

Trends in Emergency Department Resource Utilization for Poisoning-Related Visits, 2003–2011

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Received: 10 April 2016 / Revised: 30 May 2016 / Accepted: 10 June 2016 / Published online: 24 June 2016
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Abstract In recent years, there has been an increase in poisoning-related emergency department (ED) visits. This study examines trends in ED resource utilization for poisoning-related visits over time. A retrospective review of data from the National Hospital Ambulatory Medical Care Survey, 2003–2011, was conducted. All ED visits with a reason for visit or ICD-9 code related to poisoning were included. We examined the number of ED visits and resources used including diagnostic studies and procedures performed, medications provided, admission rates, and length of stay. The proportion of visits involving resource use was tabulated and trends analyzed using survey-weighted logistic regression, grouping into 2-year periods to ensure adequate sample size. Of an estimated 843 million ED visits between 2003 and 2011, 8 million (0.9 %) were related to poisoning. Visits increased from 1.8 million (0.8 %) visits in 2003–2004 to 2.9 million (1.1 %) visits in 2010–2011, $p = 0.001$. Use of

laboratory studies, EKGs, plain radiographs, and procedures remained stable across the study period. CT use was more than doubled, increasing from 5.2 to 13.7 % of visits, $p = 0.001$. ED length of stay increased by 35.5 % from 254 to 344 min, $p = 0.001$. Admission rates increased by 45.3 %, from 15.0 to 21.8 %, $p = 0.046$. Over the entire study period, 52.0 % of poisoned patients arrived via ambulance, and 3.0 % of patients had been discharged from the hospital within the previous 7 days. Poisoning-related ED visits increased over the 8-year study period; poisonings are resource-intensive visits and require increasingly longer lengths of ED stay or hospital admission.

Keywords Emergency department · Poisoning · Resource utilization

Presented as an abstract at the American College of Medical Toxicology (ACMT) Annual Scientific Meeting, Huntington Beach, CA, March 2016, and at the Society for Academic Emergency Medicine (SAEM) Annual Meeting, New Orleans, LA, May 2016.

Electronic supplementary material The online version of this article (doi:10.1007/s13181-016-0564-6) contains supplementary material, which is available to authorized users.

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Introduction

In recent years, the number of poisonings and poisoning-related deaths in the USA has increased, even surpassing deaths from traffic accidents, drawing more attention to this public health problem. In fact, over the past three decades, there has been a sixfold increase in poisoning-related deaths [1]. There have also been significant increases in drug misuse, abuse, and related morbidity [1]. Although poisoning is the most common cause of attempted self-harm [2], the majority of poisonings are unintentional [1]. In particular, rates of opioid poisoning and associated mortality have increased in the last three decades, making up approximately 40 % of drug-related deaths and contributing to the overall healthcare and human costs of these poisonings [1, 3].

Although the vast majority of patients with poisoning exposures are managed at home or on site, those who require a higher level of care are often initially treated in emergency departments (EDs) [4]. An increase in the number of poisoning-related visits and an increase in the intensity of care associated with such visits could have important implications for ED operations and patient care [5]. ED crowding is a major public health problem, not only in the USA but also around the world [5–8]. In addition to affecting parameters such as patient and staff satisfaction and ED wait times, crowding also contributes to adverse outcomes such as increased mortality, decreased quality of care, longer lengths of stay, and higher healthcare costs [9–11]. Increased rates of poisoning and poisoning-related ED visits in the USA may consume valuable healthcare resources and further contribute to ED crowding. This study examines trends in ED resource utilization for poisoning-related visits over time.

