






Are trauma surgeons prepared? A survey of trauma surgeons' disaster preparedness before and during the COVID-19 pandemic

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ABSTRACT

Objective US trauma centers (TCs) must remain prepared for mass casualty incidents (MCIs). However, trauma surgeons may lack formal MCI training. The recent COVID-19 pandemic drove multiple patient surges, overloaded Emergency Medical Services (EMS) agencies, and stressed TCs. This survey assessed trauma surgeons' MCI training, experience, and system and personal preparedness before the pandemic compared with the pandemic's third year.

Methods Survey invitations were emailed to all 1544 members of the American Association for the Surgery of Trauma in 2019, and then resent in 2022 to 1575 members with additional questions regarding the pandemic. Questions assessed practice type, TC characteristics, training, experience, beliefs about personal and hospital preparedness, likelihood of MCI scenarios, interventions desired from membership organizations, and pandemic experiences.

Results The response rate was 16.7% in 2019 and 12% in 2022. In 2022, surgeons felt better prepared than their hospitals for pandemic care, mass shootings, and active shooters, but remained feeling less well prepared for cyberattack and hazardous material events, compared with 2019. Only 35% of the respondents had unintentional MCI response experience in 2019 or 2022, and even fewer had experience with intentional MCI. 78% had completed a Stop the Bleed (STB) course and 63% own an STB kit. 57% had engaged in family preparedness activities; less than 40% had a family action plan if they could not come home during an MCI. 100% of the respondents witnessed pandemic-related adverse events, including colleague and coworker illness, patient surges, and resource limitations, and 17% faced colleague or coworker death.

Conclusions Trauma surgeons thought that they became better at pandemic care and rated themselves as better prepared than their hospitals for MCI care, which is an opportunity for them to take greater leadership roles. Opportunities remain to improve surgeons' family and personal MCI preparedness. Surgeons' most desired professional organization interventions include advocacy, national standards for TC preparedness, and online training.

Level of evidence VII, survey of expert opinion.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Provider and hospital preparedness have been shown to improve critical mortality in mass casualty incidents (MCI), however prior studies have shown a low rate of formal disaster training among US trauma surgeons. The SARS-COV-2 pandemic has been shown to have placed a considerable strain on hospitals, trauma systems and health workers, with surgeons having to adopt new roles during failures in healthcare systems.

WHAT THIS STUDY ADDS

⇒ Despite 3 years of pandemic, the number of trauma surgeons who have obtained formal training in disaster has not increased beyond a minority. Surgeons now feel pandemics, natural disasters, and mass shootings are more likely and they feel more prepared for these events. They also feel civil insurrection is more likely, but they do not feel better prepared for it. Low levels of preparedness persist for events such as cyberattacks or for chemical, biological, radiological, nuclear, explosive events (CBRNE).

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Surgeons' associations may consider making formal training in disasters mandatory for all trauma surgeons and allies as a trauma hospital verification criteria. They should also advocate for improved all-hazards national and hospital disaster preparedness, better national standards for hospital preparedness and augmented disaster training opportunities.

INTRODUCTION

Through a variety of American College of Surgeons (ACS) patient standards, surgeons are expected to be prepared to provide care during mass casualty incidents (MCIs).¹ In the USA, hospital disaster preparedness standards are provided by the Centers of Medicare and Medicaid Services (CMS), The Joint Commission, and the Federal Emergency Management Agency's (FEMA) National Incident Management System (NIMS), and compliance

is regulated by state and regional agencies. Leadership roles within disaster response are defined within the Hospital Incident Command System (HICS), which defines a structured approach to organization, communication, and command. Trauma surgeons working in trauma centers (TCs)² possess skills to manage injuries patients sustain during daily practice as well as MCIs, and may take leadership roles during MCI.

TC verification standards mandate trauma surgeon participation in their TC's emergency management (disaster) committee.^{1,3,4} In the USA during the past decade, intentional MCI events such as mass shootings and violent extremism, explosions, and severe destructive weather events have increased in frequency, propelling TCs and their trauma surgeons' responses into the lay press and the public eye. Although there is a desire and a seemingly natural alignment for trauma surgeon leadership in facility-based emergency preparedness, prior evaluations have low rates of formal trauma surgeon disaster training, including as compared with emergency physicians.^{5,6}

The SARS-CoV-2 (COVID-19) pandemic created patient surges that critically stressed US hospitals, including TCs, and negatively impacted patient outcome quality markers and timely access to non-emergent care.⁷⁻¹⁰ The effects of COVID-19 on surgeon and TC emergency preparedness are incompletely characterized but have been explored in the context of the firearm injury epidemic.¹¹ Therefore, our primary aim was to characterize current trauma surgeon and TC preparedness for disaster management. Our initial survey predated the SARS-CoV-2 pandemic, which then drove the need to repeat our assessment to determine how the pandemic reshaped surgeon and TC preparedness.

