Emergency Department Visits for Self-Inflicted Injuries in Adolescents

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abstract

OBJECTIVES: To describe emergency department (ED) visits for self-inflicted injury (SII) among adolescents, examine trends in SII mechanisms, and identify factors associated with increased risk.

METHODS: Analyses included patients aged 10 to 18 years from the National Trauma Data Bank, years 2009 to 2012. We used Cochran–Armitage trend tests to examine change over time and generalized linear models to identify risk factors for SII.

RESULTS: We examined 286 678 adolescent trauma patients, 3664 (1.3%) of whom sustained an SII. ED visits for SII increased from 2009 to 2012 (1.1% to 1.6%, P for trend $\leq$ .001), whereas self-inflicted firearm visits decreased (27.3% to 21.9%, P for trend = .02). The most common mechanism in males was firearm (34.4%), and in females, cut/pierce (48.0%). Odds of SII were higher in females (odds ratio [OR] 1.41, 95% confidence interval [CI] 1.13–1.77), older adolescents (OR 2.73, 95% CI 2.38–3.14), adolescents with comorbid conditions (OR 1.64; 95% CI 1.49–1.80), and Asian adolescents (OR 1.67, 95% CI 1.35–2.08) and lower in African American adolescents (OR 0.78, 95% CI 0.70–0.87). Adolescents in the public or self-pay insurance category had higher odds of SII (OR 1.44, 95% CI 1.27–1.64) than those in the private insurance category (OR 1.15, 95% CI 1.01–1.31). Adolescents with an SII had higher odds of death than those with other injuries (OR 12.9, 95% CI 6.78–24.6).

CONCLUSIONS: We found a significant increase in the number of SIIs by adolescents that resulted in ED visits from 2009 to 2012. Although SIIs increased, we found a significant decrease in the percentage of adolescents who self-injured with a firearm. SIIs reflect a small percentage of ED visits, but these patients have dramatically higher odds of death.

FREE

WHAT'S KNOWN ON THIS SUBJECT: Self-harm behavior is a major public health problem and a leading cause of death in adolescents. The majority of patients who self-injure do not die, but they are at increased risk for a successful future suicide attempt.

WHAT THIS STUDY ADDS: Emergency department visits for self-inflicted injuries in adolescents increased from 2009 to 2012, whereas visits for self-inflicted firearm injuries decreased. The presence of any comorbid condition increased risk for self-harm, indicating that increased attempts at prevention may be warranted in these young people.

Adolescent suicide is a major public health problem and one of the leading causes of death in this age group.[1] Self-harm behavior is rare under the age of 12 but increases rapidly through adolescence, especially among females.[2] Although the majority of children and adolescents who visit the emergency department (ED) for a self-inflicted injury (SII) do not die, these young people are at very high risk for a subsequent successful suicide attempt, with the greatest risk occurring in the period immediately after that episode of self-harm.[3] For this reason, patients who visit the ED for attempted suicide or SII have been identified as a high-risk group by the National Strategy for Suicide Prevention in the United States.[3]

Recent data indicate that self-harm behavior is increasing. Ting et al found that the average annual number of ED visits for attempted suicide and SII more than doubled between 1993 and 2008, and that visits were most common among adolescents aged 15 to 19 years.[4] A recent analysis looking at all age groups found that mortality rates for suicide increased by 15% from 2000 to 2009, and that suicide has surpassed motor vehicle traffic crashes as the leading cause of injury mortality in the United States.[5] Although research has shown changing patterns in self-harm, the majority of studies examining ED visits for SII in adolescents have examined data from 2008 or earlier.[4,6–10] For primary and secondary prevention, it is vital to have the most recent information possible to most accurately describe the current epidemiology of self-harm behavior in youth.

The primary objectives of this study were to describe ED visits for SII in adolescents from 2009 to 2012, examine trends in mechanisms used over time, and identify factors that are associated with increased risk of self-harming behavior. We also examined mortality outcomes, the percentage of adolescents diagnosed with a mental illness, and discharge disposition among ED patients with an SII.

