Journal of Public Health Advance Access published October 29, 2009

Journal of Public Health | pp. 1–9 | doi:10.1093/pubmed/fdp099

Analysis of 23 million US hospitalizations: uninsured children have higher all-cause in-hospital mortality

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ABSTRACT

Background The number of uninsured children in the USA is increasing while the impact on children's health of being uninsured remains largely uncharacterized. We analyzed data from more than 23 million US children to evaluate the effect of insurance status on the outcome of US pediatric hospitalization.

Methods In our analysis of two well-known large inpatient databases, we classified patients less than 18 years old as uninsured (self-pay) or insured (including Medicaid or private insurance). We adjusted for gender, race, age, geographic region, hospital type, admission source using regression models. In-hospital death was the primary outcome and secondary outcomes were hospital length of stay and total hospital charges adjusted to 2007 dollars.

Results The crude in-hospital mortality was 0.75% for uninsured versus 0.47% for insured children, with adjusted mortality rates of 0.74 and 0.46%, respectively. On multivariate analysis, uninsured compared with insured patients had an increased mortality risk (odds ratio: 1.60, 95% CI: 1.45–1.76). The excess mortality in uninsured children in the US was 37.8%, or 16 787, of the 38 649 deaths over the 18 period of the study.

Conclusion Children who were hospitalized without insurance have significantly increased all-cause in-hospital mortality as compared with children who present with insurance.

Introduction

Within the USA, the number of uninsured children has been increasing in recent years, both in absolute number and in proportion to the population. In 2006, an additional 1.4 million children were added to the ranks of the uninsured, bringing the total to 9.4 million, or 12.1% of all US children.[1] This increase has been attributed to declines in employer coverage without commensurate increases in coverage provided through Medicaid or the State Children's Health Insurance Program (SCHIP).[2,3] Uninsured adults[4] are less likely to receive preventative care,[5,6] are more severely ill when diagnosed,[7,8] and have worse outcomes.[7–12] In pediatric patients, insurance status has been shown to reduce unmet healthcare needs,[13] improve access to health care,[14,15] and improve utilization of health care.[16] Furthermore, pediatric data from the National Inpatient Sample (NIS) has demonstrated an association between increased mortality and pediatric patients without insurance.[17] Nevertheless, the global impact of insurance status on inpatient pediatric mortality remains largely uncharacterized.

Given the substantial policy debates regarding expanding SCHIP, a better understanding of the risks and benefits of providing improved insurance coverage to children is needed. The specific aim of this study was to use a collection of administrative databases in the USA from 1988 to 2005 to characterize the impact of insurance status on inpatient mortality and costs of care.

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Methods

Databases

The analysis was based on a non-overlapping combination of 15 years of the NIS (1988–1996, 1998–1999, 2001–2002, 2004–2005) and 3 years of the Kids' Inpatient Database (KID) database (1997, 2000, 2003). Both databases are produced by the Healthcare Cost and Utilization Project (HCUP) of the Agency for Healthcare Research and Quality. The NIS is an all-payer database that annually contains information from up to 8 million inpatient discharges from approximately 1000 hospitals across the USA and represents a 20% stratified sample of all hospitals from 37 states.[18]

The KIDs' database contains a sample of pediatric discharges from all the community, non-rehabilitation hospitals in states, which participate in the HCUP. Unlike the NIS, with hospital-level sampling, the KID samples patient discharges are then weighted to obtain national estimates. The algorithm involves systematic random sampling to select 10% of uncomplicated in-hospital births and 80% of complicated in-hospital births as well as other selected pediatric cases. The KID contains information from up to 36 states.[19] Information collected on patients in both databases includes age at admission, gender, race, diagnosis and procedure information, insurance status, admission source, total hospital charges, disposition, length of stay (LOS) and descriptive hospital information (state, urbanicity, teaching status and bed size). Geographic regions were defined by US Census standards. Hospitals in metropolitan counties were considered urban, while hospitals in micropolitan or non-core areas were classified as rural. A hospital is considered to be a teaching hospital by the American Hospital Association if it has an American Medical Association-approved residency program, is a member of the Council of Teaching Hospitals or has a ratio of full-time equivalent interns and residents to beds of 0.25 or higher.[20] Admission sources of the non-emergency department category included transfers from another acute care hospital, long-term care facility, outpatient clinics or correctional facilities.

