resulted in reducing the Hispanic ethnicity reporting level from 10% to 4%. Ethnicity was reconfigured to one for Hispanic and two for non-Hispanic. Finally, mortality was created as a categorical variable through a composite of patients who expired during ED disposition and those who died as part of hospital disposition. Mortality was coded as a categorical variable, with one representing patients who died and two for those who remained alive.

The first part of the data analysis was to examine whether insurance status could independently predict differing experiences and outcomes of trauma cases. There were 17 variables included in the analysis: injury severity, primary mode of transport, EMS response time if applicable, EMS vital signs and GCS documentation if applicable, emergency department vital signs and GCS documentation, presence of concurrently positive alcohol and drug testing, emergency department length of stay (LOS), emergency department disposition (death, admission, or discharge), presence of inter-hospital transfer, hospital LOS, number of ICU days, and hospital disposition (death, transfer to another facility, or home). The main analysis involved using these factors as intermediate variables in conjunction with insurance status to determine their combined influence on trauma mortality rates.

Statistical Analysis

Statistical analysis varied based on the involved associate factor. In all situations, insurance status as the independent variable was always a categorical predictor. Primary mode of transport, positive alcohol or drug testing, presence of transfer, emergency department disposition, and hospital disposition were measured as categorical variables. The primary statistical test used for this category was multiple logistic regression, given the need to control for five covariates of mixed categorical and continuous types.[29] Injury severity score, EMS response time, EMS and emergency department vital signs (heart rate, blood pressure), EMS and emergency department GCS documentation, emergency room and hospital length of stay (LOS), and number of ICU days were measured as continuous variables. The primary statistical method used for this category was ANCOVA.[29] When analyzing the effect on mortality rate, mortality was set as a dependent variable that was categorical in nature. In this case, all mortality-related analysis was completed via multiple logistic regression, with the previous intermediary variable included as a second covariate.[29] This methodology was consistent with prior mortality analysis studies interpreting NTDB data with multiple logistic regression.

Given the very large study group, there was concern prior to study analysis that clinically insignificant effect sizes would be determined to be statistically significant as a result of the high power. Thus, it was anticipated that even small effect sizes would meet criteria of P being < 0.05. P was calculated using significance values from ANCOVA and multiple logistic regression tables corresponding to payment for when the associated factor under study (e.g. TMODE_PRI, TRANSFER) was being studied as the dependent

variable. When these risk factors were used as intermediate variables and mortality served as the dependent variable, significance values from each individual factor were used to determine P. In cases where this information was not available, P values for payment were used as surrogates.

More importantly, r^2 was determined to be the primary method of accounting for effect size between risk factors, insurance status and mortality. Adjusted r^2 was the value used from ANCOVA calculations. For multiple logistic regression, three different pseudo r^2 values were present with each calculation – Cox and Snell, Nagelkerke and McFadden. There is currently little consensus as to the best individual test for pseudo r^2 with logistic regression. As part of the most conservative measure, the smallest r^2 and therefore smallest effect size was chosen as representative. A value of 0.01 was considered small effect size, 0.09 medium effect size, and 0.16 large effect size. This corresponded to r values of 0.1, 0.3, and 0.4, and was performed in an attempt to be consistent with prior literature in this area. Both isolated and mortality-associated analysis values for each study variable had to be equal to 0.09 or 0.16 to meet requirements for classification. It was anticipated that many variables would have small effect size differences noted, therefore this group was not the primary focus of this research. Categorical variables meeting criteria for medium or large effect size were considered for rudimentary breakdown by proportions across different payer types using crosstabs.

