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SURGERY ARTICLES

The epidemiology of upper extremity injuries presenting to the emergency department in the United States

Daan Ootes · Kaj T. Lambers · David C. Ring

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Abstract
Background The epidemiology of upper extremity injuries presenting to emergency departments in the USA is not well studied. The purpose of this investigation was to estimate the incidence rates of upper extremity injuries presenting to emergency departments.
Methods The National Electronic Injury Surveillance System (NEISS)—a database of emergency department visits based on a sample of hospitals selected and weighted to represent the entire US population in order to allow estimates of overall incidence—was queried for all upper extremity injuries presenting to US emergency departments in 2009. Injury types were analyzed for each region of the upper extremity, and incidence rates were calculated based on population estimates from the US Census.
Results A query of the NEISS resulted in 92,601 records of upper extremity injury treated at an emergency department in the USA in 2009, which translates to an estimated total of 3,468,996 such injuries that year. This corresponds to an incidence of 1,130 upper extremity injuries per 100,000 persons per year. The most common region injured was the finger (38.4%). The most common upper extremity injury was a fracture (29.2%). Specific injuries with high incidence rates (all per 100,000 per year) included finger lacerations (221), wrist fractures (72), finger fractures (68), and lower arm fractures (64). Home is the most common setting for an upper extremity injury.
Conclusions The NEISS provides estimates of the incidences of upper extremity injuries that may be useful for public health initiatives.

Keywords Emergency department · Epidemiology · Upper extremity

D. Ootes · K. T. Lambers · D. C. Ring (✉)
Orthopaedic Hand and Upper Extremity Service,
Massachusetts General Hospital,
Yawkey Suite 2100, 55 Fruit street,
Boston, MA 02114, USA
e-mail: dring@partners.org

Introduction

To our knowledge, little is known about the epidemiology of upper extremity injuries that bring patients to the emergency department in the USA. Emergency department visits are rising; crowding of emergency departments is an increasing global problem [3]. According to the National Hospital Ambulatory Medical Care Survey, there were an estimated 117 million emergency department visits in 2007 [8]. A more detailed description and characterization of upper extremity injuries presenting to emergency departments would inform public health measures such as injury prevention, resource allocation, and training priorities.

The National Electronic Injury Surveillance System (NEISS) database contains the most comprehensive surveillance of injuries treated in the emergency department [10]. The NEISS database is produced by the Consumer Product Safety Commission (CPSC). It includes data from 100 hospitals in the USA selected and weighted to represent the average US population to allow estimates of specific injury types presented to all US emergency departments. A full description of the sample design is published on the CPSC website [6]. The NEISS database has been a reliable source of data for many epidemiological studies [14, 15, 17].

The purpose of this study is to calculate estimates of the epidemiology of upper extremity injuries presenting to

emergency departments in the USA to inform public health measures.

Materials and Methods

This is a cross-sectional descriptive epidemiological study. All data were obtained from the NEISS database, which is de-identified, and therefore, no institutional review board approval is required.

The CPCS NEISS database is a probability sample of 100 emergency departments in the USA. These hospitals are selected and weighted to represent the average US population by accounting for geographic location, department size, and children's hospitals. Each year, a sampling frame based on all emergency department visits in the USA is used to determine statistical weights for the current NEISS hospital sample that provide estimates of the entire US population [6]. A NEISS query for a specific injury provides both the number of cases presenting to the 100 emergency departments in the probability sample as well as the estimate for the entire US population. Based on these estimates, we calculated incidence rates using estimates of the US population from the US Census Bureau, Population division [16].

At participating emergency departments, a case record is made of each injury that includes treatment date, age, sex, race, diagnostic category, body region (e.g., wrist, shoulder), patient disposition (e.g., treated and released, treated and admitted, etc.), location of injury, and two descriptive narrative fields. These data are directly keyed in computer systems by staff at each participating hospitals [7, 11].

