Burden of Hand Maladies in US Emergency Departments

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Abstract

Background: Hand conditions commonly present to the emergency department (ED), yet data are lacking regarding the magnitude of hand-related conditions in the emergency setting. The purpose of this study is to describe the burden and quantify the health care resource utilization of hand conditions seen in EDs across the United States. **Methods:** Using the National Emergency Department Sample, we identified all ED encounters by patients at least 18 years of age that were associated with a hand condition in 2009 to 2012. The primary outcomes were prevalence, etiology, and associated health care charges for specific categories of hand conditions. **Results:** The final sample included 34.4 million ED encounters associated with a common hand condition generating \$180.4 billion in health care charges. The volume of hand-related presentations varied in a predictable and cyclical manner, peaking in July and waning in December of each year. Trauma was the most common etiology (77.5%) predominantly due to falls (26.2%) and lacerations (19.7%). Over 4 years, the volume of ED encounters rose (5% increase, $P < .001$) and as did the resulting health care charges (24.6% increase, $P < .001$). **Conclusions:** Our study confirms that hand-related conditions contribute significantly to ED volume and consume a growing quantity of health care resources in the United States. The volume of patients presenting to EDs with hand-related conditions fluctuates cyclically throughout the year. Open wounds are the most common cause of presentation and mostly occur in young adults, followed by joint pain, contusions, and fractures.

Keywords: hand, hand trauma, emergency department, epidemiology, HCUP, NEDS, health care

Hand injuries are commonly treated in American emergency departments (EDs),²¹ yet on-call hand surgeons remain in short supply nationwide.² In a 2006 national survey, ED physicians reported that hand surgeons (along with plastic and orthopedic surgeons) were among the consulting specialists needed most in EDs across the country.³ The root cause of this trend is manifold and includes decline in physician reimbursement, perceived financial disadvantage of caring for hand trauma patients, and growing patient burden on EDs.¹ Consultations and referrals from EDs, on the contrary, are an important component of establishing and maintaining a successful and solvent hand practice both in private practice and in academic medicine.¹⁰

In light of ongoing changes in health care coverage and physician reimbursement, it is important for hand surgeons to understand the trends in the volume and composition of hand-related conditions presenting to EDs. Although previous studies have investigated the epidemiology of hand and forearm fractures in particular,^{5,13} no comprehensive description inclusive of other hand diagnoses exists in the literature. With data regarding the volume, payer mix, and seasonality of the most common hand maladies presenting to EDs, practicing hand surgeons taking emergency call would be better equipped to

develop and structure their practices. Therefore, we conducted this study to estimate the frequency of ED visits related to common hand maladies, describe their diagnoses, elucidate patterns of visit volume within a year and over several years, and quantify the related health care resource utilization.

Materials and Methods

We conducted a cross-sectional study of US ED visits between 2009 and 2012 using the National Emergency Department Sample (NEDS) databases, which are available through the Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project (HCUP).¹¹ The

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NEDS draws data from 30 states to create a 20% stratified sample of US hospital-based EDs. The 2009 to 2012 data sets were selected because they encompass an extended period prior to the implementation of the health care exchanges as a part of the Affordable Care Act (ACA) which would potentially confound the data, particularly the payer mix. The 5 stratifying characteristics are geographic region, trauma center designation, urban-rural location, teaching status, and ownership. In 2012, the data set included information on 31 million ED visits from 950 hospital-based EDs. Weights are provided within the data set to calculate national estimates. Each discharge abstract contains information about related diagnoses and procedures using *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) and *Current Procedural Terminology* (CPT) codes, as well as patient demographic, anticipated payer, hospital charges, and discharge disposition information. If the patient was admitted to the hospital, a supplemental file provides information about subsequent inpatient diagnoses, procedures, and charges. US Census data were used to determine national population data over the same time course.²³

ED Visit Selection

We identified all ED visits, whether subsequently discharged home or admitted to the hospital, for all patients between January 1, 2009, and December 31, 2012, for any listed diagnosis of a hand condition. Hand conditions were defined by primary and secondary ICD-9-CM diagnostic coding for any soft tissue, joint, bone, vascular, or nerve injury distal to the shoulder. Although the definition of “hand” surgery varies across centers from conditions affecting the extremity distal to the wrist to maladies as proximal as the shoulder, we opted for a more inclusive definition so that it may be most applicable to all health care providers. Because several codes can represent a similar clinically relevant condition, we grouped them into the following broad categories: amputations, open wounds without tendon injury, tendon injury, arterial injury, nerve injury, neuropathy, infections, crush injury, fractures, dislocations, sprains, soft tissue injuries (contusions), joint pain, arthropathy, superficial wounds and foreign bodies, burns, and frostbite (see Supplemental Appendix).