Since this research project involved secondary analysis of de-identified data, an application was sought for exemption from the University of Connecticut Health Center (UCHC) Institutional Review Board (IRB). However, there was no risk present to any of

the human subjects that initially provided data, either physically or through breach of confidentiality. The data present within the database had been compiled as part of an existing publically available national data set by a third-party independent from any later sorting, analysis and interpretation of the data. The NTDB consists entirely of de-identified HIPAA compliant data and is publically available to researchers who submit a request for approval through their research institutions.[30]

Results

Age was similar across self-pay, Medicaid and privately insured patients, with Medicaid patients being the youngest on average. Medicare patients were, understandably, several standard deviations older than the next oldest group, those with private insurance. Uninsured patients had the highest proportion of males (78.6%) while Medicaid and private insurance were approximately equal (65%). Medicare was the only category with a majority of females (52.9%). Race and ethnicity resembled each other in distribution. The uninsured and Medicaid populations were nearly identical in their proportions of White (57%), Black (25%), and Hispanic Latino (16-17%) individuals. Privately insured individuals were substantially less diverse (77.2% Caucasian), and Medicare patients even less so (85.2%). Figures for other races were small in each group, although those of Asian background were more likely to be privately insured (2.7% compared to 1.4% of the uninsured population) while those of American Indian background were more likely to be uninsured (1.6% compared to 0.8% of those with private insurance). A demographic breakdown of each payer group is provided (**Table 1**).

Table 1. *Demographic Characteristics by Payer Status*

Demographics (N = 77,051)	Self/uninsured (N = 20669)		Medicaid (N = 11293)		Medicare (N = 24097)		Private (N = 20992)	
Age, mean	36.22		32.49		72.82		41.10	
Age, SD	14.22		19.22		13.06		20.78	
Male	16248	*78.6%*	7411	*65.6%*	11344	*47.1%*	13620	*64.9%*
Female	4421	*21.4%*	3882	*34.4%*	12753	*52.9%*	7372	*35.1%*
White	11904	*57.6%*	6484	*57.4%*	20523	*85.2%*	16215	*77.2%*
Black	5273	*25.5%*	2834	*25.1%*	2020	*8.4%*	2540	*12.1%*
Asian	281	*1.4%*	236	*2.1%*	507	*2.1%*	570	*2.7%*
American Indian	334	*1.6%*	251	*2.2%*	105	*0.4%*	167	*0.8%*
Pacific Islander	56	*0.3%*	188	*1.7%*	52	*0.2%*	96	*0.5%*
Hispanic Latino	3562	*17.2%*	1803	*16.0%*	880	*3.7%*	1545	*7.4%*

Nearly every risk factor studied both as the dependent variable and as a predictor of mortality outcome carried a p-value of < 0.001 (alpha = 0.05). By the criteria established prior to conducting data analysis, the majority of the 17 studied aspects of patient care showed the presence of either a small or medium effect size. This was true both as the dependent variable being affected by insurance status or as an intermediate risk factor for increased mortality. The strongest association was seen with hospital

disposition, with a pseudo r^2 of at least 0.190 when studied by itself but increased to 0.270 when analyzed in conjunction with a change in ultimate patient mortality. This represented the only categorical variable meeting the standard for a large effect size being present. The only other categorical variable meeting criteria for medium effect size across both r^2 figures was emergency department disposition, with a pseudo r^2 of 0.114 on its own and 0.152 when accounting for mortality (**Table 2**).

Table 2. *Association of Categorical Variables with Payer Status and Mortality*

	Payer Status	Mortality
Mode of EMS Transport	P = <0.001; r^2 = 0.063	P = <0.001; r^2 = 0.095
Need for Transfer	P = <0.001; r^2 = 0.012	P = <0.001; r^2 = 0.094
Alcohol Use	P = <0.001; r^2 = 0.052	P = <0.001; r^2 = 0.095
Drug Use	P = <0.001; r^2 = 0.036	P = <0.001; r^2 = 0.095
ED Disposition	P = <0.001; r^2 = 0.114	P = <0.001; r^2 = 0.152
Hospital Disposition	P = <0.001; r^2 = 0.190	P = <0.001; r^2 = 0.270

