

Hospitalization Trends of Fractures Presenting to the Emergency Room From 2009 to 2021

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Objective: Assessing trends in hospitalization rates due to fractures may be used as an indirect epidemiologic metric to predict future patient volumes, staffing needs, revenue, expenditures, and allocation of resources. The aim of this study is to analyze the trend of hospitalizations for patients who presented to Emergency Departments (EDs) with fractures from 2009 to 2021 in the United States (USA).

Setting: We extracted data from the National Electronic Injury Surveillance System (NEISS) database. All consecutive patients with a primary injury involving a fracture in the years 2009 to 2021 were eligible for inclusion in this study. The Cochran-Armitage test was used to assess the trend in fracture-related hospitalization rates over the years studied.

Results: This study showed a significant increase in hospitalizations due to fractures from 2009 to 2021 ($p < 0.001$). This increase in hospitalizations was observed consistently across various factors, including sex, fracture location, age categories, and the pre- and during-COVID-19 pandemic period. From 2009 to 2021, the mean age of patients presenting to EDs increased from 34 to 40 ($p < 0.001$) and the percentage of women increased from 45% to 48%. There was a significant increase in hospitalizations across five fracture regions including the upper trunk, proximal and distal upper extremity, and proximal and distal lower extremity.

Conclusions: Our findings show hospitalization trends due to fractures have been increasing across the USA. While reasons for this increased trend are multifactorial, increased utilization of urgent care for less severe injuries may be artificially driving these trends.

Level of Evidence: Level IV

Keywords: NEISS; epidemiology; fractures; hospitalization; database

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INTRODUCTION

A substantial number of patients with fractures initially present to the emergency department (ED) with an estimated 20% of all ED visits attributed to musculoskeletal diagnoses¹. The ED serves patients from all demographics and insurance statuses and is a crucial entry point for

many patients into the healthcare system for the treatment of orthopaedic trauma. This represents an essential opportunity for orthopaedic services to provide high-quality, cost-effective patient care. Medicaid is the primary health insurance program for people of low income and resources in the United States (USA), which is provided through government funding.² For patients on Medicaid with acute-on-chronic exacerbations of orthopaedic pathologies presenting as intractable pain, the ED is often the primary point of care and only treatment source due to limited outpatient Medicaid services available.^{3,4} It is essential for institutions to ensure the needs of these patients are justly met while also ensuring the financial well-being of the orthopaedic trauma service and associated health system.

There are widespread growing concerns regarding the affordability and sustainability of the USA Healthcare System.⁵ While physicians within surgical specialties have historically been less dramatically impacted by changes to federal reimbursement rates, this may not be true in the future, as shown for both ophthalmologists and plastic surgeons.⁶ Utilizing national data trends can be useful in the endeavor to understand critical points of waste in patient care and to learn how to mitigate costs associated with the healthcare system in the USA.

Table 1. Patients Presenting to ED with Fracture: Demographics and Characteristics

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
<i>n</i>	57,322	58,360	56,740	56,611	54,152	53,511	52,730	56,067	57,669	54,325	55,666	52,396	57,183
Mean Age	34	34	34	34	36	36	37	37	37	39	39	40	40
Male (%)	55	55	55	55	55	54	54	53	53	52	53	51	52
Body Part Fractured %													
Neck	0.7	0.8	0.8	0.9	0.9	1	1	1	1	1	1	1	1
Head	5	5	5	6	5	5	6	5	5	5	5	5	5
Thorax	5	5	6	6	6	6	6	6	7	7	7	7	8
Shoulder Humerus	10	10	10	10	11	10	10	11	10	11	11	12	11
Elbow to Hand	43	43	43	43	41	41	40	40	40	38	38	35	40
Pelvis & Hip	9	9	9	9	9	10	11	10	10	11	11	12	11
Femur & knee	3	3	3	3	4	4	4	4	4	4	5	5	6
Tibia to Foot	23	23	23	23	23	23	22	22	22	22	21	21	21