Inclusion criterion for the analysis was an age at admission of less than 18 years. The primary-dependent variable was inpatient mortality while secondary-dependent variables were hospital LOS and total hospital charges in 2007 dollars using the medical care consumer price index.[21] The primary exposure variable was insurance status. Patients were divided into uninsured and insured groups based on the recorded primary payer. Self-pay patients were defined as uninsured while individuals whose expected primary payer was Medicare, Medicaid or private insurance (including Blue Cross, commercial carriers, private HMOs and PPOs) were classified as insured. Unknown insurance status patients were excluded from comparative analyses.

Data management and analysis

A descriptive analysis was performed using variables of gender, race, inpatient mortality, geographic region (Northeast, Midwest, South, West), type of hospital (urban teaching, urban non-teaching and rural), and admission source (emergency department, non-emergency department). Summary statistics for LOS and inflation-adjusted total hospital charges were calculated.[21] National estimates were produced by using the discharge weights to extrapolate from the NIS or KID data sets to the discharges from all US non-rehabilitation hospitals.

Unadjusted comparisons between groups were performed using Pearson's chi-square for categorical variables or the Wilcoxon Rank Sum test for non-normally distributed continuous variables. Multiple logistic regression was utilized to evaluate the impact of insurance status on inpatient mortality. To evaluate the impact of insurance status on LOS and charges, we used linear regression without transformation to facilitate interpretation. An interaction term between race and insurance among patients with available data was included in the regression analysis. Subset analysis was performed in patients aged 1 or older to eliminate the potential influence from inadequate prenatal care. Additional subset analyses were performed in subgroups across the entire spectrum of ICD-9 diagnosis codes, divided into subcategories by major disease groupings similar to that used by the National Hospital Discharge Survey (NHDS), the largest and longest running survey of hospital utilization in the USA.[22] Simulation was performed by applying the adjusted death rates among insured hospitalizations, as calculated based on the overall multivariate model, to uninsured hospitalizations. An alternative simulation analysis was performed where uninsured patients were grouped with Medicaid patients for comparison with insured patients. Stata/Multi-Processor, version 10 (College Station, TX), was used for the analysis.

The study was exempted by the Johns Hopkins Institutional Review Board.

Results

Demographic data of uninsured and insured patients

Data from 23 535 491 pediatric inpatient hospitalizations from 37 US states were analyzed. Of these, 5.4%

($n = 1\,262\,452$) were uninsured and 94.6% ($n = 22\,273\,039$) were insured (Table 1). Although statistically different, there was similar proportion of female patients in both the uninsured and insured groups (48.90 versus 48.67%, $P < 0.001$). Analysis of available race information demonstrated that Black (17.37 versus 15.72%) and Hispanic (26.38 versus 19.65%, $P < 0.001$) patients were more likely to be uninsured versus White patients (45.86 versus 56.82%, $P < 0.001$). Race data were not available for approximately 30% of identified pediatric patients as reporting is limited by hospitals and states.[23] Similar proportions of uninsured children were under age 1 (66.83 versus 66.62%, $P < 0.001$) and 11–18 (16.56 versus 15.24%, $P < 0.001$).