The only continuous variables that met criteria for medium or large effect size were the EMS and emergency department GCS scores, hospital LOS, and number of ICU days. EMS GCS as a risk factor carried an adjusted r^2 of 0.181 when analyzing only insurance status. When combining any association with differing outcomes in mortality, this value remained at 0.171. Similarly, r^2 for emergency department GCS scores were 0.197 in isolation and 0.154 when accounting for mortality. Hospital length of stay, as measured by number of hospital days carried r^2 values of 0.133 and 0.134 while ICU

days had r^2 values of 0.090 and 0.118. Remaining variables under study did not have r^2 more than 0.09 for both calculations (**Table 3**).

Table 3. *Association of Continuous Variables with Payer Status and Mortality*

	Payer Status	Mortality
Injury Severity Score	P = <0.001; r^2 = 0.009	P = <0.001; r^2 = 0.105
EMS Response/Scene Time	P = <0.001; r^2 = 0.005	P = <0.001*; r^2 = 0.098
EMS HR	P = <0.001; r^2 = 0.090	P = <0.001*; r^2 = 0.000
EMS Systolic BP	P = <0.001; r^2 = 0.087	P = <0.001*; r^2 = 0.000
EMS GCS	P = 0.001; r^2 = 0.181	P = <0.001; r^2 = 0.171
ED HR	P = <0.001; r^2 = 0.114	P = <0.001*; r^2 = 0.069
ED Systolic BP	P = <0.001; r^2 = 0.091	P = <0.001*; r^2 = 0.072
ED GCS	P = <0.001; r^2 = 0.197	P = <0.001; r^2 = 0.154
ED LOS/Minutes	P = <0.001; r^2 = 0.018	P = <0.001*; r^2 = 0.000
Hospital LOS/Days	P = <0.001; r^2 = 0.133	P = <0.001; r^2 = 0.134
ICU Days	P = <0.001; r^2 = 0.090	P = <0.001; r^2 = 0.118

Special consideration was given to emergency department disposition given its strength of association. Crosstabs analysis of insurance type and disposition allowed for a more detailed breakdown of variations among each payer group, although with limited ability to analyze aspects such as odds ratios given the lack of accurate confidence intervals. Uninsured patients were found to have a 271% (Medicaid) or 333% (private) higher likelihood of dying within the emergency department. The uninsured were less

likely to be admitted following trauma, either to a general floor bed or ICU, and more likely to be discharged home without services. Rates of operative management were approximately equal, with Medicare again being an outlier (**Table 4**). Although GCS and hospital LOS and ICU days also showed medium or large effect size, crosstabs were not used for continuous variables due to questions of interpretation and utility.

Table 4. *Emergency Department Disposition by Insurance Status*

ED Disposition (N = 77,051)	Self / uninsured (N = 20,669)		Medicaid (N = 11,293)		Medicare (N = 24,097)		Private (N = 20,992)	
Expired	535	*2.6%*	84	*0.7%*	115	*0.5%*	130	*0.6%*
Operating Room	3341	*16.2%*	1838	*16.3%*	1631	*6.8%*	2987	*14.2%*
Intensive Care Unit	4079	*19.7%*	2637	*23.4%*	6131	*25.4%*	4759	*22.7%*
Telemetry / step-down unit	1151	*5.6%*	563	*5.0%*	2219	*9.2%*	1306	*6.2%*
General admission	7907	*38.3%*	4966	*44.0%*	12599	*52.3%*	9374	*44.7%*
Observation unit	1175	*5.7%*	386	*3.4%*	825	*3.4%*	899	*4.2%*
Home, with services	40	*0.2%*	17	*0.2%*	21	*0.1%*	72	*0.3%*
Home, no services	2366	*11.4%*	783	*6.9%*	551	*2.3%*	1450	*6.9%*

