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Traumatic Injury Under COVID-19 Stay-at-Home Advisory: Experience of a New England Trauma Center

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ABSTRACT

Background: With the onset of the COVID-19 pandemic and subsequent widespread stay-at-home advisories throughout early 2020, hospitals have noticed a decrease in illnesses unrelated to COVID-19. However, the impact on traumatic injury is relatively unknown. This study aims to characterize patterns of trauma during the COVID-19 pandemic at a Level I Trauma Center.

Materials & methods: A retrospective review was performed of adult trauma patients from March to June, in the years 2018 through 2020. Primary outcome was the number of trauma activations (volume). Secondary outcomes included activation level, mechanism of injury, mortality rate, and length of stay, and other demographic background. Trauma patterns of the 2018 and 2019 periods were combined as historical control, and compared to patterns of the biweekly-matched period of 2020.

Results: A total of 2,187 patients were included in analysis (Pre-COVID $n = 1{,}572$; COVID $n = 615$). Results were significant for decreased trauma volume but longer length of stay during COVID cohort, and for an increased proportion of males. No significant difference was found for other demographic variables, trauma mechanisms, or severity. Trauma volume patterns mirrored COVID rates in the state.

Conclusions: Despite a decline in trauma volume, other trauma patterns including severity and mechanism remained unchanged during the COVID-19 period. The decreased volume was not associated with a markedly lower clinical workload, change in team structure, or provider coverage re-distribution. Our data suggests that trauma volume and severity remained high enough during COVID-19 peak to necessitate full staffing, which may provide guidance in the event of a pandemic resurgence.

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Introduction

Traumatic injury has remained a leading cause of death in the United States over the last four decades.[1] While emergency and essential surgical diseases, including traumatic injury, have increasingly become regarded as a predominant global healthcare burden, infectious diseases continue to pose significant strains on health resources across the world.[2,3] In 2020, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus causing COVID-19 disease, caused a worldwide pandemic. This led to widespread government mandates regarding stay-at-home advisories, business closures, and school shutdowns as various attempts to limit the community spread of the virus. Specifically, following Massachusetts' (MA) first confirmed positive case on March 2, Governor Charlie Baker declared a state of emergency on March 10, 2020 to allow the Commonwealth of MA more flexibility and additional resources to respond to the outbreak.[4] The following day, the World Health Organization (WHO) declared the outbreak a pandemic and global health emergency.[5]

Throughout 2020, as hospitals were overwhelmed with COVID-19 related emergency room visits and inpatient admissions, many noticed a marked decrease in emergency department visits for illnesses that were unrelated to the outbreak.[6,14] This may extend to trauma as well, however there remains a paucity of information regarding whether the initial phases of the COVID-19 pandemic and subsequent stay-at-home orders have had an overall significant impact on trauma volume, mechanism of injury, or injury severity. A prolonged decrease in volume or lower acuity of injured patients, for instance, may reduce workflow to such an extent that it could provide a surplus of critical care-trained trauma surgeons available to be re-distributed for overwhelming intensive care needs in the case of COVID-19 resurgences, or in a potential future novel pandemic. Such investigation is crucial, then, to provide a system framework for emergency capacity, workforce planning, and resource allocation. Although some recent studies have demonstrated the impact on trauma patterns in certain regions of the United States, including Southern California,[7] Louisiana,[8] New Hampshire,[6] New Jersey,[9] and Pennsylvania,[10] there are geographically- and community-specific determinants including trauma center catchment areas and propensity for certain distributions of injury mechanisms that suggest a need for regional investigation to better inform local system capacity planning. Most other studies did not assess the correlation of trauma and community COVID-19 rates or alcohol use.[6]

