

The physiology of emergency response

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Goals:

- Understand the physiologic response to stressful situations including the sympathetic surge and parasympathetic backlash often encountered by EMS personnel.
- Understand the effect of stress, heart rate, and breathing on mental and physical performance, including memory, time perception, and decision making.
- Identify ways to better control our stress response including Stress Inoculation Training and methods to help control heart rate and decrease decision making time.
- Increase job satisfaction and application to future careers

The unique stress of EMS:

By the nature of the job, paramedics must remember crucial information or skills, focus their attention on the relevant information, solve problems rapidly and efficiently, and make high- consequence decisions under time pressure¹. Training and work experience cannot be used to predict the stress responses that individuals will have when confronted with stressors. Stress response is independent of your experience or time spent in a career^{1,2}. There is little to no training within EMS to deal with the stress of the job, and most training focuses more on long-term burnout. Almost one-third of ambulance staff show signs of burnout, PTSD, or other psychosomatic manifestations². Firefighters and EMS providers are known to be among the highest rates of suicide fatalities in the workplace, and report higher rates of suicidal ideation, plans, and attempts than both the general public and the military³. Symptoms of PTSD could be linked to a low sense of context, low sense of coherence, and/or previous stressful experiences². Ambulance staff, in comparison with other professions, seem to be at greater risk of profession- related illness, which may be due to poor management and/or lack of a supportive organization². The average professional life of emergency medical technicians worldwide is that of four years⁴. Decreased burnout rates is associated with decreased patient interaction. I.e. firefighter paramedics are less likely to show emotional exhaustion or depersonalization when compared to paramedics working only with patients⁴.

While the effects of chronic stress are well known to the public, most EMS personnel are not well informed about the short-term effects. Soldiers frequently lose bowel and bladder control during their first combat situation. Responders who survived the September 11, 2001, attacks on the World Trade Center reported numerous cases of uncontrolled loss of bowel and bladder control. In the same sense, medical students and EMTs frequently faint during their first anatomy response or blood, etc. Yet the movies and war stories never mention these events, and those who experience such events are frequently humiliated and suffer anxiety and apprehension. Treating long-term effects of stress should start by identifying ways to decrease the stress response and mitigate the short and long-term effects of EMS patient care on the provider.

Sympathetic & Parasympathetic Responses

The “fight or flight” response prepares our body for survival. Most organs receive both sympathetic and parasympathetic innervation, which work towards opposite means. Sympathetic responses usually expend reserve energy, increase heart rate, inhibit digestion to save blood flow for muscles, increase the secretion of epinephrine, dilate lung tissue and tense your muscles. Blood vessels in the abdominal organs and peripheral tissue constrict to shunt blood to the muscles and vital organs. Alternately, the parasympathetic system prepares your body for rest; increases blood flow to digestive organs and allows for storing of energy. These systems run in balance, and eventually, the parasympathetic will take over after exhaustion of the sympathetic system. The General Adaptation Syndrome (GAS) has long been used to explain the reaction to stress. GAS contains three phases; an alarm phase where the stressor or threat is identified, the resistance phase in which the person attempts to react to the stressor, and the exhaustion phase when resources are depleted and the body is unable to maintain normal function⁵.

In addition to the sympathetic nervous response, the Hypothalamic-Pituitary-Adrenal axis (HPA axis) is activated during stress responses^{6,7}. This is a complicated system of hormones which regulates the immune system, mood, emotions, and energy storage and expenditure. The overall function of the HPA axis during an acute stress response is to produce stress hormones; corticosteroids such as cortisol, which results in increased glucose production and suppression of the immune system.

Parasympathetic Backlash: After an intensely stressful situation, there comes a backlash of parasympathetic response. A Korean War unit overtook a hill position during an early morning attack. The soldiers setup positions for a counterattack, and although the troops had slept well the night before, the NOCs had to go around to each of the positions and wake up soldiers, despite the fear of returning attackers⁸. This parasympathetic backlash can also take another form for EMS and police. After a day of continuous or multiple stressful responses, we go home with a parasympathetic backlash, becoming tired, detached, and apathetic.

“The moment of greatest vulnerability is the instant immediately after victory” –Napoleon

Adrenaline Dump: Alternatively, officers involved in shootings, paramedics involved in running a code, or those involved in car crashes have difficulty go to sleep, have tremors, and other symptoms of increased stress hormones and adrenaline. This is due to an adrenaline dump that is not fully utilized. When an altercation or stress response causes an adrenaline dump, yet you do not utilize it, you are left with a prolonged sympathetic response⁸.