Similarly, hospital disposition, which met consistent criteria for moderate effect size, was analyzed using crosstabs to discover any underlying differences. Medicare proved to be a consistent outlier, likely from its demographic discrepancies. Among remaining insurance groups, uninsured patients were 37% (Medicaid) or 61% (private) more likely to die during their hospital admission. People without health insurance coverage were also more likely to be discharged home without services, and were 43% (Medicaid) or 233% (private) more likely to leave the hospital against medical advice. The use of home services following discharge was distributed along a spectrum with the highest rate in those with private insurance, followed by Medicaid and then self-pay. Both Medicaid and private insurance allowed for greater usage of Skilled Nursing Facilities and long-term rehabilitation centers upon leaving the hospital, but only privately insured patients were more likely to be recommended a short-term general inpatient stay. (**Table 5**).

Table 5. *Hospital Disposition by Insurance Status*

Disposition (N = 70,773)	Self / uninsured (N = 17653)		Medicaid (N = 10390)		Medicare (N = 23405)		Private (N = 19325)	
Expired	649	*3.7%*	283	*2.7%*	1243	*5.3%*	436	*2.3%*
Hospice	14	*0.1%*	18	*0.2%*	261	*1.1%*	30	*0.2%*
Short-term inpatient	127	*0.7%*	76	*0.7%*	269	*1.1%*	734	*3.8%*
Skilled Nursing Facility	302	*1.7%*	641	*6.2%*	7099	*30.3%*	1349	*7.0%*
Intermediate Care Facility	76	*0.4%*	55	*0.5%*	279	*1.2%*	139	*0.7%*
Rehabilitation	818	*4.6%*	957	*9.2%*	4178	*17.9%*	1975	*10.2%*
Home, with services	649	*3.7%*	531	*5.1%*	1843	*7.9%*	1301	*6.7%*
Home, no services	14662	*83.1%*	7684	*74.0%*	8124	*34.7%*	13238	*68.5%*
Left against medical advice	356	*2.0%*	145	*1.4%*	109	*0.5%*	123	*0.6%*

Discussion

The demographic breakdown contained within each payer group reflects the disparity in the general population, as there is a higher prevalence of minority Americans within the uninsured and Medicaid groups, and a higher prevalence of white Americans within the private insurance and Medicare groups. Individuals within the Medicaid and

uninsured groups are also younger on average than those with private insurance. The trauma patient population was dominated by males in all but the Medicare group.

The decision to focus on a criteria other than statistical significance proved to be useful, as the immense sample size of the data set allowed for detection of many small effect sizes. This was not a surprise given that an N of 400 is sufficient to evaluate for small effect sizes and the population of this study after sorting for exclusion criteria was 77,051. Within the 17 variables chosen for study, hospital disposition dwarfed all other aspects of patient care in its association with insurance status. By looking at crosstabs, it was shown that there were differences in death rates within hospital admission (independent of death rates within the emergency department), leaving against medical advice, Skilled Nursing Facility usage, rehabilitation center usage, short-term inpatient stays, discharge home with services, and discharge home without services. In nearly every disposition domain, self-pay patients were at a disadvantage with higher mortality and less medical care. This area presents itself as a topic for future more focused study and makes intuitive sense regarding why those with less means to access healthcare are less likely to use it.

Of further interest is that emergency department disposition also showed a medium effect size. This was seen in crosstabs with differing death rate, ICU admission, general floor admission, and discharge home without services. The mortality rate was disproportionately unfavorable for uninsured patients. A total of 1,184 self-pay patients passed away during the acute care of their sustained trauma, when combining emergency department and hospital death statistics. Hospital figures do not overlap with emergency