Table 1 Demographics of study population and hospital characteristics

Characteristic	*Uninsured, N = 1 262 452 (%)*	*Insured, N = 22 273 039 (%)*	*P-value*
Gender			
Male	643 733 (50.99)	11 400 733 (51.19)	<0.001
Female	617 355 (48.90)	10 839 366 (48.67)	
Unknown	1364 (0.11)	32 940 (0.15)	
Race[a]			
White	413 047 (45.86)	8 912 760 (56.82)	<0.001
Black	156 470 (17.37)	2 465 233 (15.72)	
Hispanic	237 584 (26.38)	3 081 338 (19.65)	
Other	93 576 (10.39)	1 225 742 (7.81)	
Age (in years)			
<1	843 646 (66.83)	14 838 719 (66.62)	<0.001
1–5	137 059 (10.86)	2 664 839 (11.96)	
6–10	72 715 (5.76)	1 374 012 (6.17)	
11–18	209 032 (16.56)	3 395 469 (15.24)	
Geographic region			
Northeast	304 636 (24.13)	4 570 735 (20.52)	<0.001
Midwest	298 308 (23.63)	4 776 434 (21.44)	
South	396 722 (31.42)	7 179 995 (32.24)	
West	262 785 (20.82)	5 745 874 (25.80)	
Unknown	≤10	≤10	
Type of hospital			
Urban, teaching	600 339 (47.55)	10 638 658 (47.76)	<0.001
Urban, non-teaching	484 827 (38.40)	9 025 059 (40.52)	
Rural	170 956 (13.54)	2 543 238 (11.42)	
Unknown	6 330 (0.50)	66 084 (0.30)	
Admission source			
Emergency department	289 411 (22.92)	4 056 350 (18.21)	<0.001
Non-emergency department	877 28 (69.49)	16 863 218 (75.71)	
Unknown	95 755 (7.58)	1 353 471 (6.08)	

[a]Not all states collected information on race (29.58% unknown in insured and 28.66% in uninsured).

Hospital characteristics of uninsured and insured pediatric patients

A higher percentage of uninsured pediatric patients were seen in hospitals located in the Northeast (24.13 versus 20.52%, $P < 0.001$) and Midwest (23.63 versus 21.44%, $P < 0.001$) while a lower percentage were seen in states in the South (31.42 versus 32.24%) and West (20.82 versus 25.80%, $P < 0.001$) (Table 1). Pediatric patients from both groups were almost equally likely to be treated at urban teaching hospitals (47.55 versus 47.76%, $P < 0.001$) and urban non-teaching hospitals (38.40 versus 40.52%, $P < 0.001$). Uninsured pediatric patients compared with insured were more likely to present through the Emergency department (22.92 versus 18.21%, $P < 0.001$).

Inpatient hospitalization outcomes of uninsured and insured pediatric patients

Median LOS was 2 days (interquartile range: 1–3) for both the uninsured and insured groups (Table 2). Among patients who died during the admission, the uninsured pediatric patient had a shorter median LOS of 0 days (interquartile range: 0–2) versus insured patients with a median LOS of 1 day (interquartile range: 0–9). In contrast, among patients who survived their hospitalization, there was a smaller difference in LOS, with the uninsured having a median LOS of 2 days (interquartile range: 1–3) and the insured patients having a similar a median LOS of 2 days (interquartile range: 2–3).

Mean and median total hospital charges were lower in the uninsured ($9388, $3034) versus insured group ($12 637, $43 349). Among pediatric patients who died during their hospitalization, insurance status was significantly associated with total hospital charges, as median total hospital charges for uninsured patients who died were substantially lower than those who died and were insured ($8058 versus $20 951). Disparity remained between median total hospital charges of uninsured and insured children who survived their hospitalizations but was not as large ($3024 versus $3333).

