COVID-19 and Prehospital Post-Crash Care

by Rebecca Dieken

The mission of the National Highway Traffic Safety Administration is to save lives, prevent injuries, and reduce economic costs due to road traffic crashes, through education, research, safety standards, and enforcement activity. NHTSA uses the Safe System Approach[1] to traffic safety, a holistic undertaking to build and reinforce several layers of protection to prevent crashes and minimize harm after a crash occurs. Post-crash care, which depends on a safe and healthy emergency medical services (EMS) workforce, is a crucial component of the Safe System Approach and traffic safety. This research note looks at COVID-19 pandemic-related changes that may have affected prehospital post-crash care and motor vehicle crash (MVC) outcomes.

According to NEMSIS, the National Emergency Medical Services Information System (*EMS Data Cube: Version 3*) data, the probability of surviving a MVC decreased overall in 2020 compared to 2019. A review of literature revealed that EMS professionals were significantly affected by the COVID-19 pandemic with impacts to the emergency response environment and the mental health of first responders. A summary of the impacts on the environment and EMS professionals found in the literature is shown in Table 1.

Table 1
Literature Review – Summary of Impacts of COVID-19 on EMS Professionals

Reduced MVC calls	Mental health declines pertaining to:
Changes in EMS travel time	• Anxiety
Staff felt underprepared/underequipped	• Depression
Occupational stress and burnout	• Post-Traumatic Stress Disorder
Reduced work performance	• Generalized Anxiety
Reduced desire to stay in the field	• Stigma

Crash survivability is assessed by on-scene EMS professionals who estimate injury severity using the Revised Trauma Score (RTS). The RTS estimates the level of post-crash care required based on injury severity and is accessed during triage or when making the determination of the level of care a patient requires. The RTS ranges from 0 to 7.84 with a higher value being associated with a higher chance of survival. To find the value, the Glasgow Coma Scale,[2] systolic blood pressure, and respiratory rate are used as shown in Figure 1.

Figure 1
Revised Trauma Score

The RTS is a physiological scoring system, with high inter-rater reliability and demonstrated accuracy in predicting death. It is scored from the first set of data obtained on the patient, and consists of the Glasgow Coma Scale, systolic blood pressure, and respiratory rate.

Glasgow Coma Scale (GCS)	Systolic Blood Pressure (SBP)	Respiratory Rate (RR)	Coded Value
13-15	>89	10-29	4
9-12	76-89	>29	3
6-8	50-75	6-9	2
4-5	1-49	1-5	1
3	0	0	0

$$RTS = 0.9368\ GCS + 0.7326\ SBP + 0.2908\ RR$$

Values for the RTS are in the range of 0 to 7.8408. The RTS is heavily weighted towards the Glasgow Coma Scale to compensate for major head injury without multi-system injury or major physiological changes. A threshold of RTS < 4 has been proposed to identify those patients who should be treated in a trauma center, although this value may be somewhat low.

Source: Champion et al., 1989; NEMSIS V3 EMS Data Cube

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[1] More information on the Safe System Approach can be found at www.transportation.gov/NRSS/SafeSystem.

[2] The Glasgow coma scale is explained here: www.ncbi.nlm.nih.gov/books/NBK513298.

Patients with an RTS of 3 or less are classified as severely injured with a probability of survival (POS) of 0.361 or less[3] (Champion et al., 1989). The RTS and related survival probability have been incorporated into the Field Triage Guidelines,[4] which aid EMS clinicians in determining injury severity. To improve the probability of surviving the crash, trauma triage guidelines recommend these patients be transported to a Level 1 or Level 2 trauma center[5] that is capable of successfully treating patients with the most severe injuries. In tracking initial crash survivability, metrics are reported through NEMSIS. NHTSA funds NEMSIS operations, the largest publicly available database of prehospital medical care in the United States. NEMSIS data are stored and maintained for all States and territories. Figure 2 shows the probability of general distribution of scores for all cases in NEMSIS.