department figures. This represents a 5.7% total mortality rate. The corresponding value for Medicaid is 3.2%, and 2.7% for private insurance. Across the majority of statistics, the gap between Medicaid and self-pay is far larger than that between private insurance and Medicaid. This shows that even the presence of limited health insurance coverage is far better than no insurance at all. In terms of health disparities, it is perhaps reassuring that differences between health insurance groups largely arise when it is time for patients to leave the emergency department and, even more so, the hospital. This reaffirms the initial hypothesis that acute care is being provided in a more standardized fashion and the concept of payment does not factor in until after the emergency department. However, the medium effect size differences seen with total hospital length of stay and duration of stay within the ICU suggest that the remainder of the hospital service is not as resistant to this social determinant of care. It is also unclear how much of this effect can be from provider and patient "shared decision-making" where patient choice from a range of options is valued and included in the treatment plan to heighten autonomy.

Among other variables under study, GCS was found to have medium to large effect size differences. This reinforces its importance in the trauma setting as a means of standardized communication with accurate prediction of subsequent mortality risk, especially when other physical signs such as heart rate and blood pressure can be highly variable. Interestingly, GCS scores were very different across populations prior to accounting for effect on mortality despite no initial differences in injury severity score. Although several factors showed small effect size, this was to be expected from the large sample size and these areas were therefore not highlighted as highly influential or relevant for this study. Pertinent negatives to mention are no difference in EMS scene

time or emergency department length of stay, further confirming pre-hospital and acute hospital services are initially responding largely equally prior to disposition management. The issue of emergency department crowding also appears to have very little input in differences in patient mortality across different insurance payer groups. Crowding and "boarding" are when full hospital inpatient floors combined with the emergency department serving as an increasingly used point of access for many marginalized by the healthcare system results in many admitted patients having a lengthy stay within the emergency department.[31] In this study, emergency department length of stay was shown to have zero effect size in final mortality differences. This is not to say that crowding is inconsequential regarding quality of care, as that is outside the scope of this analysis, but rather there is equality in this issue between uninsured and insured patients.

There are several limitations to this study. The dataset itself contains threats to internal validity as there can be unknown inaccuracies in coding and data entry that are unable to be vetted. This analysis required the exclusion of 95,000 patient cases for incomplete data entry regarding demographics, insurance, or mortality. It is certainly possible that further data entry errors may be present within the remaining study sample. With so many different reporters across the country that combine their data to create this national dataset, there is room for errors and low inter-rater reliability as well. However, with such a large sample size it is likely that individual inaccuracies have minimal influence on the aggregate results of data analysis. There are threats to external validity in attempting to extrapolate these findings to trauma patients nationwide. Data within the NTDB is submitted on a voluntary basis, can be geographically biased, and will likely have some inherent degree of skew. The NTDB is perhaps less vulnerable to regional

differences given the extent of its size and adoption nationally and across all types of emergency trauma centers. Additionally, care was taken during this study to use the national sample program (NSP) from the ACS for better weighting of individual facilities and more accurate extrapolation of findings for population-level impact.

Further limitations can be linked to the research design and initial intention of the dataset. A secondary analysis of these data has the benefit of large statistical power due to the large sample size, but the drawback of not being able to operationalize the variables oneself but having to rely on the specification of variables from the original data collection. One instance is the inability to separate self-purchase insurance, with its higher deductible and premiums, from employer-based insurance. In this data set, they are both listed as private insurance despite one being not as high in quality of coverage as the other. With an increasing private insurance marketplace through health insurance exchanges, it is possible subsequent editions of the NTDB will separate these different modalities.

The existing data set does not exclude potential confounding influences. Every attempt was made to control for known demographic covariates and injury severity. Still, a large number of measures were unable to be evaluated. The most important of these is mechanism of injury, as blunt and penetrating traumatic injuries were not able to be separated. Although listed as being included within prior versions, these data were not available for the 2013 NTDB. Prior literature has shown mechanism of injury to lead to differences in mortality rate in certain types of injury (e.g., abdominal), while having no statistical significance in others (e.g., chest).[32,33] For the purpose of this study, there is

therefore an assumption that the rates of these mechanisms is similar across different payer populations. This is supported by the fact that injury severity shows no effect size difference by insurance type. Regardless, having an extra element of uncertainty may partially limits the utility and applicability of the results from this study.

