Original Article

Processes for Trauma Care at Six Level I Trauma Centers During the COVID-19 Pandemic

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ABSTRACT

Introduction: As the COVID-19 pandemic spread, patient care guidelines were published and elective surgeries postponed. However, trauma admissions are not scheduled and cannot be postponed. There is a paucity of information available on continuing trauma care during the pandemic. The study purpose was to describe multicenter trauma care process changes made during the COVID-19 pandemic.

Methods: This descriptive survey summarized the response to the COVID-19 pandemic at six Level I trauma centers. The survey was completed in 05/2020. Questions were asked about personal protective equipment, ventilators, intensive care unit (ICU) beds, and negative pressure rooms. Data were summarized as proportions.

Results: The survey took an average of 5 days. Sixty-seven percent reused N-95 respirators; 50% sanitized them with 25% using ultraviolet light. One hospital (17%) had regional resources impacted. Thirty-three percent created ventilator allocation protocols. Most hospitals (83%) designated more beds to the ICU; 50% of hospitals designated an ICU for COVID-19 patients. COVID-19 patients were isolated in negative pressure rooms at all hospitals.

Conclusions: In response to the COVID-19 pandemic, Level I trauma centers created processes to provide optimal trauma patient care and still protect providers. Other centers can use the processes described to continue care of trauma patients during the COVID-19 pandemic.

Keywords: COVID-19, trauma care, PPE

Introduction

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was first identified in Wuhan, Hubei Province, China, in December 2019 causing a cluster of acute respiratory illness now known as novel coronavirus disease 2019 (COVID-19).[1,2] The virus quickly spread internationally and became a worldwide pandemic.[3] The White House issued social distancing guidelines for the United States on March 16, 2020.[4] As of June 1, 2020, the World Health Organization (WHO) identified more than six million cases of COVID-19 with more than 370,000 lives lost to the virus.[2] The quick rise in acutely ill patients significantly overwhelmed some hospital systems and has shown to be a risk to healthcare providers if not adequately protected.[5–7] In fact, Bartoszko et al.[8] stated that healthcare workers treating patients infected with COVID-19 are among those at the highest risk of infection. Countries impacted by COVID-19 earlier showed how changes to patient care and provider practice are important to slow the spread of the disease.[7] Ahead of the surge in acutely ill patients, many hospitals in countries not yet significantly impacted began cancelling or postponing elective procedures and preparing to care for patients with COVID-19.[6,9] Trauma centers have a unique situation in that admissions for traumatic injuries are not scheduled and therefore cannot be cancelled or postponed. Accordingly, they must prepare for an influx of patients with acute respiratory symptoms and continue care for patients with traumatic injuries.

The American College of Surgeons (ACS) Committee on Trauma expeditiously produced a guidance document on maintaining trauma center access and care during the COVID-19 pandemic.[10] This guidance document provided a starting point for changes to implement; however, the detailed process changes were left to the discretion of individual facilities.[10] For example, when discussing the intensive care unit (ICU), the document states to: (1) maintain situational awareness of the ICU capacity

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and ensure needs for trauma patients are considered and (2) monitor the availability of ventilators and oxygen supply but does not provide guidance on how to select patients for ICU admittance or how to select patients for ventilators or oxygen supplies in the event of an overwhelming surge of patients.[10]

The purpose of this study was to summarize process changes for trauma patient care and protection of trauma care providers within our network of six United States (US) Level I trauma centers. The trauma centers included are located in Colorado, Kansas, Missouri, and Texas. Data available shows that the burden of COVID-19 varied by the states included in this study.[11,12] The Centers for Disease Control and Prevention (CDC) released a report of the number of cases per state on April 7 and reported 5,429 in Colorado, 900 in Kansas, 3,037 in Missouri, and 8,262 in Texas.[11] Smith-Rey et al. created a model to report the number of people at risk for complications per 1,000 persons by the US county with eight levels for each risk category.[12] The centers involved in this study resided in counties that were designated as risk categories 3–5, ranging from 125 to 200 persons at risk for developing complications from COVID-19 per 1,000 persons; these data could be indicative of the burden of hospitalizations for patients with complications from COVID-19.[12]

Methods

This descriptive survey, protocol number 1594746, was approved by our institutional review board and was designated as nonhuman subject's research. Survey questions were designed by the study personnel including the epidemiologists, clinical research coordinators, and the director of research. The questions were reviewed and revised by the principal investigator as well as one coauthor who did not participate in the survey.

