Trends in Hospitalization Rates and Severity of Injuries From Abuse in Young Children, 1997–2009

WHAT’S KNOWN ON THIS SUBJECT: Child welfare data show declines in child physical abuse since the early 1990s, but analysis of national data from hospitalized children in the Kids’ Inpatient Database showed an increased incidence of serious physical abuse in children from 1997 to 2009.

WHAT THIS STUDY ADDS: We found no significant change in hospitalization rates for injury from abuse in young children and increases in injury severity using the National Inpatient Sample from 1997 to 2009. This data helps provide a more complete perspective of the problem.

abstract

OBJECTIVES: To examine trends in incidence of hospitalizations for injury from abuse in young children from 1997 through 2009 and to examine injury severity trends.

METHODS: Cases were identified in the National Inpatient Sample database of the Healthcare Cost and Utilization Project by using International Classification of Diseases, Ninth Revision, Clinical Modification codes for child maltreatment and external cause of injury for assault in children aged 0 through 3 years. Incidence was calculated by age, gender, and region. Trends in incidence of hospitalization and injury severity were calculated over time.

RESULTS: Hospitalization rates for injury from abuse showed no significant change over the study period, ranging from a low of 2.10 per 10,000 children in 1998 to a high of 3.01 per 10,000 children in 2005 (P = .755). Children aged <1 had significantly higher hospitalization rates for injury from abuse (6.01 vs 1.12, P < .001) and higher mean injury severity scores compared with children aged 1 to 3 years (12.50, SD = 0.14 vs 8.56, SD = 0.21, P < .001). Injury severity scores increased significantly over the study period.

CONCLUSIONS: No significant change in hospitalization rates for injury from abuse among young children was observed from 1997 to 2009. These results coincide with other reports of stable or modestly increasing rates of serious physical abuse or death in young children but not with reports from child welfare data showing declines in physical abuse during the same period. Diverse sources of data may provide important complementary methods to track child abuse.

Pediatrics 2013;131:e1796–e1802

AUTHORS: Karen Farst, MD, MPH,a Pratibha B. Ambadwar, MBBS, MPH,b Andrew J. King, MS,b T. M. Bird, PhD,c and James M. Robbins, PhDb
aSection for Children at Risk and bCenter for Applied Research and Evaluation, Department of Pediatrics, and cDepartment of Obstetrics and Gynecology, University of Arkansas for Medical Sciences, Little Rock, Arkansas

KEY WORDS
injury, maltreatment, child abuse, health policy

ABBREVIATIONS
AIS—abbreviated injury severity score
aOR—adjusted odds ratio
CI—confidence interval
HCUP—Healthcare Cost and Utilization Project
ICD-9-CM—International Classification of Diseases, Ninth Revision, Clinical Modification
ISS—injury severity score
KID—Kids’ Inpatient Database
NCANDS—National Child Abuse and Neglect Data System
NIS—Nationwide Inpatient Sample
Dr Farst developed the clinical research question, drafted the original and revised manuscripts, and approved the final manuscript as submitted; Ms Ambadwar carried out data collection and analysis, contributed to the explanation of statistical analysis in the original manuscript, and approved the final manuscript as submitted; Mr King participated in the current revision by providing statistical analysis and reviewing original data collection, contributed to the statistical corrections and clarifications of methods/analysis in his review, and approved the final manuscript as submitted; Dr Bird developed the original databases used in data collection, performed data analysis, and reviewed and approved the final manuscript as submitted; and Dr Robbins collaborated with the biostatisticians and clinician to conceptualize the study design, reviewed and revised the manuscript, and approved the final manuscript as submitted.

Preliminary data were presented in poster format at the annual meeting of the Pediatric Academic Societies; May 5, 2009; Baltimore, MD.

www.pediatrics.org/cgi/doi/10.1542/peds.2012-1464
doi:10.1542/peds.2012-1464
Accepted for publication Feb 26, 2013