The primary aim of this study was to characterize current trauma surgeon and TC preparedness. To achieve this, we developed a survey to assess MCI preparedness, formal MCI training, individual surgeon beliefs related to personal and family readiness, and individual surgeon opinions on how trauma organizations could advocate for improved preparedness.

We initially hypothesized that trauma surgeons feel prepared to deal with MCIs, but most lack formal training. Our secondary hypothesis was that surgeons' infection-related disaster preparedness improved due to the COVID-19 pandemic.

METHODS

Pre-COVID-19 survey

In January 2019, the Disaster Committee of the American Association for the Surgery of Trauma (AAST) and the Subcommittee on Disaster and Mass Casualty Management of the American College of Surgeons Committee on Trauma (ACS-COT) developed a survey instrument to assess MCI preparedness, formal MCI training, surgeon perceptions related to personal and family disaster readiness, as well as opinion on how relevant medical professional organizations can better assist with surgeon MCI preparation and response. No personally identifiable information was obtained from the survey. Questions were created by a working group in the AAST Disaster Committee based on the ACS Disaster Management and Emergency Preparedness (DMEP) course and the *Resources for Optimal Care of the Injured Patient (2014 Standards)*.^{1,12} The survey was pretested by 10 members of the AAST Disaster Committee for ease of use.

All members of the ACS-COT and the AAST were invited by email to participate in an online, cross-sectional survey in February and again in April 2019. Data were securely collected using SurveyMonkey with IP (internet protocol) address tracking to avoid duplicate participation; data collection ceased on September 1, 2019. The results and responses to the survey questions are provided in tables 1–6 and also in the online supplemental files. The 2019 and 2022 survey methodology and questionnaires are presented in the online supplemental files.

Within COVID-19 survey

After completion and analysis of the initial survey, the COVID-19 pandemic emerged. We thought that immersion

Table 1 Training received in disaster preparedness and responses

	2019 (n=215)		2022 (n=180)		P value (χ^2)
	Yes	%	Yes	%	
Stop the Bleed bleeding control course	170	79.1	149	82.8	0.809
Hospital or organization exercises (eg, annual exercises)	165	76.7	146	81.1	0.959
CE conference presentation (AAST session, ACS Clinical Congress, Las Vegas Medical Disaster Response)	120	55.8	93	51.7	0.153
Departmental, medical school, residency lecture(s)	92	42.8	88	48.9	0.498
Active Shooter Response course (eg, FBI, DHS, "Run, Hide, Fight")	75	34.9	62	34.4	0.611
Disaster Management and Emergency Preparedness course	69	32.1	64	35.6	0.755
Online course (eg, FEMA ICS ISP courses, TIIDE Clinical Primer)	68	31.6	58	32.2	0.790
Occupational training (military, law enforcement, EMT training)	62	28.8	55	30.6	0.999
Decontamination training	56	26	66	36.7	0.060
CBRNE training	49	22.8	49	27.2	0.496
Residency or fellowship rotation or experience	41	19.1	50	27.8	0.085
Fundamentals of disaster management	33	15.3	39	21.7	0.180
PTSD, acute stress reaction, critical incident stress debriefing	25	11.6	21	11.7	0.844
Live course (eg, Center for Domestic Preparedness, ICS 300 and 400 courses, BDLS, ADLS)	24	11.2	22	12.2	0.907
No disaster-related training	4	1.9	4	2.2	0.864

All that apply were chosen by the respondents.

AAST, American Association for the Surgery of Trauma; ACS, American College of Surgeons; ADLS, Advanced Disaster Life Support; BDLS, Basic Disaster Life Support; CBRNE, Chemical, Biological, Radiological, Nuclear, and Explosives; CE, continuing education; DHS, Department of Homeland Security; EMT, emergency medical technician; FBI, Federal Bureau of Investigation; FEMA, Federal Emergency Management Agency; ICS, Incident Command System; ISP, Independent Study Program; PTSD, post-traumatic stress disorder; TIIDE, Terrorism Injuries: Information, Dissemination and Exchange Project.