The survey consisted of 35 questions and was disseminated to the director of trauma services, trauma program manager, and/or director of trauma research at each hospital for completion through SurveyMonkey Inc. (San Mateo, CA; **www.surveymonkey.com**). Participants were encouraged to reach out to their trauma team members if assistance was needed to accurately identify COVID-19 related changes at their institution and trauma program. If they did not know the answer to any question, they were able to skip the question and forward the email containing the participation link to another person at their center for completion. SurveyMonkey's skip logic was implemented to skip questions deemed irrelevant based on previous closed-ended questions. In addition, participants could skip questions for any reason. After the initial invitation was sent, two reminder emails were sent weekly. Those invited to participate were given a total of 3 weeks to complete the survey.

The primary objective was to summarize processes developed related to National Institutes for Occupational Safety and Health approved N-95 respirators and powered air purifying respirators (PAPRs) for provider protection and trauma patient care. The secondary objectives were to summarize process changes regarding the use of ventilators, blood products, oxygen supplies, ICU beds, continuous positive airway pressure (CPAP), and BiLevel positive airway pressure (BiPAP) machines. Survey responses were exported from SurveyMonkey Inc. and imported into SAS 9.4 (Cary, NC) for analysis. Survey responses are summarized as proportions (counts).

Results

The survey was completed between May 17 and May 31, 2020. It took an average of 5 days to complete, and all six participating hospitals completed the survey. Fifty percent (n = 3) of hospitals implemented changes to care before the first case of COVID-19 was confirmed. Sixty-seven percent (n = 4) of hospitals were reusing N-95 respirators; of those, 17% (n = 1) were reusing them throughout the day and disposing of them at the end of the day, and 50% (n = 3) were screening N-95 respirators for reuse and then sanitizing them (Table 1). Four of the hospitals (67%) were sanitizing masks. Ultraviolet light was used as a sanitization method by 25% (n = 1) of those sanitizing N-95 respirators, another 25% (n = 1) used the Battelle System, and the remaining 50% (n = 2) used a Steris sterilization system. Half of the trauma centers (n = 3) gave trauma care providers one mask per shift or day, 17% (n = 1) of trauma centers gave trauma care providers one mask per week, 17% (n = 1) gave 2 per day, and the remaining center allocated masks based on the hospital patient volume. All trauma-team providers were fit tested for N-95 respirators at 50% (n = 3) of the participating trauma centers. Similarly, 50% (n = 3) were educating trauma team providers on N-95 use. Fit testing for PAPRs was provided more often than education on their use, 50% versus 17%, respectively.

To minimize the need for personal protective equipment (PPE), trauma patient contact was

Table 1. Face Masks and Respirators During the COVID-19 Pandemic

Question	Responses	% (n)	Total n
Are N-95 respirators being reused?	Yes, reused throughout the day, then screened for reuse potential and sanitized	50 (3)	6
	Yes, reused throughout the day and disposed at the end of the day	17 (1)	
	No, we are not now, nor have we previously reused masks	33 (2)	
How were/are you sanitizing N-95 respirators?	Battelle system through FEMA	25 (1)	4
	Steris V-Pro 1 plus, maX, maX2, low-temp sterilization	50 (2)	
	UV light	25 (1)	
Approximately how many masks are each provider given per week currently?	One per shift/day	50 (3)	4
	Two per day	17 (1)	
	Depends on patient volume	17 (1)	
	One per week	17 (1)	
Were trauma-team providers N-95 respirator or PAPR fit tested or educated on use? Select all that apply.	Yes, all trauma-team providers were N-95 respirator fit tested	50 (3)	6
	Yes, some trauma-team providers were N-95 respirator fit tested	33 (2)	
	Yes, the trauma-team providers were provided education on N-95 respirator use	50 (3)	
	Yes, the trauma-team providers were PAPR fit tested	17 (1)	
	Yes, some trauma-team providers were PAPR fit tested	33 (2)	
	Yes, the trauma-team providers were provided education on PAPR use	17 (1)	
	Surgeons with beards were fitted	17 (1)	
	All employees were already fit tested annually. Surgeons were fit tested as needed	17 (1)	