Methods

Study Design

This study used data from the National Hospital Ambulatory Medical Care Survey (NHAMCS) from 2003 to 2011. NHAMCS is an annual survey, conducted by the National Center for Health Statistics (NCHS) at the Centers for Disease Control and Prevention, that uses a multistage probabilistic sample of hospital-based ED visits in the USA to generate estimates of ED utilization at a national level. NHAMCS includes data on patient-level visit characteristics, such as demographics, payment source, reasons for visit, diagnoses, services provided, and patient disposition, as well as hospital-level information, including the geographic region, metropolitan status, teaching status, and hospital funding source. As NHAMCS is a deidentified, publicly available data source, this study was determined to be exempt from institutional board review at the George Washington University.

Methods and Measurements

NHAMCS data from 2003 to 2011 were analyzed. We chose these years because all variables of interest were not recorded prior to 2003 and the data is not publically available beyond 2011. NCHS recommends that raw sample sizes exceed 30 cases per subgroup analysis. To ensure sample sizes for each subgroup met this criterion, we combined years into 2-year blocks for most analyses. To assess trends across the study period, we compared the period 2003–2004 with the period 2010–2011. Analyses that did not require subgroups were conducted on a year-by-year basis.

Our sample included all visits for which the patient presented with a reason for visit related to overdose (intentional and unintentional), adverse effects of alcohol or drugs, and exposure to potentially poisonous substances. We also used ICD-9 codes for diagnoses related to overdose. Visits that did not have a poisoning-related reason for visit or diagnosis code were excluded. A complete list of included diagnoses and reasons for visit can be found in the [Supplemental Appendix](#).

To examine trends in poisoning-related visits, we tabulated data across several patient-level categories, including age, gender, race, and payment source. We tabulated the proportion of patients presenting with poisoning-related complaints who arrived via emergency medical services (EMS) over the years 2003–2011. We also tabulated visits by hospital-level variables, including geographic region, location, type, and teaching status. To examine ED service utilization trends, we tabulated the proportions of visits during which patients received imaging, laboratory tests, urine studies, and medications. We investigated whether the patient had a previous ED visit or hospitalization within the past 7 days. To investigate trends in patient dispositions, we also calculated national admission rates for poisoning-related ED visits.

We examined the mean length of stay (LOS) for patients presenting with poisoning-related complaints. Additionally, we calculated the mean LOS for the subgroups of patients admitted vs. those discharged. To assess the total annual hours spent on poisoning-related visits to US EDs, we multiplied the average ED LOS by the number of survey-weighted visits and then compared them to trends in total ED hours for all types of visits. Trends were analyzed using survey-weighted logistic regression, while changes in proportions across the study period were analyzed using survey-weighted chi-squared tests. Differences in survey-weighted means (e.g., mean LOS) were tested using linear combinations of estimators.

All analyses were conducted and reported only where cell sizes met or exceeded NCHS guidelines. *p* values of <0.05 were considered significant. Analyses were performed using Stata, version 12 (College Station, TX).

Results

From the NHAMCS data, of an estimated 843 million US ED visits between 2003 and 2011, 8 million (0.9 %) were related to poisoning. Poisoning-related visits increased from 1.8 million (0.8 %) visits in 2003–2004 to 2.9 million (1.1 %) visits in 2010–2011, $p = 0.001$. Overall visits increased from 168.1 million in 2003–2004 to 206.9 million in 2010–2011, an increase of 23.1 %.

Demographics of Poisoning-Related Visits

There was a decrease in poisoning-related visits for younger (<20 years) patients whereas poisoning-related visits increased the most (230.4 %) in the 50–59-year age group. ED visits decreased among women and increased among men. There were no changes in trends in poisoning-related visits based on race, payer, geographic region, or hospital funding. The majority of poisoning-related visits were managed in the urban setting, and there was a greater increase in those managed in a teaching hospital. Details regarding patient and

hospital characteristics and subsequent trends associated with poisoning-related visits are presented in Table 1.