Our institution is an American College of Surgeons-verified Level I Trauma Center that serves a population of approximately one million and sees about 3000 trauma activations annually. We hypothesized that there would be a decrease in the number of trauma activations during the beginning of the COVID-19 pandemic, the time period in which the majority of governmental stay-at-home advisories were in full effect, as compared to previous years. Certainly, one would presume that after the implementation of work closures and any sort of "lockdown," the decrease in overall road traffic[11] would lead to a decrease in motor vehicle collisions and traffic-related injuries. Additionally, we hypothesized that there may also have been a relative increase in violent trauma and penetrating injuries due to increased interpersonal violence provoked by lockdown status and employment furloughs. We further predicted an increase in alcohol-related injury as liquor stores remained open as "essential" businesses, and that as COVID-19 rates declined, trauma volume would return to prepandemic levels. This study aims to characterize the volume and severity of trauma patients presenting to our institution, the sole regional Level I Trauma Center for Central MA, during the beginning of the COVID-19 pandemic when the majority of stay-at-home advisories were in effect This study can then provide a framework of how to inform capacity planning and workforce structuring in the case of a COVID-19 resurgences or other future pandemics.

Methods

A retrospective review of medical records was performed of all patients age 18 years and older who presented as trauma activations to our center from March 1 to June 30 in the years 2018, 2019, and 2020. All data was obtained from a single-institution electronic trauma registry database. This study was approved by the University of Massachusetts Medical School Institutional Review Board, and the need for informed consent was waived.

The primary endpoint was the number of trauma activations (volume), defined as the mean number of activations per day during each designated period. Secondary outcomes included demographic, presentation, and hospital outcome variables, including activation level, age, sex, race, Injury Severity Score (ISS), serum alcohol level, type of injury (penetrating or blunt), whether the injury was work-related, mechanism of injury, mortality rate, and length of stay (LOS). Both activation level and injury severity score (ISS) were used as surrogate markers for severity of presentation. Activation level is defined by pre-determined institutional criteria based on the Centers for Disease Control and Prevention Guidelines for Field Triage of Injured Patients[12] and categorized at our hospital from most to least severe as: Level 1 – physiologic instability (intubated and/or hypotensive) or penetrating torso trauma; Level 2 – predefined high-risk mechanism; and Level 3 – transfer from outside hospital or isolated injury for which trauma consultation is requested. Mechanisms of injury were categorized into five groups as follows: *traffic-related* – motor vehicle collisions, motorcycle collisions; *violent* – stabbing, gunshot wound, assault; *fall; sport* – all-terrain vehicle (ATV), bicycle, horse, boating, skateboard; and *other*.

The trauma patterns of the period of March through June of 2018 and 2019 were used as historical control (combined and referred to as "Pre-COVID" cohort), and compared to trauma patterns of the March through June period of 2020 (referred to as "COVID" cohort). As data sets for our predefined variables were complete for all patients, none were excluded from analysis. Prior to combining the 2018 and 2019 periods, statistical analysis demonstrated no significant differences precluding consolidation into one cohort. Continuous values were determined to be non-normally distributed by Shapiro-Wilk normality test. All data was analyzed using chi-squared testing for categorical variables, and the Mann-Whitney U-test for

Table 1 – Demographic and presentation characteristics of trauma activations of Pre-COVID (March through June periods of 2018 and 2019) compared to COVID (March through June of 2020).

Variable	Pre-COVID	COVID	P-value
Age, median (IQR)	57 (33 – 76)	56 (34 – 73)	0.38
Sex (male)	1001 (63.6%)	422 (68.6%)	0.03*
Race (Caucasian)	1262 (80.3%)	485 (78.8)	0.30

* Significant at $P < 0.05$

continuous variables, as appropriate. Analysis was performed using Excel version 16.33 and SAS version 9.4.

Statewide COVID-19 metrics, defined as newly incident confirmed cases per day, were obtained from public reports. These were published by the Commonwealth of MA Department of Public Health, updated daily and released in various formats beginning on March 9, 2020.[13]

Results

A total of 2,187 eligible patients were included in our analysis (Pre-COVID $n = 1{,}572$; COVID $n = 615$). Demographics of the trauma populations in the Pre-COVID and the COVID period did not significantly differ, except for an increased proportion of male trauma patients from the Pre-COVID cohort to COVID cohort (63.67% and 68.62%, respectively, $P = 0.03$). The median ages were 57 and 56 (for Pre-COVID and COVID, respectively, $P = 0.38$) and the majority of patients of both cohorts were of Caucasian race (Table 1).