In this study, the NEISS database was queried for all injuries in the upper extremity between 01 January 2009 and 31 December 2009. The NEISS database uses a body part diagram. The upper extremity includes the following regions: finger, wrist, lower arm, elbow, upper arm, and shoulder. In the NEISS estimates query builder, three parameters are entered: treatment dates, product codes, and other parameters. Treatment date was between 01 January 2009 and 31 December 2009. The product code section (each diagnosis is coded) was not filled in, and the section with other parameters was queried for each body part of the upper extremity separately in the Body Part section and then put in a common database. The specific diagnostic categories used in the NEISS database are amputation, contusion/abrasion, crush, dislocation, presence of a foreign body, fracture, hematoma, laceration, nerve damage, puncture, strain or sprain, hemorrhage, avulsion, dermatitis, burns, and other/not stated. Burns can be divided into electrical, scald, chemical, radiation, thermal, and burns not specified, but we considered them as a single group because they were relatively uncommon.

We analyzed the data in several ways. First, we calculated the percentage of total upper extremity injuries that occurred in each body region. Next, for each body region, we calculated the distribution of injury types as a percentage of the total number of injuries for that region. Next, for each injury type, we calculated the distribution among the body regions as a percentage of the total number of that type of injury. Next, we calculated the distribution of the circumstances/location where the injury occurred as a percentage of the total number of injuries and as a percentage of the total number of injuries for each body region. Finally, we calculated incidence rates for each specific type of injury in a specific body part. For the ten most common injuries, we used the Spearman correlation test to see whether age correlated with incidence. To calculate age-specific incidences, we used 5 year age groups to age 105 years.

For the five most common injuries with high incidence rates, we analyzed annual incidence rates from 2000 to 2009 (Fig. 1). Linear regression was used to analyze if there was an increase or decrease in incidence with time.

Results

A total of 92,601 patients were diagnosed with an upper extremity injury between 01 January 2009 and 31 December 2009 in the NEISS database. According to the NEISS

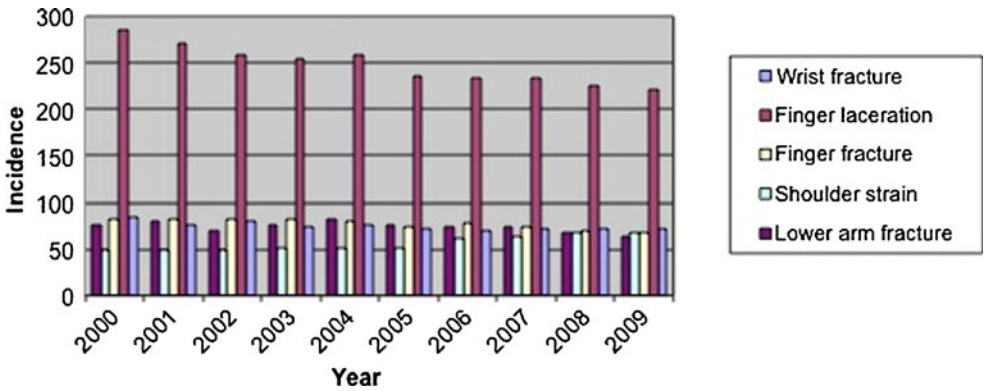

Fig. 1 Incidence rates per 100,000 persons per year from 2000–2009

Table 1 Injury percentages per body part in the USA 2009

Diagnosis	Finger	Wrist	Lower arm	Elbow	Upper arm	Shoulder
Burns, total	1.3	0.6	5.3	0.3	2.6	0.5
Amputation	2.0	0	0	0	0	0
Contusion/abrasion	9	9.6	15.4	30.3	9.6	18.7
Crushing	1.5	0	0.1	0	0	0
Dislocation	2.6	0.2	0.3	12.6	0.3	13.2
Foreign body	3	0.1	0.7	0.1	0.6	0.1
Fracture	16.7	40.6	47.1	31	62.4	22.4
Hematoma	0.7	0.1	0.4	0.3	0.4	0.1
Laceration	47.1	7.5	19.1	7	9	0.6
Nerve damage	0	0.2	0.2	0	0.2	0.1
Puncture	1.2	0.3	0.8	0.1	0.6	0
Strain/sprain	8.4	34.9	3.7	10.5	8.3	34
Hemorrhage	0	0	0	0	0	0
Other/not stated	3.6	5.7	4.7	7	5.1	10.3
Avulsion	2.9	0.1	1.3	0.7	0.5	0
Dermatitis	0	0.1	1	0	0.4	0.1
Total	38.4	15.2	15.3	10.5	3.7	16.8

methodology, this represents an estimated total of 3,468,996 upper extremity injuries presenting to an emergency department in the USA during this time period. This would be an estimated incidence of 1,130 upper extremity injuries per 100,000 persons per year, meaning that a resident of the USA has a 1-in-88 chance of presenting to the emergency department with an upper extremity injury in a given year.

