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Self-harm, Assault and Undetermined Intent Injuries among Pediatric Emergency Department Visits

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Emergency Service; Hospital; Injuries; Pediatrics; Assaultive Behavior; Suicide; Attempted; Costs and Cost Analysis; Epidemiology

Introduction

Injuries, whether unintentional, self-inflicted or perpetuated by others, are a leading cause of mortality, morbidity and healthcare costs in US children and adolescents.[1,2] Initiatives to reduce unintentional pediatric injuries, such as bike helmet regulations, seat belt laws, child resistant packaging and smoke detector programs have demonstrated substantial success in preventing injury and improving quality of life.[3–5] The same level of progress has not been achieved for intentional injury such as suicide and child maltreatment, both of which may actually have increased with the recent economic depression.[6,7] A recent study indicates that youth who visit the emergency department (ED) for injury are 44% more likely to experience an unnatural death than expected rates in their age group.[8] As pediatric EDs see many injured patients, this setting is well-situated for early prevention and intervention efforts.[9–11]

Among ED visits due to injury, there is a subset of self-inflicted, assault-related or undetermined intent injuries, which place a disproportionate burden on ED and hospital resources.[12] For example, ED visits for self-harm, which have increased over the last two

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decades,[13] are associated with increased rates of hospitalization and ED recidivism.[14] Assault-related medical treatment for individuals under 18 years is associated with over $240 million in yearly ED medical costs[2] and injuries of undetermined intent have shown to predict ED visits for deliberate self-harm[15] as well as increased risk of death by suicide.[16] Although these studies implicate that these visit types are particularly burdensome to hospital systems, little is actually known about their epidemiology, costs, and outcomes.

To our knowledge, this is the first study to examine the prevalence, characteristics, and outcomes associated with self-harm, assault, undetermined, and unintentional injuries among in a cross-sectional sample of pediatric ED visits in the US. Specifically, we will examine differences in demographics, psychiatric diagnosis, discharge disposition, mortality, method of injury, and cost among these visit types. We will also examine the effect of visits due to injury type on three specific outcomes: death in the ED, inpatient admission, and ED related visit costs. It was hypothesized that ED visits for self-harm, assault and undetermined intent injury would be associated with higher likelihood of each of these outcomes compared with visits for unintentional injury. Such an analysis will provide a more thorough understanding of the burden of this public health problem, and motivate further prevention and intervention-based research in this area. It is hoped that the successes of unintentional injury prevention initiatives can be achieved for intentional injury.

Materials and Methods

Data from the United States 2008 National Emergency Department Sample (NEDS) were used in this study. The Agency for Healthcare Research and Quality (AHRQ) created the NEDS as a hospital-based ED database as part of the Healthcare Cost and Utilization Project (HCUP). The NEDS incorporates discharge data from both the State Emergency Department Database and the State Inpatient Database which results in a dataset that includes both patients who were discharged into the community and those who were hospitalized.

The NEDS is a stratified sample of 20% of community, non-rehabilitation hospital-based ED visits in the US representing 980 hospitals across 28 states. Data from ED visits are de-identified which precludes tracking of ED patients with multiple ED visits over time. As such, all findings from this study relate to a single visit or ED encounter. In accessing the NEDS, HCUP also provides weights to make inferences to all ED visits from hospital-based emergency departments in community, non-rehabilitation hospitals in the US. The NEDS is meant to be a “microcosm” of ED visits in the United States; as an example, the percentage of visits to hospitals with Trauma Centers are meant to represent national rates for these types of visits. More information on the NEDS is available at http://www.hcup-us.ahrq.gov/nedsoverview.jsp.

Data from this study were limited to children and adolescents ages 8 to 17 years, as attempted self-harm is rarely reported under the age of 8 years.[17] Data were also limited to ED visits for an injury-related presenting complaint, identified via E-code. Up to four E-codes could be recorded for any ED visit, resulting in a total unweighted sample size of 1,023,522 visits and a weighted sample size of 4,511,753. Missing data were minimal (less than 3% of variables), except for the total cost of the ED visit, which was missing in 16% of

variables. There was no pattern of missing cost data by other variables, such as zip code, rurality, disposition, etc.