METHODS

Study Cohort

The data used in this study came from the National Trauma Data Bank (NTDB), years 2009 to 2012, and included adolescent patients between 10 and 18 years of age. The NTDB is sponsored by the American College of Surgeons (ACS) and represents the largest centralized collection of trauma patients in the United States.[11] The NTDB collects deidentified data from >700 trauma centers and hospitals, including >95% of all ACS-verified Level 1 and Level II trauma centers, which are required to report data as part of their verification requirements.[12] To be included in the NTDB, patients must sustain at least 1 traumatic injury. This study was reviewed and deemed exempt by the Institutional Review Board at Children's Hospitals and Clinics of Minnesota.

Self-Inflicted Injury

We were not able to determine whether the SIIs in the NTDB were done with suicidal intent. In our analysis, SII refers to all injuries that are self-inflicted, including suicide, attempted suicide, and nonsuicidal self-injury. We identified patients with an SII using *International Classification of Diseases, Ninth Revision, Clinical Modification* codes for self-inflicted injury (E950 to E959). SIIs were defined as cut/pierce (E956), firearm (E955.0 to E955.4), suffocation (E953.0 to E953.9), fall (E957.0 to E957.9), and other (drowning [E954], fire/burn [E958.1, E958.2, E958.7], fire/flame [E958.1], hot object/substance [E958.2, E958.7], motor vehicle traffic [E958.5], transport [E958.6], natural/environment [E958.3], other specified and classifiable [E955.5, E955.9,

E958.0, E958.0.4], other specified and not elsewhere classifiable [E958.8, E959], and unspecified [E958.9]). We also identified patients with self-inflicted poisonings (E950.0 to E952.9). Poisonings are not normally coded or reported as trauma within the NTDB; therefore, data on this specific self-inflicted injury mechanism is not complete. Poisonings have never been considered trauma within the NTDB, and there has been no change in documentation of this injury since the NTDB started collecting data. A previous analysis of the NTDB (years 2002 to 2006) included all available data on self-inflicted poisonings.[6] Therefore, we decided to include all available data on self-inflicted poisonings in our analysis, even though incomplete, to examine changes in SII trends over time within the NTDB.

Covariates

Additional data obtained from the NTDB included age, gender, race/ethnicity, Injury Severity Score (ISS), comorbid conditions, payment method, ED disposition, and mental health diagnosis. Early adolescents were defined as patients aged 10 to 14, and late adolescents were defined as patients aged 15 to 18. Race/ethnicity was categorized as follows: white, African American, Hispanic, Asian, other (Native Hawaiian or other Pacific Islander, other race), and unknown. The NTDB categorizes 24 comorbid conditions. A patient was considered to have ≥1 comorbid conditions if they had any condition listed in the database. A patient was considered to have the specific conditions of alcoholism or obesity if these were listed in the comorbid condition variable for that patient in the database. We chose to focus on the specific comorbid conditions of obesity and alcoholism, as we had an a priori hypothesis that these would be the most likely of the 24 NTDB categorized conditions to increase risk of self-harm in adolescents based on existing literature.[13–16] Insurance

status, based on the payment method listed in the NTDB database, was categorized as private (private/commercial, Blue Cross/Blue Shield), public (Medicaid, Medicare, other government), self-pay, or other (not billed, workers compensation, no fault automobile, unknown). Patients were considered to have died of their injuries if they were dead on arrival, died in the ED, or died after being admitted to the hospital. Mental health diagnoses, identified from *International Classification of Diseases, Ninth Revision, Clinical Modification* codes, were classified as depressive disorders (296.2 to 296.26, 296.3 to 296.36, 296.82, 298.0, 300.4, 309.0 to 309.1, 301.12, 311) and all other mental disorders (290 to 319). Patients with missing data for the race/ethnicity (5.5%) and insurance status (8.1%) variables were included in an "unknown/missing" or "other" category, respectively. Patients with missing/unknown values for comorbid conditions (7.9%) were included in the "0" comorbid conditions category. The percentage of missing values was low (<3%) for all other variables, and these patients were excluded from the analysis.

