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Disparate resource allocation during the COVID-19 pandemic among trauma centers: A Western Trauma Association national survey

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Abstract

Background: During the pandemic, hospitals implemented disaster plans to conserve resources while maintaining patient care. It was unclear how these plans impacted injury care and trauma surgeons.

Study design: A 16-question survey assessing COVID-related hospital policy and resource allocation pre-COVID-19 peak (March), and a 19-question post-peak (June) survey was distributed to Trauma/Critical Care attending via social media and the Western Trauma Association member email list.

Results: There were 120 pre- and 134 post-peak respondents. Most (95%) altered trauma PPE components, and 67% noted changes in their admission population pre-peak while 80% did so post-peak. Penetrating injury increased 56% at Level 1 centers and 27% at Level 2 centers. Altered ICU and transfusion criteria were noted with 25% relocating TBI patients, 17% revised rib fracture admission criteria, and 23% adjusted transfusion practices. Importantly, 12% changed their massive transfusion protocol, with 11% reducing the symptomatic transfusion threshold from 7 g/dL to 6 g/dL. Half (50%) disclosed impediments to patient care including PPE shortages and COVID test-related procedural delay (Fig. 2). While only 14% felt their institution was overwhelmed by COVID, the vast majority (81%) shared durable concerns about personal health and safety.

Conclusions: Disparate approaches to COVID-19 preparedness and response characterize survey respondent facility actions. These disparities, especially between Level 1 and Level 2 centers, represent opportunities for the trauma community to coordinate best-practice planning and implementation in light of future consequence infection or pandemic care.
noted a rapid surge in persons requiring inpatient care in select geographic areas, thus exposing resource scarcity including but not limited to ventilators, personal protective equipment (PPE), clinicians, and ICU beds. To respond to the patient surge and preserve healthcare worker safety, both medical and surgical practices were acutely altered. In mid-March, the American College of Surgeons Committee on Trauma (ACS-COT) posted safety guidelines to address anticipated resource limitations that would impact injury care. Hospitals maintained urgent/emergent patient care, but ceased most or all elective procedures, thus freeing beds and clinicians to redeploy for COVID-19 care, including in novel ICUs.

Many of the reallocated clinicians did not previously work in critical-care spaces and therefore, required training and guidance to work within a tiered staffing structure. During these periods, specialty clinicians – like students and family members – were often absent from the acute care facility, leaving trauma surgeons and other intensivists devoid of their usual support network of specialty consultants. Despite these radical changes in patient volumes, acuity, and available resources, trauma surgeons were expected to maintain full trauma care coverage and services, in addition to frequently providing direct COVID-19 critical care, procedural support, or Emergency Department coverage. Recognizing that each facility may have significant unique stressors and experiences, we sought to assess and characterize the experiences of Trauma/Acute Care surgeons (T/ACS) during the early phase of the COVID-19 pandemic to better understand how to plan for subsequent events.

2. Methods

A novel 16-question pre-peak COVID-19 survey (March 27, 2020) and expanded 19 questions post-peak COVID-19 (June 1, 2020) was dispersed. T/ACS experiences and perspectives regarding COVID-19 related hospital policies, resource allocation, and the impact of those changes on their practice, trainee education, and patient care were queried. Surveys (voluntary and anonymous) were distributed via multimedia sources (Twitter, Facebook, and the Western Trauma Association member email list). Each survey remained open for 120hrs with responses tabulated using Survey Hero (2020; Zurich, Switzerland) and Excel (Microsoft 365, 2020; Redmond, Washington). Data was parsed by trauma center verification level. Incomplete surveys were excluded. International respondents were omitted due to substantive differences in COVID-19 surge timing, practice patterns, available resources, and additional non-COVID coverage responsibilities.

Exploratory descriptive analysis and summary statistics were performed to characterize the data and responses. Qualitative analysis was embraced to identify and group common themes. Open ended responses were reviewed by two independent reviewers for inter-rater reliability. The comments were categorized and placed into “themes”. The Salem Health (Salem, Oregon) Institutional Review Board approved the survey and research protocol. Standard descriptive statistics were analyzed utilizing means ± standard deviation or median and range for continuous variables, and percentiles for categorical variables. Univariate comparisons between groups were performed using student’s t-test, chi-squared or Fisher’s exact tests as appropriate. Statistical significance was set at an alpha of 0.05.