Figure 2
Survival Probability by Revised Trauma Score
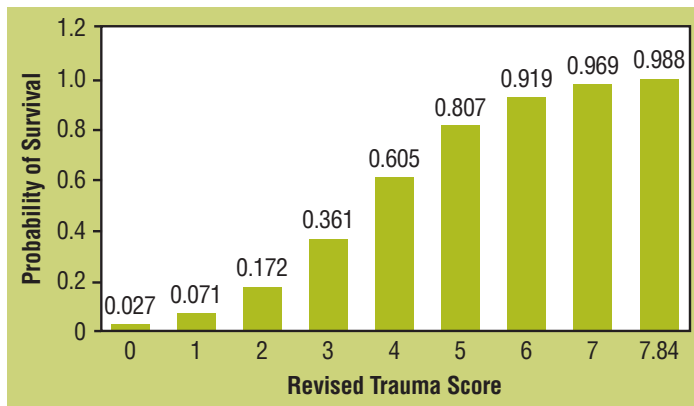
Source: Champion et al., 1989

For those involved in an MVC in 2019, on average, 0.86% had a POS of 0.361 or less. In 2020 the percent of crash patients with a POS of 0.361 or less increased to 1.05%. This means that among people who were treated for MVC injuries, there was a higher proportion of severely injured people in 2020 compared to 2019. In 2021 the percentage decreased slightly to 1.02%. This means that for every 10,000 people injured in a crash, 86 were severely injured in 2019, 105 in 2020, and 102 in 2021. Figure 3 shows the annual fluctuations of the POS of 0.361 or less from 2019 through 2021.

NHTSA's research indicates that increased fatality rates during the pandemic were related to an increase in unsafe driving behaviors, such as increases in the percentage of unbelted drivers in crashes, increases in the percentage of impaired driving cases, and increases in speeding, as well as a decrease in speeding enforcement (Wagner et al., 2020; Thomas et al., 2020; Office of Behavioral Safety Research, January 2021 and October 2021). This occurred at the same time as an increase in the percentage of MVC patients who had low probability of survival (more patients in need of higher levels of care), likely contributing to a more challenging patient care environment for first responders during the COVID-19 pandemic.

The health of EMS personnel and other first responders is a vital factor in roadway crash outcomes. EMS staffing and the physical and mental well-being of these professionals, especially during and after the COVID-19 pandemic, may have affected post-crash response capability (FICEMS, 2022).

This literature review showed that EMS staff faced various challenges related to COVID-19. Quantitative and qualitative scholarly articles were collected. The criteria included research involving prehospital emergency personnel after the onset of the COVID-19 pandemic. Only studies with the unit of analysis at the level of the individual were included. Studies predating or not related to COVID-19 were omitted as well as studies not related to EMS personnel or first responders. Due to the recent onset of the COVID-19 pandemic, only a small collection of studies were available. Two prominent themes emerged among the studies: emergency response environment and first responder health.

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[3] A 0.361 POS means a patient has a 36.1% chance of survival for a specified time after treatment starts.

[4] The National Guidelines for the Field Triage of Injured Patients can be found at www.facs.org/quality-programs/trauma/systems/field-triage-guidelines.

[5] Information on trauma centers, including definitions, can be found at www.ncbi.nlm.nih.gov/books/NBK560553.