With respect to primary endpoint of trauma volume, we saw a statistically significant overall decrease in mean activations per day from the Pre-COVID cohort to the COVID cohort (median 6.5 trauma activations per day, IQR 5.0-7.5, and median 5.0 trauma activations per day, IQR 3.0-7.0, respectively, $P < 0.0001$). After analysis, this data was consolidated into total activations per 2-week period, to negate variability due to day of week for graphical representation purposes (Fig. 1).

With the exception of LOS, the remainder of the trauma pattern variables did not differ significantly between Pre-COVID to COVID cohorts (Table 2). LOS was found to be significantly longer in the COVID cohort by one day (2 days for pre-COVID, IQR 1-5 days, and 3 days for COVID, IQR 1-6 days, $P = 0.015$). There were similar distributions of mechanisms of injury between the two cohorts, including no measured difference in traffic-related or violent injuries. Notably, there was no significant difference in the proportion of penetrating injury to blunt injury. For purposes of analysis, serum alcohol level, which in our institution is measured as a continuous value in mg/dL with an institutional laboratory negative cutoff value of <10 mg/dL was defined as dichotomous negative (<10) or positive if detected (>10). The legal driving limit in Massachusetts is 80 mg/dL. There was no significant difference in proportion of presenting trauma patients with a positively detected serum alcohol level from Pre-COVID to COVID cohort ($P = 0.73$).

Statewide COVID-19 metrics followed a bell-shaped curve during our study period, with a peak occurring the week of April 19th (Fig. 2). Notably, the decline in trauma volume inversely mirrors the increasing curve of weekly COVID-19 cases; the nadir of weekly trauma activations ($n = 19$) occurred the week of April 12th, the week prior to the peak of new COVID-19 cases.

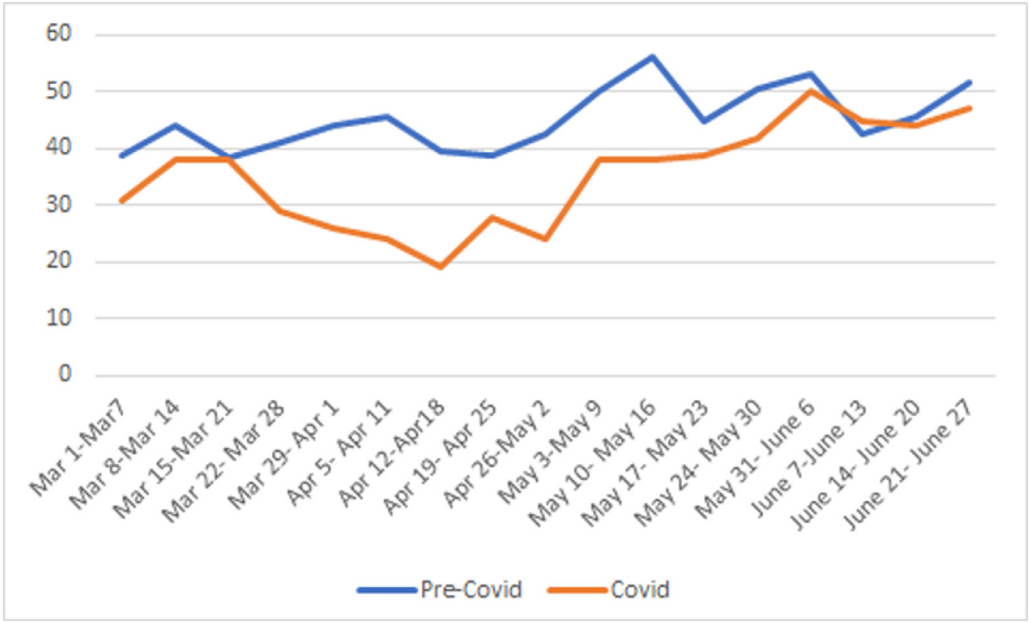

Fig. 1 – Number of trauma activations by 14-day blocks during Pre-COVID period (March through June periods of 2018 and 2019) and COVID period (March through June of 2020).

Table 2 – Trauma patterns and severity of Pre-COVID (March through June periods of 2018 and 2019) compared to COVID (March through June of 2020).