3. Results

3.1. Demographics

Survey viewing increased from 401 pre-peak to 543 post-peak with 120 pre-peak (30% response rate) and 134 post-peak (25% response rate) respondents. 3 incomplete surveys were excluded. Respondents spanned 35 US states and 4 other countries (Sweden, Canada, Israel, and South Africa). Physicians from Level 1 (77% pre, 80% post), Level 2 (21% pre, 17% post) and Level 3 (1.5% pre, 1.5% post) trauma centers responded. The pre-peak Level 3 data (n = 1) was omitted as it was incomplete, and the single post-peak survey (n = 1) was included in the Level 2 post-peak data due to similarities of responses (Fig. 1).

Ninety-two pre-peak respondents practiced at a Level 1 center and 25 at Level 2, while 107 post-peak respondents worked at a Level 1 and 23 from a Level 2 center. Most respondents were T/ACS. Although the Western Trauma Association is multidisciplinary, most respondents were T/ACS with 10% (pre-peak) and 5% (post-peak) practicing, (Cardiothoracic, Pediatric, Vascular, Hepatobiliary), Emergency Medicine, and Anesthesia or Pulmonary Critical Care.

3.2. Resident duties

Most respondents worked in a teaching facility (88% pre-peak, 93% post-peak). Initially, 15% of residents were displaced from clinical duties (7% @ Level 1, 8% @ Level 2) versus post-peak where 13% were excluded from clinical care (10% @ Level 1, 3% @ Level 2). Resident duties were modified at 33% of Level 1 and 56% of Level 2 centers pre-peak, while duty modification occurred at 31% of Level 1 and 35% of Level 2 post-peak. Modified schedules included “reduction of duties” and altered shifts by day vs night or by week. Four participants noted that immunocompromised or pregnant residents were excluded from clinical care.

3.3. Blood product use protocol

Most (54% pre and 57% post-peak) understood blood bank capabilities and their MTP and anemia transfusion thresholds. Component allocation shifted for 25% pre and 22% post-peak. MTP component ratios were altered in 16% pre and 12% post-peak to preserve PRBC stores. Relatedly, the anemia transfusion threshold was lowered for symptomatic patients from 7 g/dL to 6 g/dL for 20% pre-versus 11% post-peak. Differences between Level 1 and 2 centers are presented in Fig. 2. Although pre-to-post-peak changes of blood product allocation were not statistically significant (p = 0.5), a difference was noted when comparing qualitative responses collected and collated between Level 1 and 2 centers for all variables excluding MT futility (p < 0.02) (Fig. 3).

3.4. Trauma personal protective equipment (PPE) and personnel

Given PPE shortages that plagued the nation, access to and use of PPE during trauma resuscitations was assessed. Both the pre- and post-peak surveys demonstrated that 95% and 94% respectively experienced undesirable challenges in PPE availability. Ninety-eight percent of Level 1 surgeons pre- and 95% post-peak indicated some change compared to 88% both pre- and post-peak at Level 2 centers. Respondents from Level 1 centers noted the following changes to preserve PPE; minimize bedside personnel (92% pre, 86% post), airway precautions against aerosol generation (76% pre, 72% post), and reuse of at least some PPE (40% pre, 50% post). Nonetheless, most reported that all bedside team members donned full PPE (58% pre, 64% post). Level 2 centers indicated changes including minimizing bedside personnel (88% pre, 83% post), reuse of PPE (50% pre and post), and ensuring droplet precautions for all patients (80% pre, 65% post) (Fig. 4). Fig. 4 presents additional actions undertaken regarding PPE and safety. No center noted COVID screening questions for EMS or Police present in the trauma bay or ED.

3.5. Trauma population during the initial US COVID-19 surge

The pre-peak majority (67%) reported changes in the injured patient composition (81% Level 1, 74% Level 2; p = 0.08) (Fig. 5). Qualitative analysis of March 2020 common themes included: 1) reduced late-night patient flow perceived to be related to closure of restaurants, bars and entertainment venues, 2) reduced MVC frequency, 3) increased

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domestic violence injury, 4) enhanced pediatric volume, and 5) more frequent suicide attempts. Post-peak themes included: 1) fewer MVCs, 2) increased All-Terrain Vehicle crashes, 3) increased suicide attempts, 4) increased intentional violence, and 5) overall lower injured patient volume putatively related to lockdown and decreased overall travel especially for seasonal recreation and vacation.