Figure 3

Percentages of All Patients in MVCs With Probabilities of Survival 36.1% or Less (Severely Injured; Transport to Higher Level Trauma Center Recommended) by Week of Year
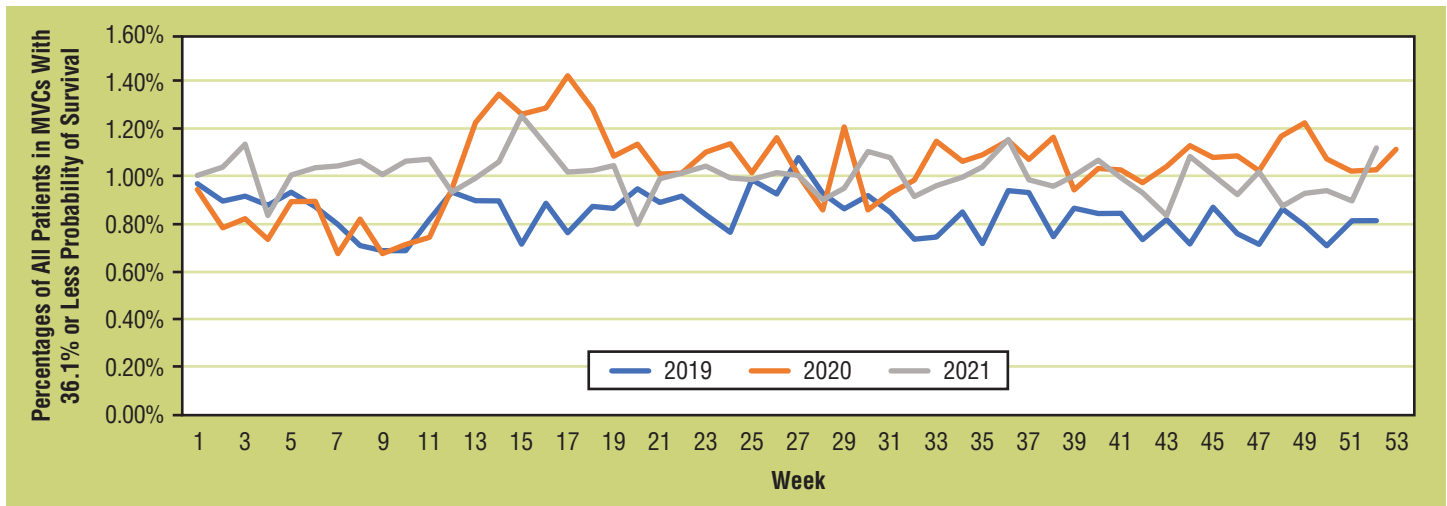
Source: NEMSIS V3 EMS Data Cube

Emergency Response Environment

This literature review indicated emergency response environment was an important challenge for first responders. Ferron et al. (2021) performed a cross-sectional analysis of an EMS database for Niagara, Canada. Comparing the first 5 months of 2020 to the first 5 months of 2016 through 2019, they analyzed call volumes and patient acuity scores assigned by paramedics. Although some types of calls significantly increased, such as cardiac arrests and overdoses, motor vehicle collisions significantly decreased. In 2020, MVC calls accounted for 3.2% of all EMS calls compared to 3.8% for the 2016 to 2019 average, a 17% reduction in MVC calls, which was the greatest reduction of all call types. In comparing the number of calls per person in these five months in 2020 to the 2016 to 2019 average for the same five months, the call rate significantly decreased. They also found that while the number of calls decreased, the number of patients with the most severe paramedic-assessed acuity level increased (Ferron et al., 2021). Consistent with these findings, in the United States from 2019 to 2020, vehicle miles traveled decreased 11% while fatalities increased 6.8% from 36,355 to 38,824 (Stewart, 2022). It should be noted that universal healthcare coverage is provided in Canada, which may have increased the likelihood a call was made and when it was made compared to calls with similar circumstances in the United States, which has a different healthcare system.

Jarvis et al. (2021) investigated travel times of EMS for 9,400 trauma patient calls in 2019 and 2020 after the pandemic's onset in the United States to determine differences in prehospital travel times. Using data from six Level 1 trauma centers, the date range for the 2019 sample consisted of the full year while the 2020 sample only included March 16 to June 30. In this retrospective study, researchers examined the total time from the initial dispatch to EMS returning to the trauma center, the time of injury to when the dispatch was made, the time from when the dispatch was made to EMS arriving on the scene, how long EMS remained on the scene, and the transport time from the scene to the hospital. While there were no significant differences between the years for most times, findings revealed the transport time from the scene to the hospital was marginally yet significantly less in 2020 during the onset of COVID-19 compared to before it. A possible explanation is there were fewer vehicles on the road during the pandemic. Contrary to Jarvis et al. (2021), NEMSIS shows increased response and turnaround times for ambulance services after the onset of the COVID-19 pandemic (Hoffman et al., 2022).

