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Trends in upper extremity injuries presenting to emergency departments during the COVID-19 pandemic

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1. Introduction

On March 13, 2020, the United States (U.S.) declared a national emergency to combat coronavirus disease 2019 (COVID-19) – a lethal respiratory illness caused by the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). With its unbiased infectivity and rapid rate of spread, COVID-19 quickly placed significant strain on the U.S. and other national healthcare systems, prompting strategic resource reallocation and reorganization of healthcare services [1,2]. Hospital staff and medical resources were redeployed to handle the abrupt surge in critically ill patients, which led to a near complete cessation of elective services and large drop in patients seeking emergent medical care for fear of COVID-19 transmission [1,3]. As national quarantine orders came into effect and the fear of COVID-19 permeated throughout the country, the number of patients presenting to emergency departments (EDs) decreased precipitously by as much as 42% in the early phases of the pandemic [1,4]. With this, concerns arose from the medical community about patients delaying or foregoing emergency medical care altogether. While there is considerably more understanding of the epidemiology, physiology, and treatment of COVID-19, less is understood about how COVID-19 has impacted other facets of patient care in the setting of the current pandemic.

Prior to the pandemic, musculoskeletal (MSK) conditions accounted for 602.3 million medical consultations, 2.2 billion prescriptions, and 21.5 million hospital discharges annually in the U.S. [5,6]. Among all MSK regions, hand and upper extremity (UE) injuries have historically accounted for 12% of all traumatic injuries in the U.S. that present to emergency departments (EDs) [7]. This equated to 34 million ED visits for hand injuries from 2009 to 2012. However, fear of contagion and the implementation of national quarantines to curb the spread of COVID-19 have deterred...
some patients with significant UE injuries from seeking emergent medical attention [2,8].

Higher acuity UE fractures, nerve injuries, and dysvascular limbs can often result in considerable disability if there are delays in treatment [9]. Management often requires access to level-1 trauma centers with readily available operating rooms and microsurgical equipment – many of which have been limited with the reallocation of resources due to the COVID-19 pandemic [2]. In addition, lower-acuity UE injuries that are more tolerable are at risk of neglect if patients avoid emergency care, pushing a subset of patients outside the window of predictably favorable outcomes. Thus, it is critical that we better characterize the influence of COVID-19 on UE emergency care to better allocate resources and maximize outcomes during this unique public health crisis.

The purpose of this study was to assess the impact of the COVID-19 pandemic on the epidemiology of UE MSK injuries and care in the U.S. We compared trends in UE injury presentation and admission from four years prior to the pandemic to the first year of the pandemic. Given national stay-at-home mandates and social distancing restrictions, we hypothesized that there would be a decrease in the incidence of both ED presentations and hospital admissions across all UE injury types during the pandemic compared to years prior.

2. Methods

This is a retrospective, cross-sectional epidemiological study using the Consumer Product Safety Commission’s (CPSC’s) National Electronic Injury Surveillance System (NEISS) database, a public database containing deidentified data not requiring institutional review board (IRB) approval [10]. The NEISS database includes consumer product-related injuries and is generated via a complex probability model of all-injury data from ED visits at a stratified sample of 100 hospitals with EDs around the U.S. and its territories. Each injury is assigned a weighted value based on the inverse probability of being selected to create a national estimate of injuries presenting to U.S. EDs. Each year the CPSC generates a new 100 hospital sample, selected from both children’s and adult hospitals, rural and urban, to ensure accuracy. A full description of the database, including design and utilization, is publicly available on the CPSC electronic webpage [10]. The NEISS database serves as a public resource for epidemiological studies and has been used as such in many studies [11-16]. The NEISS database has also been used recently to examine changes during the COVID-19 pandemic [17-19].

Using the NEISS database, we performed annual queries from 2016 to 2020 to extract all information regarding UE MSK injuries during the four years prior to the COVID-19 pandemic (2016–2019) and the first year of the pandemic (2020). Data from the four years prior to the pandemic provided the statistical strength to determine if there were any changes in ED presentation of UE injuries. According to the NEISS Coding Manual, the Body_Part_2 and Diagnosis_2 numeric fields were added in 2018. These fields were utilized to augment the data extraction for 2018 through 2020. These queries extracted all patients with at least one identified UE injury; this includes isolated UE injuries and those that present in addition to other diagnoses. Information regarding the UE area injured was extracted using the following codes within the Body_Part and Body_Part_2 numeric fields: Elbow (code 32), Finger (code 92), Hand (code 82), Lower Arm (code 33), Shoulder (code 30), Upper Arm (code 80), and Wrist (code 34). Information regarding the primary diagnosis was extracted using the following diagnosis codes within the Diagnosis and Diagnosis_2 numeric fields: Contusion or Abrasion (code 53), Crushing (code 54), Dislocation (code 55), Fracture (code 57), Strain or Sprain (code 64), and Nerve Injury (code 61). These queries returned 285,583 cases that fit the above criteria, representing a total estimate of 10,452,166 injuries presenting to U.S. EDs.