In-hospital crude mortality was higher for uninsured children than insured (0.75 versus 0.47%). Crude mortality rates

Table 2 In-Hospital mortality, LOS and total hospital charges for uninsured and insured patients

Outcome	*Uninsured, N = 1 262 452 (%)*	*Insured, N = 22 273 039 (%)*	*P-value*
In-hospital mortality			
Total death	9468 (0.75)	104 520 (0.47)	<0.001
Gender			
Male	5546 (0.86)	58 320 (0.51)	<0.001
Female	3908 (0.63)	46 080 (0.43)	
Race			
White	2539 (0.61)	35 039 (0.39)	<0.001
Black	1911 (1.22)	17 102 (0.69)	
Hispanic	1409 (0.59)	14 133 (0.46)	
Others	661 (0.71)	6981 (0.57)	
Age (in years)			
<1	7370 (0.87)	78 722 (0.53)	<0.001
1–5	604 (0.44)	9778 (0.37)	
6–10	286 (0.39)	4655 (0.34)	
11–18	1208 (0.58)	11 365 (0.33)	
LOS (days)			
Median (IQR)	2 (1–3)	2 (1–3)	<0.001
Death	0 (0–2)	1 (0–9)	
Alive	2 (1–3)	2 (2–3)	
Total hospital charges ($)[a]			
Mean (no.)	9388 (1 218 077)	12 637 (21 374 281)	<0.001
Median (IQR)	3034 (1419–7637)	3349 (1551–8852)	
Death	8058 (1283–31 119)	20 951 (3527–83 958)	
Alive	3024 (1420–7570)	3333 (1549–8778)	

IQR, interquartile range.

[a]Adjusted for medical care inflation to 2007 dollars.

Table 3 Adjusted analysis for factors associated with inpatient mortality, 1988–2005

Mortality	*OR*	*P-value*	*95% CI*	
Insurance status				
Insured	Ref.			
Uninsured	1.60	<0.001	1.45	1.76
Gender				
Male	Ref.			
Female	0.85	<0.001	0.83	0.86
Race				
White	Ref.			
Black	1.50	<0.001	1.40	1.61
Hispanic	0.96	0.260	0.88	1.03
Others	1.19	0.001	1.07	1.31
Age (in years)				
<1	Ref.			
1–5	0.62	<0.001	0.58	0.66
6–10	0.57	<0.001	0.54	0.61
11–18	0.63	<0.001	0.60	0.67
Hospital region				
Northeast	Ref.			
Midwest	1.25	0.046	1.00	1.55
South	1.31	<0.001	1.13	1.52
West	1.42	<0.001	1.20	1.68
Type of hospital				
Urban, teaching	Ref.			
Urban, non-teaching	0.37	<0.001	0.33	0.42
Rural	0.22	<0.001	0.18	0.27
Calendar year				
1988–92	Ref.			
1993–97	0.91	0.221	0.79	1.05
1998–2002	0.87	0.088	0.74	1.02
2002–05	0.92	0.297	0.78	1.08

for uninsured were higher in every patient subgroup analyzed by gender, race, age, hospital region, or type of hospital (Table 3).

Adjusted analysis of factors affecting mortality

Multivariate analysis of factors that contribute to mortality is presented in Table 3. Children hospitalized while being uninsured had a 1.60 (95% CI: 1.45–1.76) times higher likelihood of death. Among the entire cohort of 23 million children, girls had decreased mortality compared with boys (odds ratio (OR): 0.85, 95% CI: 0.83–0.86). Black children had increased mortality (OR: 1.50 versus reference White, 95% CI: 1.40–1.61). Increasing age was protective against mortality, with OR of 0.62, 0.57, 0.63 for age groups 1–5, 6–10, 11–18, respectively, versus age less than 1.

Hospitals in the Midwest, South, and West demonstrated a higher mortality as compared with the Northeast (OR 1.25, 1.31, 1.42). Rural and non-teaching urban hospitals were protective (OR: 0.22 and 0.37 versus urban teaching hospitals). Analysis of mortality trends showed improvement in outcomes over time with OR of 0.91, 0.87, 0.92, for calendar years 1993–1997, 1998–2002, 2002–2005, respectively, as compared with 1988–1992. In subset analysis of patients aged 1 or older, mortality did not change significantly, with OR of 1.50 (95% CI: 1.36–1.64) for uninsured versus insured hospitalization. Interaction terms between race and insurance were found to be non-significant.