Evaluating trends in hospitalization rates due to fractures may be used as an indirect epidemiologic metric to gauge future patient volumes, staffing needs, revenue, expenditures, and allocation of resources. This information may further be utilized to direct investigations into improving cost-effective care for orthopaedic trauma patients. In this analysis, we assessed trends in hospitalizations for traumatic fractures presenting to EDs across the USA. While trends in hospitalization for specific fracture types and age groups have been explored in previous literature, no large database study has been conducted to explore trends in hospitalization rates due to all fractures.⁷⁻⁹ It is the aim of this study to describe the incidence of hospital admissions secondary to fractures from 2009 to 2021 and seek potential causes for any trend changes.

METHODS

2.1 Study Design

This multicenter, retrospective cohort study included patients within the National Electronic Injury Surveillance System (NEISS) database who were treated in an Emergency Department with a primary diagnosis of bone fracture from 2009 to 2021. The NEISS database was used in this analysis as it collects data from 100 hospitals with trauma centers in the USA and provides a nationally representative sample of over 5,000 USA EDs.¹⁰ This study was exempt from institutional review board approval as the data provided by the NEISS database is publicly available and contains deidentified patient information.¹⁰

Data collected from each patient for inclusion into the NEISS database included principal diagnosis, body part affected, intent of injury, disposition of discharge, as well as age, ethnicity, and sex. Of 30 available diagnostic code classifications, the NEISS database was queued for

Table 2. The Percent of Patients Presenting to ED with Fractures That Required Hospitalization

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
<i>n</i>	57,322	58,360	56,740	56,611	54,152	53,511	52,730	56,067	57,669	54,325	55,666	52,396	57,183
% Hosp.	19	19	19	21	22	22	24	24	24	26	27	30	28
% Hospitalized by Gender													
Male	16	16	16	17	19	18	20	20	20	23	23	26	25
Female	24	24	24	25	26	27	29	29	28	30	31	34	32
% Hospitalized by Age Range (in years)													
2-17	10	10	10	11	11	10	11	11	10	12	12	13	12
18-39	9	9	9	9	11	11	12	13	13	14	13	17	16
40-64	19	19	20	21	22	22	24	26	25	27	27	30	29
65+	52	52	52	53	54	54	55	56	55	56	57	59	56
% Hospitalized by Fracture Location													
Neck	74	80	78	76	82	80	77	81	81	79	79	77	78
Head	24	25	25	26	29	27	28	28	28	28	27	31	29
Thorax	26	28	28	30	33	33	38	39	39	43	43	47	46
Shoulder & Humerus	13	13	15	16	16	16	17	19	19	20	20	21	20
Elbow to Hand	7	7	8	8	8	7	8	8	7	9	9	9	9
Pelvis & Hip	79	79	78	78	79	81	80	81	79	80	79	80	77
Femur & knee	61	61	61	64	66	66	65	68	66	70	69	73	69
Tibia to Foot	12	11	12	13	13	12	14	16	15	17	17	29	18

the primary diagnosis of fracture, corresponding to code 57 of the NEISS coding manual, from the years 2009 to 2021.¹¹ Within the NEISS database, fractures are separated into 26 body part codes and were grouped by anatomical location within the NEISS manual into 8 distinct subgroups within this analysis: head and face, neck, upper trunk, proximal upper extremity (shoulder, upper arm), distal upper extremity (elbow, lower arm, wrist, hand, finger), lower trunk and pelvis (including femoral neck), proximal lower extremity (femur excluding femoral neck, knee), and distal lower extremity (tibia, fibula, foot, ankle, toe).

2.2 Inclusion and Exclusion Criteria

Patients were excluded from the study if they were under two years of age or had no sex entry. Children two and under were excluded due to the increased likelihood of being managed non-

operatively. By excluding this age group, the study can focus on fractures that are more commonly observed in older children and adults, which may have different underlying causes and demographics. Additionally, 17 patients with no sex entry were excluded from the analysis as they would not provide accurate data for thorough analysis using patient gender across all years studied.