Trends in Resource Utilization

Use of laboratory studies, EKGs, plain radiographs, and procedures remained stable across the study period. The mean number of total diagnostic tests (laboratory tests, radiology studies) per visit decreased slightly from 5.9 to 4.7 ($p = 0.035$), whereas the mean number of medications administered or prescribed during each visit increased 27.3 %. The most common procedure performed was blood laboratory studies, which occurred in nearly two thirds of all visits. There was no significant increase in urine studies performed, remaining stable at nearly one third of visits. Computed tomography (CT) use was more than doubled, increasing from 5.2 to 13.7 % of visits, $p = 0.001$. There was a 55.7 % decrease in visits that received gastrointestinal decontamination by administration of activated charcoal or whole bowel irrigation over the study period. There were inadequate data to determine trends in gastric lavage. A summary of ED resources

Table 1 Demographics and hospital characteristics of poisoning-related ED visits

Characteristic	2003–2004	95 % CI	2010–2011	95 % CI	Relative increase (%)	<i>p</i> value
Total visits	1,838,350	(1,542,576–2,134,124)	2,931,934	(2,489,301–3,374,567)	59.5	0.001
Patient						
Age (years)						
<10	17.2 %	(13.8–21.2)	7.6 %	(5.2–11.0)	–55.8	0.001
10–19	19.0 %	(15.5–23.0)	11.3 %	(8.7–14.6)	–40.5	
20–29	18.4 %	(15.0–22.2)	22.4 %	(19.1–26.1)	21.7	
30–39	13.3 %	(10.4–17.0)	15.4 %	(12.3–19.0)	15.8	
40–49	18.5 %	(15.4–22.0)	18.1 %	(14.8–22.0)	–2.2	
50–59	5.6 %	(4.1–7.7)	18.5 %	(14.8–22.8)	230.4	
60+	8.1 %	(5.6–11.4)	6.7 %	(4.8–9.3)	–17.3	
Gender						
Male	49.0 %	(44.6–53.4)	58.6 %	(53.7–63.3)	19.6	0.002
Female	51.0 %	(46.6–55.4)	41.4 %	(36.7–46.3)	–18.8	
Race						
White	81.3 %	(76.9–85.1)	78.0 %	(73.0–82.3)	–4.1	0.241
Nonwhite	18.7 %	(14.9–23.1)	22.0 %	(17.7–27.0)	17.6	
Source of payment						
Private insurance	34.8 %	(29.8–40.2)	28.1 %	(23.5–33.3)	–19.3	0.164
Medicaid	27.0 %	(22.4–32.2)	34.0 %	(28.9–39.5)	25.9	
Medicare	9.0 %	(6.4–12.6)	9.3 %	(6.7–12.8)	3.3	
Self-pay	29.2 %	(24.4–34.5)	28.6 %	(24.1–33.5)	–2.1	
Hospital						
Geographic region						
Northeast	23.7 %	(17.0–32.1)	27.3 %	(19.9–36.3)	15.2	0.436
Midwest	20.0 %	(12.9–29.7)	23.4 %	(16.6–32.0)	17.0	
South	33.1 %	(24.8–42.6)	27.6 %	(20.5–36.0)	–16.6	
West	23.1 %	(15.4–33.2)	21.7 %	(15.0–30.3)	–6.1	
Location						
Urban	82.8 %	(71.2–90.4)	90.3 %	(81.9–95.0)	9.1	0.027
Nonurban	17.2 %	(9.7–28.8)	9.8 %	(5.0–18.1)	–43.0	
Type						
For-profit	8.8 %	(5.5–13.8)	9.6 %	(5.8–15.3)	9.1	0.712
Nonprofit	70.8 %	(62.8–77.8)	73.1 %	(65.6–79.4)	3.2	
Government	20.4 %	(14.3–28.2)	17.3 %	(12.3–23.8)	–15.2	
Teaching						
Teaching	16.0 %	(11.3–22.3)	25.3 %	(18.8–33.2)	58.1	0.024
Nonteaching	84.0 %	(77.7–88.7)	74.7 %	(66.8–81.2)	–11.1	

used for poisoning-related visits and trends over time is presented in Table 2. The most common medications provided during poisoning-related visits were naloxone (9 %), lorazepam (4.2 %), and normal saline (4.1 %). A full list of the most commonly provided medications is presented in Table 3.

