


# Planning for the Next Pandemic: Trauma Injuries Require Pre-COVID-19 Levels of High-Intensity Resources

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## Abstract

As hospital systems plan for health care utilization surges and stress, understanding the necessary resources of a trauma system is essential for planning capacity. We aimed to describe trends in high-intensity resource utilization (operating room [OR] usage and intensive care unit [ICU] admissions) for trauma care during the initial months of the COVID-19 pandemic. Trauma registry data (2019 pre-COVID-19 and 2020 COVID-19) were collected retrospectively from 4 level I trauma centers. Direct emergency department (ED) disposition to the OR or ICU was used as a proxy for high-intensity resource utilization. No change in the incidence of direct ED to ICU or ED to OR utilization was observed (2019: 24%, 2020 23%;  $P = .62$  and 2019: 11%, 2020 10%;  $P = .71$ , respectively). These results suggest the need for continued access to ICU space and OR theaters for traumatic injury during national health emergencies, even when levels of trauma appear to be decreasing.

## Introduction

US hospital capacity has been overwhelmed during the coronavirus disease 2019 (COVID-19) pandemic. As the virus spread, the United States (US) implemented unprecedented social isolation measures, including stay at home orders (SAHOs), radically changing day-to-day life. Inside hospitals, intensive care units (ICUs) were quickly overrun, forcing drastic changes in staffing, resource allocation, and triaging of patients.<sup>1</sup> These changes placed immense strain on the health care system, and stretched both personnel, the supply chain, and even bed capacity to the brink.

In an early response to the pandemic and its potential impact on trauma care, the American College of Surgeons Committee on Trauma (ACS-COT) distributed a guide on maintaining access to trauma care during the pandemic.<sup>2-4</sup> A single-region multi-center study from Los Angeles County highlighted the necessity of maintaining access to high-intensity resources for trauma care during COVID-19.<sup>5</sup> Herein, we present a multi-regional and multi-institutional study describing patterns of high-intensity

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**Table 1.** Comparing Rates of Direct ED to ICU or Admission Over the Study Period by Injury Mechanism.

Total Resource Utilization	Pre-COVID-19 (n = 2916)	COVID-19 (n = 2700)	P-Value
ED to ICU	700 (24%)	633 (23%)	.62
ED to OR	307 (11%)	276 (10%)	.71
<b>ED to ICU</b>	<b>Pre-COVID-19 (n = 700)</b>	<b>COVID-19 (n = 633)</b>	<b>P-value</b>
<b>Injury type, n (%)</b>			
Blunt	658 (94%)	598 (94%)	.71
Penetrating	41 (6%)	33 (5%)	.61
<b>Injury mechanism, n (%)</b>			
MVC	157 (18.0%)	142 (18.6%)	.73
MCC	50 (6.8%)	48 (7.0%)	.76
Fall	377 (53.7%)	4342 (55.2%)	.95
GSW	32 (4.1%)	27 (3.9%)	.79
Stab wound	8 (1.1%)	5 (.9%)	.51
<b>ED to OR</b>	<b>Pre-COVID-19 (n = 307)</b>	<b>COVID-19 (n = 276)</b>	<b>P-value</b>
<b>Injury type, n (%)</b>			
Blunt	216 (70%)	177 (64%)	.11
Penetrating	91 (30%)	99 (36%)	.11
<b>Injury mechanism</b>			
MVC	40 (12.5%)	43 (13.5%)	1.0
MCC	25 (7.2%)	16 (6.1%)	.27
Fall	76 (27.4%)	64 (24.6%)	.66
GSW	41 (12.0%)	53 (16.4%)	.06
Stab wound	32 (11.2%)	41 (15.8%)	.11