Statistical Analysis

Descriptive statistics were used to examine the patient population. Baseline characteristics were compared between subgroups using t tests for continuous variables and χ^2 tests for categorical variables. Cochran–Armitage trend tests were used to examine change in SII rates and mechanisms from 2009 to 2012. Generalized linear models (GLMs) with a binomial distribution and logit link were used to identify risk factors for SII, risk factors for SII death, and risk of death from SII compared with other injuries. All models adjusted for clustering of patients by hospital. The GLM model examining risk factors for SII included the following variables that were associated with SII at $P < .05$ in unadjusted models:

early/late adolescence, race/ethnicity, gender, number of comorbid conditions, and insurance status. An additional model was run including the comorbid conditions of alcoholism and obesity and excluding number of comorbid conditions. A GLM model examining risk of death in trauma patients included the following variables: SII (yes/no), early/late adolescence, race/ethnicity, gender, insurance status, and ISS. Finally, a GLM model examining risk of death in patients with SIIs was run and included all of the above variables except SII. All analyses were run using the Statistical Analysis System (SAS, version 9.3, Cary, NC).

RESULTS

In 2009 to 2012, there were 286 678 adolescent trauma patients in the NTDB database, 3664 (1.3%) of whom sustained an SII. Demographics and characteristics of our overall study population along with SII cases are provided in Table 1. Most patients were male (71.6%), were in the older adolescent age group (60.3%), had no comorbidities (85.8%), and were not considered severely injured (17.8% with ISS ≥16). Although the majority of the cohort was white, 37.3% represented other racial/ethnic groups, resulting in a diverse sample. Compared with adolescents without an SII, those with an SII were more

TABLE 1 Demographics and Characteristics of the Study Population

Variable	Overall Population	SII	No SII	P[a]
n	286 678	3664	283 014	
Gender,				
Female	81 398 (28.4)	1295 (35.4)	80 103 (28.3)	<.001
Male	205 149 (71.6)	2366 (64.6)	202 783 (71.7)	
Age				
10 to 14	113 916 (39.7)	714 (19.5)	113 202 (40.0)	<.001
15 to 18	172 762 (60.3)	2950 (80.5)	169 812 (60.0)	
Race/ethnicity				
White	170 722 (59.6)	2155 (58.8)	168 567 (59.6)	<.001
African American	51 764 (18.1)	623 (17.0)	51 141 (18.1)	
Hispanic	38 161 (13.3)	487 (13.3)	37 674 (13.3)	
Asian	4041 (1.4)	83 (2.3)	3958 (1.4)	
Other	13 003 (4.5)	215 (5.9)	12 788 (4.5)	
Unknown	8987 (3.1)	101 (2.8)	8886 (3.1)	
ISS				
Mean (SD)	8.7 (8.9)	9.2 (11.3)	8.7 (8.9)	.005
≥16	49 549 (17.8)	847 (23.8)	48 702 (17.7)	<.001
Comorbid conditions				
Alcoholism	4320 (1.5)	144 (3.9)	4176 (1.5)	<.001
Obesity	2634 (0.9)	62 (1.7)	2572 (0.9)	<.001
No. of comorbidities				
0	245 967 (85.8)	2784 (76.0)	243 183 (85.9)	<.001
1	35 681 (12.5)	700 (19.1)	34 981 (12.4)	
≥2	5030 (1.8)	180 (4.9)	4850 (1.7)	
Insurance type				
Private	122 286 (42.7)	1442 (39.4)	120 844 (42.7)	<.001
Public	80 428 (28.1)	1364 (37.2)	79 064 (27.9)	
Self-pay	26 337 (9.2)	397 (10.8)	25 940 (9.2)	
Other	57 627 (20.1)	461 (12.6)	57 166 (20.2)	
ED disposition				
Died	2358 (0.9)	150 (4.3)	2208 (0.8)	<.001
Discharged	42 244 (15.2)	185 (5.3)	42 059 (15.3)	
Left against medical advice	286 (0.1)	5 (0.1)	281 (0.1)	
Transferred to another hospital	15 042 (5.4)	211 (6.0)	14 831 (5.4)	
Transferred to other facility	1108 (0.4)	86 (2.4)	1022 (0.4)	
Mental health diagnosis				
Depressive disorder	433 (0.2)	85 (2.3)	348 (0.1)	<.001
Other mental disorder	3755 (1.3)	95 (2.6)	3660 (1.3)	<.001

Values are express as n (%) unless noted otherwise.
[a] P value from t test (continuous variables) or χ^2 (categorical variables).