3.6. Changes to trauma ICU admissions criteria

ICU admission criteria were altered at 13% of Level 1 centers both pre- and post-peak addressing age, comorbidities, rib fractures, and TBI. More Level 2 centers (16% pre- and 22% post-peak) changed ICU admission criteria regarding TBI, age, and comorbidities (Fig. 6). The- matic analysis noted reduced admission of TBI patients to the ICU regardless of guideline recommendations, requiring more rib fractures for admission, and focusing on hemodynamic compromise as an admission driver. Additionally, a few noted that their surgical ICU did not admit patients with COVID-19 disease, instead displacing them to the medical ICU. Others noted vast expansion of COVID-19 care in surgical and trauma ICUs, including geographic coverage of those patients. Bed conservation was a persistent theme throughout.

3.7. Trauma transfers

Pre-peak, 10% of participants from a Level 1 center noted changes to their incoming trauma criteria while 0% of Level 2 participants noted changes. Post-peak survey found 5% from Level 1 centers noted changes and 9% from Level 2. Changes included reducing transfers driven by Brain Injury Guidelines, increase selectivity around minor injuries, shifting patients <21 years of age to Pediatric centers, and using telemedicine to provide remote consultation and reduce transfer frequency.
3.8. Access to care

Impediments to care were noted in an increasing fashion (40% pre- and 49% post-peak). Of those who felt they met challenges during this time, 43% pre-peak were from Level 1 versus 29% from Level 2 centers. Post-peak follow-up noted 48% at Level 1 centers experienced difficulties compared to 52% post-peak at Level 2 (p < 0.03). Common themes surrounded PPE and device availability, as well as communication with those garbed in full PPE, especially PAPRs or CAPRs. Patient care themes included delays in pursuing tracheostomy, OR delays related to COVID-19 testing, and increased OR turnover times related to decontamination practices (Fig. 7).
3.9. Acute care surgery coverage

Most (87% pre- and post-peak) noted no changes to their practice profile in that they continued to provide ACS coverage at both Level 1 and 2 centers. Several had planned to leverage non-trauma focused general surgeons to cover night-time trauma call, but those plans were never activated.

3.10. Hospital COVID-19 burden

Between surveys, facilities were perceived to be overwhelmed in an increasing fashion (4% pre (similar at Level 1 and 2 centers), vs 14% post-peak). Eleven percent of Level 1 and 3% of Level 2 center respondents reported being overwhelmed post-peak. The remainder of respondents reported a successful surge response but believed they remained at risk of being overwhelmed with additional patient volume.

3.11. Post-peak survey additional data

3.11.1. COVID-19 ICU patient coverage

Twenty-eight percent of follow-up survey respondents staffed COVID ICU’s with more redeployment occurring at a Level 1 (29%) than Level 2 centers (17%). Thematic analysis revealed respondents that were willing to cover COVID patients but were not asked to do so, while others reported serving as proceduralists for vascular, respiratory, or enteral access.

3.11.2. PPE

PPE inadequacy surfaced as a dominant theme and included disinfection supplies. Reuse of previous single use items was a strongly articulated concern. Inadequate PPE for patient care was noted by 64% of Level 1 and 74% of Level 2 center respondents.

3.11.3. Personal safety and career concerns

Eighty-one percent expressed concern for their health and survival during this 4-month period. Of those working at Level 1 centers, 42% had “some concern”, 23% had “moderate concern” and 16% were...
“majorly” concerned while 12% contemplated a career change. Many participants from Level 2 centers showed “some concern” (57%), while only 9% considered a career change.

3.11.4. Shared thoughts and opinions

Respondents were provided a space to share any additional thoughts or information. Ten physicians commented on the initial survey and 14 subsequently. These qualitative responses were assessed and summarized in the supplemental digital content Table 1.

4. Discussion

The COVID-19 pandemic has impacted healthcare systems and providers worldwide and in virtually every field and specialty. However, these impacts have been widely disparate, ranging from overwork and exhaustion providing direct COVID patient care to being furloughed with loss of income due to the shutdown of key functional areas such as elective surgery.

Variability between responses based on location was likely due to differences in state laws, COVID burden, timing and quantity of COVID patient surgery, and policy and resource allocation across institutions. Regardless, pandemic preparation, accommodation, and care addition- ally stressed hospital staff, perhaps most notably in the Emergency Department and the ICU. Along with ED and medical ICU staff, T/ACS’s provide care in both areas to COVID and non-COVID patients. Changes in injured patient volume, injury spectrum, and mechanism have been reported. Importantly, this survey explores two distinct pandemic time frames to garner T/ACS perceptions of care, resource allocation, and personal impact. Unsurprisingly, impediments to delivering high quality, timely injury care predominate but were punctuated by concerns regarding high-consequence infection acquisition and transmission as well as clinician mortality. Such concerns were underpinned by supply chain disruption and failure as well as evolving approaches to infection diagnosis, isolation, cohorting, and procedural safety that occurred in the void of an effective therapeutic. The time frame after this survey witnessed the triumph of multinational inquiry and discovery that established current best practice for now standard of care therapeutics. Therefore, our survey data provides insight into a period marked by only supportive care with unquestioned individual clinician risk.