By anatomic site, the majority were finger injuries (38.4%), followed by shoulder (16.8%), lower arm (between the elbow and the wrist) (15.3%), wrist (15.2%), elbow (10.5%), and upper arm (between the shoulder and the elbow) injuries (3.7%) (Table 1). Specific diagnoses for each body part are also detailed in Table 1.

The most common type of injury of the upper extremity that brings a patient to an emergency department in the USA is a fracture (29.2%). Other frequent diagnoses in the upper extremity are lacerations (23.3%), strains/sprains (16.2%), contusions/abrasions (14.0%), and dislocations (4.6%) (Table 2).

The majority of upper extremity injuries occur at home (45.4%), while 16.2% are sports-related. Other common sites are school (6.6%), other public property (4.1%), and

Table 2 Percentages of total number of specific injury type

Diagnosis	Finger	Wrist	Lower arm	Elbow	Upper arm	Shoulder	Total (n=92,601)
Burns, total	30.9	5.8	50.2	1.9	6.1	5.1	1.6
Amputation	99.4	0.4	0	0	0.1	0	0.8
Contusion/abrasion	24.8	10.4	16.9	22.8	2.6	22.5	14
Crushing	95.9	1.1	2.2	0	0.2	0.7	0.6
Dislocation	21.5	0.6	1.1	28.7	0.2	48	4.6
Foreign body	86.5	1.4	8.6	0.8	1.7	1	1.3
Fracture	22	21.1	24.8	11.2	8	12.9	29.2
Hematoma	68.1	3.7	15.9	6.5	3.7	2.1	0.4
Laceration	77.5	4.9	12.5	3.2	1.4	0.4	23.3
Nerve damage	10.5	34.9	31.4	3.5	8.1	11.6	0.1
Puncture	69.5	6.8	17.5	2.1	3.2	1	0.7
Strain/sprain	19.8	32.7	3.5	6.8	1.9	35.2	16.2
Hemorrhage	75	0	12.5	0	0	12.5	0
Other/not stated	24.8	15.4	12.8	13	3.3	30.7	5.6
Avulsion	78.6	1	13.8	5	1.4	0.3	1.4
Dermatitis	7.5	4.8	72.6	1.6	7.5	5.9	0.2

Table 3 Percentages of location of injury per body part

Location	Finger	Wrist	Lower arm	Elbow	Upper arm	Shoulder	Total
Home	51.9	38.2	44.7	42.1	49.3	39.1	45.4
Farm/ranch	0	0	0.1	0.1	0.1	0.1	0.1
Street/highway	0.7	3.5	3	3.9	2.1	4.5	2.5
Other public property	2.6	4.4	4.1	4.8	7.4	5.9	4.1
Manufactured home	0	0	0	0	0	0	0
Industrial place	0	0	0	0	0	0	0
School	6.4	7.9	7.6	7.8	4.1	4.9	6.6
Place of recreation or sports	11.3	22.4	15.9	17.3	14.1	21.9	16.2
Not recorded	27	23.5	24.6	24.1	22.8	23.6	25.1

street (2.5%). However, a substantial amount of locations were not recorded (25.1%) (Table 3). In the most common injury types, we found that most fractures occur at home (38.6%). Most lacerations also occur at home (67.1%), and most contusions and abrasions occur at home as well (44.5%).

According to incidence rates, the five most common *specific* injury (body part and type of injury combined) that brings a person to the emergency room is a laceration of the finger (221 per 100,000 persons per year; or 1 in 452 of us each year), wrist fractures (72 per 100,000 persons per year), finger fractures (68 per 100,000 persons per year), shoulder strains/sprains (68 per 100,000 persons per year), and lower arm fractures (64 per 100,000 persons per year) (Table 4). Incidence rates over the past 9 years of the five most common injuries all show significant change. The following injuries showed decrease: finger lacerations ($B=-6.6$; $p=0.000$; $R^2=0.94$), wrist fractures ($B=-1.3$; $p=0.002$; $R^2=0.72$), finger fractures ($B=-1.7$; $p=0.000$; $R^2=0.88$), and lower arm fractures ($B=-1.1$; $p=0.047$; $R^2=0.41$). Shoulder strain/sprain showed an increase ($B=2.5$; $p=0.000$; $R^2=0.86$).