Variable	Pre-COVID	COVID	P-value
Volume in activations per day, median (IQR)	6.5 (5.0 – 7.5)	5.0 (3.0 – 7.0)	< 0.0001*
Level 1 Activation	534 (14.7%)	94 (15.3%)	0.83
Injury Severity Score, median (IQR)	9.0 (5.0 – 14.0)	9.0 (5.0 – 14.0)	0.07
Serum alcohol level (>10 mg/dL)	334 (21.2%)	130 (21.1%)	0.73
Penetrating injury	130 (8.2%)	43 (7.4%)	0.48
Work-related injury	45 (2.9%)	15 (2.4%)	0.58
Mechanism of injury			0.50
Traffic-related	450 (28.6%)	180 (29.3%)	
Violent	158 (10.1%)	74 (12.0%)	
Fall	752 (47.8%)	281 (45.7%)	
Sport	78 (5.0%)	35 (5.7%)	
Other	134 (8.5%)	45 (7.3%)	
Deceased	74 (4.7%)	24 (3.9%)	0.41
Length of stay in days, median (IQR)	2.0 (1.0 – 5.0)	3.0 (1.0 – 6.0)	0.015*

* Significant at $P < 0.05$.

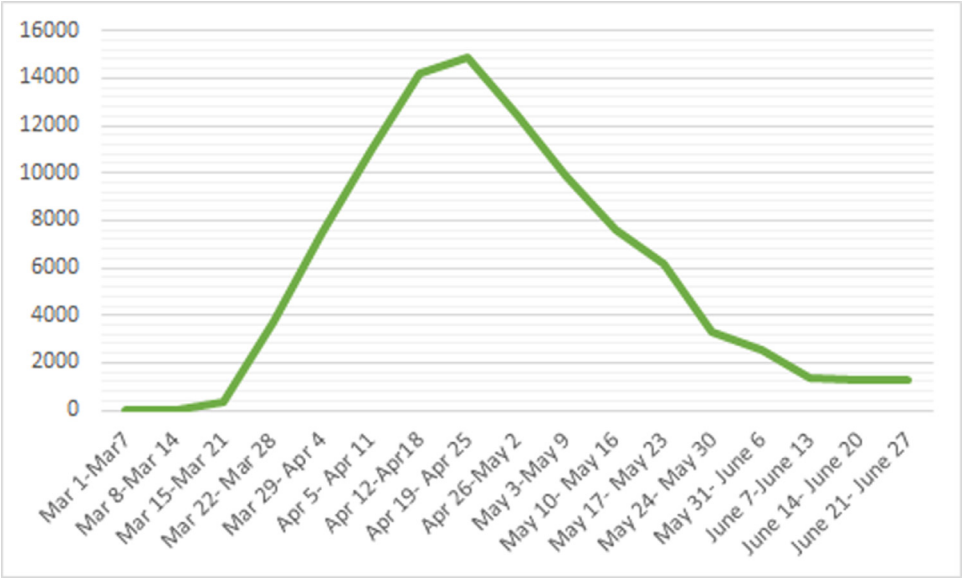

Fig. 2 – Number of newly incident COVID-19 cases per week in Massachusetts.

Discussion

The COVID-19 pandemic has had many significant impacts on the presentation of medical and surgical illnesses in acute care settings. Studies have reported a decrease in emergency department visits unrelated to COVID-19 infection, especially during the beginning months of the pandemic.[14] In a similar manner, the authors of this study had hypothesized that the COVID-19 pandemic would have a regional impact of decreased trauma volume presenting to our Level I Trauma Center in Central MA. The cancellation of elective operative cases in accordance with state advisories, combined with a decline in emergency general surgery volume (as evidenced by the reduced amount of emergency department visits), led to a notable decrease in the number of admitted patients for specialty services. In stark contrast, however, the inpatient census of trauma patients remained substantial at our institution.