Other sources of data limitation include access to a primary care physician, underlying patient health literacy, and existing comorbidities. Although there was an attempt by the NTDB to include existing comorbidities as a data category, there was such variance in provider answers that attempting to standardize for comorbid conditions would likely require a particular focus and new study design. It is possible that the influence of comorbid illnesses can be further explored in more targeted studies of aspects such as hospital and emergency department disposition. Finally, there was no ability to follow patients after final discharge from the hospital; each patient case represented only a single treatment encounter. Long-term sequelae, morbidity, and delayed mortality such as from subsequent disability, infections, or other health problems were not able to be assessed. The primary focus of this study was therefore on what was recorded for an acute care episode.

The results of this study suggest topics for further, more focused investigation. One potential future topic involves the evaluation of subsequent encounters such as emergency department “bounce-backs,” future hospital admissions, and the persistent long-term disability that can accompany severe traumatic injuries. This can provide greater insight into the consequences of the differences in emergency department and hospital disposition determined to be present within this study. Another topic to be

further approached is the impact of comorbidities both by standardizing for them and removing their impact altogether as well as identifying if there are certain medical illnesses that are high risk prognosticators of mortality in acute trauma care. The fact that GCS scores were markedly different across insurance populations prior to accounting for mortality also marks this as an area of potential future investigation, especially in the context of equal injury severity score distribution.

Conclusion

This study confirmed that there is an existing difference in mortality rates following trauma for patients with different types of health insurance, with especially poor outcomes for uninsured patients. A smaller disparity was noticed between those with Medicaid versus private or commercial insurance. Interpretation of Medicare patients was difficult due to the substantial demographic differences within this population. This study provided new insight into individual aspects of patient care and treatment that may be contributing to prior observed differing mortality rates. The strongest effect sizes were associated with hospital disposition, emergency department disposition, hospital length of stay, number of ICU days, EMS GCS score, and emergency department GCS score. The first four variables identify the major finding of this paper that an individual's health insurance category is leading to differences in disposition both after leaving the emergency department and after final discharge from the hospital, more than differences in initial pre-hospital and hospital medical treatment. The secondary finding of GCS score playing a large role in mortality serves to confirm the utility of this test over other physical signs as a predictor of trauma mortality.

These disposition differences are linked with disparate patient survival outcomes. The reasons why this phenomenon is occurring needs to be more fully investigated with subsequent research. Possible causes include patient preference during "shared decision making" given financial pressures, bias on the part of providers possibly out of financial pressures to help patients, systemic or institutional policies that may unknowingly favor certain groups, or a combination of these issues. Knowledge of this information can be of benefit at many levels. It can prompt further research and investigation into an underexplored area, based on an assumption that this type of inequality is not acceptable to the practice of emergency medicine. Dissemination of these findings to providers can better help to guard against inherent biases, if they are present. Similarly, better awareness of these results can help identify systemic barriers that may be working at an institutional level and allowing differences in health insurance coverage to exert themselves during the hospital encounter.

Ultimately, this study helped further identify a shortcoming in the emergency response system that was previously thought to be corrected by federal statute. In doing so, it showed the immense power of health insurance coverage to shape final outcomes within our current healthcare system across every aspect of medical care, even when medical care itself has been standardized. Thirty years after the mandate to see all presenting patients equally, the United States healthcare framework is still failing uninsured and underinsured individuals even in the emergency setting. The fact that such a difference exists even for trauma mortality suggests that the ultimate healthcare burden for uninsured individuals is can be higher in other areas of medicine. Efforts must continue to reduce any inequities experienced by uninsured and underinsured Americans

in their healthcare. This study adds to our understanding of potential deficiencies in our society's goal of providing all Americans with equal, high-quality care.

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