Gibson et al. (2020) sought to determine the competency and resource accessibility of the individual EMS provider through a self-reported survey. The survey was administered online to 192 EMS staff in the United States in April 2020. When presented with the statement, "I am at increased risk for severe illness due to exposure to COVID-19," 19% responded Strongly Agree, 23% Agree, 37% Neither agree nor disagree, 19% Disagree, and 2% Strongly Disagree. When given the statement, "My facility is or was prepared to respond effectively to the COVID-19 pandemic," 1% responded Strongly Agree, 29% Agree, and 20% Neither agree nor disagree. The most frequent response was Disagree (34%) while

16% responded Strongly Disagree. Although 94% of EMS personnel surveyed reported having access to medical gloves when needed, only 48% stated they had access to N95 masks, 5% stated they had limited COVID-19 training and 36% stated no training was provided. Limitations of this study included there was no validated model available for these survey questions and the study used a small sample size.

First responder participants in a study by Vilendrer et al. (2021) agreed that increasing availability of science-based information related to the COVID-19 pandemic would be beneficial. In this study, a user-needs assessment and evaluation of implementation for an application-based intervention was performed. The application was intended to supply first responders and essential workers in California with information and aid in COVID-19 testing needs. The research used a mixed methods approach by incorporating qualitative and quantitative research methods into the survey design. For the qualitative portion, semi-structured interviews were held, and for the quantitative, the researchers counted the number of downloads performed by each participant. Although there were mixed results relating to adoption levels and beliefs of appropriateness of the app, most respondents stressed the need for a trusted data source.

Like Vilendrer et al. (2021), a study conducted by Mohammadi et al. (2021) found the need for improvements in the emergency response environment. The researchers conducted semi-structured, in-depth interviews in Iran from May through November 2020 of 27 prehospital emergency care personnel who held at least 1 year of experience in the field. Mohammadi et al. (2021) used WhatsApp to administer the questions and the content analysis method developed by Graneheim and Lundman (2004) to analyze the responses. Participants commented on the need for comprehensive and systematic planning and the provision of medical equipment. Comprehensive and systematic planning included developing a protocol that is beneficial in pandemic environments and directly applicable to EMS staff, promoting education for the public on how to prepare for and engage with EMS personnel during the COVID-19 pandemic and developing a protocol for the right kind of care emergency personnel should be giving. The provision of medical care and having access to adequate personal protective equipment (PPE) and separate ambulances provided for COVID-19 patients concerned both EMS staff and the public (Mohammedi et al., 2021).

First Responder Health

Another first responder challenge reported in the literature is the well-being of the responder. In Vilendrer et al. (2021), the authors discussed mental health and noted some first responders reported the humanitarian nature of their job prevented poor mental health, stating they had signed up for what they faced during the pandemic. For example:

> Several first responders shared their ongoing willingness to face the pandemic despite unfavorable circumstances because they had made a commitment to serve when choosing their profession. … Some described an underlying desire to be helpful … and an expansive view of their own roles in the community. … The role of choice in their profession was reported to protect against the adverse mental health effects of their roles, as with the attitude that "this is what I signed up for." (p. 9)

Such a heroic mindset, however, led to reluctancy to seek health services and report symptoms. A solution offered by first responders was to have resources provided that aid in the management of anxiety and stress (Vilendrer et al., 2021).