(Continued on last page)
Surveillance of child maltreatment in the United States has been addressed by multiple researchers and data sources, resulting in inconsistent and at times contradictory findings. The National Child Abuse and Neglect Data System (NCANDS), a federal repository of child welfare data in the United States, has reported a continuing decline in overall child maltreatment since the early 1990s among children aged 0 to 18 years and among young children aged 0 to 3 years. This decline has been driven by falling rates of substantiated physical and sexual abuse cases. Other studies using national data to evaluate the incidence of physical abuse over time have shown both a decline from 1993 to 2006 as well as an increase from 1997 to 2009. Berger found a significant increase in incidence of abusive head trauma in a multicenter analysis from 2004 to 2009 among children younger than 5 years. Parks and colleagues, using mortality reports from death certificates between 2003 and 2007, reported decreasing rates of death due to accidental head injury among children aged ≤5 years but constant rates of death due to abusive head trauma. NCANDS reports death rates due to maltreatment among children aged ≤3 years of 7.4 per 100 000 in 2002 with an identical rate in 2010. In comparison, data compiled by the Centers for Disease Control and Prevention from National Center for Health Statistics mortality reports show a decline in homicide death rates per 100 000 children aged ≤3 from 4.2 in 2002 to 3.8 in 2009. Similarly, this data set reports a decline in intentional nonfatal injuries among children aged ≤3 from 194 per 100 000 in 2001 to 130 per 100 000 in 2009. Health professionals are recognized as being in an important position to document evidence of child abuse. In the absence of population-based linked databases, hospital morbidity data could provide an efficient, nationally standardized source of information on child abuse. Hospitals use a standard system to describe diagnoses related to medical care that is required by insurers. Standardized hospital discharge data represent an attractive surveillance mechanism for abuse serious enough to require inpatient medical attention. Appreciating the value of multiple sources of data in evaluating trends, this study uses nationally representative hospital discharge data from the Healthcare Cost and Utilization Project (HCUP) Nationwide Inpatient Sample (NIS) to examine trends in the hospitalization of young children for injury from abuse between the years of 1997 and 2009. We test the hypothesis that trends in injury from abuse serious enough to require hospitalization have decreased over time. To account for possible trends in thresholds for the hospitalization of injured children, we also determine trends over time in the mean injury severity score (ISS) for identified cases.

**METHODS**

Data for this study came from a large nationally representative hospital discharge database created by the Agency for Healthcare Research and Quality for the HCUP-NIS. NIS is the largest, longitudinal, all-payer, inpatient care database in the United States, with an average of 8 million hospitalizations from ~1000 hospitals each year. The HCUP-NIS approximates a 20% stratified random sample of all short-term US community hospitals. The HCUP-NIS was selected for this study over the HCUP Kids’ Inpatient Database (KID). Although the KID includes a larger sample of children aged 0 to 19 years, it is compiled every third year compared with the NIS, which is available yearly. The HCUP-NIS also includes sufficient unweighted numbers of hospitalizations of children aged 0 through 3, ~280 000 each year, to allow stable estimates of hospitalization rates. The HCUP-NIS includes both patient-level data, such as demographic characteristics (eg, age and gender), admission type, admission source, International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnostic and procedural codes, insurance status, total hospital charges, length of stay, and discharge disposition, and hospital-level information such as hospital ownership, number of beds, urban/rural location, geographic region, and teaching status. The Agency for Healthcare Research and Quality has developed appropriately scaled discharge weights to generate national estimates of hospitalizations from the HCUP-NIS. By using these weights to address the complex sampling design of the HCUP-NIS, national estimates of hospitalizations and hospitalization rates are comparable across years, despite the varying numbers of states participating in each year of the HCUP project. Following Leventhal’s strategy of combining ICD-9-CM diagnoses codes for abuse with E-codes for assault to identify cases of specific injuries such as fractures and head injury related to abuse, we used a similar strategy but expanded to identify children aged 0 through 3 years who were hospitalized with an ICD-9-CM diagnoses code for any child maltreatment (995.50–995.59) or an E-code for assault (E960–E969) and defined these cases as hospitalized for injury from abuse. We then excluded children with an ICD-9-CM diagnoses code for sexual abuse (995.53), emotional abuse (995.51), and neglect (995.52) and E-code for rape (E960.1) due to infrequency of these diagnoses resulting in admission within the age group of the study. To reduce the possibility of double counting,
hospitalizations of patients who were discharged to another short-term care facility were not included in the analysis. Infants <1 day old were also excluded because these cases were predominantly normal newborns.

Three mutually exclusive racial/ethnic codes are available in HCUP-NIS with sufficient numbers of cases to allow for meaningful analyses: white, black, and Hispanic. Median household income is coded in the HCUP-NIS according to zip code. Because of inconsistencies in categories across years, median household income for this study is coded into more proportionately consistent categories of low, medium, and high. Three health insurance categories are used: public representing a combination of Medicare and Medicaid, private including health maintenance organizations, and uninsured. Four regions of the country are coded in the HCUP-NIS: Northeast, Midwest, South, and West.

National weighted estimates of all hospitalized children aged 0 to 3 years with any ICD-9-CM diagnosis code for maltreatment (995.50–995.59) or an E-code (E960–E967.9) for assault were calculated excluding sexual abuse, emotional abuse, and neglect. These estimates served as numerators for rate calculations.