Among the ten most common injuries (the five injuries described above plus: wrist strains, shoulder fractures, shoulder contusions, elbow contusions, and finger strains) found that the only significant correlation with age was found in finger fractures (Correlation Coefficient −0.614, $p=0.009$).

Discussion

Published incidence rates of common upper extremity injuries vary widely. For example, the incidence rates of scaphoid fractures vary from 1.47 per 100,000 people to 26 per

Table 4 Estimated incidence rates per 100,000 persons in the USA

Diagnosis	Finger	Wrist	Lower arm	Elbow	Upper arm	Shoulder
Burns. electrical	0.5	0	0	0	0	0
Burns, scald	0.7	0.4	2.9	0	0	0
Burns, thermal	3.5	0.6	5.2	0	0.7	0
Amputation	7.4	0	0	0	0	0
Contusion/abrasion	35.4	16.8	25.4	37.6	4.6	38.7
Crushing	7	0	0	0	0	0
Dislocation	11.3	0	0	11.3	0	26.9
Foreign body	14	0	1.5	0	0	0
Fracture	67.9	71.6	64.2	28	25.2	42.2
Hematoma	2.8	0	0.7	0	0	0
Laceration	221.1	14.7	33.9	9	3.7	1.1
Nerve damage	0	0.4	0	0	0	0
Puncture	6.2	0.6	1.5	0	0	0
Strain/sprain	37.3	64.1	5.5	11.9	4.2	67.6
Other/not stated	14	10.6	7.1	8.9	2.2	21.7
Avulsion	14.7	0	2.8	1	0	0
Dermatitis	0	0	1.4	0	0	0
	444	181	153	108	24	200

100,000 people [4, 15]. A more reliable estimate of incidence rates nationally and regionally may help guide public health measures and allocation of resources.

Larsen and colleagues found that 1 out of 55 Dutch and 1 out of 28 Danish people presented to emergency departments with hand injuries between 1997 and 1998 [5]. A Dutch study reported that 19% of all fractures presenting to the emergency department of a large university hospital in The Netherlands were fractures of the hand [9]. Prior reported incidences of finger fractures include 380 per 100,000 in the UK [2]. These results are similar to our findings.

Singer and colleagues reviewed 90 million lacerations presenting to an emergency department in the USA between 1992 and 2002 and found that 35% involved the upper extremity [12]; Singer and colleagues [13] looked at fracture incidence in 15,000 adults in Edinburgh between 1992 and 1993 and found patterns consistent with lifestyle and osteoporosis risk.

The NEISS database has been a useful tool for identifying injuries that present to US emergency departments. Zacchilli and colleagues used the NEISS database to look at shoulder dislocations in the USA between 2002 and 2006. They calculated an estimated incidence rate of 23.9 per 100.000 persons. This is approximately twice the previously reported value [17]. The Center for Disease and Control Prevention studied nonfatal traumatic brain injuries from sports and recreational activities and found that most injuries (both for males and females) occurred between the ages of 10–14 years [1]. They advocate increased awareness and development of prevention strategies.

This study should be interpreted in light of its shortcomings. The diagnostic categories are broad, which may decrease the likelihood of inaccuracy, but there is no way to know, for example, if a diagnosis of fracture was sometimes used for a suspected fracture. The NEISS database also uses estimates for incidence rates; this may influence accuracy as well. Further more, we studied the rates of injury presenting to an emergency department, which would underestimate the true incidence of injuries since some patients do not present to the emergency department. Finally, the NEISS database does not account for return visits to the emergency department for the same injury.

According to our findings, finger laceration is the most common diagnosis of the upper extremity made in US emergency departments in 2009. This is similar to other studies that found high percentages of upper extremity lacerations [12]. Other frequently seen upper extremity injuries are wrist, finger, and lower arm fractures. The majority of injuries that bring patients to emergency departments occur at home. However, a substantial percentage of upper extremity injuries are sports related. In our opinion, these data provide the most accurate and reliable estimates of the epidemiology of upper extremity injury presenting to an emergency room in the USA.

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