FEMA = federal emergency management agency; PAPR = powered air purifying respirators; UV = ultraviolet.

clustered at 50% (n = 3) of the participating hospitals, 33% (n = 2) of hospitals clustered patient contact for patients with COVID-19, whereas one center (17%) did not cluster patient contact (Table 2). A majority (83%, n = 5) of hospitals used more PPE during the pandemic per trauma care provider because of the increased risk of exposure to the trauma team; one hospital limited the number of personnel in the room rather than limiting the use of PPE. A majority (67%, n = 4) increased the use of PPE for all trauma patients on arrival, whereas 33% (n = 2) provided PPE to trauma patients who were symptomatic. The remaining hospitals developed other specific criteria to apply PPE to trauma patients on arrival, which can be found in Table 2. Only one hospital (17%) had regional resources impacted because of the COVID-19 pandemic. For this trauma center PPE was impacted and requests for PPE had to

Table 2. Personal Protective Equipment During the COVID-19 Pandemic

Question	Responses	% (n)	Total n
Is trauma patient contact being clustered to minimize patient contact and the need for PPE donning/doffing?	Yes, for all trauma patients	50 (3)	6
	Yes, but only for COVID-19 patients	33 (2)	
	No	17 (1)	
Have you made changes to the PPE that the trauma-team providers normally wear in the trauma bay during activations?	More PPE per person are used because of increased risk to the trauma team	83 (5)	6
	Specific masking guidelines were created, and staff are limited in the room on trauma patient arrival	17 (1)	
How has your PPE use changed over time? Select all that apply.	Increased use for trauma patients	67 (4)	6
	Increased use for trauma-team providers	83 (5)	
	We limited the number of providers in the room rather than limiting use of PPE	17 (1)	
Are PPE for droplet contact precautions currently being used on all trauma patients on arrival? Please select all that apply.	Yes, for all trauma patients	67 (4)	6
	Yes, for symptomatic trauma patients	33 (2)	
	Yes, for trauma patients who have recently travelled	17 (1)	
	Yes, for trauma patients with previous COVID-19 exposure	17 (1)	
	All patients with GCS < 8 received PPE	17 (1)	
	Yes, for all patients we were unable to assess symptoms	17 (1)	
Was regional resource allocation impacted?	Yes, PPE was impacted by nationwide shortages. Some orders were diverted. Requests for PPE had to go through local government	17 (1)	6
	No	83 (5)	

COVID-19 = novel coronavirus 2019; GCS = Glasgow coma scale; PPE = personal protective equipment.

go through local government. None of the participating trauma centers surveyed decreased the use of PPE as a result of low supplies on hand.

In addition, none of the participating trauma centers changed the way that ICU beds were monitored (Table 3). A specific ICU suite was designated for patients with COVID-19 at 50% (n = 3) of participating centers. COVID-19 trauma patients were isolated to negative pressure rooms at all of the participating trauma centers. Most trauma centers (83%, n = 5) also designated more beds as ICU beds, and 17% (n = 1) converted ICU rooms to double occupancy. At the center which converted ICU rooms to double occupancy, patients in double occupancy rooms were cohorted by the COVID-19 status. ICU triage criteria was changed at 50% (n = 3) of the participating hospitals. Of those that implemented changes to ICU triage criteria, 33% (n = 1) developed a plan to triage patients of the ICU based on acuity if a surge occurred, 33% (n = 1) planned for patients to be cared for in the progressive care unit with detailed oversight and guidance similar to that in the ICU, and the remaining center did not allow trauma patients with COVID-19 to be triaged to the ICU and instead treated COVID-19 patients in critical care units or negative pressure rooms.

Negative pressure rooms were used for all procedures which were considered high risk for COVID-19 exposureat all participating trauma centers, such as intubation or bronchoscopy. In addition, negative

Table 3. Intensive Care Units and Negative Pressure Rooms During the COVID-19 Pandemic