When calculating rates of injury from abuse across age, gender, and region of the country, denominators were derived from US census data. Rates of injury across age, gender, and region were thus calculated per 10,000 children aged 0 to 3 in the US population.

Census data do not exist for race as collected by the HCUP-NIS, insurance status, or income. Thus, when calculating relative frequency of injury from abuse within race, income, and insurance status categories, total number of hospitalizations for all children aged 0 to 3 was used as the denominator. Rates across racial/ethnic groups, income groups, and insurance categories were calculated per 100 hospitalizations and expressed as the percent of all hospitalizations for a given category of child that were due to injury from abuse.

A logistic regression model was developed to assess the odds of admission for injury from abuse versus any other admission associated with race/ethnicity, insurance status, and income. Odds ratios were adjusted for all other variables in the model. The complex sampling design of each year of the NIS was used to calculate SEs.

Trends in the rates of hospitalizations were calculated for the study period. A test for a linear trend using the β coefficient for the year of hospital discharge was used to test the 13-year trend in the incidence rate of injury from abuse. All statistical analyses were performed with the appropriately weighted, stratified sample design, by using Stata statistical software (Stata Corp, College Station, TX).

ICD-Map90 software was used to calculate an ISS (an anatomic scoring system) for all identified cases of abusive injury. This software uses clinically derived algorithms to assign an abbreviated severity score to each of 6 major body regions based on ICD-9-CM diagnosis codes and the age of the individual. Abbreviated injury severity scores (AIS) vary from a low of 1 to high of 6, the latter indicating a non-survivable injury. The 3 highest AISs for a given child are then squared and summed to arrive at an overall ISS for that child. A test for trend using β coefficient for the year of hospital discharge was used to test significant change in ISS over the study period.

RESULTS

An unweighted total of 10,100 and weighted total of 49,144 children aged 0 through 3 years were identified as being hospitalized for an injury from abuse during the study period 1997 through 2009. Of the weighted number, 65% were aged <1 year, 72% were publically insured, and 40% were from low-income families (Table 1). An E-code for assault alone (no 995 series code assigned) uniquely identified approximately a third of the cases of children hospitalized for injury from abuse. This proportion remained consistent across study years.

Incidence of hospitalization for abuse per 10,000 children 0 through 3 in the US population is shown in Table 2 and by age, gender, and region of the country. Over the study period, 2.36 children per 10,000 in the US population were hospitalized for injury from abuse. A higher incidence of hospitalization for injury from abuse was observed for those <1 year of age.
TABLE 2 Incidence of Hospitalization for Injury From Abuse, Children Aged 0 to 3 Years, 1997–2009

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Rate/10,000*</th>
<th>OR (95% CI)b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total, ages 0–3 y</td>
<td>2.36</td>
<td>—</td>
</tr>
<tr>
<td>1–3 y (ref)</td>
<td>1.12</td>
<td></td>
</tr>
<tr>
<td>Age 0</td>
<td>6.03</td>
<td>5.37 (5.27–5.47)</td>
</tr>
<tr>
<td>Gender</td>
<td>1.94</td>
<td></td>
</tr>
<tr>
<td>Female (ref)</td>
<td>2.63</td>
<td>1.36 (1.33 –1.38)</td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Region</td>
<td>2.47</td>
<td></td>
</tr>
<tr>
<td>South (ref)</td>
<td>2.11</td>
<td>0.86 (0.83–0.88)</td>
</tr>
<tr>
<td>Northeast</td>
<td>2.65</td>
<td>1.07 (1.05–1.10)</td>
</tr>
<tr>
<td>Midwest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>West</td>
<td>2.08</td>
<td>0.84 (0.82–0.86)</td>
</tr>
</tbody>
</table>

Ref, reference.
* Denominators derived from US census population for children aged 0 to 3 y.
† Unadjusted odds ratios.

(6.03) than those 1 to 3 years (1.12). Similarly, male children had a higher population-based incidence of hospitalization for injury from abuse (2.65) than their female counterparts (1.94). Compared with children in the South with an incidence of 2.47 per 10,000, children from the Midwest had a higher incidence (2.65) and children from the Northeast (2.11) and the West (2.08) had lower incidence for injury from abuse.