To determine incidence rates, both the national estimates from the NEISS query and U.S. census data from 2016 to 2020 were used. This population data was used to assess the incidence of UE injuries in the U.S. presenting to EDs per 100,000 person-years. Ages were divided into five age groups for further comparison: 0–20 years, 21–40 years, 41–60 years, 61–80 years, and 81 years and older. Analyses of these incidence rates and the distribution of injuries and patient disposition

**Fig. 1.** Trends in the incidence of UE MSK injuries presenting to U.S. emergency departments between 2016 and 2020. The fig. provides a trend line of the incidence of UE MSK injuries for each respective year within the study period. The upper and lower 95% confidence intervals are depicted as dashed blue lines with light blue color fill presenting the 95% confidence interval of the incidence of UE MSK injuries between 2016 and 2020. These values were calculated using the national estimates provided by the National Electronic Injury Surveillance System (NEISS). (For interpretation of the references to color in this fig. legend, the reader is referred to the web version of this article.)
Table 1
Average annual incidence of injuries to each respective body part that presented to U.S. emergency departments between 2016 and 2020.

| Body Part   | Average Annual Incidence | 95% Confidence Interval |
|-------------|--------------------------|-------------------------|
| Elbow       | 66.3                     | 65.6–67.0               |
| Finger      | 117.2                    | 116.3–118.1             |
| Hand        | 85.6                     | 84.9–86.3               |
| Lower Arm   | 75.7                     | 74.9–76.4               |
| Shoulder    | 136.2                    | 135.3–137.1             |
| Upper Arm   | 46.0                     | 45.4–46.5               |
| Wrist       | 113.3                    | 112.4–114.1             |

Following an injury across age groups and before and after the COVID-19 pandemic were done using chi-square analysis. Z-test column proportion post-hoc analysis with Bonferroni adjustments was used to analyze differences between proportions of injuries and disposition across age groups and time. Logistic regression was used to calculate odds ratios (ORs) and 95% confidence intervals (CIs). To account for the weighted sampling methodology underlying NEISS, the Weight numeric field was specified as an importance weight prior to statistical analysis. A cutoff of \( P < 0.05 \) was considered statistically significant. The statistical significance of incidence rates and ORs was reported using 95% CIs. Analysis was performed using Microsoft Excel (Microsoft Corporation, Redmond, WA), SPSS (Version 28, SPSS Inc., Chicago, IL), and Stata (Version 15.1, StataCorp, Durham, NC, USA).

3. Results

An estimated total of 10,452,166 UE MSK injuries presented to U.S. EDs from January 1st, 2016, to December 31st, 2020. The mean incidence of UE MSK injuries was 640.2 injuries per 100,000 person-years (95% CI, 638.2–642.3). The year with the greatest incidence of injuries was 2016 with 701.5 injuries per 100,000 person-years, while 2020 (95% CI, 678.3–642.3) had the lowest overall incidence for all body parts except for the upper arm (Fig. 1).

Overall, the top three most injured areas presenting to U.S. EDs from 2016 to 2020 were: shoulder, finger, and wrist. The average annual incidence of injuries to each respective body part can be seen in Table 1. A similar pattern was observed for each year individually; 2020 had the lowest overall incidence for all body parts except for the upper arm (Fig. 2).

Regarding the patient’s disposition at discharge from the ED, the largest estimated number of hospital admissions from U.S. EDs occurred in 2020 at 135,018 admissions (95% CI, 131,518–138,517) (Fig. 3). Fig. 4 demonstrates the trend in the proportion of the estimated number of UE injuries presenting to EDs that resulted in hospital admission each year during the study period. The proportion of patients admitted with UE MSK injuries after presenting to the ED was 5.8% in 2019 and 7.8% in 2020, which is a 31.7% year-to-year increase. The OR and respective 95% CI regarding the likelihood of a patient being admitted to the hospital by injury type and within each 20-year age group is available in Supplemental Table 1. Overall, there was a significant increase in the likelihood of being admitted to the hospital for an UE MSK injury following the start of the COVID-19 pandemic (OR = 1.81, 95% CI, 1.815–1.820). For each age cohort, there were increased odds of being admitted to the hospital during the pandemic compared to the four years prior. In the 0–20 age group, there was a 51% increase in the likelihood of being admitted to the hospital during 2020 compared to the previous 4 years (OR = 1.51). Similarly, the 21–40 (100% increase), 41–60 (70% increase), 61–80 (58% increase), and 81 and older (48% increase) age groups all experienced significantly increased likelihood of hospital admission following the initial presentation to the ED in 2020 compared to the previous 4 years. Injuries to the hand yielded the greatest increased odds of being hospitalized in the 0–20, 21–40, 41–60, and 61–80 age groups. In the 81 and older age group, injuries to the finger had the highest odds of leading to hospital admission. The only body parts that had decreased odds of being admitted during the pandemic were elbow injuries in the 0–20 age group (OR = 0.936). The data used to calculate the ORs in Supplemental Table 1 are located in Supplemental Table 2.