Question	Responses	% (n)	Total n
How are ICU beds being used or monitored differently?	Designated ICU for COVID patients	50 (3)	6
	Number available tracked through command daily	50 (3)	
Are suspected or confirmed COVID-19 trauma patients isolated from the remaining population? Select all that apply.	COVID-19 trauma patients are isolated in negative pressure rooms	100 (6)	6
	COVID-19 trauma patients are isolated in a specific unit	83 (5)	
	COVID-19 trauma patients are isolated in a specific floor	50 (3)	
Did your hospital develop a plan for ICU surge capability and capacity based on the COVID-19 pandemic? Select all that apply.	More beds were designated as ICU beds	83 (5)	6
	Rooms have been converted to double occupancy	17 (1)	
	ICU triage criteria were changed	50 (3)	
Please select any options that apply to your hospital regarding negative pressure rooms.	Negative pressure rooms are being used for all high-risk procedures (e.g. bronchoscopy)	100 (6)	6
	Negative pressure rooms are being used for all procedures (e.g. nebulizer and extubation)	83 (5)	
	Single rooms are being converted to double occupancy to convert more rooms to negative pressure rooms	33 (2)	
	An entire floor has been converted into a negative pressure floor	33 (2)	
	Other changes to negative pressure rooms have been implemented. OR could not be changed to negative pressure so other accommodations were made	17 (1)	

COVID-19 = novel coronavirus 2019; ICU = intensive care unit; OR = operating rooms.

pressure rooms were used for all procedures at 83% (n = 5) of the participating trauma centers. Negative pressure rooms were located within a specific unit at 83% (n = 5) of the participating trauma centers and/or to a specific floor at 50% (n = 3) of the participating trauma centers. Thirty-three percent (n = 2) of trauma centers converted an entire floor to a negative pressure floor, and 33% (n = 2) converted single rooms to double occupancy to convert more rooms to negative pressure rooms, with patients cohorted by the COVID-19 status in double occupancy rooms at both centers.

Only one hospital implemented ventilator selection criteria based on the patient's respiratory severity score, this hospital did not need to request more ventilators because of a shortage and also did not request more ventilators in anticipation of a surge (Table 4). Another hospital created a process for the ethics committee to review patients on a case-by-case basis to decide who would receive a ventilator if there were not enough ventilators for the persons in need. The hospital did not have to implement this process because there was not a shortage of ventilators; however, this hospital did request more ventilators in anticipation of a surge. Ventilator use was being tracked at 50% (n = 3) of the participating hospitals, and 17% (n = 1) indicated that no changes were made to the way that ventilators were used or monitored. Of those monitoring ventilator use, two participants indicated the number used was being tracked daily or twice a day, the remaining center stated they created a ventilator utilization committee

Table 4. Hospital Resources During the COVID-19 Pandemic

Question	Responses	% (n)	Total n
What is the process for ventilator allocation (selection criteria) during resource-limited intervention?	None	67 (4)	6
	Based on the respiratory severity score	17 (1)	
	Cases would be reviewed by an ethics committee to decide who would get a vent. BiPAP machines converted if necessary	17 (1)	
How are ventilators being used or monitored differently?	Ventilator use tracked daily through command	50 (3)	6
	Monitor and triage plan developed, but not invoked	17 (1)	
	Extra ventilators received and a utilization committee implemented	17 (1)	
	No changes implemented for ventilator use	17 (1)	
Have you requested more ventilators for trauma patients?	Yes, in anticipation of a surge in need	50 (3)	6
	Yes, in response to low resources available	17 (1)	
	No, but we plan to request more when we reach a specific number of COVID-19 cases.	17 (1)	
	No, we have not requested more ventilators and have no plan for requesting more ventilators	17 (1)	
Have your intubation protocols changed for trauma patients? Select all that apply.	Earlier intubation to protect providers	17 (1)	6
	Increased use of PPE and barrier protection	33 (2)	
	Limited intubation to a small group of providers and limited personnel in the room	50 (3)	
	Room is in isolation for one hour afterward	17 (1)	
	No, the intubation protocols have not changed	33 (2)	
Have your protocols for BiPAP or CPAP machines changed? Select all that apply.	Using CPAP or BiPAP for COVID-19 patients	17 (1)	6
	We are not using CPAP or BiPAP for COVID-19 patients	17 (1)	
	Disallowing the use of home CPAP	17 (1)	
	Using CPAP and BiPAP machines for longer duration before going to ventilation	17 (1)	
	We are filtering circuits	17 (1)	
	No	33 (2)	
How is the oxygen supply being used or monitored differently?	Command center monitors use	17 (1)	6
	No changes	83 (5)	