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likely to have high injury severity (23.8% vs. 17.7% with ISS ≥16, $P < .0001$), have ≥2 comorbid conditions (4.9% vs. 1.7%, $P < .001$), and have alcoholism or obesity listed as a specific comorbid condition (3.9% vs. 1.5% and 1.7% vs. 0.9%, respectively, both $P < .001$). Only 4.9% of adolescents with an SII were diagnosed with any mental disorder; half of these patients (47.2%) were diagnosed with depressive disorders. Adolescents with an SII were less likely to be discharged from the ED than those with other injuries (5.3% vs. 15.3%, $P < .001$) and more likely to die in the ED (4.3% vs. 0.8%, $P < .001$).

Trends Over time

The percentage of visits to NTDB trauma centers for SII increased significantly, from 1.1% in 2009 to 1.6% in 2012 (P for trend <.001). Trends in SII mechanism by year are shown in Fig 1. Cut/pierce was the most common mechanism of injury in all years, followed by firearm, whereas poisoning was the least common. Interestingly, although the overall proportion of ED cases attributed to SII went up during this time, there was a significant decrease in firearm injuries as a fraction of the total SII cases from 2009 to 2012 (27.3% to 21.8%, P for trend = .02). Differences in mechanism by gender

and stage of adolescence are shown in Figs 2 and 3. Females were more likely to be seen for cut/pierce injuries, whereas males were more likely to be seen for firearm injuries (females versus males for each SII mechanism, both $P ≤ .001$). Both early and late adolescents were most likely to visit the ED for cut/pierce injuries, but early adolescents were more likely to self-injure through suffocation than older adolescents (15.1% vs. 7.6% $P ≤ .001$).

Results of Adjusted Models: Risk Factors for SII

Female gender, late adolescence, and the presence of comorbid conditions were all associated with increased odds of SII (Table 2). Adolescents with public insurance had 44% higher odds of an SII than adolescents with private insurance, and adolescents in the self-pay category had 15% higher odds. Asian adolescents had higher odds of an SII compared with white adolescents, whereas African American adolescents had lower odds. In a separate model, we examined the presence of alcoholism or obesity as a comorbid condition, and each was associated with increased odds of an SII (odds ratio [OR] 2.00, 95% confidence interval [CI] 1.64–2.45 and OR 1.54, 95% CI 1.18–2.00, respectively).

Results of Adjusted Models: Risk of Death

We also created models to examine risk of death in adolescents who self-harm and relevant risk factors. In Table 3, we report the odds of death for adolescents with SIIs. Those most likely to die of their SII injuries included males, older adolescents, white adolescents, and those who self-paid. In a separate model, we found that adolescents visiting the ED with an SII had a higher risk of death than adolescents visiting for other injuries (OR 12.9, 95% CI 6.78–24.6).

DISCUSSION

Adolescent ED visits for SII increased from 2009 to 2012, and patients with SII injuries had a dramatically higher risk of dying compared with those with other injuries. These findings highlight the importance of addressing and preventing self-harm behavior in this age group. Although multiple studies have highlighted that rates of SII are increasing in both adolescents and adults,[4,5] this study represents the most current analysis in an adolescent population. Our finding that cut/pierce was the most common mechanism differs from an earlier study using data from the NTDB[6] and may indicate a shift in self-harm behavior in youth.