- **Loss of mission momentum**
- **Shift of momentum following stressful event (intubation, full arrest, IO placement)**
- **Inability to move onto the next step (BVM after intubation)**
- **Shaking; unable to place IV**
- **Unable to focus**
- **Potentially unable to make decisions**

Burning off an Adrenaline Dump: Loss of mission momentum or shift momentum immediately following a full arrest, an intubation or other stressful event people frequently have a moment where we forget to continue to the next step. i.e. squeezing the bag after KING airway placement. It's important to reassess the situation and 'visually sweep' the area for threats, reassess the patient. These moments may leave us shaking, unable to sleep, unable to focus on new tasks, and potentially unable to make decisions.

The Effects of Acute Stress

High stress situations, such as responding to a call, results in a sympathetic surge². In addition to the sympathetic fight/flight response, the HPA axis is activated⁷. This results in increased cortisol release from the adrenal glands, influencing areas of the brain involved in cognition⁵. High-stress situations during EMS response result in decreased performance and memory failures⁹. Paramedics are more likely to incorrectly reconstruct events, and remember things that did not actually occur, during a stressful call¹⁰. Studies show that EMS personnel have increased heart rates and stress hormone levels during their entire shift, peaking during 'high stress events' such as being dispatched, arriving on-scene, and transferring care². Even when sleeping on shift, EMS providers have a higher resting heart rate. Calls involving children are known to increase this level of stress even further. Patient care is known to be effected negatively by this stress^{1,10}.

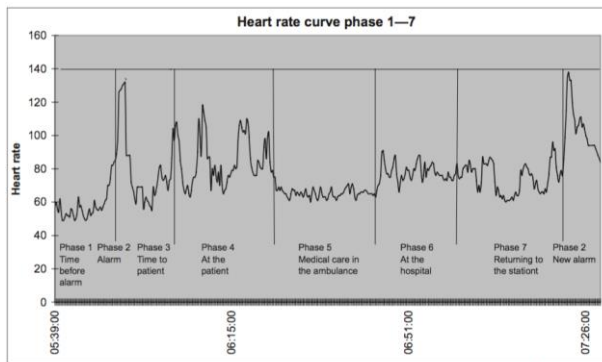


Figure 1—Heart rate during alarm phase 1-7 concerning all alarms, children alarms and other alarms. Comparison between alarms concerning children and other alarms. The difference phases are marked for clarity with vertical lines to show the start of each phase.

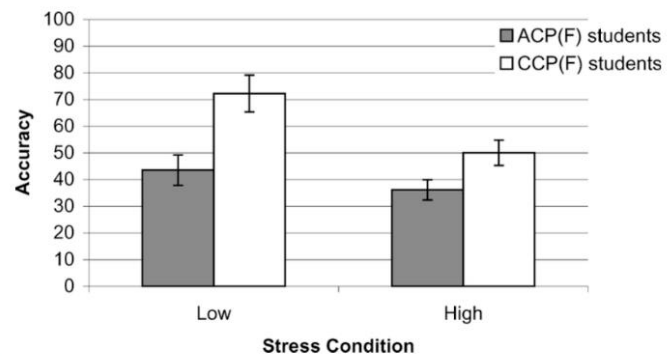


FIGURE 2. Accuracy scores on the drug dosage problems, as a function of training and stress manipulation. ACP(F) = Advanced Care Flight Paramedic; CCP(F) = Critical Care Flight Paramedic.

Impact on patient care

Acute stress response is known to negatively impact patient care, both in the prehospital and hospital setting⁵. This is due to perceptual distortions and a decline in cognitive abilities, resulting in loss of scene control, inappropriate or delayed patient care, and loss of mission momentum.