Additional multivariate analysis revealed that uninsured hospitalizations have 0.6 days shorter lengths of stay and $2342 lower total hospital charges. Adjusted mortality rates calculated based on the multivariate analysis were 0.74% for uninsured patients versus 0.46% for insured patients, corresponding to an excess mortality of 37.8% (Fig. 1).

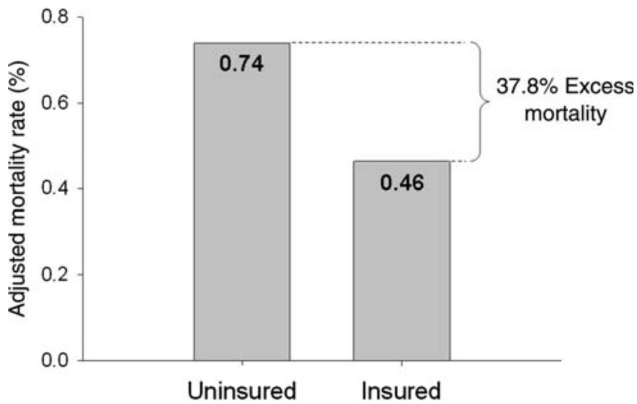

Fig. 1 Adjusted mortality rates calculated based on the multivariate analysis for uninsured versus insured patients.

Subset analysis of factors affecting mortality by first-listed diagnosis

Subset analysis for groups of patients separated by first-listed diagnosis is presented in Table 4. The largest categories of the first-listed diagnosis were complications relating to birth, pneumonia and asthma, a distribution that was similar to data from the NHDS. There was no quantitative difference across categories, in almost all groups uninsured patients were significantly more likely to die than uninsured patients.

Another subset analysis was performed by race, and similarly confirmed the deleterious effects of uninsurance in all racial groups (data not shown).

Preventable death projections

Applying the adjusted mortality rate among insured hospitalizations (0.46%) to the uninsured hospitalizations, our simulation estimated that 3535, or 37.8%, of the deaths among uninsured hospitalizations might have been prevented by insurance coverage, assuming no other confounding factors (Fig. 1). Extrapolating data to the entire US population

Table 4 Number of discharges, deaths, and adjusted OR of death by first-listed diagnosis

Category of first-listed diagnosis	*ICD-9 code*	*Total number*	*Number of deaths*	*Death rate (%)*	*OR*[a]	*95% CI of OR*	
All conditions		23 535 491	113 988	0.48	1.60	1.45	1.76
Infectious and parasitic diseases	001–139	573 686	1472	0.26	1.00	0.79	1.26
Septicemia	038	76 477	1432	1.87	0.76	0.54	1.07
Neoplasms	140–239	9676	146	1.51	1.09	0.40	3.01
Malignant neoplasms	140–208, 230–234	83 084	3041	3.66	0.91	0.72	1.15
Malignant neoplasm of large intestine and rectum	153–154, 197.5	326	23	7.06	0.75	0.04	14.60
Malignant neoplasm of trachea, bronchus, and lung	162, 176.4, 197.0, 197.3	1,922	125	6.50	0.75	0.27	2.08
Benign neoplasms	210–229	34 144	51	0.15	NC	NC	NC
Benign neoplasm of uterus	218–219	93	0	0.00	NC	NC	NC
Endocrine, nutritional and metabolic diseases, and immunity disorders	240–279	74 094	710	0.96	0.91	0.54	1.52
Diabetes mellitus	250	110 577	132	0.12	1.38	0.61	3.13
Volume depletion	276.5	369 598	263	0.07	1.03	0.53	2.01
Diseases of the blood and blood-forming organs	280–289	104 386	214	0.21	0.48	0.16	1.43
Anemias	280–285	120 400	287	0.24	1.55	0.86	2.82
Mental disorders	290–319	299 874	48	0.02	0.54	0.07	4.13
Psychoses	290–299	98 431	10	0.01	NC	NC	NC
Schizophrenic disorders	295	12 489	≤10	0.02	NC	NC	NC
Major depressive disorder	296.2–296.3	147 526	12	0.01	3.46	0.32	37.81
Diseases of the nervous system and sense organs	320–389	306 924	2328	0.76	1.44	1.14	1.82