A positive finding was a significant decrease in adolescent ED visits for self-inflicted firearm injuries, which may reflect a rise in strategies focused on reducing access to highly lethal means, including firearms, in suicidal youth (ie, lethal means restriction). There is strong evidence to support using the ED as a setting for injury prevention and intervention,[17] and efforts have been made to promote the use of lethal means restriction counseling by ED providers, as this approach has been shown to reduce suicide rates.[18,19]

Although self-harm behavior is a major public health problem, there is limited research on the epidemiology of ED visits for SII in
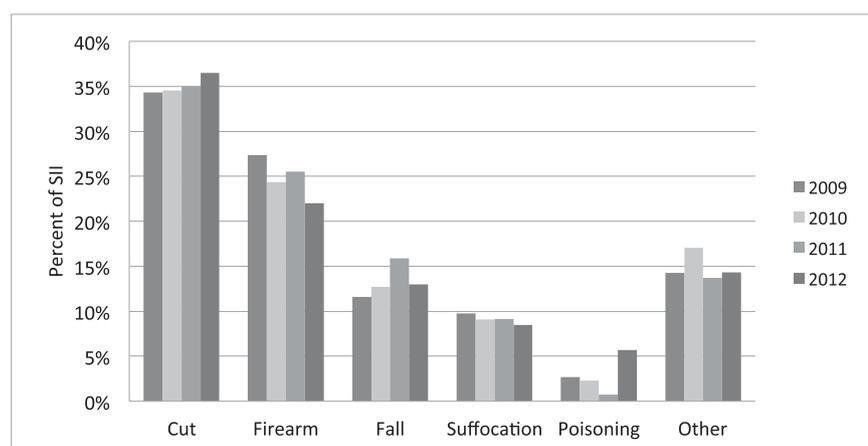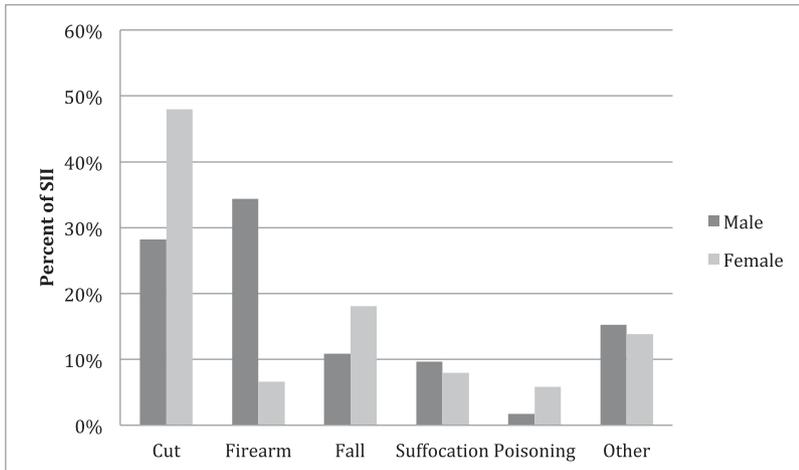
FIGURE 2
SII mechanism by gender.

adolescents. Three studies have examined SII behavior in youth presenting to EDs in the United States, with all examining data from 2007 or earlier.[6–8] Similar to our findings, female youth have been shown to be more likely to visit the ED for SII injuries compared with males,[7,8] but males have been shown to have a greater risk of dying from their injuries, likely because they tend to use more lethal mechanisms such as firearms.[6,7]

Adolescents with any comorbid condition were at increased risk of SII in our study, and those with ≥2 comorbid conditions had nearly 3 times the odds, findings that may warrant increased attempts at prevention in these young people. We also found that the specific comorbid conditions of obesity and alcoholism were associated with increased risk of an SII, results that align with other research on self-harm behavior in adolescents.[14,15]

We found that risk of SII was lower in African American adolescents than in white adolescents, which differs from previous research. Cooper et al found that rates of self-harm in patients presenting to EDs in 3 English cities were highest in young black females,[20] whereas Ting et al found that blacks in the United States had higher population rates of ED visits for attempted suicide and SII compared with whites.[4] Our finding that Asian adolescents were more likely to visit the ED for an SII is unique in the United States, although a study in England found that South Asian females were more likely to visit EDs for SII.[21] The lack of agreement in findings on SII risk across studies may be influenced by variances in the socioeconomic profiles experienced by a specific racial/ethnic group residing in one area versus another.[20]