All other patients were included for this analysis with a primary diagnosis of fracture within the 12-year study period from 2009-2021, which provided 10 years of data before the Coronavirus Disease-19 (COVID-19) pandemic, as well as the 2 years available from the NEISS database including the pandemic from 2020-2021.

2.3 Primary Outcomes

The primary outcome of this study was to determine the trend in hospital admissions for

fracture-related causes in the USA. Hospitalization was defined by NEISS entries as patients who were either treated and transferred, treated via admission, held for observation, or expired. This study's comparison group consisted of patients who experienced fractures but did not require hospitalization. These patients were classified by the NEISS as either treated and released or examined and released without treatment.

2.4 Secondary Outcomes

Secondary outcomes of this study included establishing fracture hospitalization trends according to sex, age, fracture location, and whether the injury occurred pre- or during the COVID-19 pandemic. A separate post-hoc analysis compared fracture hospitalization rates in the two years leading up to the pandemic (2018, 2019) with the two years during the pandemic (2020, 2021). These ranges were chosen because complete data within the NEISS database was only available through the year 2021 at the time of this analysis.

2.5 Statistical analysis

Patient characteristics are summarized as proportions for categorical and as median and standard deviation (SD) for continuous variables. The trend in fracture-related hospitalization rates across years was assessed using the Cochran-Armitage test. The statistical significance was set at 0.05 for all analyses. Data analysis was performed using IBM SPSS statistical analysis package version 28.

RESULTS

Between 2009 and 2021 there were 722,732 fractures presented to EDs by 100 hospitals in the

NEISS database. There was a statistically significant increase in the mean age of patients presenting to ED with fractures with increasing years ($p < 0.001$), specifically, the mean age of patients in 2009 was 34 years (± 27) and 40 years (± 30) in 2021. There was also a significant trend in the incidence of fracture-related ED visits among males and females ($p < 0.001$). While there was a decrease in the incidence of fracture-related ED visits for males (55% in 2009 and 52% in 2021), the incidence of fracture-related ED visits among females increased (45% in 2009 and 48% in 2021). Over the study period, there was also a statistically significant change in the incidence of various body parts fractured, with all regions increasing in incidence across the years studied ($p < 0.001$) (Table 1).

The overall trend in fracture-related hospitalizations

There was an observed increase in the incidence of fracture-related hospitalization, which was statistically significant ($p < 0.001$, Table 2). The hospitalization rate for patients with fractures was 19% in 2009 and had steadily increased to 28% in 2021 (Table 2) The greatest percentage of fractures resulting in hospitalization occurred in 2020 with 30% of patients being hospitalized (Table 2).

Fracture-related hospitalization by gender

The relationship between fracture-related hospitalization was also observed to increase for both males and females from 2009 to 2021 ($p < 0.001$). The fracture-related hospitalization rate for males was 16% in 2009 which increased to 25% in 2021.

Similarly, the fracture-related hospitalization rate was 24% for females in 2009 and had increased to 32% in 2021.

3.2.2 Fracture-related hospitalization by age group

Fracture-related hospitalization rates additionally increased for all age groups (2-17, 18-39, 40-64, 65+) from 2009 to 2021 ($p < 0.001$). The highest rate of hospitalization occurred in the 65+ group across all years studied. The changes in fracture-related hospitalization rate from 2009 to 2021 were 10% to 12% in 2–17-year-old patients, 9% to 16% in 18–39-year-old patients, 19% to 29% in 40–64-year-old patients, and 52% to 56% in over 65-year-old patients.

Fracture-related hospitalization by body region

Fracture-related hospitalizations were found to increase from 2009 to 2021 for head and face, upper trunk, proximal upper extremity, distal upper extremity, proximal lower extremity, and distal lower extremity fractures ($p < 0.001$). The neck ($p = 0.31$) and lower trunk and pelvis ($p = 0.08$) were the two fracture sites that did not observe an increased proportion during the study period.