Continued

Table 4 *Continued*

Category of first-listed diagnosis	*ICD-9 code*	*Total number*	*Number of deaths*	*Death rate (%)*	*OR*[a]	*95% CI of OR*	
Diseases of the circulatory system	390–459	34 201	156	0.46	1.59	0.72	3.53
Essential hypertension	401	3027	≤10	0.17	7.59	0.84	68.78
Heart disease	391, 392.0, 393–398, 402, 404, 410–416, 420–429	22 798	816	3.58	1.40	0.93	2.10
Acute myocardial infarction	410	481	66	13.72	1.04	0.18	6.14
Coronary atherosclerosis	414.0	155	≤10	1.94	NC	NC	NC
Other ischemic heart disease	411–413, 414.1–414.9	455	≤10	1.98	NC	NC	NC
Cardiac dysrhythmias	427	22 064	1045	4.74	2.22	1.60	3.09
Congestive heart failure	428.0, 428.2–428.4	9,023	579	6.42	1.13	0.68	1.88
Cerebrovascular disease	430–438	10 884	789	7.25	1.52	1.02	2.28
Diseases of the respiratory system	460–519	548 554	3357	0.61	0.76	0.60	0.97
Acute bronchitis and bronchiolitis	466	560 320	232	0.04	0.40	0.13	1.22
Pneumonia	480–486	727 209	1937	0.27	0.49	0.34	0.69
Chronic bronchitis	491	3775	20	0.53	2.08	0.23	18.50
Asthma	493	681 283	204	0.03	0.91	0.45	1.84
Diseases of the digestive system	520–579	289 048	1012	0.35	1.10	0.78	1.56
Appendicitis	540–543	311 970	39	0.01	1.01	0.24	4.31
Non-infectious enteritis and colitis	555–558	236 772	220	0.09	0.70	0.27	1.84
Intestinal obstruction	560	44 240	191	0.43	0.72	0.27	1.91
Diverticula of intestine	562	417	≤10	0.48	NC	NC	NC
Cholelithiasis	574	19 075	14	0.07	NC	NC	NC
Acute pancreatitis	577.0	12 490	49	0.39	NC	NC	NC
Diseases of the genitourinary system	580–629	254 547	291	0.11	0.73	0.33	1.65
Calculus of kidney and ureter	592	13 255	≤10	0.01	NC	NC	NC
Urinary tract infection	599.0	101 664	62	0.06	NC	NC	NC
Complications of pregnancy, childbirth, and the puerperium	630–677	854 127	79	0.01	3.69	1.70	7.99
Diseases of the skin and subcutaneous tissue	680–709	57 401	48	0.08	0.46	0.07	3.20
Cellulitis and abscess	681–682	142 111	26	0.02	NC	NC	NC
Diseases of the musculoskeletal system and connective tissue	710–739	196 643	209	0.11	1.12	0.50	2.50
Osteoarthrosis and allied disorders	715	432	0	0.00	NC	NC	NC
Intervertebral disc disorders	722	4117	≤10	0.02	NC	NC	NC
Congenital anomalies	740–759	405 786	7854	1.94	1.55	1.33	1.79
Certain conditions originating in the perinatal period	760–779	565 037	12 702	2.25	1.64	1.46	1.85
Symptoms, signs, and ill-defined conditions	780–799	607 388	1376	0.23	1.15	0.83	1.58
Injury and poisoning	800–999	460 322	7337	1.59	1.77	1.58	1.98
Fractures, all sites	800–829	395 786	3099	0.78	1.84	1.57	2.15
Fracture of neck of femur	820	11 259	52	0.46	NC	NC	NC
Poisonings	960–989	145 161	355	0.24	1.81	1.26	2.59
Certain complications of surgical and medical care	996–999	172 449	1090	0.63	0.62	0.35	1.08
Supplementary classifications	V01–V84	13 175 628	58 193	0.44	1.78	1.59	1.98
Females with deliveries	V27	122	0	0.00	NC	NC	NC

NC, not calculable.