Table 2 Roles ever served by the respondents

	2019 (n=215)		2022 (n=180)		P value (χ^2)
	Yes	%	Yes	%	
Responded to a natural disaster or non-intentional mass casualty event	71	35.3	63	35.4	1.0
Military or conflict surgery	51	25.4	44	24.7	0.876
Responded to an intentional manmade mass casualty event	41	20.4	48	26.9	0.138
Emergency medical services (ie, emergency medical technician)	36	17.9	41	23.0	0.223
Humanitarian aid (ie, Operation Giving Back, Operation Hope)	35	17.4	23	12.9	0.225
Disaster response team (ie, DMAT, IMSURT, state or city teams)	33	16.4	37	20.8	0.281
Law enforcement	7	3.5	8	4.5	0.617
None of the above	61	30.4	45	25.3	0.273

All that apply were chosen by the respondents.
 *P<0.05.
 DMAT, Disaster Medical Assistance Team; IMSURT, International Medical/Surgical Response Teams.

in the SARS-CoV-2 patient surge and infection management would shape disaster preparedness and so the initial survey was supplemented with additional questions (28 additional true/false questions related to surgeons' experience in the pandemic and 7 COVID-19 preparedness characteristics of their facility and themselves using a 5-point Likert scale). This new survey was launched in March 2022 and closed on September 1, 2022.

Data analysis

A sample size calculation for a 95% confidence level and a membership population size of 1575 members with a 10% margin of error yielded a needed sample size of 91 respondents. SPSS V.28 (IBM, Armonk, NY) statistical software was used for statistical analysis.

Same-period Likert scale means were compared by t-test. Roles between periods were compared by Chi-Square. Different-period Likert scale data (ie, survey 1 vs. survey 2) were compared by Mann-Whitney U test. Missing responses were excluded from the analysis. Data reporting adhered to the Checklist for Reporting of Survey Studies requirements (see online supplemental files).

RESULTS

In 2019, 1544 ACS-COT and AAST surgeons were either members of the ACS-COT or members of the AAST. Of these members, 258 responded, for a response rate of 16.7%. Of the responses, 215 (83.3%) were complete responses of all questions. In 2022, 189 of 1575 AAST members and associate members responded, establishing a response rate of 12%; 163 (82.6%) were complete responses of all questions. The median age group (IQR) was not significantly different between surveys: 50 to 59 years (40–49, 60+) in 2019 and 50 to 59 years (40–49, 60+) in 2022 ($p=0.90$). Of the respondents in 2019, 138 (74.6%) were male versus 158 (76.3%) of the respondents in 2022. The majority of the respondents identified themselves as acute care surgeons (ie, trauma surgery, emergency general surgery, surgical critical care). In 2019, 78.8% of the respondents were acute care surgeons compared with 82.0% of the respondents in 2022 ($p=0.42$) (see online supplemental table S1).

Most respondents had served as a trauma medical director in the 2019 survey compared with slightly less than half of the respondents in 2022 (58.7% vs. 48.9%, $p=0.77$) (see online supplemental table S2 in online supplemental files). In both surveys, most respondents served on a trauma call panel, but only a minority had participated in HICS. There was a significant decrease between surveys in membership on the hospital

disaster committee. There was a significant increase between surveys in having no identifiable emergency management role.

Table 1 presents the respondents' disaster-related training. The most common training was Stop the Bleed (STB) bleeding control courses, with 79.1% in 2019 and 82.8% in 2022. A majority in both surveys had annual hospital-based disaster training or participated in Continuing Medical Education (CME) offerings. Some form of disaster training was completed by 76.6% of the respondents in 2019 and 74.1% in 2022 ($p=0.61$). However, only a minority completed more formal disaster training such as an ACS DMEP course. Chemical, Biological, Radiological, Nuclear, and Explosive agent (CBRNE) training was completed by 22.8% in 2019 and increased to 27.2% by 2022.

Table 2 describes the respondents' MCI experience. The majority (69.6% in 2019, 74.7% in 2022) reported some experience in MCI management experience. However only a minority have responded to an intentional MCI (20.4% in 2019 vs. 26.9% in 2022). Table 3 presents surgeons' opinions on their systems' and personal disaster preparedness and likelihood of 10 possible disaster events using 5-point Likert scale scores. Table 4 indicates surgeons' opinions on specific systems and personal disaster preparedness characteristics and activities. Tables 5 and 6 present data from the supplemental COVID-19-related questions provided with the 2022 survey.