Health Care Utilization

We defined 3 measures of health care utilization: (1) number of visits within each diagnosis category, (2) average health care charges for each diagnosis category, and (3) percentage of patients requiring inpatient admission. Health care charges are a defined variable in the database. For patients who were discharged home without admission, these charges reflect those associated with ED care. For patients requiring hospital admission, these charges are the

sum of charges generated from the ED visit and inpatient hospitalization. All health care charges were adjusted for inflation according to the medical component of the consumer price index to 2015 US dollars.

Covariates for Description

We identified several patient demographic, initial presentation, trauma score, and medical comorbidity variables. Patient demographic variables included age, sex, and anticipated primary payer (Medicare, Medicaid, Private, or Other). Workers' compensation payment is not reported by all states in the HCUP database and therefore was classified under the “other” category of primary payer. Initial presentation variables included whether the hand condition was the primary diagnosis associated with the encounter, whether trauma precipitated presentation, and if so, the mechanism of injury and injury severity score. To determine chronic medical comorbidity, we assessed the number of chronic medical conditions each patient had according to the enhanced Elixhauser algorithm described by Quan,¹⁷ which identifies 31 chronic medical conditions.

Statistical Analysis

First, the total sample was categorized according to age: young adult (18-34 years), middle-aged (35-64 years), and senior (65+ years). These age groups were chosen based on generally accepted demographic groups used to study other population-based behavior (eg, voting, marketing, employment). Next, we used descriptive statistics including age and gender to present baseline characteristics of the 3 age-stratified populations. Similarly, characteristics of the ED visits, including associated diagnoses, health care charges, and hospital admission, were presented. Then, trends in national health care utilization were analyzed over time to determine whether ED visits for hand maladies were changing throughout the study time period. To account for US population changes, the rate of ED visits per year was expressed as visits per 1000 population. Significance in observed trends was tested using regression analysis. All analyses were conducted using SAS version 9.3 (SAS Institute, Cary, North Carolina). All *P* values were 2-sided and considered significant at the <.05 level. Because it used publicly available data that do not include patient identifiers, this study was exempt from review by the University of Pennsylvania institutional review board.

Results

Volume of Hand-Related ED Visits

Over the 4-year period of this study, there were a total of 34.4 million discharges from EDs across the United States involving hand maladies, including those that resulted in

Table 1. Discharges Associated With Common Hand Maladies for Adult Patients From US Emergency Departments (2009-2012).

	Overall		18-34 years old		35-64 years old		65+ years old		P value
	n	%	n	%	n	%	n	%	
Discharges	34 380 069	100	12 796 829	100.0	15 390 517	100.0	6 192 722	100.0	—
Hand malady as primary diagnosis	25 623 418	74.5	10 208 027	79.8	11 589 738	75.3	3 825 653	61.8	<.001
Trauma related	26 673 332	77.6	10 355 559	80.9	11 523 947	74.9	4 793 825	77.4	<.001
Male	18 012 562	52.4	7 529 091	58.8	8 089 650	52.6	2 393 821	38.7	<.001
Anticipated primary payer									<.001
Medicare	7 170 574	20.8	280 596	2.2	1 653 501	10.7	5 236 477	84.6	
Medicaid	5 107 485	14.8	2 728 945	21.3	2 312 305	15.0	66 235	1.1	
Private	10 891 203	31.7	3 998 931	31.2	6 214 564	40.4	6 777 708	10.9	
Other	11 236 861	32.7	5 793 900	45.3	5 229 209	34.0	213 752	3.5	
Medical comorbidity									
Cardiovascular diseases other than hypertension	1 591 965	4.6	72 120	0.6	398 449	2.6	1 121 395	18.1	<.001
Hypertension	5 697 971	16.6	293 373	2.3	2 682 409	17.4	2 722 189	44.0	<.001
Chronic obstructive respiratory disease	1 760 075	5.1	377 086	2.9	760 168	4.9	622 821	10.1	<.001
Diabetes	2 426 394	7.1	153 868	1.2	1 229 191	8.0	1 043 336	16.8	<.001
Mental health diagnoses	2 219 147	6.4	714 767	5.6	1 134 690	7.4	369 690	6.0	<.001
History of smoking	4 524 256	13.1	1 917 395	15.0	2 211 408	14.4	395 452	6.4	<.001