[a]OR (uninsured versus insured) adjusted for gender, race, age category, hospital region, type of hospital and calendar year interval.

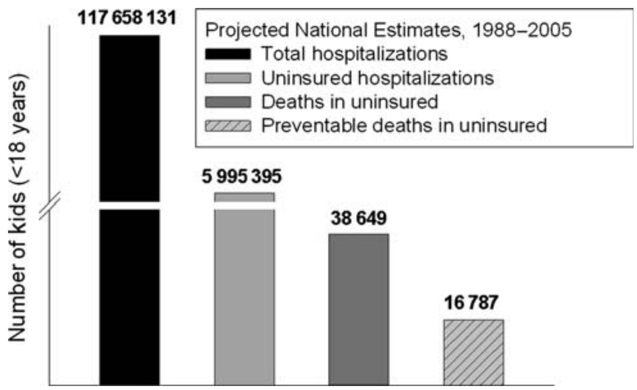

Fig. 2 Data showing number of hospitalizations with regard to uninsured patients.

using the weights provided in the NIS database, the total number of hospitalizations for the time period of the study in the US was 117 million (Fig. 2). Of these, 5 995 395 were hospitalized with no insurance at admission and 38 649 of this group went on to die during that same hospitalization. Provision of insurance may potentially have allowed 16,787 children to survive over the 18 years period of the study according to the simulation.

Preventable death projections: alternative classification of the uninsured

Since Medicaid patients are heterogeneous with a proportion maintaining long-term coverage while others might gain retroactive coverage upon discharge, we decided to perform the analysis utilizing an alternative classification where patients who received insurance retroactively were classified into the uninsured group. Using this alternative categorization, the adjusted mortality rate among the insured was 0.44% as compared with 0.52% among the uninsured/Medicaid population. Of the 241 209 deaths that occurred in the uninsured/Medicaid population, the simulation suggests that 39 323 deaths may have been prevented by providing insurance. This sensitivity analysis confirmed that our model does not change qualitatively regardless of whether Medicaid patients were classified as insured or uninsured.

Discussion

Main finding of this study

Analyzing data from 23 million admissions over 18 consecutive years, our study demonstrates that US children who were hospitalized without insurance had significantly increased all-cause mortality as compared with children with insurance. The adjusted mortality of uninsured children was approximately 60% higher than insured children. Extrapolating data to national figures, we estimate that 16 787 deaths of 5 995 395 uninsured hospitalizations might have been prevented over this time period assuming lack of insurance was the driving factor.

Although the overall LOS of insured and uninsured children was the same, insured children who died were likely to be hospitalized longer by 1 day, which may be an indirect indicator of disease severity of the uninsured at presentation. Similarly, total hospital charges for insured children who died were substantially higher at $20 951 per patient as compared with uninsured children at $8058. This may be due to the higher disease severity of uninsured children, which precludes them from receiving additional care as they likely expired sooner than the group of insured children who also died in the hospital. This presumption of increased disease severity of uninsured children is partially supported by the noted difference in resources being expended on uninsured and insured children who live during their hospitalization which is much less.

While this type of study cannot establish a causal relationship between lack of insurance and increased mortality in children, the findings are consistent with similar associations found in adults.[24–26] The lack of insurance may be a surrogate for socioeconomic status especially impacting pre-natal care. Similar to analysis of adult populations,[4] parents of children without insurance may have limited access to health services and be more likely to use the Emergency department as their primary source of care,[5,6] have more advanced disease when they present for care[7,8] and have a higher rate of avoidable hospital stays.[27,28] However, when we limited our analysis to patients 1 year and older, in an attempt to exclude the potential negative impact of poor pre-natal care, results were similar.