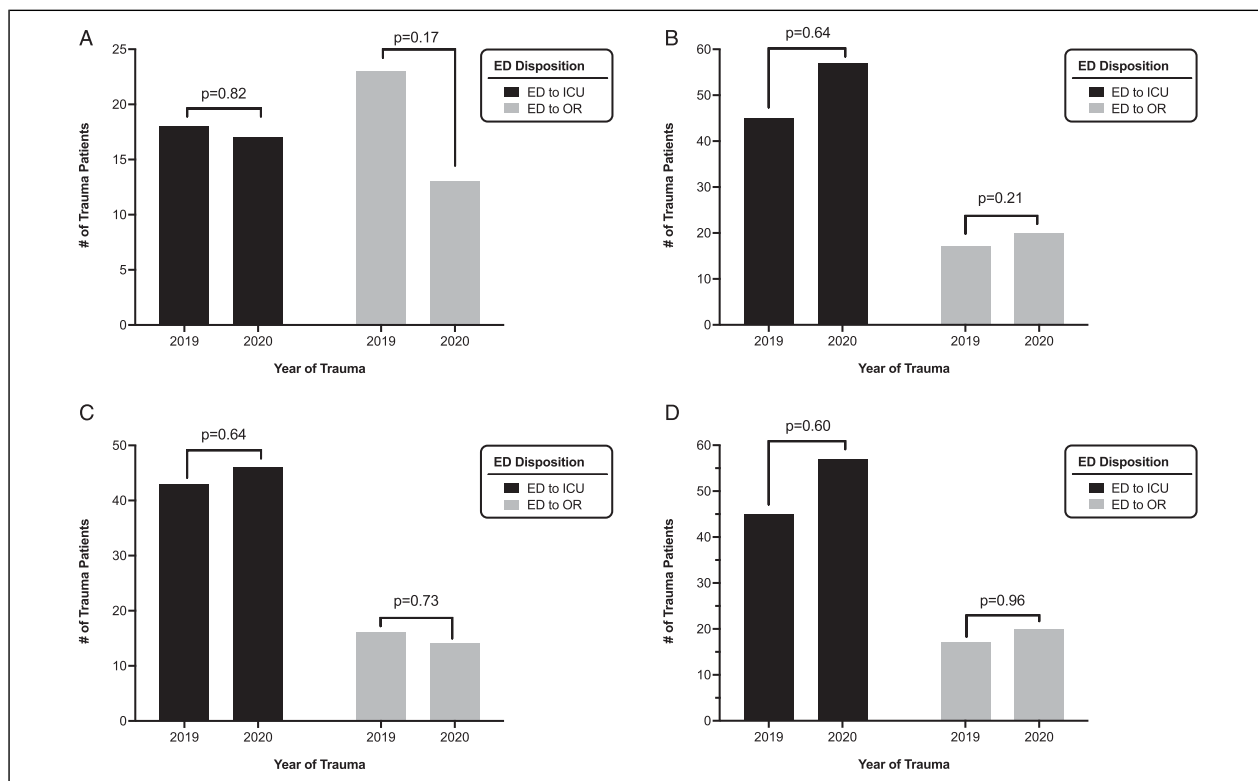
resource utilization during the first 4 months of the COVID-19 pandemic. We hypothesize that high-intensity resource utilization for trauma patients represents a stable hospital need that should be emphasized in all preparedness plans. The trauma community must utilize the current pandemic to evaluate the impact of the virus and community mitigation measures on trauma patient resource utilization. Such inquiries will provide invaluable information for disaster preparedness planning for future events, assuring appropriate resource estimations.

## Materials and Methods

A retrospective observational cohort study was conducted on all adult ( $\geq 18$  years old) trauma patients who presented to 4 different level I trauma centers from April 1, 2020 through July 31, 2020 and a month-matched 2019 cohort. Trauma centers were located in Boston, (Massachusetts), York (Pennsylvania), Dayton (Ohio), and Phoenix (Arizona). Data were collected using institutional trauma registries. Patients were dichotomized by year (2019 vs 2020) to characterize changes in direct emergency department (ED) disposition to the operating room (OR) or intensive care unit (ICU) during the early months of the COVID-19 pandemic. Additionally, patient demographic and injury characteristics

were obtained. The injury severity score (ISS) was used to characterize the severity of a patient's injuries. Injury severity score was reported as medians (inter-quartile range, IQR) and was further stratified into 3 categories, mild injury (ISS $<9$ ), moderate injury (ISS 9-14), and severe injury (ISS $\geq 15$ ). Direct ED disposition to the OR and ICU was used as a surrogate for trauma patients requiring high-intensity resources.

Descriptive statistics were performed to characterize differences in demographic variables, injury characteristics, and resource utilization (ED disposition to ICU or OR) in the month-matched 2019 and 2020 cohorts. In-hospital mortality was also reported. Median (IQR) values were used to describe continuous variables. Actual count (n) and percentages (%) were used to describe categorical variables. Univariate analyses were then performed. Pearson's chi-squared and Wilcoxon rank-sum tests were implemented as appropriate. Institutional review boards at all 4 study sites ruled this study exempt including a waiver of informed consent (Massachusetts General Hospital IRB #2020P003080; WellSpan IRB# 1617360-2; St Joseph's Hospital and Medical Center Dignity Health IRB# PHX-20-500-180-73-35; Wright State University IRB# #06943). Statistical analyses were performed using StataCorp 2017 (Stata Statistical Software: Release 15.1



**Figure 1.** ED disposition to ICU and OR during month of peak COVID-19 incidence. (A) Analysis for data from MA study site, with month of peak COVID-19 incidence for the first surge in April 2020. (B) Analysis for data from PA study site, with month of peak COVID-19 incidence for the first surge in April 2020. (C) Analysis for data from AZ study site, with month of peak COVID-19 incidence for the first surge in July 2020. (D) Analysis for data from OH study site with month of peak COVID-19 incidence for the first surge in July 2020.

College Station, TX: StataCorp LLC) and figures were designed using GraphPad Prism 9 software (Version 9.1.1(223); La Jolla California USA).