DISCUSSION

Based on training and organizational requirements, one would expect that trauma surgeons would be well prepared for disaster management. However, we find that despite the recent SARS-CoV-2 pandemic—a disaster with the highest case fatality rate and the fifth largest number of deaths in global pandemic history—only a minority of trauma surgeons have formal training in disaster management. At best, approximately one-third of the respondents received formal disaster training beyond hemorrhage control techniques or a medical professional organization lecture—a percentage that remained constant across a 3-year time span (table 3). Prior to the pandemic, surveyed trauma surgeons generally agreed that the most likely events would be cyberattacks, followed by natural disasters, mass shootings, or an active shooter at the facility. During the ongoing pandemic, an infection-related disaster was thought to be the most probable community event in the next 5 years. Our data demonstrate that immersion within a disaster, such as the SARS-CoV-2 pandemic, strongly influences trauma surgeons' perceptions regarding preparedness for a similar event. Surgeons felt better prepared to respond to mass casualty events such as shootings and bombings,

Table 3 Opinion on preparedness and likelihood of events

Statement†	2019 (n=215)				2022 (n=180)				2019 (n=215)				2022 (n=180)			
	Mean	Median (IQR)	P value	Mean	Median (IQR)	P value	Mean	Median (IQR)	P value	Mean	Median (IQR)	P value	Mean	Median (IQR)	P value	
	"It is very likely that this type of event will happen in my community in the next five years."															
Pandemic event (ie, influenza, SARS, hemorrhagic fever viruses, Ebola)	3.57	4 (3-4)	<0.001*	4.23	5 (3-5)	<0.001*	3.14	3 (2-4)	<0.001*	4.23	5 (4-5)	<0.001*	3.27	3 (2-4)	<0.001*	
Mass shooting in the community	3.58	4 (3-4)	0.048*	3.8	4 (3-4)	0.048*	3.90	4 (3-5)	0.003*	4.19	5 (3-5)	0.003*	3.82	4 (3-4)	0.003*	
Natural disaster (ie, hurricane, earthquake, tornado, wildfire)	3.67	4 (3-4)	0.639	3.68	4 (3-5)	0.639	3.71	4 (3-5)	0.007*	4.00	4 (3-5)	0.007*	3.65	4 (3-4)	0.006*	
Unintentional hazardous material incident in the community (ie, chemical, petroleum, radiological spillage or release)	3.52	4 (3-4)	0.552	3.41	4 (3-4)	0.552	3.83	4 (3-5)	0.101	4.00	4 (3-5)	0.101	3.80	4 (3-5)	0.268	
Active shooter at or near the facility(s) of work	3.44	4 (3-4)	0.195	3.55	4 (3-5)	0.195	3.49	4 (2-5)	0.045*	3.71	4 (3-5)	0.045*	3.51	4 (3-4)	0.042*	
Riots, civil insurrection, societal disruption	3.16	3 (2-4)	0.178	3.3	4 (2-4)	0.178	3.33	4 (2-4)	0.377	3.46	4 (3-4)	0.377	2.94	3 (2-4)	0.0003*	
Mass decontamination event (mass exposure of patients to chemical or radiological agent)	3.22	3 (2-4)	0.519	3.28	3 (2-4)	0.519	3.21	3 (2-4)	0.618	3.23	3 (2-4)	0.618	3.29	3 (3-4)	0.396	
Deliberate bombing/blast attack	3.17	4 (2-4)	0.539	3.26	4 (2-4)	0.539	3.07	3 (2-4)	0.332	3.19	3 (2-4)	0.332	2.86	3 (2-3)	0.734	
Deliberate chemical, radiological, biological, nuclear attack (ie, dirty bomb, sarin attack, mass poisoning, thermonuclear attack)	2.78	3 (2-4)	0.651	2.72	3 (2-4)	0.651	2.83	3 (2-4)	0.539	2.91	3 (2-4)	0.539	2.91	3 (2-4)	0.260	
Cyberattack or information services disruption (ie, ransomware, network failure, electronic health record failure)	2.77	3 (2-4)	0.325	2.86	3 (2-4)	0.325	2.61	3 (2-3)	0.199	2.81	3 (2-4)	0.199	2.60	3 (2-4)	0.67	

*P<0.05 (Mann-Whitney U test p value).
†Agreement with the statement indicated by a Likert scale: 1, strongly disagree; 2, somewhat disagree; 3, neither agree nor disagree; 4, somewhat disagree; 5, strongly agree.
SARS, severe acute respiratory syndrome.