Fig. 2. Trends in the incidence of specific UE MSK injuries presenting to U.S. emergency departments between 2016 and 2020. Each specific body part (elbow, finger, hand, lower arm, shoulder, upper arm, and wrist) is depicted as a different colored line representing the incidence of a MSK injury to that respective body part between 2016 and 2020. These values were calculated using the national estimates provided by the National Electronic Injury Surveillance System (NEISS).
Analysis of specific types of injuries (i.e. contusion, dislocation, fracture) is presented in Table 2. There was a significant difference between the proportion of specific UE injuries admitted to the hospital prior to and during the pandemic. Rates of admission following the pandemic varied across all contusions, crushing injuries, dislocations, fractures, and sprains.

4. Discussion

The COVID-19 pandemic has placed a tremendous strain on the U.S. healthcare system, necessitating fundamental changes in practice across all specialties including orthopaedic surgery and emergency medicine [20-24]. The impact of the pandemic on MSK injury presentation, particularly UE injuries, has not been fully elucidated. UE injuries are one of the most common types of injuries treated in EDs [25]. They also benefit from timely identification and management in order to maximize outcomes and improve long-term function [26-28]. Therefore, it is important to recognize the impact of COVID-19 on UE injury care. In this study, we utilized a national database to compare trends in UE injury presentation during the pandemic to pre-pandemic levels. As strict lockdown procedures and social distancing took effect, we hypothesized that there would be a decrease in the incidence of UE injuries presenting to EDs resulting in a decrease in hospital admissions during the first year of the pandemic compared to prior years.

Fig. 3. Trends in the (estimated) number of UE MSK injuries resulting in hospital admissions between 2016 and 2020. The figure provides a trend line of the number of UE MSK injuries resulting in hospital admissions for each respective year within the study period. The upper and lower 95% confidence intervals are depicted as dashed blue lines with light blue color fill presenting the 95% confidence interval of the total (estimated) number of UE MSK injuries leading to hospital admissions between 2016 and 2020. (For interpretation of the references to color in this fig. legend, the reader is referred to the web version of this article.)

Fig. 4. Changes in the proportion of UE MSK injuries that resulted in hospital admission between 2016 and 2020. The figure provides a trend line of the proportion of UE MSK injuries resulting in hospital admissions for each respective year within the study period. The upper and lower 95% confidence intervals are too small to be seen on the graph.
There were significantly fewer UE injuries presenting to U.S. EDs in 2020 compared to prior years. There are several potential explanations for this finding, the most likely of which relate to hospital avoidance at the height of the pandemic and a large-scale decrease in activities leading to UE injuries. We speculate that patients with chronic or less acute UE injuries either delayed their presentation or avoided the ED altogether during pandemic times. Similar findings have been demonstrated in previous studies which noted decreased hand and UE injury volume seen in EDs during the pandemic [3.29]. Other factors potentially contributing to the overall reduction in ED visits include travel restrictions and lock-down measures that encouraged patients to remain at home and the closing of nonessential businesses employing manual laborers. This has also led to a marked change in the workforce and workplace-related injuries, which would change the patient population and associated care and resource requirements.

The results of the current study provide a broad framework to characterize UE injury care during the COVID-19 pandemic. However, on an individual level, the pandemic was associated with social, economic, psychological, and physical hardships, some of which likely contributed to delays in UE injury presentation. Prompt diagnosis and treatment of UE injuries is essential for long-term function and recovery [25-28]. Furthermore, decreased inpatient ancillary service availability, such as physical and occupational therapy, may adversely affect long-term outcomes for patients with UE injuries who presented in 2020 [32,33].
increased rates of admissions also exposed patients to the hospital setting where the highest rates of COVID-19 transmission were observed, putting patients with UE injuries at an increased risk of disease transmission [34,35]. Importantly, increased rates of admissions for UE complaints contributed to the increased hospital utilization in 2020, further stressing a hospital system already suffering from bed shortages in many areas of the country.