Measures

Dependent Variables—Three outcome variables were extracted from the NEDS database. First, death on ED visit included visits in which patients in the target age group came into the ED for injury-related reasons and died in the ED. This variable did not include patients who died on the inpatient unit after transfer from the ED. Second, an inpatient admission category was created by collapsing two categories reported in the NEDS: transfer to a short-term hospital (as distinct from long term skilled nursing or home health care) and admitted as an inpatient to this hospital. These variables were collapsed since the purpose was to examine the likelihood of inpatient admission, regardless of where such hospitalization occurred. Unfortunately, when a visit resulted in an inpatient hospitalization, the NEDS does not include information surrounding the type of inpatient unit. Therefore, this hospitalization could have involved medical or psychiatric care. The third outcome variable was total ED charges related to the ED visit, which does not include additional charges from inpatient hospitalizations.

Charges of less than $50 and more than $50,000 are considered to be unreliable and were not included in the analysis. All patients who died in the ED were included in the first analysis, but excluded from further analysis of hospitalization/transfer and ED costs since the status of the child upon arrival to the ED visit was unknown.

Independent Variables—Injury intent was determined via E-code and Clinical Classification Software (CCS) for ICD-9-CM provided by HCUP. CCS provides a coding scheme for ICD-CM to create smaller, more clinically relevant categories. Self-inflicted injury was determined by the CCS code 662, which includes E codes: 950–959 and all other diagnoses related to self-injury and suicide. Other-inflicted injury or assault was determined by E-codes 960–969 and undetermined intent was coded via E-codes 980–989. All other injury-related visits were included in the unintentional injury category (see Table 2 details on the method of injury related to this category).

Demographic variables included gender, age, insurance type (collapsed into private, medical assistance, self-pay and other), median household income by patient zipcode and whether the visit occurred on a weekend or a weekday. Race/ethnicity was not collected in the NEDS. Hospital variables included the region of the country, rurality, and hospital trauma level (collapsed into nontrauma and trauma I–III).

Additional variables included psychiatric diagnoses, which were extracted using CCS categories. The categories included mood disorders (CCS: 657), anxiety disorders (CCS: 651), externalizing disorders (CCS: 652), drug-related disorders (CCS: 661), alcohol-related disorders (CCS: 660) and psychotic disorders (CCS: 657). As a crude measure of psychiatric severity, a variable was created adding the number of psychiatric diagnoses per patient.

Method of injury was identified using the suggested matrix from the Centers for Disease Control and Prevention (CDC) on presenting injury mortality and morbidity data and

included the following categories: poisoning, cut/pierce, suffocate, fall, burn, firearms and struck by/against (which was not included in the self-inflicted injury or undetermined intent codes).[18]

Data Analysis

First, weighted Chi-Square and ANOVA analyses were performed to examine overall differences in demographic and psychiatric characteristics, including psychiatric diagnosis and method of injury, by injury intent (self-inflicted, assault, undetermined and unintentional). Next, a survey weighted logistic regression model was used to estimate the association between injury intent and death on ED visit, while adjusting for demographic and hospital-related factors. A similar adjusted model was used to evaluate the association between injury intent and hospitalization/transfer. This model was also run controlling for number of psychiatric diagnoses (as a measure of psychiatric severity) to better understand if these injury-types were still associated with disposition even after accounting for a well-known correlate of pediatric injury. All coefficients of the logistic models are reported as odds ratios (e.g., odds of death in ED for those with assault visit-types as compared to odds of death in the ED for unintentional injury). The final outcome of this study was cost of ED visit. Since this variable was not normally distributed, we log transformed this variable prior to running the model. Coefficients from the linear model with the log transformed outcome were exponentiated to be interpreted as percent difference in total charges between groups while holding all other variables constant. This analysis was also run controlling for hospitalization/transfer after ED visit, which could impact length of stay, and therefore ED charges. Analyses were conducted using the svy commands of STATA/SE 12.1.[19]