Table 4 Agreement with preparedness-related statements in 2019 and 2022

	2019 (n=215)		2022 (n=215)		P value (Mann-Whitney U test)
	Mean	Median (IQR)	Mean	Median (IQR)	
My hospital/organization participates annually in planning and exercises with other local and regional facilities.	3.89	4 (3–5)	3.91	5 (3–5)	0.350
A trauma surgeon has had meaningful input into our hospital/organization emergency operations plan/disaster plan.	3.76	4 (3–5)	3.77	4 (3–5)	0.632
A trauma surgeon always participates in my hospital's/organization's disaster drills and rehearsals.	3.77	4 (3–5)	3.76	5 (3–5)	0.603
A member of the trauma surgery call panel attends most meetings of the emergency management/disaster committee.	3.70	4 (3–5)	3.67	5 (3–5)	0.586
My hospital/organization is receptive to my coworkers' and my own input on disaster and emergency management issues.	3.68	4 (3–5)	3.66	4 (3–5)	0.946
I always keep a personal "Stop the Bleed" bleeding control kit in my home, office, or car.	3.53	5 (1–5)	3.41	5 (1–5)	0.452
I always keep a disaster kit (emergency food, water, flashlight, cell charging device, etc...) in my home, office, or car.	3.40	4 (2–5)	3.46	4 (2–5)	0.751
My coworkers and I have access to adequate additional surge/disaster supplies at my workplace.	3.34	4 (2–4)	3.27	4 (2–4)	0.719
My family/loved ones know exactly what to do if I cannot come home during a disaster/mass casualty response.	3.10	3 (2–4)	3.12	3 (2–4)	0.862
My coworkers and I spent a significant amount of time in emergency management/disaster planning and rehearsal.	2.69	3 (2–4)	2.67	3 (2–4)	0.924

Agreement indicated by a Likert scale: 1, strongly disagree; 2, somewhat disagree; 3, neither agree nor disagree; 4, somewhat agree; 5, strongly agree.
*P<0.05.

but less felt prepared for infection-related or hazardous material incidents in 2019. In 2022, confidence in preparedness for pandemic consequences was much more highly rated, matched only by confidence in responding to mass shootings.

The authors thought the pandemic likely increased respondents' participation in non-surgical patient critical care, including care of primary COVID-19 disease. Also, they may have experience in establishment of surge intensive care units, as well as pandemic-related resource limitations and changed care processes. We think this likely helped shape the improved surgeon perception of infection-related disaster preparedness between surveys. However, we think surgeons' competence could be further improved by formal disaster training, especially with regard to leadership in disasters, given the low rates of emergency management training and experience.

Although the respondents seemed comfortable with MCI, there was a general consensus of discomfort with cyberattacks, possibly due to publicized disruptive ransomware intrusions into hospitals that occurred throughout 2019 to 2022. Despite surgeons ranking this as the most likely event in 2019 and the second most likely in 2022, cyberattack preparedness remained low. The emergence of informatics science fellowships for surgical residents may be an avenue for improved surgical cyber-attack preparedness in academic TCs.¹³

The 2019 to 2022 National Health Security Strategy (NHSS) developed by the Department of Health and Human Services Administration for Strategic Preparedness and Response outlines the most likely health threats to our national security in the near term.¹⁴ These include extreme weather events, CBRNE events, infectious diseases with pandemic potential, cyber threats, and misuse of advanced biotechnology. We expected that recent events such as the Boston Marathon improvised explosive device attacks would have raised CBRNE preparedness concerns.¹⁵ However, the survey revealed that most surgeons continue to not consider CBRNE preparedness a high priority for them or their facility. We think most respondents may view CBRNE preparedness as a state or national imperative, or that their current training and preparedness such as the STB training addressed the "E" portion of CBRNE preparedness.

Despite most respondents' active involvement in trauma care, trauma program direction, or hospital preparedness planning, only about 75% had engaged in some kind of disaster training (including hemorrhage control courses and presentations at a conference), despite expecting MCIs within the next 5 years. This may be due to the non-mandatory nature of disaster training. We think formal disaster training should be mandatory for trauma surgeons. Currently the only disaster training mandated for healthcare workers comes from CMS, which requires hospitals to provide annual employee disaster training, but does not specify it be a formal disaster course.¹⁶ FEMA expects hospital leaders, and in particular those who will serve in incident command, to complete online FEMA NIMS training. Unfortunately, only one-third of the respondents have undertaken the free, online NIMS training despite most serving in TC leadership roles. The reasons for less than expected or desired disaster training multifactorial may include, but are not limited to, time commitment required for a formal course, interference with clinical care, competition with expanding mandatory hospital online training, and perhaps most importantly the perception that the surgeon has garnered sufficient experience to successfully provide care during an MCI without additional education. We think this perception of educational adequacy in MCI has been repeatedly proven wrong by the history of "predicable surprises."¹⁷

Despite a minority of surgeons having undertaken formal training in disaster management, the majority have trained family members in disaster planning and hemorrhage control techniques. Nonetheless, less than 40% of the respondents agreed that their family members or loved ones understood an actionable plan for safety and security if the respondent could not return home during an MCI—a clear opportunity for improvement.