Fracture-related hospitalization by COVID-19 period

Fracture-related hospitalization was also found to increase during the COVID-19 period (2020-2021) when compared to the previous two years (2018-2019) ($p < 0.001$). Specifically, the hospitalization rate increased by 2% during COVID-

19, from 27% in 2018-2019 to 29% in 2020-2021 (Table 3).

Table 3. Hospitalization Increased by 2% Surrounding the COVID-19 Pandemic ($p < 0.001$)

Year Group	2018-2019	2020-2021
	(n=109,991)	(n=109,579)
Hospitalized, n (%)	29,400 (27)	31,575 (29)
Not, n (%)	80,591 (73)	78,004 (71)

DISCUSSION

The results from this study show that the proportion of fracture-related hospitalizations significantly increased over time. The increased trends were consistent across all age groups and sexes. In addition, the increased trend in fracture-related incidence was also consistent across all ethnic categories except for American Indian/Alaskan Native (0.3%), Native Hawaiian/Pacific Islander (0.1%), and ‘Other’ (5.6%), presumably due to relatively smaller representation compared with other ethnic groups. Similarly, the significantly increased trend in fracture-related hospitalization was also evident across all body parts/locations except for neck (from 74% to 78% in 2009 to 2021) and lower trunk/pelvis (from 79% to 77% in 2009 to 2021) which are rare fracture locations in comparison to other major body parts for traumatic fractures. Furthermore, the increased trend in hospitalizations due to fractures over time remained consistent despite the occurrence of the COVID-19 pandemic. This data supports previous findings from Wong et. al., that demonstrated a decreased absolute number of fractures reporting to Emergency Departments during the COVID-19 pandemic with a statistically larger proportion of them being admitted for continued care.¹² A systematic review conducted

by Jain et. al. however found a significant decrease in the load of fracture patients globally during the pandemic, but the incidence of fragility fractures remained unchanged.¹³ The findings in this study suggest an increased incidence of fractures overall in the USA, however the underlying mechanism of these fractures is unknown due to the nature of this study.

Implications for research and practice

This analysis offers important insight in into the ensuing healthcare trends when juxtaposed across a 2006 to 2015 analysis by the Agency for Healthcare Research and Quality (AHRQ) Healthcare Cost & Utilization Project.¹⁴ During this period, AHRQ found ED visits reached a ten-year high for all age groups in 2015, with patients aged 45 – 65 contributing to the largest percent increase. However, the proportion of ED visits that resulted in hospital admission decreased for all age groups during this period.¹⁴ For fractures specifically, however, this analysis demonstrates an increasing proportion of hospitalizations from 2009 (19%) to 2015 (24%) which continued to rise to 30% in 2020. It appears that fracture-related injuries are being admitted at a higher frequency despite decreased overall fracture prevalence in the ED over the time period studied.

The results of this study suggest an increasing proportion trend in hospitalizations for all fractures in the USA each year from 2009-2021. However, this relationship may exist due to patients with less severe fractures receiving their initial care outside of the ED. The number of urgent cares in the USA has

doubled between the years 2008 to 2018 and the utilization of these services has grown by 1,434%.¹⁵ With a national trend of increasing urgent care utilization, more patients with simple fractures may be presenting to urgent care centers for evaluation and treatment, reducing the number of simple fractures presenting to EDs. In this regard, an increasing trend in the proportion of hospitalizations due to fractures in the USA may primarily be due to a decrease in simple fractures presenting to EDs. The presence of an urgent care center in the same zip code as an ED has been shown to reduce the total number of ED visits by 17.2%, and up to 29.1% in areas with longer ED wait times.¹⁶ In addition to waiting times, these trends may be driven by costs. ED treatments have been shown to cost ten times more than urgent care treatments for a patient with similar diagnoses.¹⁷ Our findings further support this hypothesis given that hospitalizations due to fractures that may be considered especially severe (the neck, lower trunk, and pelvis), did not demonstrate a significant increase in the proportion of hospitalizations. Additionally, as the global population increases in age, fragility fractures due to osteoporosis are hypothesized to increase and have been found in multiple other countries.¹⁸ The results of this analysis further support this increase in hospitalizations in patients over 65 years old and may explain why women are being increasingly hospitalized for fractures over the time period studied.