Figure 1. Volume of hand-related emergency department visits (2009-2012).

admission to the hospital for inpatient care (Table 1). This represents 6.6% of the 524.3 million estimated ED visits in the United States during the same 4-year period. From 2009 to 2012, there was a 5% absolute increase in the volume of hand maladies in EDs, rising from 8.4 million hand visits in 2009 to 8.7 million visits in 2012 (Figure 1).

Description of Hand Malady

The nature of hand conditions presenting to US EDs is shown in Table 2. Overall, adults were most likely to arrive with open wounds of the upper extremity (24.9%) followed by contusions (15.7%), joint pain (14.6%), fractures

(14.5%), and sprains (13.3%). Amputations were rare, presenting in 0.5% of patients with upper extremity-related conditions.

Traumatic injury was the predominant cause of presentation overall (77.6%) and within each age subgroup (young adult = 80.9%, middle age = 74.9%, senior = 77.4%) (Table 1). Traumatic mechanisms of injury are detailed in Table 3, which shows that falls were the predominant inciting cause of patient presentation (26.3%) and were responsible for the majority of injuries in the senior age group (58.3%). This was followed closely by laceration in 19.7% of all presentations, while blunt trauma injuries (10.6%) and motor vehicle collisions (9.8%) were also significant.

Table 2. Nature of Hand Malady Stratified by Age Group.

	Overall		18-34 years old		35-64 years old		65+ years old	
	n	%	n	%	n	%	n	%
Discharges, n	34 406 123	100.0	12 802 373	100.0	15 409 578	100.0	6 194 172	100.0
Amputation	186 365	0.5	52 532	0.4	106 288	0.7	27 544	0.4
Open wounds	8 584 059	24.9	3 505 121	27.4	3 674 269	23.8	1 404 669	22.7
Tendon injuries	318 897	0.9	137 893	1.1	154 247	1.0	26 757	0.4
Arterial injuries	43 011	0.1	20 290	0.2	19 125	0.1	3 596	0.1
Peripheral nerve injuries	79 542	0.2	35 429	0.3	37 623	0.2	6 491	0.1
Neuropathy	580 351	1.7	158 305	1.2	327 308	2.1	94 738	1.5
Infections	3 883 632	11.3	1 575 625	12.3	1 793 090	11.6	514 918	8.3
Crush injuries	259 335	0.8	118 132	0.9	124 228	0.8	16 975	0.3
Fractures	4 983 148	14.5	1 479 733	11.6	2 105 340	13.7	1 398 076	22.6
Dislocations	300 634	0.9	114 341	0.9	136 419	0.9	49 874	0.8
Sprains	4 566 331	13.3	1 888 902	14.8	2 174 793	14.1	502 637	8.1
Contusion	5 396 986	15.7	2 194 336	17.1	2 201 472	14.3	1 001 178	16.2
Joint pain	5 011 186	14.6	1 430 936	11.2	2 618 178	17.0	962 072	15.5
Arthropathy	920 185	2.7	73 081	0.6	369 697	2.4	477 406	7.7
Superficial wounds (abrasions, blisters, etc)	2 470 876	7.2	991 458	7.7	973 286	6.3	506 132	8.2
Burns	757 119	2.2	358 328	2.8	347 322	2.3	51 470	0.8
Frostbite	6 440	0.02	2 205	0.02	3 433	0.02	802	0.01

Table 3. Analysis of the Trauma-Related Subgroup.