Most respondents felt that their professional trauma organizations should advocate for further funding of TC and national preparedness. The ACS-COT and AAST and their disaster committees have echoed the value of disaster preparedness and continue to actively advocate for this at the federal level. The Mission Zero legislation, part of the Pandemic and All-Hazards Preparedness and Advancing Innovation Act passed by Congress in 2019, needs increased funding to allow civilian

Table 5 Team and personal experience of any issues at the hospital or organization during the COVID-19 pandemic

Question	Yes	%
Have been vaccinated against COVID-19	160	98.2
Had a coworker or colleague become ill with COVID-19	139	85.3
Inadequate numbers of staff	129	79.1
Resident duty modifications (changes in hours, duties)	126	77.3
Problems with disposition of patients (no skilled nursing facility beds)	122	74.9
Routinely managed all trauma airways as COVID-19-positive	110	67.5
Managing all trauma admissions wearing full PPE	107	65.6
Increase in interpersonal violence	106	65.0
Blood product shortages	105	64.4
Problems with administration (ie, frequent PPE policy changes)	104	63.8
Increase in delayed or complicated presentations of emergency general surgery cases	98	60.1
Surgical critical care intensivists required to cover non-surgical COVID-19-positive ICU patients	97	59.5
Increase in domestic violence	97	59.5
Trauma patients placed on non-trauma floors	94	57.7
Inadequate PPE	91	55.8
Lack of COVID-19 testing	85	52.2
Delays in surgery or essential care for trauma patients	83	50.9
Decrease in overall trauma volume	73	44.8
Change in medical futility/non-beneficial care/standards or application	67	41.1
Ventilator shortages	60	36.8
Increase in preventable complications	50	30.7
Triage of patients for ventilator allocation	46	28.2
Inadequate space for trauma center functions	46	28.2
Increase in child abuse	40	24.5
Change in indications for palliative care	40	24.5
Increase in elderly falls admissions	31	19.0
Change in ICU admission criteria for trauma patients	30	18.4
Had a coworker or colleague die with COVID-19	28	17.2
Increase in traumatic brain injury	25	15.3

All responses that applied were chosen by the respondents. ICU, intensive care unit; PPE, personal protective equipment.

hospitals to partner with the military to enhance clinical readiness and national preparedness. Other efforts supported by a majority of the respondents included articulating national standards for TC disaster preparedness supported by readily available online training. Several TC institutions currently support or are actively developing civilian–military partnerships with the goal of combating a detrimental “peacetime effect” on military preparedness.¹⁸ Only a minority of respondents indicated that

such partnerships would improve preparedness. We think that respondents may view such partnerships as primarily benefiting the military medical corps rather than civilian facility and community preparedness. This may be an opportunity to further publicize the intents and benefits of Mission Zero.

Only a small majority of respondents felt that inclusion of more disaster-related training into medical school and residency training was desirable. It is not clear if their reticence to include such training during those phases stemmed from a belief that it was too early in careers to be embraced and should be provided later, or a perceived lack of value or needed time requirements.

Adverse experiences in providing acute care during the pandemic were exceedingly common, with respondents experiencing high rates of colleague and coworker illness, overwhelmed resources during patient surges, and widespread resource limitations. There were also high rates of moral distress as well as burnout syndrome.¹⁹ Only a small minority of respondents considered changing their career despite slightly more than half sharing serious concerns about their personal health and well-being. We thought that these misaligned proportions reflect patient care-driven dedication despite personal risks and that this a characteristic of the medical profession. This also represents an opportunity for improved hospital preparedness, including adequate training, appropriate personal protective equipment,²⁰ and other stockpiles.