Table 4. Hospital Resources During the COVID-19 Pandemic *(Continued)*

Question	Responses	% (n)	Total n
How are blood products being used or monitored differently?	Blood bank supervisor checks supply daily	17 (1)	6
	Consideration for survivability with MTP	17 (1)	
	Providers considering need and availability	17 (1)	
	No changes	50 (3)	

BiPAP = BiLevel positive airway pressure; COVID-19 = novel coronavirus 2019; CPAP = continuous positive airway pressure; MTP = massive transfusion protocol.

who monitored ventilator use. A majority of participants (67%, n = 4) requested more ventilators; of those, 50% (n = 3) requested more ventilators in anticipation of a surge, and 17% (n = 1) requested more ventilators in response to low resources at their hospital. All hospitals which requested additional ventilators (n = 4) received them.

Intubation protocols were revised at 67% (n = 4) of the participating hospitals. Some participants indicated changes to multiple aspects of their intubation protocols, 50% (n = 3) limited the procedure to be conducted by smaller group of providers and limited the number of personnel in the room, whereas 33% (n = 2) increased the use of PPE and barrier protection during intubation. One center (17%) boxed items in the trauma bay and used no curtains during intubation, then cleaned and isolated the trauma bay room for one hour after the intubation procedure. In addition, 17% (n = 1) intubated patients earlier to protect providers from the potential of COVID-19 exposure.

Two hospitals reported no changes to the way they were using CPAP or BiPAP machines. The remaining hospitals each made different changes to the use of CPAP and BiPAP machines, with one response each as follows: (1) the hospital is using CPAP or BiPAP for patients with COVID-19 and placing filters on the circuits to prevent the spread of infectious material, (2) the hospital is using CPAP or BiPAP machines longer before the patient is ventilated, (3) the hospital is not using CPAP or BiPAP for COVID-19 patients, or (4) the hospital is disallowing the use of home CPAP machines.

A majority of hospitals, 83% (n = 5) did not change the use or monitoring of oxygen supplies. One center (17%) stated that the oxygen supplies were being monitored by both registered technicians and their command center due to COVID-19. Half of the hospitals (n = 3) also did not change the way they used or monitored blood products, whereas 33% (n = 2) were taking more consideration on survivability and availability of blood products for patients needing transfusions. At the remaining trauma center (17%), the blood bank supervisor checked the blood supply daily.

Limitations

This study was limited to the small sample size of six hospitals across four states. This represents 3.4% of US Level I trauma centers identified by the American College of Surgeons. In addition, none of the hospitals experienced a surge in patients which overwhelmed their hospital. This could be due to the actions taken to allow for additional treatment beds. However, shortages of PPE were reported as well as a decreased availability of ventilators. Therefore, processes changes described could be especially useful to other trauma centers as the pandemic continues to threaten our healthcare systems. Although, most hospitals reported that selection criteria for ventilator allocation were not created, two centers did create ventilator allocation selection criteria. In addition, processes on monitoring and requesting ventilators were provided. This may be important for hospitals expecting a shortage of ventilators in the future. Future research assessing how ventilator selection criteria impacted both the need for ventilators and patient outcomes could also be useful for centers which need to modify criteria to allocate ventilators while optimizing patient outcomes.

Discussion

Some reports show a second wave of COVID-19 has already occurred for countries such as South Korea, Iran, and Italy and may be likely in the United States.[13–15] In preparation, trauma centers can learn

from process changes made from the initial pandemic response. This study is the first, to the best of our knowledge, to summarize the change in practices and resources allocation of ICU beds, negative pressure rooms, oxygen supplies, CPAP, BiPAP, blood products, and ventilators among multiple US Level 1 trauma centers.

The CDC released recommendations that the general public should wear cloth masks to prevent COVID-19 transmission.[16] The need for masks by the general public, US healthcare workers, and among those in international countries contributed to the reported lack of supply of masks and respirators.[8] As a result, restricted use of supplies and methods to sanitize masks have been implemented and were reported within our network of trauma centers. The CDC states that N-95 respirators are not approved for routine decontamination but that reuse may be needed during times of shortage.[17] Before reverting to decontamination of N-95 respirators, the CDC suggests issuing each employee five respirators and rotating through them on a five day basis because of the survival time for SARS-CoV-2 on surfaces.[17] In this study, a majority reported that they were reusing and sanitizing N-95 respirators using a variety of sanitation methods.