The percentage of all hospitalizations that were for injury from abuse is shown in Table 3 for race/ethnicity, insurance status, and income. Compared with white children, a greater percentage of hospitalizations of black children were for injury from abuse (0.27% vs 0.17%, adjusted odds ratio [aOR] 1.17, 95% confidence interval [CI] 1.06–1.29), and a lower percentage of hospitalizations of Hispanic children were for injury from abuse (0.13% vs 0.17%, aOR 0.55, 95% CI 0.49–0.62). Significantly fewer young children with private insurance who were hospitalized were admitted for injury from abuse than publically insured (0.09% vs 0.31%, aOR 3.44, 95% CI 0.48–0.62) or uninsured (0.09% vs 0.16%, aOR 2.40, 95% CI 2.10–2.75). Low- (0.23%) and medium-income categories (0.21%) had higher percentages of all hospitalizations that were for injury from abuse compared with the high-income group (0.15%). aOR for these comparisons included 1.0 suggesting no significant differences among percentages.

Figure 1 illustrates the trend in hospitalization rates per 10,000 children for injury from abuse in children aged 0 through 3 years from 1997 to 2009. These rates ranged from lows of 2.10 in 1998 and 2008 to a high of 3.01 in 2005 (P < .755) showing no significant linear association. The unusual spike in 2005 was consistent with a similar spike in admissions of young children for all injuries in 2005.

Among children with an injury from abuse, infants <1 year of age had a higher mean ISS (mean 11.97 ± SD 0.14) compared with children 1 through 3 years of age (mean 8.56 ± SD 0.21, P < .001). As shown in Fig 2, the mean ISS increased significantly over the study years for abused children <1 year of age (P < .001) and those 1 through 3 years of age (P < .001).

**DISCUSSION**

Approximately 3700 infants and young children are hospitalized for injury from abuse each year in the United States. Our findings showed no significant changes in the rate of admission for this problem over the 13 years of study. Consistent with other work, infants comprised the predominant proportion (65%) of young children who were admitted for injury from abuse.18,19 Also consistent with other findings, children who were black, had public insurance or no insurance, and those from lower-income neighborhoods, when compared with white children, privately insured, and those from higher-income areas, were more likely to be admitted for injury from abuse than for other reasons for admission.9,18,20,21 The severity of injuries of hospitalized children increased slightly but significantly over the study period.

Much has been made of the decline in the overall rate of maltreatment among all children reported by the NCANDS registry.2,22 This decline has been specifically driven by falling rates of substantiated cases of physical and sexual abuse.2 The NCANDS definition more closely aligned with injury from abuse serious enough to require hospitalization is deaths attributable to maltreatment. Rates based on this definition show no change over the period of this study for young children.1 The Centers for Disease Control and Prevention reports of homicide deaths and intentional nonfatal injuries among children 0 through 3 years of age show modest recent declines. In contrast, rates of death due to abusive head trauma among young children remained constant from 2003 to 2007.6 Leventhal has evaluated national hospital discharge data in the KID and showed an increase in the incidence of serious physical abuse in children from 1997 to 2009.4

Biases inherent in child welfare reports, death investigations, and hospital coding systems suggest that no single surveillance mechanism may be adequate to monitor trends in child maltreatment. Child welfare reports may be influenced by state-level
differences in definitions of what constitutes maltreatment and processes for investigating, substantiating, or refuting reports.\textsuperscript{2,8} Causes of death certifications may differ by variety of practice among medical examiners, and some states still allow nonmedical county coroners to determine cause of death. Hospital discharge databases may be subject to coder variability and the ability of providers to recognize abuse, and they are limited to cases severe enough to warrant hospitalization. Examining trends in child abuse in diverse data sets may provide a more complete description of the problem than can be gained from a sole source.

Nationally standardized hospital discharge data has been used to describe trends in hospitalizations of infants with traumatic brain injury,\textsuperscript{9} track deaths related to child abuse,\textsuperscript{10} and establish the incidence of conditions resulting from intentional injury such as abdominal trauma\textsuperscript{23} and fractures.\textsuperscript{12} Hospital discharge data have been proposed for use in a system to monitor the incidence of inflicted traumatic brain injury over time\textsuperscript{11} and to monitor trends in serious physical abuse as a means to evaluate effects of prevention programs.\textsuperscript{4,19}

Hospital discharge databases using ICD-9 codes allow the use of E-codes for assault to better identify cases of inflicted injury and injury severity scoring to judge the seriousness of the child’s abuse.\textsuperscript{12,13,24} Our study population was limited to children 0 through 3 years of age because this represents the age group most likely to require hospitalization for injury from abuse.\textsuperscript{18,19} Limiting the study population to the youngest age group also minimizes the potential confounder of an E-code for assault representing peer on peer violence in older age groups instead of injury perpetrated by a person responsible for the child’s care although serious injury can occur to young children by their siblings. The percentage of cases identified by E-code alone was stable during the study period, which is consistent with published data supporting relative stability of E-coding since 1997.\textsuperscript{25,26}