As a result of the healthcare burden placed upon society during the early stages of the COVID-19 pandemic, many institutions resorted to the cancellation of outpatient procedures as bed availability reached critically low levels and operating room ventilators were being redistributed to treat COVID-19 patients [36]. This not only affected orthopaedic providers who rely heavily on short post-operative hospital stays for therapy optimization and pain control but placed a greater burden on the greater emergency medicine community. Lockdown procedures also mandated the closure of ambulatory surgical facilities in most areas of the U.S. in 2020, a setting in which the majority of UE injuries can be surgically managed [37]. The cancellation of ambulatory surgical services may have contributed to the increase in hospital admissions in 2020. A potential explanation is that elective, semi-elective, or urgent surgeries that otherwise would have been performed in outpatient surgery centers or had a hospital admission scheduled in advance were instead directed to the ED for admission. This also resulted in a large backlog of patients requiring elective or outpatient orthopaedic procedures who were unable to receive their surgical care during the first year of the pandemic [21,38]. The lack of available resources to surgically manage this patient population likely led to inappropriate or otherwise avoidable ED utilization, which places additional burden on an already stressed staff and system trying to manage the early stages of the COVID-19 pandemic [24].

As patients begin to feel more comfortable seeking standard medical care as the pandemic state improves, orthopaedic providers and emergency medicine services could be faced with an increase in undiagnosed or under-treated UE injuries from during the COVID-19 pandemic. This delayed presentation could not only impact patient treatment plans and outcomes but could also place further strain on the U.S. hospital system, emergency medical services, and orthopaedic providers as they attempt to recover from the pandemic. As the COVID-19 pandemic continues into 2021, many orthopaedic providers continue to struggle with a large backlog of patients requiring operative intervention [38-40]. This may result in a shift to increased utilization of ambulatory surgical centers for injury patterns previously managed in the inpatient setting in an effort to decrease the backlog of patients waiting for operative intervention. These results suggest that treatment strategies to prevent and care for UE injuries should be incorporated into planning for future pandemics when allocating resources in times of crisis. An upfront investment of resources, as well as a well-designed plan to better prepare health care systems to manage those patients who require surgical services, may provide long term decompression of the system and prevent inappropriate or otherwise avoidable ED utilization.

This retrospective database study has limitations. The NEISS database is generated via a complex probability model creating a national database that lacks detail about the specific types of injuries presented to EDs in 2016 and relies on ED classification of injuries which may have been misidentified or later changed following diagnostic testing. The chosen categories may not cover the full spectrum of orthopaedic UE injuries presenting to EDs in 2016 and the COVID-19 pandemic. Another limitation includes the inability of the database to capture tele-health and virtual consultations which increased dramatically in 2020. Furthermore, the database fails to identify pertinent specifics about patient care, such as surgically versus nonsurgically managed patients, specific injury patterns, or those with an UE complaint not related to their admission. Finally, the study does not evaluate outcome measures which may be a future area of interest in orthopaedic and emergency medicine research.

5. Conclusion

Our study demonstrated that when compared to pre-pandemic levels, fewer patients presented to the ED with UE injuries in 2020 but the estimated number of hospital admissions related to UE conditions increased from prior years, regardless of age or body part affected. The decreased incidence of UE injuries observed may be a result of hospital avoidance in fear of COVID-19 transmission and decreased risky behaviors during lockdown conditions. We speculate that the increased rates of hospital admissions for UE complaints may be explained by delays in care and lack of available outpatient resources resulting in both higher acuity and complexity of ED visits and potential inappropriate use of ED services in the setting of strains on resource utilization and the cancellation of ambulatory surgical services in the early months of the pandemic. Upfront resource allocation to treat UE injuries may be an important way to decrease strain on the healthcare system in future pandemics.

CRediT authorship contribution statement

J. Alex Albright: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Writing – review & editing. Writing – original draft. Edward J. Testa: Writing – review & editing. Writing – original draft, Investigation, Formal analysis, Conceptualization. John Hanna: Writing – original draft, Writing – review & editing. Michael Shipp: Writing – review & editing. Writing – original draft. Christopher Lama: Writing – original draft, Writing – review & editing. Michel Arcand: Writing – review & editing, Project administration.

Declaration of Competing Interest

There are no relevant conflicts of interest for any authors or involved parties.

There were no sources of financial assistance for this work.

This work has not been submitted or presented for publication elsewhere.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ajem.2022.02.033.