There are several relevant limitations to our study. First, the sample size is small and is accompanied by a low response rate. Prior surveys of similar groups had a response rate of about 30%.^{3, 21} We speculate that the low response rate may be due to survey fatigue in the membership, or in the possibly negative emotional nature of the survey topic. However, the sample size was sufficient for the power analysis. The demographics, roles, and experience of the respondents reasonably reflect key characteristics of all potential respondents and are consistent with earlier analyses. However, respondents were on average younger than the overall AAST membership (54 years vs. 65 years) and represent a greater proportion of trauma medical director experience than the trauma surgeon population as a whole (47% vs. 21%). Second, respondents were principally surgeons employed at level I TCs. Most of the US trauma care is provided by level II and III centers, rendering the data potentially unrepresentative of those experiences and perceptions. Third, our survey relies on self-reporting of experience as experiential elements were impossible to validate. Fourth, our implicit assumption is that every trauma surgeon had a defined amount of formal disaster training or experience. It is not clear to what extent those who did not respond to the survey invitation have undergone formal training outside of residency or fellowship. Fifth, survey participation may reflect self-selection bias as those with lesser interest in this topic may not have answered the survey. Therefore, the

Table 6 Agreement with pandemic-related statements in 2022

	2022 (n=163)	
	Mean	Median (IQR)
I felt well prepared in my own job to manage the consequences of the COVID-19 pandemic.	3.80	4 (2–5)
My hospital/organization was well prepared to manage the COVID-19 pandemic.	3.39	4 (2–4)
The COVID-19 pandemic had a severe impact in my hospital's/organization's ability to care for trauma patients.	3.34	4 (2–4)
My coworkers were severely stressed looking after trauma patients during the COVID-19 pandemic.	3.33	4 (2–4)
I was very concerned for my own health and mortality during the COVID-19 pandemic.	3.15	3 (2–4)
I felt overwhelmed in my own job to manage the consequences of the COVID-19 pandemic.	2.5	2 (2–4)
I strongly considered changing careers during the COVID-19 pandemic.	1.67	1 (1–2)

Agreement indicated by a Likert scale: 1, strongly disagree; 2, somewhat disagree; 3, neither agree nor disagree; 4, somewhat agree; 5, strongly agree.

rate of training, preparation, and perceived competence may be overestimated compared with the non-respondent surgeons. Sixth, we did not survey other surgeons who engage in trauma care, such as orthopedic, plastic, or neurosurgeons, whose responses may be different from those of trauma surgeons. Seventh, the pandemic evolved over more than 3 years and may have provided sufficient time for surgeons to obtain knowledge and on-the-job training, especially related to non-surgical critical care and infection-related disaster care. It was this likelihood that drove us to resend the survey with pandemic-related questions that would not have been anticipated. Eighth, children under 18 years represent approximately 22% of the population and we did not specifically include questions on children's interests or other special populations in 2019. However, since most of these limitations may have further reduced the measured level of preparedness and training, we think our findings of lower than desired levels of surgeon preparedness and training are consistent with previous data and remain valid.

CONCLUSIONS

It is imperative that surgeons participate in hospital system disaster preparedness and take a leadership role in response to trauma-related MCI events. This survey of acute care surgeons indicates the belief that MCIs can be expected at TCs in the near future. This aligns with the results of the NHSS and the need for enhanced national disaster preparedness. Many members have had some MCI experience, but only a minority have taken a formal disaster course, including ones related to incident command. Trauma surgeons rated themselves as better prepared than their hospitals for MCI care, which may be an opportunity for them to take greater leadership roles in MCI preparedness. Surgeons felt more prepared to deal with MCIs than infection-related disasters, hazardous materials events, or cyberattacks. A small majority have taken steps to increase personal and family preparedness, although a large majority are trained in STB techniques. Most felt that trauma professional organizations should pursue advocacy for hospital disaster preparedness, articulating and deploying national standards for hospital preparedness and augmenting online disaster training opportunities.