Results

Comparison of demographic and clinical characteristics across injury types

As an overview, out of all ED visits for injury in this age group, 4% were in the ED for assault, 1.5% for self-harm, 0.5% for undetermined intent and 94% for unintentional injury. Less than one percent of all injury-related visits resulted in a death in the ED and 5% resulted in hospitalization or transfer. The mean cost of an injury-related ED visits was $1186 (SD = 1638.116).

Table 1 presents weighted demographic, patient and hospital data for ED visits for children with self-inflicted, assault, undetermined and unintentional injuries. All comparisons were statistically significant ($p < .001$). Overall, ED visits for self-inflicted, assault and undetermined injuries were more prevalent among older children than visits for unintentional injuries. Visits for self-inflicted injury were more likely to be by females, while assault and unintentional injuries were more likely to be by males. Compared to the other injury intent groups, patients with ED visits for assault were less likely to have private insurance and more likely to have medical assistance or self-payment. For household income by zip code, visits for assault were more likely to come from lower income zip codes, while undetermined intent injury visits were more likely to come from higher income zip codes. By region, undetermined intent injury visits were more likely to occur in the Northeast, assault and undetermined intent visits in the South and self-inflicted injury visits in the

Midwest and West. Assault visits were also more likely to occur in larger metropolitan areas, while unintentional injuries were more likely to occur in more rural areas. Assault-related ED visits were more common at trauma hospitals and unintentional injury visits were more common on weekends.

Weighted descriptive statistics of disposition and ED costs are also presented in Table 1. Visits for self-inflicted injury were more likely to result in inpatient admission than the other injury groups. While not included in the table, a weighted total of 1336 patients with injuries died while in the ED and 24% died from firearms. Of injured patients who died in the ED, 16% had been in the ED for assault related reasons, 7% for self-harm related reasons, 3% for undetermined intent and 73% for unintentional injury. Self-inflicted injuries were associated with greatest ED costs, followed by undetermined intent injuries, assault injuries and then unintentional injuries.

Table 2 displays the method of injury and psychiatric diagnosis weighted descriptive statistics. Self-inflicted and undetermined intent injury visits were characterized primarily by poisoning, assault visits were characterized by being struck by or against and unintentional injury visits were predominately for falls and being struck. Self-inflicted and undetermined intent injury visits also had a large percentage of patients with psychiatric diagnoses. Mood disorders were most common in self-inflicted injury visits, followed by anxiety and drug-related disorders. Psychiatric diagnostic codes were not reported in around 35% of self-inflicted injury visits.

Association between injury type and outcome

Adjusted results from survey weighted regressions of injury intent and death in the ED are presented in Table 3. Adjusting for demographic and hospital related-factors, ED visits for self-harm (aOR 6.1, 95% CI 3.7, 10.0), assault (aOR 3.9, 95% CI 2.8, 5.6), and undetermined intent (aOR 8.7, 95% CI 4.2, 17.7) were associated with increased odds of dying in the ED as compared to visits for unintentional injuries.

Table 4 presents the survey weighted regression of injury intent and inpatient admission, both before and after adjusting for number of psychiatric diagnoses. After controlling for demographic and hospital related factors, self-harm, assault and undetermined intent injury visits were associated with higher odds of inpatient admission than injury visits for unintentional injuries. In particular, ED visits for self-harm were associated with almost 27 times the odds of hospitalization or transfer (aOR 26.4, 95% CI 25.4, 27.5). Undetermined intent was associated with 5 times the odds (aOR 5.0, 95% CI 4.6, 5.4) and assaults were 50% (aOR 1.5, 95% CI 1.5, 1.6) more likely to be hospitalized. All estimates were attenuated but still statistically significant when adjusting for number of psychiatric diagnoses (all $p<0.001$).