The capacity for orthopaedic departments to adequately prepare for the changing healthcare landscape is essential. Despite the above observations, the ability of orthopaedic departments

to sufficiently meet the demands of EDs has been suggested to be under-satisfactory. In fact, it has been found that up to 66% of EDs had insufficient subspecialty coverage.^{1,19} Furthermore, insufficient subspecialty coverage was coupled with increased interfacility transfers to another ED.¹⁹ With an increase in fractures reported to nationwide EDs and an increasing trend in hospitalizations due to fractures, local EDs may become increasingly strained. In combination with the possibility of increased urgent care utilization and reducing face-time with local orthopaedic departments in the ED, these factors represent a potentially substantial loss of revenue in an already under-tapped market for many orthopaedic services. For example, one evaluation of ED consults done by orthopaedic surgery residents demonstrated a \$445,000 per year loss in uncaptured professional fees due to billing alone.²⁰ During the COVID-19 pandemic, telemedicine was found to be exceedingly useful in the field of orthopaedic surgery for patients with non-obligatory fractures which did not require an operation.²¹ Due to the restriction of diagnostic tests and the closure of many elective procedures during the pandemic, telemedicine provided a useful addition to orthopaedic surgeons and allowed patients to be seen without having to come into the emergency room for evaluation. A study by Vaisha, et al. in New Delhi found the reduction in surgeries was greatest in arthroplasty, pediatric orthopaedic surgery, and spinal surgery.²² Further research is required to explore the frequency of different types of orthopaedic surgeries within the years

encompassing the COVID-19 pandemic in the United States.

Limitations

While the results show an increasing trend in fracture-related hospitalizations, there are a few limitations to the present analysis due to the presence of confounding variables. One key limitation of this study relates to the applicability of ecological data. Particularly, while the overall proportion of hospitalizations for fracture-related injuries is increasing, explanations for this trend and specifically whether the trend is driven in a particular geographic region cannot be ascertained from the NEISS database. Furthermore, when evaluating fractures by body part, the findings are limited by the pre-existing categories designated by the NEISS system which may limit the application of this information to individual orthopaedic departments. For example, the lower trunk category included lumbar spine fractures, which may not be treated in the same manner or by the same surgical team as the other regions within this category (i.e. femoral neck, sacrum, pelvis, and coccyx). Additionally, even though the NEISS database was constructed from 100 hospitals deemed to be representative of the USA population, the possibility exists that the hospital selection process introduced biases that cannot be accounted for and that may limit the validity of this database. The NEISS database correspondingly provides a narrow window of follow-up within this retrospective study, so longitudinal analysis for each patient is not possible. Due to the large sample size, more care is required to

ensure data quality, minimize confounding factors, and conduct appropriate statistical analyses to increase the power of the study. Despite these limitations, this study hopes to address the impact of several factors via sensitivity analyses. This analysis helps to quantify the increase which may help hospitals predict future volumes of orthopaedic trauma patients and respond accordingly through discovering a significant increase in fracture-related hospitalizations over time. Despite these limitations, the NEISS database provides a systematic and standardized data collection process that improves data quality and minimizes data collection errors. This, in turn, strengthens the reliability and validity of the results of this study by reducing biases commonly associated with retrospective studies based on individual data collection. Correspondingly, utilizing data from 2009 to 2021 allows for a more comprehensive longitudinal analysis and provides valuable insights into the evolution of patients presenting to the ED with fractures in the USA.

CONCLUSION

The findings of the present study indicate that it is essential for orthopaedic trauma specialists to engage in careful and comprehensive planning to adjust to the evolving healthcare environment, which includes increasing hospitalizations of patients presenting with traumatic fractures. This will allow orthopaedic trauma surgeons to uphold the delivery of excellent care to the community, aid their ED counterparts, and ensure the financial stability of their healthcare systems.

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