ED LOS increased by 35.5 % from 254 to 344 min, $p = 0.001$. LOS increased regardless of whether the patient was discharged or admitted (Table 2). Whereas total ED hours (for any type of visit) increased by 54.0 % over the study period, ED hours for poisoning-related visits increased to a much greater extent, 179.5 % (Fig. 1). Admission rates increased by 45.3 %, from 15.0 to 21.8 %, $p = 0.046$. Intensive care unit admissions remained stable over the study period. From 2003 to 2011, 52.0 % of poisoned patients arrived via ambulance, and 3.0 % of patients had been discharged from the hospital within the previous 7 days; however, sample size was too small to perform trend analysis for these two variables.

Discussion

This study examined trends in resource use for poisoning-related visits to the ED between 2003 and 2011. Our results are consistent with prior studies that demonstrate that poisoning-related visits are a small, but important demographic of patients evaluated in the ED; however, the proportion of ED visits involving poisoning significantly increased in recent years [12]. While other studies have found that poisoning-related visits to the ED tend to be common in a bimodal

distribution involving pediatric patients and older, middle-aged patients, we demonstrate the most dramatic increases in visits from adult patients aged 50–59 years while exposures in pediatric patients had decreased [12]. The decrease in pediatric visits related to poisoning exposures may be attributed, in part, to improve public awareness of the risk of pediatric poisoning, access to poison information services, and improved poison prevention efforts. Regional poison centers are a good example of an effective method to reduce hospital visits and healthcare costs [12–14]. In addition, the impact of previously enacted legislation mandating child-resistant packaging for hazardous household products and prescription drugs and the more recent labeling changes for pediatric over the counter cough and cold medications are also important methods of prevention that may help explain the fall in pediatric visits [15–17].

The increase in poisoning-related visits in adult patients aged 50–59 is likely to also be multifactorial. Polypharmacy has been seen as an increasing issue in multiple countries [18–20]. As patients age, they tend to gather more diagnoses and worsening of disease natural history, leading to more prescriptions [20]. In addition to adverse drug-drug reactions due to polypharmacy, it makes it increasingly difficult for patients to correctly manage these prescriptions, which may lead to unintentional poisonings. There has also been a rapid rise of opioid prescription rates in all age groups and rates of illicit drug use are higher in this age group as opposed to adults older than 65 years [21–24]. This may have contributed to the increase in visits for this demographic as some studies have found the majority of unintentional ingestions involve

Table 2 ED resource utilization for poisoning-related visits

Resource	2003–2004 visits % (95 % CI)	2010–2011 visits % (95 % CI)	Relative percent change	<i>p</i> value
Any procedure	54.0 (48.9–59.0)	52.2 (47.1–57.2)	–3.3	0.597
Blood labs	59.5 (55.0–63.9)	65.2 (60.4–69.7)	9.6	0.095
CT scan	5.2 (3.3–8.1)	13.7 (10.7–17.4)	163.5	0.001
EKG	32.0 (27.2–37.3)	33.5 (28.9–38.5)	4.7	0.667
GI decontamination	19.4 (15.5–23.9)	8.6 (6.3–11.6)	–55.7	0.001
Urine studies	28.7 (24.2–33.7)	33.2 (28.8–37.8)	15.7	0.207
X-ray	15.8 (12.2–20.2)	17.8 (14.2–22.2)	12.7	0.399
Observation stay	Insufficient	4.3 (2.5–7.2)	N/A	N/A
Hospital admission	15.0 (11.4–19.5)	21.8 (17.0–27.5)	45.3	0.046
ICU admission	7.4 (4.9–11.1)	5.7 (3.5–9.0)	–23.0	0.384
Mean no. of medications	1.1 (0.9–1.2)	1.4 (1.2–1.6)	27.3	0.009
Mean no. of tests	5.9 (4.9–6.8)	4.7 (4.3–5.1)	–20.3	0.035
Mean length of stay (min)	254.0 (232.5–275.4)	344.2 (307.7–380.7)	35.5	0.001
Mean length of stay discharged (min)	291.0 (258.2–323.8)	356.5 (310.0–402.9)	22.5	0.021
Mean length of stay admitted (min)	274.0 (224.2–323.9)	365.3 (276.3–454.2)	33.3	0.081