	Overall		18-34 years old		35-64 years old		65+ years old		P value
	n	%	n	%	n	%	n	%	
Discharges, n	26 673 332	100.0	10 355 559	100.0	11 523 947	100.0	4 793 825	100.0	—
% of traumas by age group		100%		38.8%		43.2%		18.0%	
% of total admissions that were traumatic by age group		77.6%		80.9%		74.9%		77.4%	
Mechanism of injury, %									<.001
Cut	5 248 538	19.7	2 397 497	23.2	2 399 409	20.8	451 632	9.4	
Drown	2712	0.0	1031	0.0	1318	0.0	363	0.0	
Fall	7 001 185	26.2	1 408 279	13.6	2 795 852	24.3	2 797 055	58.3	
Fire	625 852	2.3	295 528	2.9	287 545	2.5	42 780	0.9	
Firearm	75 354	0.3	51 277	0.5	21 094	0.2	2 983	0.1	
Machinery	361 873	1.4	115 915	1.1	197 039	1.7	48 920	1.0	
Motor vehicle	2 465 731	9.2	1 175 261	11.3	1 073 749	9.3	216 721	4.5	
Nature	1 188 664	4.5	411 900	4.0	583 851	5.1	192 913	4.0	
Poison	39 655	0.1	14 803	0.1	20 363	0.2	4 488	0.1	
Blunt trauma	2 829 477	10.6	1 591 228	15.4	1 044 716	9.1	193 533	4.0	
Suffocation	3 090	0.0	1 588	0.0	1 032	0.0	470	0.0	
Multiple	221 977	0.8	99 406	1.0	88 818	0.8	33 752	0.7	
Intent of injury, %									<.001
Assault	586 867	2.2	365 929	3.5	211 104	1.8	9834	0.2	
Self harm	191 016	0.7	121 476	1.2	66 453	0.6	3 087	0.1	
Unintentional	23 471 183	88.0	8 757 191	84.6	10 243 115	88.9	4 470 877	93.3	
Multiple	756 421	2.8	459 920	4.4	279 203	2.4	17 297	0.4	
Disposition									
Home discharge	24 688 058	92.6	9 904 093	95.6	10 803 009	93.7	3 980 956	83.0	<.001
Admitted to same hospital	1 599 221	6.0	321 825	3.1	562 642	4.9	714 754	14.9	<.001
Transfer to another hospital	313 986	1.2	98 867	1.0	126 614	1.1	88 505	1.8	<.001
Died in the emergency department	8 991	0.03	3 298	0.03	3 484	0.03	2 209	0.05	<.001

Figure 2. Monthly trend in hand maladies presenting to US emergency departments (2009-2012).

Note. ED = emergency department.

Trends in Hand Maladies Within and Over Multiple Years

There was a clear cyclic pattern of volume of ED visits by season throughout our study period. When adjusted for the number of days in each month (Figure 2), we show increased visits during the summer months, peaking in July, and reduced visits in the wintertime, reaching a nadir in December. These peaks and troughs in the sinusoidal curve tend to correlate with the beginning of summer and winter, respectively, for each year. This seasonality phenomenon was evident in all age groups.

Presentations by Demographic

The number of visits increased in each subgroup (+3% in the young adult group, +4% in the middle-aged group, and +8% in the senior group), but adjusted for the relative populations of each group (Figure 3), the number of overall visits per capita rose only by 1.06%. The middle-aged group, however, was the only group in which the total visits per capita rose appreciably over the course of the study (+4.35%) whereas the young adult group remained essentially unchanged (−0.14%) and the elderly group fell slightly (−2.02%). All these relative changes were statistically significant ($P < .001$). Male patients comprised just over half of all patients (52.4%) and predominated in the young adult and middle-aged groups (58.8% and 52.5%, respectively). Female patients made up 61.3% of all ED visits in the senior age group.

Young adult group (age 18-34 years). By population, young adults had the highest rate of hand-related presentations in our study (Figure 3) with a mean 45 hand-related ED visits

per 1000 people in the United States, compared with 32 per 1000 people in the middle-age group and 39 per 1000 people in the senior group. Compared with the older age groups, young adults were most likely to present with their hand condition as the primary visit diagnosis (79.8%) and had the highest proportion of trauma-related injuries (80.9%). These traumas were typically a result of laceration (23.2%) or a blunt trauma injury (15.4%). Young adults were most likely to present with open wounds (27.4%) and had the lowest rate of fractures (11.6%) (Figure 4). They were also the most likely group to present after self-harm (1.2%) or assault (3.5%).