The ISS has been used in studies of both abusive and accidental pediatric injury\textsuperscript{24,27,28} but has had limited usage in studies of trends in injury from child abuse. The authors chose to study ISS in this population to possibly explain trends in thresholds for the hospitalization as well as examine whether the severity of injuries from abuse may be increasing. Our results show mean ISS scores among children injured by maltreatment who were <1 year of age of ~12 and among children 1 to 3 of ~8. A score of 12 is comparable to a patient with a femur fracture (AIS = 3) and a mild or moderate traumatic brain injury (AIS = 2). An ISS 8 patient could have 2 AIS = 2 injuries in separate body regions (such as a mild or moderate traumatic brain injury and minor contusion of the liver), along with an AIS = 1 injury (superficial cut/scrape/contusion). The higher mean ISS in the youngest age group was not unexpected because this age group will encompass a majority of the children admitted with abusive head trauma that often have poor outcomes.\textsuperscript{29}

Of particular interest was the increase in the ISS over the study period, which may be traced to several sources. First, the proportion of children covered by public or no insurance has increased

![FIGURE 1](http://pediatrics.aappublications.org/)

**FIGURE 1**
Trend in hospitalization rate for injury from abuse among children aged 0 to 3 years 1997–2009. Error bars represent 95% CIs. The trend in annual hospitalization rates for injury from abuse did not increase significantly from 1997 to 2009 ($P = .755$).

![FIGURE 2](http://pediatrics.aappublications.org/)

**FIGURE 2**
Trend in ISS among children by age groups, 1997–2009. Error bars represent 95% CIs. Among children aged <1 year, the trend in mean ISS increased significantly from 1997 to 2009 ($P < .001$). Among children aged 1 to 3 years, the trend in mean ISS increased significantly from 1997 to 2009 ($P < .001$).
over time, perhaps suggesting greater economic strains and stress on social support services for families in need. These factors may influence the types and severity of injuries among young children. Second, adherence to and severity of injuries among young children may have risen over time due to forces in play by insurers to limit inpatient care by definitions of medical necessity. Finally, prehospital care may have improved during the study period leading to fewer children dying before being hospitalized.

Use of information in health care databases has the advantage of providing a large nationally representative patient sample. The HCUP-NIS was chosen for this project due to the ability to examine patient-level data on a yearly basis. As with any study relying on data collected for billing purposes, case-specific data were not readily available for additional examination of the disparities found in this study of higher hospitalization rates for injury from abuse for patients who were black and/or publically insured, which is consistent with previously published results. Even though we chose definitions for identification of abuse cases that had been used in previous resources, and the cases identified by E-code remained stable during our study period, the data set is limited overall by the accuracy of the documentation and coding practices at the institutional level. With those cautions, we believe the results represent an estimation of incidence of injuries from abuse severe enough to require hospitalization.

REFERENCES


CONCLUSIONS

There was no significant change in hospitalization rates for young children injured from abuse found during 1997–2009. Injury severity increased during the study period and the youngest children had the highest mean ISSs. Despite the limitations inherent to working with hospital discharge coding data, information concerning trends of injury from abuse serious enough to require hospitalization in young children may be useful in the evaluation of the effectiveness of community based intervention programs and in the formation of policies for governmental and nongovernmental organizations. Providing access to information from multiple perspectives can be helpful in ensuring that program evaluators and policy makers have a broad view of the issue at hand.


(Continued from first page)

Address correspondence to Karen Farst, MD, MPH, Section for Children at Risk, Department of Pediatrics, University of Arkansas for Medical Sciences, 1 Children’s Way, Slot 512-24 A, Little Rock, AR 72202. E-mail: kfarst@uams.edu

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

Copyright © 2013 by the American Academy of Pediatrics

FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: Partially supported by a Young Investigator Grant awarded by the Academic Pediatric Association in 2008 to Dr Karen Farst, who was the principal investigator for the grant.
Trends in Hospitalization Rates and Severity of Injuries From Abuse in Young Children, 1997–2009
Karen Farst, Pratibha B. Ambadwar, Andrew J. King, T. M. Bird and James M. Robbins

Pediatrics 2013;131:e1796
DOI: 10.1542/peds.2012-1464 originally published online May 20, 2013;
Trends in Hospitalization Rates and Severity of Injuries From Abuse in Young Children, 1997–2009
Karen Farst, Pratibha B. Ambadwar, Andrew J. King, T. M. Bird and James M. Robbins

Pediatrics 2013;131;e1796
DOI: 10.1542/peds.2012-1464 originally published online May 20, 2013;

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://pediatrics.aappublications.org/content/131/6/e1796