GI gastrointestinal, ICU intensive care unit

Table 3 Most common medications for ED poisoning-related visits 2003–2011

Medication	Percentage of visits
Charcoal	9.0
Ativan (lorazepam)	4.2
Normal saline	4.1
Narcan (naloxone)	3.4
Zofran (ondansetron)	2.4
Tylenol (acetaminophen)	1.8
Haldol (haloperidol)	1.6
Thiamine	1.3

analgesics, particularly opioids [25, 26]. In addition, prescription of high-risk medications such as benzodiazepines has also increased [27].

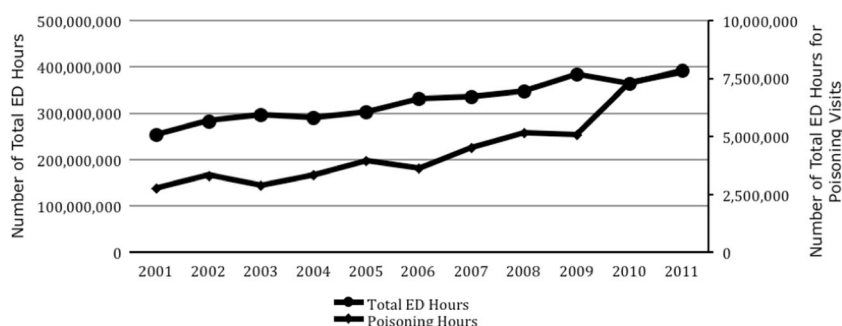
There was also a large decrease in the use of gastrointestinal decontamination using activated charcoal and whole bowel irrigation, following the trend of gastric lavage for poisoning patients in the USA [28]. This finding is consistent with current recommendations that single-dose activated charcoal could not be routinely administered for most poisonings, but reserved for patients with early presentations who have ingested a substance that is potentially bound by activated charcoal in an amount that is anticipated to be toxic [29]. ED providers may have incorporated these recommendations into their practice, or it may also be that opioid ingestions, which comprise many unintentional ingestions, have an antidote (naloxone). In addition, patients with opioid and other poisonings may have significantly depressed mentation, and thus may obviate the administration of oral activated charcoal without placement of a nasogastric tube or securing the airway by endotracheal intubation.

Our study found that patients with poisoning-related visits consume an increasing amount of ED resources as it pertains to length of stay and CT imaging. Increased numbers of patients require more provider time and physical space in the ED. Although the mean number of overall diagnostic tests decreased, patients still received an average of over four tests. This decrease in testing may be due to an increasing recognition of the limited utility of tests that were commonly ordered

such as ethanol levels and urine toxicology screens. In addition, nearly two thirds of visits received labs and patients often received medications. Interventions such as specimen collection and medication preparation and administration consume nursing and pharmacy resources. In addition, a large proportion of patients also received radiology studies, potentially to assess for adverse impact related to the poisoning itself, or the events surrounding the poisoning (e.g., trauma). The time required for multiple diagnostic studies may contribute to longer lengths of stay and potentially worsen ED crowding [6–8]. In addition, high rates of ambulance transport among poisoned patients, although often appropriate, may place additional stress on an already overwhelmed emergency medical services (EMS) system [30].