Lastly, Table 5 displays the adjusted results of the survey weighted regressions of injury intent and total ED costs. After adjusting for demographic and hospital-related variables, self-harm (1.9, 95% CI 1.8, 1.9), assault (1.2, 95% CI 1.2, 1.2) and undetermined intent injury visits (1.6, 95% CI 1.6, 1.6) were each associated with increased ED costs as compared to unintentional injury visits. When adjusting for rate of hospitalization and

transfer (which may impact ED costs by increasing length of stay as patients wait for open hospital beds), all estimates were attenuated but still statistically significant at $p<0.001$).

Discussion

Using a nationally representative sample, it is clear that pediatric ED injury visits due to self-harm, assault, or undetermined intent, while quite small compared to visits for unintentional injuries, require a disproportionate amount of hospital resources. Even after adjusting for numerous covariates, these injury types resulted in greater financial costs as well as an increased likelihood of inpatient admission and mortality. These findings highlight the need for ED-based interventions targeted for children and adolescents with intentional injuries.

Self-harm visits represent a small percentage of all injury ED visits (1.5%), but have a particular set of defining characteristics. These patient visits are often made by females, involving self-poisoning or cutting and psychiatric diagnoses, notably mood and externalizing disorders. These visits are associated with substantial resources and financial burden on EDs, which does not take into account the provider's stress in treating a suicidal child.[20] Improved interventions for pediatric patients at risk for suicide is a much-needed and burgeoning area of research, whether through screening efforts,[21] staff training [22] access to crisis intervention services including hotlines[23] or on-site intervention.[24] As stated in the 2012 National Strategy for Suicide Prevention, initiatives connecting patients with outpatient mental health treatments in a timely manner are needed both to ensure that patients receive appropriate treatment and that ED resources are not overwhelmed.[25] Additionally, mental health disposition plans for children who are discharged from the ED must be carefully planned in order to ensure compliance with referral and reduce recidivism.

Patients in the ED for assault represent a vulnerable patient population in need of targeted resources. In contrast to visits for self-harm, ED visits for assault were characterized by male gender, lower income brackets and a higher percentage of patients on medical assistance or self-pay. The majority of injuries were due to being struck by or against another object. Although the perpetrator could not be identified from the current data, this injury category likely includes visits characterized by both child abuse and peer-related violence, who may be high utilizers of ED resources and have unmet mental health needs.[26,27] Further research is needed to distinguish the resource impact of child abuse as compared to peer related assault visits, but new ED-based initiatives have been developed to address the needs of these patient groups. Recent research in abuse-related injuries has supported the use of ED-based screening for increased detection of child abuse.[28] In addition, case management interventions for peer-related violence have had promising results, with larger randomized clinical trials still needed.[29,30] Similar to the research surrounding suicide prevention, it is possible that better identification and treatment of individuals with assault-related injuries may lead to reduced ED resource use and costs.

Patients with injuries due to undetermined intent were more likely to have higher income and private insurance and be from the Northeast. This group presents a conundrum for both clinicians and researchers. Classification can be difficult, as patients at times cannot, or will

not, disclose the intent of the injuries. For clinicians, differences between individuals with assault versus undetermined injuries have legal implications; identification of injury due to violence should involve the police and social services. Similarly, identification of self-harm may lead to intensive psychiatric assessment and treatment, which may burden ED resources. For researchers, since the term “undetermined injuries” can refer to any of the injury intent categories, interpretation of results can be difficult. Some researchers have advocated for reclassifying undetermined injuries related to cutting or poisoning to self-harm.[15] Even so, this analysis demonstrates that undetermined intent injury has an impact on ED resources and underscores the need for better assessment of both self-harm and assault.

