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Insurance status, mortality, and hospital use among pediatric trauma patients over three decades

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ABSTRACT

Background: We investigated the association between lack of insurance and mortality, resource use, and medical comorbidities among pediatric trauma patients.
Methods: Our trauma database was queried for patients <18 years old from 1989 through 2013. Data collected included demographics, injury severity score (ISS), and insurance status. Dependent variables included major medical comorbidities, hospital and ICU lengths of stay (LOS), and mortality. Logistic regression and tests of equivalence were used to analyze the data.
Results: A total of 3120 patients were included. The mortality among patients with insurance was 3.6% compared to 8.4% among those without insurance ($p = 0.0001$, OR = 2.42, 95% CI = 1.53–3.82). This relationship remained statistically significant with adjustment via multivariable logistic regression ($p = 0.0001$, OR = 2.83, 95% CI: 1.64–4.74). Hospital and ICU LOS were significantly greater among insured patients in severely and moderately injured samples, respectively. There was no correlation between insurance and medical comorbidities. The uninsured mortality rate was 12.9% from 1989 to 1997 compared to 3.9% in 2006–2013.
Conclusion: Lack of insurance was associated with mortality but not preexisting comorbidity. This relationship persisted over time despite an overall decline in mortality. Additionally, lack of insurance was associated with decreased hospital stay and ICU utilization.
Level of evidence: Treatment Study, Level III.

Despite advances in prevention and treatment, injury remains a leading cause of both morbidity and mortality among pediatric patients of all age groups in the United States [1]. Prior studies using the National Trauma Data Bank have established an association between both race and lack of insurance among pediatric trauma victims and in-hospital mortality [2,3]. While the number of subjects included from multiple institutions is of considerable merit in such studies, the validity of conclusions from these studies has been questioned because of the nature of using a large, national database; in particular, with respect to heterogeneity of available data and handling of missing data points [4,5]. In some cases, a slightly different methodology using similar data may yield different results. For example, another study found no association between race and mortality among pediatric trauma victims when controlling for additional physiologic variables at admission, but did reiterate the connection with insurance status [6].

Although evidence for the relationship between pediatric trauma victim insurance payer status and outcome continues to expand, fewer studies have suggested possible explanations for this association. There is a similar paucity of published data regarding such trends over any considerable length of time. We aim to investigate a possible association among race, preexisting medical comorbidities, insurance status, hospital and intensive care unit lengths of stay (HLOS and ICU LOS), and mortality among pediatric trauma patients evaluated at our Level I trauma center over 25 years. Additionally, we aim to describe associated trends in these areas over time.

1. Patients and methods

Since the advent of computerized records at our state-verified Level I trauma center in 1989, our institution has maintained an electronic database of all patients evaluated by its trauma service. While the variables captured by this database have undergone expansion since its inception, those collected continuously include basic demographics, mechanism of injury with injury severity score (ISS), Glasgow Coma Score (GCS), payer and insurance statuses, mortality, ICU LOS, and HLOS. Preexisting medical comorbidities prior to evaluation have been captured since 2000.

This database was queried for all patients <18 years of age evaluated from 1989 through 2013, for a total of 25 years. Only patients with complete demographics and injury data were included in the study. Patients were considered to have some insurance if they had any private or

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Medicaid coverage during their stay. Children receiving any Medicaid benefits were also analyzed in the Medicaid group. Analyses of medical comorbidities were performed separately and included all pediatric patients evaluated from 2000 through 2013.

Major medical comorbidities were captured based on organ system and included chronic and congenital cardiovascular, respiratory, endocrine, gastrointestinal, and neurological diseases. Both HLOS and ICU LOS were analyzed among patients after stratification by ISS, a validated predictor of need for ICU among pediatric trauma patients [7].

Chi-square and Fisher's exact tests were then used to analyze the unadjusted association between independent categorical variables (insurance status, race) and the primary outcome of mortality, as well as the association between insurance status and medical comorbidities. The Wilcoxon rank-sum test was used for continuous variables without normal distributions (HLOS, ICU LOS). Percent mortality by insurance group over time was then calculated and reported for three time periods (early, 1989–1997; middle, 1998–2005; late, 2006–2013). These time periods were based on equal length of time for analysis. Finally, a stepwise logistic regression model was fitted to adjust for effects of relevant confounders on mortality. Age, gender, race, ISS, mechanism, GCS on arrival, and insurance status were included in the model as explaining variables regardless of statistical significance.

Area under the receiver operating characteristic (ROC) curve was calculated to determine model performance, and $p < 0.05$ was taken to indicate statistical significance in all cases. Odds ratios (OR) and 95% confidence intervals (CI) were calculated and reported. All statistical analyses were performed with JMP Pro 11 (SAS Institute Inc., Cary, NC).