Vujanovic et al. (2021) also examined the mental health of first responders in the United States exposed to COVID-19 through an online survey June to August 2020. Of the 189 survey participants, 122 first responders reported exposure to the virus. Study findings revealed those reporting exposure were more likely to have been in an EMS role as opposed to a non-EMS role such as a firefighter or law enforcement officer. Likewise, those who reported exposure were more likely to hold a career position as a first responder instead of being a volunteer. In bivariate correlation analysis, the study found statistical significance for the relationship between COVID-19 exposure and alcohol use severity. Significance was also found between the variables of COVID-19-related worry and depression severity. Likewise, COVID-19-related worry and anxiety severity had a statistically significant relationship with one another in bivariate regression, as did COVID-19-related worry and post-traumatic stress disorder (PTSD) symptom severity.

In a phenomenological qualitative study, Zolnikov and Furio (2020) conducted semi-structured interviews of first responders to examine the effect stigma from COVID-19 exposure has on mental health. Of the 31 participants, 28 were in the United States and 1 each in Kenya, Ireland, and Canada. Overall, the findings revealed the workers felt stigmatized after exposure and these beliefs led to

poor mental health conditions including feelings of sadness, feeling blue, and being extremely stressed. Workers discussed states of anxiety and depression because of the stigma but also mentioned increases in communicating with others and receiving science-based information regarding COVID-19 as potential solutions to feeling the negative effects of the stigma (Zolnikov & Furio, 2020). In a followup study, Zolnikov and Furio (2021) also found first responders experienced isolation as their family, friends, and the public distanced themselves from the first responders. This isolation led to heightened levels of anxiety, depression, and stress in addition to reductions in work performance.

In a retrospective study conducted by Carbajal et al. (2020), the mental health of first responders in the United States who were either law enforcement officers, emergency medical technicians, or fire rescue was compared before the onset of the pandemic and after to gauge levels of resiliency. All participants in this study were seeking mental health treatment. Findings revealed a moderate negative correlation between attachment avoidance and resilience, and attachment avoidance had a weak yet significant positive correlation with depression and PTSD. Also, there was a weak yet significant negative correlation between attachment anxiety and resilience, and attachment anxiety had a moderate positive correlation with depression, generalized anxiety, PTSD, and suicide risk which includes ideation and attempts. Further, a moderate negative correlation existed between resilience and depression, generalized anxiety, and PTSD (Carbajal et al., 2020). In other words, after the pandemic started, these first responders felt more distance and insecurity in their relationships with others which manifested in lower resiliency and higher scores for depression, general anxiety, PTSD, and suicide risk.

Hendrickson et al. (2021) conducted a self-report assessment study on COVID-19-related occupational stressors (CROS) in which 510 first responders and healthcare workers in the United States participated. Of all subjects, 200 were first responders. In this study, associations were examined between CROS, psychiatric symptoms, and occupational outcomes. Findings revealed CROS was positively and significantly correlated with troubles doing usual work, desire to leave one's occupation, and psychiatric symptoms of PTSD, depression, insomnia, and generalized anxiety disorder.

In exploring the effect of COVID-19 on first responders, Peat (2022) found that of the 415 surveyed in the United States, 11% reported having had suicidal thoughts and 67% stated they knew of another first responder who thought about or died by suicide.

Mental health issues of EMS personnel during the COVID-19 pandemic were not isolated to North America. Benincasa et al. (2022) conducted a study in Italy to determine the level of first responder burnout and the associated levels of phobic anxiety, psychoticism, and depersonalization. In this study, depersonalization is referred to as a professional's avoidance and reluctance to attend to and treat patients, minimizing or denying need for care, and harboring negative affect. There were 228 participants and data were collected through two surveys. Findings revealed first responders experienced a high level of burnout, which was evaluated using the Maslach Burnout Inventory (MBI). The MBI tests for emotional exhaustion, depersonalization, and personal accomplishment (Maslach & Jackson, 1986, as cited in Benincasa et al., 2022). Benincasa et al. (2022) also found first responders suffered from anxiety, phobic anxiety, and somatization (psychological distress manifesting as physical symptoms).