Limitations to this analysis include, first, the use of a cross-sectional dataset from one calendar year (2008). The cross-sectional nature of the data limited the outcomes that could be studied, as other outcomes after the ED visit, including repeated visits or healthcare utilization in other settings, could also cause additional resource burden. Second, because the NEDS databases are de-identified, there is no way to link ED visit to a particular patient and therefore it is not known if one patient made multiple visits. Third, the cost variable contained the most missing data and should be interpreted with caution. It is also difficult to ascertain whether differences in cost are due to psychiatric evaluation or additional procedures involved in care of the patient. Fourth, data on race are not available. Fifth, there were limited data on hospitalization and transfer; consequently, it is not known whether patients were hospitalized for psychiatric versus medical reasons. Sixth, data on perpetrator of assault were not available in this dataset, which limits interpretation of assault-related data. Seventh, it is likely that misclassification could be present especially for more stigmatized causes of injury (self-injury, assault) and determination of those injuries that were classified as undetermined. Lastly, assessment of injuries and psychiatric diagnoses are not systematic and access to psychiatric professionals and mental health expertise varies across the country, which is a limitation inherent in analyses using nationally sampled medical record data. Further prospective research with detailed assessment of injury and diagnoses is indicated. These limitations should be counterbalanced by the use of an epidemiologic dataset that allows for both assessment of fairly rare outcomes and making inferences about the US as a whole.

Conclusions

In the US, pediatric ED visits due to self-harm, undetermined injury intent and assault are associated with increased resources and mortality when compared to unintentional injuries. At the same time, these visits represent a small subset of all patients presenting for injury-related reasons. Additional resources for intentional and assault-related injury, such as implementation of enhanced screening and intervention, could be of substantial benefit to the ED, healthcare system, and public as a whole.

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Table 1

Weighted Demographic, Patient and Hospital-Related Descriptive Statistics of Children and Adolescents in the ED for Injuries Reasons, ages 8–17 years

	Self-Harm Visits (n = 66895)	Assault Visits (n =176125)	Undetermined Intent Visits (n = 24144)	Unintentional Injury Visits (n = 4244589)	Weighted *F* or X^2 value	*P*
Age, mean (SD)	15.3(1.6)	14.7(2.2)	14.3(2.5)	12.9(2.8)	28353.0	<.001
Female, %	68.5	34.7	45.3	39.4	5767.6	<.001
Insurance, %					6068.2	<.001
Private	50.4	37.7	56.2	55.6		
Medical Assistance	36.9	43.4	30.8	30.8		
Self-Pay	8.0	14.7	9.8	9.0		
Other	4.7	5.2	3.2	4.7		
Household Income by zip, %					3519.4	<.001
$1–$38,999	23.4	38.8	27.5	27.1		
$39,000–$48,999	30.6	27.6	24.0	28.5		
$49,000–63,999	24.2	19.4	17.6	22.4		
>$63,000	21.9	14.2	30.1	22.1		
Region, %					1443.1	<.001
Northeast	19.2	24.3	35.9	22.2		
Midwest	27.6	21.1	19.7	23.3		
South	29.5	34.9	29.7	36.3		
West	23.7	19.7	14.8	18.1		
Rurality, %					5177.6	<.001
Large central metropolitan	22.7	34.7	25.0	20.8		
Large fringe metropolitan	22.0	20.8	24.6	24.9		
Medium metropolitan	24.0	20.0	26.1	21.5		
Small metropolitan	11.9	9.0	7.2	10.4		
Micropolitan	12.2	9.9	9.7	13.6		
Neither metropolitan nor micropolitan	7.1	5.6	7.4	9.3		
Trauma hospital, %	39.8	42.3	29.2	32.9	1866.5	<.001
Weekend, %	24.4	24.6	28.5	30.3	830.3	<.001
Disposition, %					9.3e04	<.001
Discharged	48.2	91.6	83.1	95.6		