2. Results

A total of 3380 patients <18 years of age were evaluated by the trauma service from 1989 through 2013. Of these, 3120 (92.3%) had complete records and were included in subsequent analysis. The overall mortality rate in the sample was 4.2%. The mortality rate for those with insurance was 3.7% compared to 8.8% among those who were uninsured ($p < 0.0001$, OR 2.5, 95% CI 1.6–4.0). Overall, 8.8% of children lacked insurance during their admission. In total, 25.4% of children received some Medicaid benefits. The sample was 82.9% white and 13.2% African American or black, with the remainder roughly equally divided among other races. These demographics are closely representative of the metropolitan area [8]. There was no statistically significant difference between mortality among white patients (4.2%) and non-white patients (3.9%, $p = 0.7588$). There were subtle but statistically significant differences in the distributions of injury mechanism, race, and age between the variable (uninsured) and control (insured) groups. However, groups were statistically equivalent with respect to gender, ISS, and ED arrival GCS ($p > 0.05$, Table 1).

The proportion of children receiving some Medicaid benefits gradually but progressively increased throughout the course of the study (Fig. 1). This increase became most pronounced in the early 2000s, culminating in a maximum of over 50% of children evaluated for traumatic injury receiving at least some Medicaid benefits in 2013. There was not an obvious trend in the percent of patients without any insurance over time.

Multivariable logistic regression considering age, gender, ISS, GCS, white race, mechanism of injury (blunt vs. penetrating/burn), and lack of insurance as explaining variables with an outcome of mortality revealed multiple independent associations (Table 2). Predictably, ISS, lower GCS, and penetrating mechanism were all directly associated with mortality ($p < 0.05$). Lack of insurance was significantly associated with mortality ($p = 0.0068$, OR 2.8, 95% CI 1.3–6.1). There was no statistically significant association between age, gender, or race and mortality in this analysis. Model performance was deemed to be adequate based on an area under the ROC curve of 0.98.

Analysis of preexisting medical comorbidities among patients evaluated from 2000 through 2013 included 2211 patients. Disease states most frequently observed and recorded in our sample population included asthma, obesity, and seizure disorders. There was no significant association between lack of insurance and frequency of any of preexisting medical comorbidity.

Throughout the 25-year study period, mortality progressively decreased, with the greatest absolute and relative changes among uninsured patients (Fig. 2). However, some decrease was observed in both uninsured and insured patient groups over time, as well as among children receiving some Medicaid benefits. The percent mortality among uninsured patients dropped from 13.7% in 1998–2005 to 3.9% in 2006–2013. This change was statistically significant ($p < 0.05$). Notably, the percent mortality among uninsured patients was considerably higher than the control sample at each time point, with the greatest absolute and relative difference in the middle time point (13.7% mortality among uninsured vs. 4.0% among those with some insurance). Interestingly, the mortality rate among children receiving some Medicaid benefits was somewhat lower than the overall insured sample in the middle and late time points (1998–2005 and 2006–2013).

The median HLOS in the study was 1 day (interquartile range, 2 days). Among those with only minor injuries (ISS <9), there was no significant difference in HLOS between insured and uninsured patient groups (median LOS 1 day in each study group, Table 3). However, HLOS tended to be shorter among uninsured moderately injured (ISS 9–15) patients ($p = 0.0547$), with the trend continuing and becoming statistically significant among severely injured patients ($p = 0.0004$). In the severely injured sample, the median HLOS among uninsured was 3 days less than those with any insurance. In a similar fashion, patients with moderate and severe injury severities had disparate ICU use; however, the difference was only statistically significant among the moderate injury group ($p = 0.0222$). There were 160 patients who were recorded as using positive pressure ventilation for at least one day.

Table 1
Comparison of patient and injury factors by insurance status.

	Insured ($n = 2847$)	Uninsured ($n = 273$)	p
Age, median	14 (8)	13 (9)	0.0430*
Male gender	62.5%	67.0%	0.1345
White race	83.6%	75.5%	0.0007*
Mortality	3.7%	8.8%	< 0.0001*
Referral	69.0%	69.2%	0.9331
ISS, median	6 (10)	8 (11)	0.8790
ED arrival GCS, median	15 (0)	15 (1)	0.5858
Hospital LOS, median	1 (1)	1 (3)	0.0019*
Blunt injury mechanism	93.2%	83.9%	< 0.0001*

All length of stay values are represented as median number of days. Interquartile range in parentheses. ISS: injury severity score, ED: emergency department, GCS: Glasgow Coma Scale, LOS: length of Stay.
* $p < 0.05$.

3. Discussion

Using a robust institutional database that obviates many concerns regarding data integrity of other similar studies, we have demonstrated a powerful and statistically significant association between pediatric trauma mortality and lack of insurance, independent of other factors. Importantly, we have also underscored the magnitude of the problem by finding that nearly 9% of our overall pediatric trauma patient population lacked insurance at presentation. This rate is considerably higher than figures for national pediatric inpatients and roughly in line with those pertaining specifically to trauma patients, highlighting the importance of focused efforts to reach this patient population [9,10]. By controlling for demographic, injury, and physiologic factors, the independence of this association is asserted. Race was not associated with mortality in the logistic regression model, lending further evidence