Only 4.9% of adolescents in our cohort with an SII had a diagnosis code for a mental health disorder. These findings differ from 2 other studies that reported >50% of ED visits for SII carrying a diagnosis for a mental health disorder.[8,10] To have
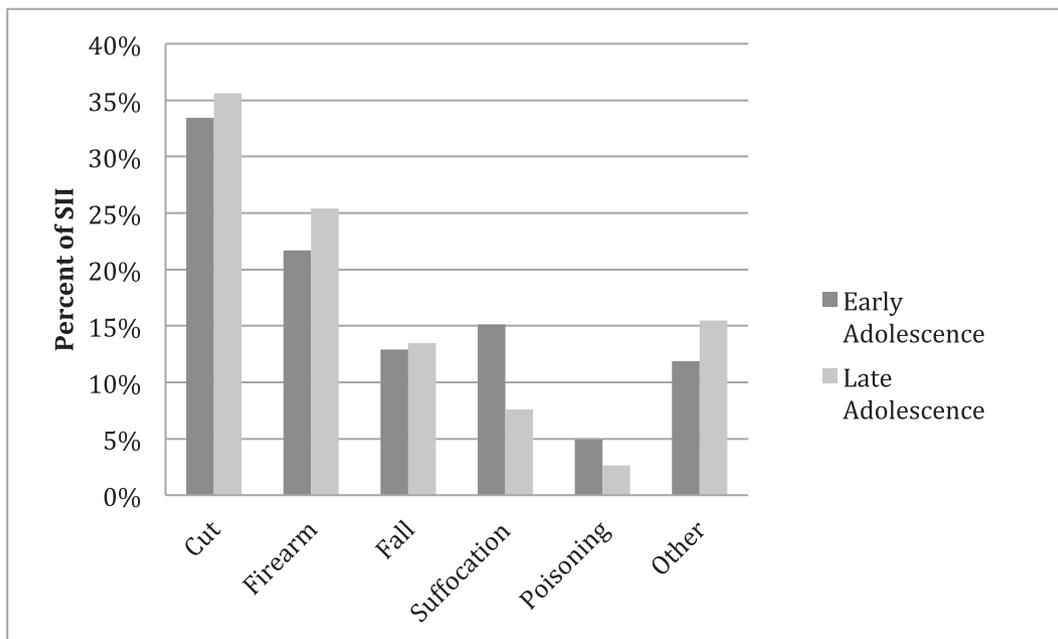

FIGURE 3
SII mechanism by stage of adolescence.

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TABLE 2 OR of Emergency Department Visit for SII

	OR (95% CI)	P
Gender		
Male	Reference	
Female	1.41 (1.13–1.77)	.003
Age		
10 to 14	Reference	
15 to 18	2.73 (2.38–3.14)	<.001
Race/ethnicity		
White	Reference	
African American	0.78 (0.70–0.87)	<.001
Hispanic	0.94 (0.83–1.07)	.36
Asian	1.67 (1.35–2.08)	<.001
Other	1.24 (1.04–1.48)	.02
Unknown	1.06 (0.83–1.34)	.65
No. of comorbidities		
0	Reference	
1	1.64 (1.49–1.80)	<.001
≥2	2.70 (2.24–3.25)	<.001
Insurance type		
Private	Reference	
Public	1.44 (1.27–1.64)	<.001
Self-pay	1.15 (1.01–1.31)	.03
Other/unknown	0.55 (0.47–0.64)	<.001

Model mutually adjusted for all variables shown.

data reported to the NTDB, a patient must sustain at least 1 traumatic injury. Therefore, not all ED patients have data reported to the NTDB, likely explaining why there were fewer mental health diagnoses in our study. It is still surprising that so few patients with an SII had a mental