We did note a statistical decrease in median daily trauma activations from 6.5 activations/day to 5.0 activations/day ($P = <0.0001$), particularly leading up to the pandemic "peak" in MA. Trauma volume decreased in the beginning of April, but recovered to near pre-pandemic levels by early May. The measured decrease in trauma volume was not necessarily clinically significant, however, and acuity remained unchanged. Patients were as severely injured during the first COVID surge as compared to pre-COVID but required a one day longer hospital stay. We hypothesize that this was related to delays in

finding rehab placements for patients due to evolving regulations regarding COVID testing and exposure. The slight activation volume decrease was transient and was not associated with a prolonged lower clinical workload, change in team structure, or provider coverage re-distributions to inpatient COVID-19 units. The trauma volume mirrored the state COVID rates; as COVID incidence went up, the trauma rates went down but again normalized as the first COVID surge resolved.

While other studies have reported overall decreases in trauma admissions,[6,9] the significance of this for those institutions with respect to systems capacity and resource allocation is unclear. We can say from the experience of our center that the decrease in trauma volume, regardless of changes in hospital admissions, did not translate to a meaningful decrease in workload for our trauma service, especially given the longer LOS. Many of the trauma activations during the first COVID surge were high acuity and required intensive resuscitation and ongoing management as demonstrated by unchanged activation levels, ISS, and LOS

Our study is one of the first to assess differences in alcohol-related injury during the first wave of the COVID-19 pandemic. We had no change in the proportion of patients presenting with positive alcohol levels, despite liquor stores remaining open, but many bars and restaurants closed. Perhaps this is driven by similar social factors as those that also negated an increase in violent/nonaccidental traumas as was seen in other institutions, but the mechanism for this is unclear based on our single-institution descriptive data.

During the peak of the initial surge in the COVID-19 pandemic (mid-April 2020 in Massachusetts), many healthcare providers across the nation were redeployed and redistributed to new divisions, such as intensive care units and emergency departments, to care for the influx of COVID-19 patients. At our hospital, most attending trauma surgeons and surgical residents were shifted into solely critical care positions, given the critical care certification of the attending surgeons, and the high relative experience of critical care during surgical residency training. Given the on-going trauma volume, trauma coverage was backfilled by board certified general surgeons from other divisions. This was not dissimilar to other elaborate restructuring of clinical coverage seen at other institutions.[15]

We anticipated a change in trauma pattern during the "lockdown" as a result of stay-at-home mandates. Anecdotally in the news and amongst our trauma team, the perception was that interpersonal violence and penetrating trauma increased during this period. Despite a statistically significant decline in trauma volume, there was no significant change in trauma patterns with respect to severity or mechanism of injury during the COVID-19 period as compared to the same time period in 2018 and 2019. Proportion of penetrating trauma cases remained unchanged and accounted for less than ten percent of our injured patients; traffic-related incidents also remained stable. Despite liquor stores being classified as essential businesses that remained open along with grocery stores, the proportion of alcohol-related injuries also did not change. Notably, this is different from findings in other studies from elsewhere which note an increase in penetrating injury and violent trauma. [7,8,16] This difference may reflect regional differences in policy, social support systems, or underlying public health determinants.

Our data suggests that trauma volume and severity remained clinically unchanged from prior years, and was high enough to necessitate maintaining full trauma staffing during the COVID-19 peak surge. That is, despite a slight decrease in volume, we did not observe major changes in trauma patterns with respect to severity, mechanisms, or patient demographics. The unchanged proportions of penetrating trauma, number of work-related injuries, and average serum alcohol levels in our study have important implications for public health, which may provide guidance in the potential event of a pandemic resurgence and is a target for future research. This can also serve as a guide for hospital resource-allocation. As our data differs from that in other regions of the country, it is clear that there is not a "one-size-fits-all" approach to the ongoing management of trauma activations and inpatient care in the face of the ongoing COVID pandemic and future surges.

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Author Contributions

Chloe H. Williams designed the study herein, and contributed to data collection, statistical analysis, manuscript writing, and final revisions. Erin M. Scott contributed to data collection, statistical analysis, manuscript writing, and final revisions. Jon D. Dorfman supervised and designed the study herein, and contributed to manuscript writing and final revisions. Bruce Simon contributed to manuscript writing and final revisions.

Disclosure

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