Resource inadequacies included information and within which to share ideas and observations to improve care and safety. Repair strategies may be anticipated to leverage organizational, structural and educational initiatives to expand facility capability and competency in providing pandemic care regardless of the pathogen. It is in this space that medical professional organizations rose to the fore to liberate resources previously sheltered behind a paywall to share them with ICU and non-ICU clinicians to enable surge care capacity and capability. Additionally, open access webinars and professional society meetings helped meet the need for rapidly deployed information. Social media enabled data sharing and fostered a global medical community as a bulwark against isolation.

A pandemic of this duration and scope exerts previously unanticipated stressors and exposes opportunities for improvement in hospital systems. While any large crisis or disaster will uncover local gaps, COVID-19 has done so nationally and globally. Dependence on extra-national manufacturing for key items including PPE or ventilators has been highlighted during the initial COVID-19 surge. Similarly, inadequacies in the Secure National Stockpile, or the lack of granular national data regarding patients, beds, staff and therapeutics for example have been explored in professional and lay press alike. Identifying vulnerabilities in current processes is a key method of fostering iterative improvement. A Canadian study evaluated the preparedness of 17 hospitals in 5 areas: communications, command structure, decon- tamination, staffing and patient tracking. Findings included the importance of having an open established communication system, adequate supply chain, and continuity of essential services such as water, power,

| Table 1 | Shared thoughts and opinions of survey participants during the 1st COVID-19 peak. |
| Concerns & Frustrations | Positive outcomes | Healthcare & Inequalities | Patient & Hospital Observations |
| Pre-Peak Responses | COVID has allowed us to re-engage with multi-disciplinary critical care team | Pandemic has pointed out continued inequities in healthcare that currently exist in the US | Impressed with # COVID + children |
| Self-isolation at home from family x 2 months so far | More productive from home but daily changes in protocol is difficult. | We should have uniform single pair for healthcare. Perhaps Medicare for all would be a good idea. | Trauma vol back to normal 5/15 |
| As an older surgeon with adequate partners and staffing, I was allowed/asked to take clinical time off in March during concerns and peak volume. | Overwhelming gratitude of patients and family members have for our teams. Previously patients would be more focused on negatives and their care, pain, injuries, etc. Currently they are so supportive and thankful. | Given the low volume of COVID cases, it felt like my hospital was “immune” from PPE crisis and shortage. Our hospital did not get hit as hard as expected. The MICU team took the brunt of COVID. |
| I have never see anything like this. NYC was crazy. We doubled our capacity, had 140 vents at peak (normally 30 max), made pop up ICU in people’s offices, had | We were amazingly prepared for a COVID surge. We converted our Ambulatory Care Unit into a 30 bed ICU COVID unit with everyone using PAPR. All COVID + patients | |

(continued on next page)
Table 1 (continued)

| Concerns & Frustrations | Positive outcomes | Healthcare & Inequalities | Patient & Hospital Observations |
|-------------------------|-------------------|---------------------------|--------------------------------|
| military and agency nurses, saw a lot of people die. | were cohorted in an isolated section of the hospital. Amazing collaboration, collegiality and team play between many different departments. The nursing and RT staff are truly heroes. It has been an incredible experience and I have learned a lot and now consider myself a COVID expert. Our country will never be the same again. | | |

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6. Conclusion

This survey identifies disparate approaches to preparedness and response during the first 12 weeks of the COVID-19 pandemic. These disparities, especially between Level 1 and Level 2 centers, represent opportunities for the trauma community to coordinate best-practice planning and implementation in anticipation of future pandemic care. Durable efforts to improve clinician safety, mitigate stressors that drive attrition, and approaches that foster inter-facility collaboration merit specific focus ahead of the next event to stress global health and injury care.

Authorship

A.M.M. and L.J.K. conceived this study. A.M.M., L.J.K., M.J.M., and R.C.M. designed the data collection tool. A.M.M. and M.W. accessed the data and performed the analysis. A.M.M. and M.W. created figures. A.M. M. drafted the initial manuscript which all authors (M.W., L.J.K., M.J. M., and R.C.M) critically revised and approved.

Declaration of competing interest

The authors have no conflicts of interest to disclose.

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