To reduce the amount of PPE used, including masks or respirators, 83% of hospitals clustered patient contact. Haut et al. 1[18] also suggested to reduce the number of times clinicians round on patients at bedside to reduce the donning and doffing of PPE for each patient. Although nationwide shortages of PPE have been reported, this study found that only 17% of trauma centers experienced a shortage of PPE, having their orders diverted to other hospitals.[8,9,17,18] Another study reported that 30% of practitioners in Lombardy, Italy, one of the most severely hit regions, stated that PPE supplies were insufficient.[7] This smaller proportion in need of masks could be in part because of the processes implemented on reuse and decontamination of masks or because of the high case volumes seen in Italy.

A study in Wuhan, China found that approximately 3.2% of patients with COVID-19 require intubation and invasive ventilation at some point and 45% of those admitted to the ICU require ventilation.[19] Selection criteria for ventilator allocation were created at two hospitals using the respiratory severity score or an ethics committee to review patients in need of a ventilator on a case-by-case basis. One participant did respond that they requested and received more ventilators in response to decreased availability. However, most participating trauma centers did not create selection criteria or need more ventilators suggesting that the hospitals were adequately prepared for the number of patients needing ventilators. This could be due to requesting more ventilators ahead of time or because the participating hospitals did not experience a surge of patients requiring ventilators causing a deficit. Some companies have attempted to remediate the problem of ventilator shortages by producing ventilators, such as Dyson who converted their vacuums into ventilators.[5,20] A national strategy for ventilator and ICU resource allocation was published, and the authors suggest that a ventilator shortage is not necessarily a problem in the United States, rather that the issue is more a problem of ventilator distribution.[21] Because of this finding that a ventilator shortage may not be an issue, monitoring the use of ventilators and requesting ventilators when the use level is high could prevent a deficit from occurring at individual trauma centers, allowing for all patients in need of ventilator to obtain one.

The national strategy for ventilator and ICU resource allocation also found that 30 states are not projected to meet their maximum ICU capacity.[21] This could be partially due to the fact that 83% of participating hospitals anticipated a surge of cases and designated more beds as ICU beds, additionally 33% converted rooms to double occupancy. Cancellation of elective procedures ahead of the peak could have also played a role in ICU bed capacities not being overwhelmed.[20] The participants in this study also reported changes to ICU triage criteria through triaging patients out of the ICU based on acuity if a surge occurred, caring for patients in the progressive care unit instead of the ICU, and disallowing COVID-19 trauma patients in the ICU. Hasan et al. 2[22] evaluated ICU admission and discharge policies and reported that increasing discharge windows, the times of the day when patients are considered for discharge, significantly lowered the average wait times for ICU admission, and increased the amount of patients able to be admitted to the ICU. Revising ICU discharge criteria during COVID-19 could allow for more patients in need of an ICU bed to be admitted.

Rooms or floors have also been converted to negative pressure to care for patients with COVID-19. However, one participant noted that their operating room (OR) could not be converted to negative pressure so other accommodations were made. A guideline on preparing to perform trauma and orthopaedic surgery for patients with COVID-19 discusses that ORs with positive pressure are not easy to reverse engineer.[23] They suggest placing portable

high-efficiency particulate air filtration systems with a high frequency of air changes in ORs with positive pressure.[23]

Conclusions

Without specific guidelines for trauma care in response to the COVID-19 pandemic, this study summarized the processes that participating trauma centers developed to protect the trauma patient and trauma care providers while providing optimal trauma care for patients. This was possible even when faced with scarce resources. The processes described were related to intubation and resource allocation of PPE, ventilators, ICU beds, oxygen supplies, CPAP, BiPAP, blood products, and negative pressure rooms. The participating trauma centers reported changes ahead of a surge of COVID-19 cases or even before the first case was identified at their center. Early process changes could reduce the risk for overwhelmed patient admittance and the risk for low availability of resources to treat patients during the pandemic.

Implications

These new processes are valuable as the pandemic continues to unfold and in preparation of a second wave of COVID-19, in the event it should happen in the future. Furthermore, the procedures on tracking resources and resource allocation for ICU beds, negative pressure rooms, ventilators, oxygen supplies, CPAP, BiPAP, blood products, and PPE that were developed can be useful to other trauma centers for any contagion phenomenon that may cause a surge or overcrowding.

Authors' Biographies

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