	Self-Harm Visits (n = 66895)	Assault Visits (n =176125)	Undetermined Intent Visits (n = 24144)	Unintentional Injury Visits (n = 4244589)	Weighted *F* or X^2 value	*P*
Transfer to other facility	31.1	2.2	8.7	1.9		
Inpatient hospitalization on-site	19.1	4.5	6.7	2.3		
Total charges, mean (SD)	2089.7(1885.8)	1626(2075.8)	1919.6(1978.9)	1152.1(1599.6)	3302.1	<.001

Table 2

Weighted Method of Injury and Psychiatric Diagnoses Descriptive Statistics in Injury ED Visits among US Children and Adolescents, ages 8–17 years

	Self-Harm Visits (n = 66895)	Assault Visits (n =176125)	Undetermined Intent Visits (n = 24144)	Unintentional Injury Visits (n = 4244589)
Method of Injury				
Poisoning, %	59.0	0.2	43.0	1.1
Cut/Pierce, %	28.8	4.9	4.0	7.6
Suffocate, %	2.8	0.2	0.5	<.1
Fall, %	0.6	0.4	3.6	25.3
Burn, %	0.4	0.2	0.8	0.8
Firearm, %	0.2	2.8	2.8	0.3
Struck by or against, %	*	59.3	*	24.5
Psychiatric Diagnosis				
Mood, %	49.9	2.2	11.7	0.7
Anxiety, %	15.3	0.7	3.1	0.3
Externalizing, %	10.6	2.7	4.7	1.7
Alcohol, %	4.8	1.6	4.7	0.2
Drug, %	11.7	1.2	10.4	0.2
Psychotic, %	1.5	0.2	0.7	<.1
No Psychiatric Diagnosis, %	34.6	93.3	74.2	97.2

* not included in code

Table 3

Weighted Associations between Death on ED Visit and Injury Intent in Injury ED Visits among US Children and Adolescents, ages 8–17 years

	Adjusted OR (95% CI)*	p
Unintentional	1 (Reference)	
Self-Harm	6.1 (3.7–10.0)	<.001
Assault	3.9 (2.8–5.6)	<.001
Undetermined	8.7 (4.2–17.7)	<.001

* Demographic and hospital-related factors: gender, age, insurance, income by zip code, rurality, region, weekend, trauma hospital

Table 4

Weighted Associations between Injury Intent and Hospitalization/Transfer in Injury ED Visits among US Children and Adolescents, ages 8–17 years

	Adjusted OR (95% CI)	p
Adjusting for demographic and hospital-related factors*		
Unintentional	1 (Reference)	
Self-Harm	26.4(25.4–27.5)	<.001
Assault	1.5(1.5–1.6)	<.001
Undetermined	5.0(4.6–5.4)	<.001
Adjusting for number of psychiatric diagnoses, demographic and hospital-related factors		
Unintentional	1 (Reference)	
Self-Harm	11.7(11.2–12.3)	<.001
Assault	1.4(1.4–1.5)	<.001
Undetermined	3.2(2.9–3.5)	<.001

*Demographic and hospital-related factors: gender, age, insurance, income by zip code, rurality, region, weekend, trauma hospital

Table 5

Adjusted Relative Total ED Charges with Injury Intent for Injury ED Visits among US Children and Adolescents, Ages 8–17 years

	Adjusted Relative Total Charges (95% CI)	p
Adjusting for demographic and hospital-related factors*		
Self-Harm Injury	1.9(1.8–1.9)	<.001
Assault Injury	1.2(1.2–1.2)	<.001
Undetermined Intent Injury	1.6(1.6–1.6)	<.001
Adjusting for hospitalization/transfer, demographic and hospital-related factors		
Self-Harm Injury	1.5(1.5–1.6)	<.001
Assault Injury	1.2(1.2–1.2)	<.001
Undetermined Intent Injury	1.5(1.5–1.6)	<.001

*Demographic and hospital-related factors: gender, age, insurance, income by zip code, rurality, region, weekend, trauma hospital