The increase in the total number of ED hours alone does not completely account for the substantial rise in the number of ED hours for poisoning-related visits. It is more likely that a combination of multiple factors have contributed to this rise in poisoning ED hours. In addition to an increasing proportion of poisoned patients, it may also signify higher acuity in the population presenting with poisoning. Patients under the influence of many common toxicants such as ethanol, opioids, or extended-release preps may require prolonged periods of observation until the patient is deemed stable for discharge. Higher rates of overall ED crowding for all visit types might contribute to increased length of stay for poisoned patients. Our findings also demonstrated a significant increase in inpatient admissions, which further supports these patients have higher acuity presentations and require more extensive observation. Higher admission rates for poisoned patients may further worsen crowding, particularly when there are high rates of ED boarding. ICU admission rates remained stable, which could be a reflection of the fact that ICU space is more limited and patients may often be downgraded to the floor from the ED because there are long waits for ICU beds in many institutions; however, this information is not available in the NHAMCS survey.

It may also be that increased utilization of studies such as CT imaging may lengthen that ED LOS as well, particularly when CT use for other indications has also increased substantially, increasing the time it takes to obtain the study [31]. CT imaging in poisoned patients have a lower likelihood of

Fig. 1 Total ED hours (for any type of visit) over the study period and ED hours for poisoning-related visits

abnormal findings on CT, but these patients are more likely to be admitted despite the negative findings [32, 33]. Our findings of increased CTs in poisoned patients may also be a function of overall increased CT use in the ED. Additionally, studies have demonstrated that many CT scans performed in the ED are often not indicated and efforts such as the Choosing Wisely campaign have focused on curbing inappropriate use of CT scanning [34]. These CTs not only increase ED LOS but also increase healthcare costs and expose patients to significant amounts of radiation [35]. The increase in the magnitude of ED visits as well as trend toward of CT utilization may have far-reaching effects on ED length of stay and overcrowding, ultimately leading to adverse patient outcomes and increased healthcare costs [6–8].

The fact that 3 % of patients involved in poisoning-related visits had been discharged from the hospital within the previous 7 days may represent an area of potential intervention. Although the reason for the previous visit is not collected in the NHAMCS survey, these repeat visits may be due to overdose or adverse effects of discharge medications or continued misuse or abuse of previous medications or illicit drugs. One study demonstrated that patients who were treated for an opioid overdose were also very likely to be continued on opioids after their discharge. Additionally, these patients were also at higher risk of repeat overdose compared to those whose opioids were discontinued [36]. As such, overdose visits may serve as an opportunity to change current drug therapy as well as to identify and refer individuals who may require substance abuse treatment.

Limitations

The main limitations of this study reflect the use of survey administrative data for this type of analysis [37, 38]. Although the multistage sampling of the NHAMCS database is designed to make the sample representative, these estimates may contain minor inaccuracies and sampling bias; however, the consistency and rigor of the NHAMCS methodology should protect against major inaccuracies [38]. NHAMCS is a national-level database that includes information pertaining to visits, not specific patients. As such, it is not possible to review individual patient charts for further detail. The reasons for visit and ICD-9 codes included did not uniformly specify individual agents involved in the poisoning, nor whether the poisoning was intentional or unintentional. There was not adequate sample size to make reliable estimates about trends in specific agents involved, such as opioid analgesics. In addition, we were unable to determine the specific type of diagnostic tests ordered. There was not adequate sample size to determine trends in individual procedures and which procedures were included in the survey varied between years. NHAMCS data are not yet publically available beyond 2011; as such, trends may not be the same with more recent

data. Finally, there are limited data comparing the resources used for poisoning-related visits compare to other visit types. A direct comparison would be difficult due to the heterogeneity of toxic exposures.

Conclusion

Poisoning-related ED visits increased significantly over the 8-year study period; poisonings can be resource-intensive visits that increasingly rely on advanced imaging and require increasingly longer lengths of ED stay or hospital admission.

Compliance with Ethical Standards

Sources of Funding No funding was provided for this study.

Financial Disclosures The authors have no financial relationships relevant to this article to disclose.

Conflict of Interest The authors declare that they have no conflicts of interest.

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