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REFERENCES

- 1 Committee on Trauma. Disaster management and emergency preparedness course manual. American College of Surgeons, 2017.
- 2 Abdallah HO, Zhao C, Kaufman E, Hatchimonji J, Swendiman RA, Kaplan LJ, Seamon M, Schwab WC, Pascual JL. Increased firearm injury during the COVID-19 pandemic: a hidden urban burden. *Journal of the American College of Surgeons* 2021;232:159–68.
- 3 Russo RM, Galante JM, Jacoby RC, Shatz DV. Mass casualty disasters: who should run the show? *The Journal of Emergency Medicine* 2015;48:685–92.
- 4 Statement on disaster and mass casualty management. *Journal of the American College of Surgeons* 2003;197:855–6.
- 5 Lewis AM, Sordo S, Weireter LJ, Price MA, Cancio L, Jonas RB, Dent DL, Muir MT, Aydelotte JD. Mass casualty incident management preparedness: a survey of the American college of Surgeons Committee on trauma. *Am Surg* 2016;82:1227–31.
- 6 Ciraulo DL, Frykberg ER, Feliciano DV, Knuth TE, Richart CM, Westmoreland CD, Williams KA. A survey assessment of the level of preparedness for domestic terrorism and mass casualty incidents among Eastern Association for the surgery of trauma members. *J Trauma* 2004;56:1033–9.
- 7 InLiepert AE, Doucet J. *The Acute Care Surgeon in Pandemics: Lessons from COVID-19*. In: *Pikoulis E, Doucet J, eds. Emergency Medicine, Trauma and Disaster Management: From Prehospital to Hospital Care and Beyond*. Springer International Publishing, 2021:417–31.
- 8 Cuschieri J, Robinson B, Lynch J, Mitchell S, Arbabi S, Bryson C, Sayre M, Maier RV, Bulger E. The COVID-19 pandemic: lessons learned for sustained trauma preparedness and responses. *Ann Surg* 2021;273:1051–9.
- 9 Reichert M, Sartelli M, Weigand MA, Hecker M, Oppelt PU, Noll J, Askevold IH, Liese J, Padberg W, Coccolini F. Two years later: is the SARS-Cov-2 pandemic still having an impact on emergency surgery? an international cross-sectional survey among WSES members. *World J Emerg Surg*.
- 10 Moren AM, Waschmann M, Martin MJ, McIntyre RC, Kaplan LJ. Disparate resource allocation during the COVID-19 pandemic among trauma centers: A Western trauma Association national survey. *Am J Surg* 2022;224:S0002-9610(22)00209-4:761–8..

- 11 Abdallah HO, Zhao C, Kaufman E, Hatchimonji J, Swendiman RA, Kaplan LJ, Seamon M, Schwab CW, Pascual JL. Increased firearm injury during the COVID-19 pandemic: a hidden urban burden. *J Am Coll Surg* 2021;232:159–68.
- 12 Committee on Trauma. Resources for optimal care of the injured patient (2014 standards). American College of Surgeons, 2014.
- 13 Reeves JJ, Longhurst CA, Mekeel KL, Goldhaber NH, Clay BJ, Waterman RS, Rhodes LP, McHale M, Clary BM. A novel fellowship in perioperative administration, quality and informatics: a pilot experience for training surgical leaders. *J Surg Educ* 2022;79:839–44.
- 14 Administration for strategic preparedness and response (ASPR), US Department of Health and Human Services. National health security strategy. 2022. Available: <https://www.phe.gov/Preparedness/planning/authority/nhss/Documents/NHSS-Strategy-508.pdf>
- 15 Gates JD, Arabian S, Biddinger P, Blansfield J, Burke P, Chung S, Fischer J, Friedman F, Gervasini A, Goralnick E, et al. The initial response to the Boston Marathon bombing: lessons learned to prepare for the next disaster. *Ann Surg* 2014;260:960–6.
- 16 Centers for Medicare and Medicaid Services, US Department of Health and Human Services. Medicare and Medicaid programs; emergency preparedness requirements for Medicare and Medicaid participating providers and suppliers. *Final Rule Fed Regist Sep* 2016;81:63859–4044.
- 17 Watkins MD, Bazerman MH. Predictable surprises: the disasters you should have seen coming. *Harv Bus Rev* 2003;81:72–80.
- 18 Cannon JW, Gross KR, Rasmussen TE. Combating the peacetime effect in military medicine. *JAMA Surg* 16, 2020.
- 19 Azoulay E, De Waele J, Ferrer R, Staudinger T, Borkowska M, Povoia P, Iliopoulou K, Artigas A, Schaller SJ, Hari MS, et al. Symptoms of burnout in intensive care unit specialists facing the COVID-19 outbreak. *Ann Intensive Care* 2020;10.
- 20 Savage SA, Li SW, Utter GH, Cox JA, Wydo SM, Cahill K, Sarani B, Holzmacher J, Duane TM, Gandhi RR, et al. The EGS grading scale for skin and soft-tissue infections is predictive of poor outcomes: a multicenter validation study. *J Trauma Acute Care Surg* 2019;86:601–8.
- 21 Dennis AJ, Brandt M-M, Steinberg J, Qureshi S, Burns JB, Capella J, Gross RI, Hammond J, Miller SF, Moront ML, et al. Are general Surgeons behind the curve when it comes to disaster preparedness training? A survey of General surgery and emergency medicine Trainees in the United States by the Eastern Association for the surgery for trauma Committee on disaster preparedness. *J Trauma Acute Care Surg* 2012;73:612–7.