Middle-age group (age 35-64 years). The middle-age group accounted for the largest proportion of visits (44.7%) during the course of the study, but this was also the largest group by population. As a result, this group had the lowest rate of ED visits per 1000 people in the United States (31.87). Middle-aged adults had the lowest rate of trauma-related visits (74.9%) but had the highest rate of joint pain (17.0%), neuropathic complaints (2.1%), and amputations (0.7%).

Senior group (age 65 years or greater). Seniors made up the smallest patient population, accounting for only 18% of visits. Women accounted for 61.3% of these visits, a distinct difference from the younger groups (Table 1). This may partially be due to women making up a larger portion of the senior group (56.4%). Seniors were least likely to present with hand complaints as a primary diagnosis (61.8%) but had the highest rate of fractures (22.6%), superficial wounds (8.2%), and arthropathy (7.7%) (Figure 4). Although falls were responsible for a significant portion of all presenting injuries (26.2%), they were disproportionately the cause of injuries in the senior group (58.3%).

Health Care Utilization and Hand Maladies in US EDs

Most hand-related visits (92.6%) were able to be managed within the ED, with only 7.4% requiring a hospital admission. When patients were admitted to the hospital, the average length of stay was 5.2 days. However, given the total volume of visits per year, hand maladies generated significant health care charges. The associated costs from these patient visits ranged from \$40.9 billion in 2009 to \$48.6 billion in 2012 (net 18.8% increase), totaling about \$180.4 billion dollars (Figure 5). The anticipated primary payer at the time of ED discharge varies by age group (Table 1). The vast majority of seniors were covered by Medicare (84.6%). On average, 20.8% of discharges over the course of the study were uninsured patients, with 30.9% of young adults without coverage versus 20.2% of the middle-aged and only 1.3% of seniors (Table 4). These uninsured patients accounted for \$23.2 billion in health care charges from 2009 to 2012.

Figure 3. Hand-related emergency department visits per 1000 people in the United States.

Figure 4. Total emergency department visits for hand malady by type, age group.

Discussion

Epidemiologic data regarding hand conditions presenting in emergency situations are lacking in the literature, and this study provides a comprehensive view of the volume and breakdown of various hand-related conditions seen in EDs over a 4-year period prior to recent legislative changes regarding US health care insurance coverage. We have shown that hand complaints are associated with a large volume of visits in EDs in the United States (34 billion visits over our 4-year study period), and these visits result in more than \$100 billion of health care charges, a significant component of our \$2.9 trillion per year in health care industry.

Our study also provides important information in other domains. We demonstrate a discrete seasonal ebb and flow of hand-related visits to EDs over the course of the year, with significantly increased activity in summer months and decreased visits in the winter. This increase in the use health care resources has previously been suggested from data from the Bureau of Labor, but never before quantified for hand-related conditions.^{15,16} We suspect this phenomenon has several causes that likely include longer daylight hours and warmer weather during the summer that results in more time spent doing physical activities and greater opportunity for traumatic hand injury. Comparisons with seasonality of emergency hand care in other geographic areas worldwide

Figure 5. Total health care charges for hand malades in US emergency departments (in 2015 dollars).

Table 4. Percentage Uninsured Over Time.

	Overall	18-34 years old	35-64 years old	65+ years old
2009	20.8	31.3	19.7	1.3
2010	21.0	31.5	20.0	1.3
2011	20.2	29.8	20.0	1.2
2012	21.3	31.2	21.3	1.2

may provide additional insight to this temporal nature of ED-related hand concerns.

We also show clear differences in the nature of presenting diagnoses by age. The young adult group had the largest proportion of traumatic presentations (80.9%) but were also the least likely to get admitted to the hospital as a result (4.4%). Furthermore, although males made up a majority of the patients in the youngest group (58.8%), females presenting with hand conditions became increasingly common in the older groups (61.3%). This may be due to the open-ended age range that defines the senior category and the gender distribution as the population gets older. Our data also stress the increased risk of injury due to falls in the older age group as they resulted in a disproportionate amount of hand injuries in elderly patients.