TABLE 3 OR of Death From SII

	OR (95% CI)	P
Gender		
Male	Reference	
Female	0.43 (0.34–0.56)	<.001
Age		
10 to 14	Reference	
15 to 18	1.46 (1.16–1.83)	<.001
Race/ethnicity		
White	Reference	
African American	0.72 (0.54–0.95)	.02
Hispanic	0.56 (0.39–0.79)	<.001
Asian	0.47 (0.17–1.30)	.15
Other	0.66 (0.40–1.10)	.11
Unknown	1.14 (0.70–1.86)	.61
ISS		
<16	Reference	
≥16	28.4 (21.3–37.8)	<.001
Insurance level		
Private	Reference	
Public	0.88 (0.68–1.14)	.32
Self-pay	2.21 (1.67–2.93)	<.001
Other/unknown	0.73 (0.53–1.00)	.05

Model mutually adjusted for all variables shown.

health disorder diagnosed during their visit. The low number of patients with a recorded diagnosis is of concern, as this indicates missed opportunities to document mental health issues and link patients with follow-up mental health care.

Although only a small percentage of visits to EDs are for SII, as our results and previous authors have documented, these patients are at increased risk of death.[22,23] We found that adolescents in the self-pay insurance category had higher odds of dying from their SII injuries than those with private insurance. Two recent studies have also found higher odds of mortality in trauma patients who self-pay.[24,25] It could be assumed that adolescents in the self-pay category include uninsured patients,[24] and these adolescents may represent families who do not qualify for public assistance and cannot afford insurance on their own. Adolescents without any type of insurance may have extremely limited access to mental health services, leading to a higher likelihood of long-term untreated mental health issues, and possibly a higher risk of death.

The low percentage of SII visits for poisoning found in this analysis is in part because an injury due to ingestion is not coded as trauma by the NTDB data standard and thus is not normally reported within this dataset. This does not mean poisonings are never reported, as shown by our analysis, but the numbers we report in no way represent the true number of self-injuries due to poisoning seen by the EDs reporting to the NTDB. Branco et al analyzed data from the NTDB, years 2002 to 2006, and still found poisoning to be the most common method in females even with the limited reporting of this SII.[6] Because there has been no change in documentation of poisoning cases since the NTDB started collecting data, a comparison of our results regarding rates of ED visits for

poisoning to the results of Branco et al may reflect a decrease in self-injury through poisoning in adolescents. A much higher percentage of adolescents visited the ED for cut/pierce injuries in our cohort compared with Branco et al, which may reflect a rise in self-mutilation behavior in adolescents.

Our study is subject to several limitations. The NTDB is a secondary source of data that treats each patient as an isolated occurrence. Thus, we cannot determine if some SIIs were repeat visits, and we were limited to the patient information documented by participating hospitals, resulting in an inability to determine suicidal versus nonsuicidal behavior. The NTDB is not a nationally representative sample. However, all ACS-verified Level I and Level II trauma centers are required to submit data to the NTDB, providing us with insight specific to these centers. The NTDB collects data on trauma cases only, and our findings are not generalizable to all ED visits for self-harm behavior. As mentioned previously, not all poisoning cases are reported to the NTDB, and these findings should be interpreted with caution. Alcoholism and obesity were recorded for only a small number of patients, and it can be assumed that many adolescents in our cohort were misclassified as not having these comorbid conditions when they actually did. It is possible that adolescents with SII visits were more likely to be diagnosed with alcoholism or obesity if these conditions were thought to be causally linked with the self-harm behavior. However, other studies have found associations between alcoholism or obesity and SII,[14,15] providing support for our findings.

CONCLUSIONS

The number of SIIs resulting in ED visits increased in adolescents from 2009 to 2012, and cut/pierce was the most common mechanism in all years.

ED providers have a unique opportunity to intervene with SII patients during a high-risk period. Our findings provide potential targets for SII prevention efforts specific to the ED setting or for the general population. Specific subgroups of adolescents who may benefit from increased prevention efforts include those with public or no insurance and those with one or more comorbid conditions.

ABBREVIATIONS

ACS: American College of Surgeons
CI: confidence interval
ED: emergency department
GLM: generalized linear model
ISS: Injury Severity Score
NTDB: National Trauma Data Bank
OR: odds ratio
SII: self-inflicted injury

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