## Results

### Patient Demographic Characteristics

A total 5616 patients met study inclusion criteria, 2916 in the 2019 cohort, and 2700 in the 2020 cohort—an 8% reduction in trauma volume. Patient characteristics are listed in [Supplementary Table 1](#). During the 2020 study period, monthly trauma volume followed a steady increase from April 1 through July 31 combining data from across study locations ([Supplemental Figure 1](#)). Median (IQR) age was higher in the 2019 (57 [35, 75]) than the 2020 (56 [34, 74]) cohort ( $P = .046$ ). The number of male patients was higher in 2020 (1728/2,700, 64%) than 2019 (1681/2,916, 58%) ( $P < .001$ ). Additionally, the racial composition of the 2019 and 2020 cohorts was significantly different ( $P < .001$ ). Patterns of traumatic injury were different between the 2 cohorts. Specifically, the proportion of injury types shifted, with decreased blunt injury and increased penetrating injury in 2020 compared to 2019 ( $P = .023$ ).

There was no significant change in median injury severity (as assessed by ISS) comparing the 2020 cohort to the 2019 cohort ( $P = .83$ ). Additionally, no change in the median (IQR) monthly ISS was observed throughout the 2020 study period ([Supplemental Figure 2](#)).

### High-Intensity Resource Utilization

The number of patients requiring direct ED to ICU or OR transfer did not change between the 2019 and 2020 cohorts (ICU: 700/2,916, 24% vs 633/2,700, 23%;  $P = .62$ ) (OR: 307/2,916, 11% vs 276/2,700, 10%;  $P = .71$ ) ([Table 1](#)). Additionally, the overall incidence of specific injury types requiring direct ED disposition to the ICU was not statistically different comparing the 2019 and 2020 study periods. A similar result was observed for direct ED disposition to the OR. We observed a trend towards increased direct ED to OR utilization for GSWs (2019 cohort 41/307, 12% vs 2020 cohort 53/276, 16.4%), although this was not statistically significant ( $P = .06$ ). No statistically significant change in high-intensity resource utilization was identified at participating study sites during their surge month of COVID-19 peak incidence ([Figure 1](#)). [Supplemental Figure 3](#) shows trends in direct ED to OR and ED to

ICU transfers from April through July of 2019 and 2020. Last, there was no difference in mortality between the 2019 cohort and the 2020 ( $P = .51$ ) cohort.

## Discussion

To our knowledge, no multi-region investigation has described hospital resource needs for the treatment of trauma patients during a pandemic surge. Results of the present study confirm the study hypothesis that there is a stable incidence of severe trauma requiring resource intense interventions even when the extremes of social isolation are imposed upon a population. These results highlight the preserved need to maintain access to critical resources (ICU space and OR theaters) in order to maintain current standards of care for severe traumatic injury during the COVID-19 pandemic and future similar events.

Results of the present study are in contrast to a recent study by Chiba et al,<sup>6</sup> where they report a decreased injury severity resulting in decreased utilization of high-intensity resources during the initial months of the COVID-19 pandemic. In contrast, present results support recent findings suggesting trauma continued to require pre-COVID-19 levels of resource-heavy interventions.<sup>5,6</sup> Limitations of the present study include a potential lack of generalizability due to its limited time scope and inclusion of 4 study sites. While direct ED disposition to the OR or ICU was used as a proxy for resource intense interventions for trauma patients, we cannot describe in granular detail the overall resource utilization of trauma patients due to limitations of the generated dataset. Additionally, we acknowledge that our data is an underestimation of total trauma ICU and OR requirements as we did not capture those patients requiring transfer to the ICU or need for the OR following their initial admission. Future studies should focus on characterizing patterns of resource utilization during the COVID-19 pandemic (eg, ventilator requirements, duration of ventilation, need for dialysis, ICU length of stay (LOS), hospital LOS, and transfusion requirements broken down to the component level, and availability of surgeons). This information is necessary for determining appropriate resource allocation for future similar events.

## Conclusion

An 8% reduction in trauma volume was observed following the implementation of SAHOs. This reduction in volume was largely driven by significantly decreased numbers of blunt injuries, with marginal increases in penetrating injuries during the initial 4 months of the COVID-19 pandemic compared to pre-pandemic levels. Overall, trends in injury severity remained unchanged

from baseline, and ICU and OR requirements occurred at pre-COVID-19 levels, with 23% of trauma patients requiring ICU and 10% of trauma patients requiring OR admission directly from the ED during the first 4 months of COVID-19 SAHOs. This same result was true at the institutional level during the month of peak COVID-19 incidence at each site. We suggest that these results can be used by the trauma community at large as planning tools to help trauma centers better understand observed trends in trauma injuries in order to maintain the high-quality care of trauma patients in the face of other pandemic-like events. Based on study results, policy makers should strongly consider earmarking the necessary resources needed to maintain current standards of care for the treatment of significantly injured trauma patients during future events of pandemic-proportions.

## Declaration of Conflicting Interests

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## Supplemental Material

Supplemental material for this article is available online.

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