Despite many studies focusing on the economics and cost-effectiveness of replantation surgery for hand and finger amputations,^{4,8,19,20} we show that amputation injuries are exceedingly rare (0.5% of all ED visits), especially considering “amputation” in our study included distal tip amputations that are frequently not treated with replantation in the United States. By demonstrating the higher frequency of other diagnoses such as wounds, fractures, contusions, and sprains, our study may suggest topics for future economic analyses to increase value and decrease cost of emergency

care for those hand diagnoses that consume the most health care resources.

Our data also reveal the immense financial burden that hand-related conditions impose in this country and prompt the question of how these patients fit into the revenue stream for hospital systems and physician practices. Alderman et al. showed that hand traumas presenting to the University of Michigan ED were a fiscally advantageous subset of patients for their hospital;¹ however, this patient population was only 4.5% uninsured, compared with the 20.8% of patients without coverage in our study. In addition to increased volume of visits, we show that the average cost per visit steadily rose between 2009 and 2012. The ACA, initiated in March 2010, promised to drastically change the economic climate of health care, yet the future of American health care policy remains uncertain. Our data provide the last snapshot of the trajectory of emergency hand care in the years leading up to the most significant facet of the ACA, the implementation of health care exchanges. Recent findings from the Oregon Health Insurance Experiment suggest that expanding health care coverage actually *increases* the amount of ED visits (as well as hospital admissions and primary care visits) contrary to many theories.⁷ Our study demonstrates the high volume and makeup of hand care provided in the emergency department which frequently requires hand surgery consultation or office follow-up with continued care.

Our study must be considered in the context of several limitations. Our definition of hand conditions was broad, including diagnoses up to the shoulder. Also, we only included visits in which hand conditions were the primary or secondary diagnoses. Many patients with overarching diagnoses (such as polytraumas and altered mental status) may have in fact had a significant hand-related problem that was not captured in our analysis. Also, patients with multiple

hand complaints were categorized based on the condition was that was the “primary hand diagnosis”—therefore, they may have fallen into a particular category arbitrarily based on the order in which diagnoses were assigned for their ED visit. We also were not able to clearly define patients who had work-related injuries or for whom the primary payer was a workers’ compensation claim due to the heterogeneous manner in which states report this information. Patients who went to urgent care clinics for their care were also not included in our study as these centers are not included in the NEDS database. Finally, although we describe the direct price of hand-related visits, we fail to capture the socioeconomic cost borne by hand patients themselves, which several authors have shown to be significant.^{6,9,12,14,18,22,24}

These data fill an important void in the hand surgery literature regarding the demographics and incidence of emergency hand care. Although the future sociopolitical and economic environment of health care is less than certain, the need for hand surgeons on call will continue to grow. Our study helps to inform hand surgeons, emergency room providers, hospitals, and health systems going forward. Future studies should be conducted to reassess how trends in hand-related presentations change over the next decade as urgent care centers become more ubiquitous and the sociopolitical landscape of health care continues to evolve.

Conclusions

Hand-related conditions contribute a significant volume of ED visits, averaging more than 8.6 million in the United States each year. As a result, hand maladies consume a growing amount of health care resources, with a significant portion of these patients being uninsured (20.8%). We also show that the number of hand maladies presenting to EDs increases in the summer, peaking each July, and falls in the winter, reaching a nadir each December. Open wounds are the most common cause of presentation and mostly occur in young adults, followed by joint pain, contusions, and fractures. Elderly patients, however, most frequently presented with fractures and a higher rate of fall-related injuries.

Author’s Note

The views expressed in this article are those of the authors and do not reflect the official policy of the US Air Force, Department of Defense, or the US Government.

Ethical Approval

This study was exempt from review by the University of Pennsylvania institutional review board.

Statement of Human and Animal Rights

This article does not contain any studies with human or animal subjects.

Statement of Informed Consent

Informed consent was obtained from all individual participants included in the study.

Declaration of Conflicting Interests

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