In a cross-sectional retrospective study in Norway, Haiklo et al. (2021) studied how paramedic students responded to the pandemic and what their self-reported, health-related quality of life was after pandemic response and exposure to COVID-19. There were 109 paramedic students who participated in this study. Responses to survey questions were collected through an online survey five months after the onset of the pandemic. Due to unpredicted stress on the healthcare system, many students were asked to step outside of their student role and take on additional and unsupervised responsibilities such as tending to patients in ambulances. Although many students reported access barriers to PPE, none reported COVID-19 symptoms. More importantly, health-related quality of life scores were not statistically different from those with and without proper access to PPE. Further, the health-related quality of life for the students was significantly higher than a general population sample from 2019. More specifically, as compared to the general population, the students fared better regarding pain, discomfort, anxiety, and depression (Haiklo, 2021).

Dreher et al. (2021) conducted a cross-sectional study on the attitudes, stressors, and work outcomes for EMS workers in Germany pertaining to the pandemic. In this study, data were collected on 1,537 respondents who completed a 29-item questionnaire. The survey was posted to the German Association of Emergency Medical Services social media site April 9 to 16 and May 14 to 21, 2020. Logistic regression analysis found 15.3% of respondents screened positive for depressive symptoms while 16.1% screened positive for anxiety (Dreher et al., 2021). Further, Dreher et al. (2021) found most participants felt prepared for the pandemic although they

perceived their risk of infection was high compared to the general population and were uncertain how long the pandemic would last. Financial stress was found to be low. A potential limitation of this study is the use of an unvalidated, self-devised survey with unknown psychometric properties (Dreher et al., 2021). These findings would be more meaningful if pre-pandemic percentages were available for EMS workers who screened positive for depressive symptoms and anxiety.

In the Mohammadi et al. (2021) study conducted in Iran, prehospital emergency care personnel expressed the need for increasing psychological security and reducing occupational stress and burnout. Participants reported suffering from PTSD, emotional instability, loss of resilience, and fear. The research noted the need for leadership to provide counseling services or workshops for staff to improve psychological well-being. Without these services, participants reported having diminished occupational health (Mohammadi et al., 2021).

Readers should consider how generalizable and applicable the international research is to the situation in the United States. The need for access to adequate PPE appears to be relatable to the United States since approximately 800 EMS personnel in the United States died due to COVID-19 from the onset of the pandemic through early September 2021 (Office of Behavioral Safety Research, October 2021).

Discussion

The COVID-19 pandemic brought on many challenges for EMS personnel and first responders, affecting the emergency response environment and well-being of the responders. Although the effect COVID-19 has had on EMS personnel and first responders is a relatively new research topic due to the recency of the pandemic, it is nonetheless an important one. During the pandemic, increases in risky driving coincided with increases in severely injured patients as measured by POS scores and a higher percentage of serious crashes requiring more intensive care from first responders. Research on first responders indicates that, in some cases, first responders found that access to appropriate PPE to treat crash patients safely and properly was inadequate, and many reported that they were underprepared for providing emergency care during the pandemic. There was a serious negative impact on the mental health of first responders including reported depression, PTSD, the need for social distancing from friends and family, and anxiety per exposure. Understanding how first responder performance and, in turn, traffic crash outcomes are impacted is important for post-crash care.

In this literature review, we looked at COVID-19 stressors among EMS personnel and, while we did not find research directly linking those stressors with the outcomes of motor vehicle crash patients, we did find evidence that COVID-19 negatively affected the emergency response environment and first responder health, and taxed existing resources for first responders. This provides us with a better understanding of the EMS workforce, a vital component of the Safe System Approach, and the challenges it may face in future pandemics. Further research is needed to determine whether stressors among EMS personnel are associated with crash outcomes, or not, and to determine how characteristics of the crash environment, available resources, and the health of responders may affect crash outcomes. However, research suggests that increased frailty of EMS systems is associated with poorer patient outcomes in other settings (Mann, 2021; Li et al., 2019; Byrne et al., 2019).

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This research note and other general information on highway traffic safety may be found at: https://crashstats.nhtsa.dot.gov/#/