What is already known on this topic

While most developed countries provide universal health insurance, the US does not. Many health policy experts believe that the US should provide health care regardless of its ability to pay.[29–33] The lack of insurance contributes to worse health outcomes and increased costs of care in adults.[7–11,27,28,33,34] Our study provides evidence that the lack of insurance in children may have similar consequences, with a 60% increased risk of mortality.

What this study adds

We used comprehensive data that covers up to 37 states over the 18 year period, thus minimizing institutional and regional variations present in smaller datasets and case series. Additionally, our study included all pediatric patients admitted to a hospital rather than patients with a specific disease or having a specific procedure. Our methodology in categorizing uninsured versus insured patients is one of the more stringent of previous approaches. Only children under 18 years of age who had insurance information available in the database at the time of discharge were included in the study. Children labeled as 'self-pay' were placed into the uninsured category whereas patients with Medicaid or private insurance were placed in the insured category. However, many children labeled as having Medicaid insurance for the purposes of our study may have initially presented to the hospital without insurance but then received coverage retroactively after being enrolled in the SCHIP program. Using discharge data, we cannot separate children who are admitted with Medicaid versus those who received it retroactively through SCHIP. As such, patients with Medicaid are often labeled or grouped with the uninsured.[25,35–37] Thus, we kept patients who carried the Medicaid designation under the insured category for the present analysis. In order to further address this issue of differing criteria of uninsured versus insured, we performed an alternative analysis categorizing both uninsured and Medicaid patients together to compare them against insured patients. This analysis demonstrated that 39 323 deaths may have been preventable due to uninsured patient status.

Limitations of this study

There are several limitations to our study. First, the present study design cannot establish a causal relationship that demonstrates being uninsured leads to higher mortality rates. Second, because we cannot link patients over time through these databases, the unit of analysis for this study is the hospitalization rather than the patient. Third, insurance status may be a marker for other factors that impact mortality such as socioeconomic status. This is especially true in evaluating infant mortality. However, as previously discussed, our findings were similar in children higher than 1 year of age. Fourth, we do not know how long patients had or did not have insurance prior to hospital admission, and this could affect patient access to preventative care which, in turn, could affect inpatient mortality when they are hospitalized. A patient could be labeled as insured even if he was uninsured for long periods of time before that hospitalization. However, it is equally likely for a patient to lose insurance just prior to hospitalization and thus be classified as uninsured. Therefore, the risk of misclassifying is equal among uninsured and insured, which would theoretically bias the study toward finding no (or less) association between insurance status and mortality.[38] Fifth, since our data are limited to inpatient records, outcomes would be unknown for patients who never had care and died at home. Sixth, the databases do not contain adequate information to allow for adjustment for disease severity or co-morbid disease, which are predictors for mortality. Besides lack of information, there are no accepted methods to adjust for comorbid disease in children, unlike adults.[39,40] However, the average number of secondary diagnosis codes, a crude method to evaluate comorbid disease, was similar between uninsured and insured groups (1.5 versus 1.3, $P = 0.15$).

In conclusion, children who were hospitalized without insurance have significantly increased all-cause in-hospital mortality as compared with children who present with insurance. Given these results and the increasing number of uninsured children, governmental and societal priorities should shift to ensure that the most vulnerable members of our society have health insurance.

Authors contributions

F.A. had full access to all the data in the study and takes responsibility of the data and the accuracy of the data analysis. F.A. and D.C.C. organized the study concept and design. F.A., D.C.C. and Y.Z. acquired, analyzed and interpreted the data. F.A., T.L., K.C., P.J.P. and P.M.C. drafted the manuscript. Y.Z. performed the statistical analysis. M.B. performed background literature research.

Acknowledgements

The authors would like to extend their appreciation to Misty Burbank and Mindy Bathurst for assistance with preparation of the manuscript.

Funding

The authors would like to extend their appreciation to the Robert Garrett Fund for the Surgical Treatment of Children for support of this study.

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