Perceptual distortions refer to the change in how we interpret our surroundings, and can include tunnel vision, auditory exclusion, memory loss or creation, and changes in time perception. Tunnel vision, auditory exclusion, and other decreases in perception of what is occurring around us is collectively referred to as selective attention⁵. Selective attention is a relatively common phenomenon resulting in failure to perceive your surrounds, including

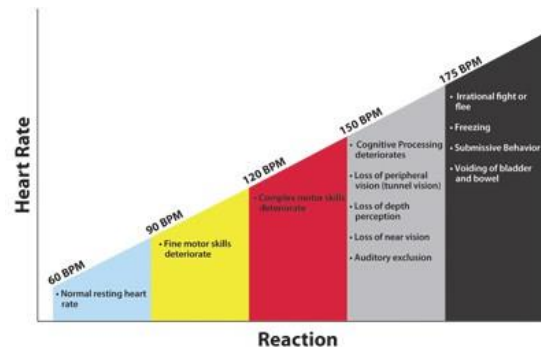
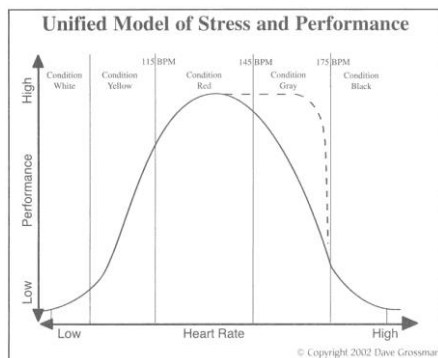
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potential threats. Auditory exclusion is frequently reported by police who state they never hear their gun fire during a shooting incident⁸. For EMS, this may include not hearing the radio or failure to respond to orders. Time perception is a very common distortion; squeezing a BVM too often while stressed due to time distortion causes hyperventilation.

Stress can cause both memory loss and creation of false memories. During acute stress responses causing SNS and cortisol production, working memory and memory consolidation are both impaired. Working memory allows you to utilize and synthesize information, such as solving a problem using available information^{5,11}. Decreased working memory causes delayed problem solving and inability to keep track of information being collected¹¹. Memory consolidation is the process of forming permanent memories from ongoing experiences. High levels of hypothalamic-pituitary-adrenal axis activation impairs memory consolidation⁵. Retrieval of memories, including memorized data such as drug dosing, is also known to be impaired. Paramedics undergoing stressful scenarios are known to make more mistakes with drug dosing and calculations¹. Due to the impact of stress, charting completed after a call may have inaccuracies and record procedures or medication administration that never occurred. Initial findings and vitals at transfer of care may be incorrect. Specifically, events or procedures which never happened, may be reported to the nursing staff¹⁰.

Unified Model of Stress

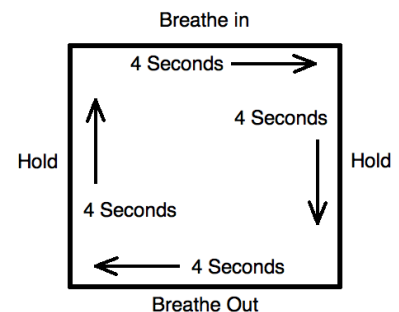
All of the negative side effects of stress results in poor performance and patient care. The Unified Model of Stress and Performance is one way to visualize how stress-induced heart rate changes directly effects our performance⁸. Heart rate is used as a guide to determine what effects we may have under a certain amount of stress. Utilizing this model, we can learn to control our heart rate to help control the negative effects of stress. Different jobs or tasks may require different levels of heart rate or stress control. A SWAT team will breakdown a door with a heart rate in Red, where complex motor skills begin to deteriorate⁸. To combat this, they train until common tasks, such as handcuffing and reloading, are muscle memory and no longer require thought. Many emergency physicians have trained to the point that complex procedures, such as placing a central venous catheter or intubation, becomes second nature. If we are not able to control our stress response, it becomes difficult to place IVs, remember protocols, or even make transport decisions or document correctly. In the same way, belligerence may become a manifestation of an acute stress response moving into the gray and black zones.



Tactical Breathing

In the acute setting, both before responding to a call and during a call, you can alter your heart rate utilizing a method taught during military training, called Tactical Breathing. This is a method where you breathe slowly over a set amount of time to decrease heart rate and increase focus. Physiologically, a deep inspiration increases the stretch on baroreceptors in the lung, which feeds back to decrease the heart rate via decreased sympathetic stimulation, while slow exhaling increases the vagal parasympathetic stimulation¹². This also results in a systemic decrease in sympathetic “fight or flight” response, and allows you to return focus to the task at hand. Additionally, the simple feeling of control over your heart rate may provide some anecdotal increase in situational awareness and confidence.

- Breathe in through your nose filling up your belly for 4 seconds
- Hold for 4 seconds
- Exhale through your mouth for 4 seconds
- Hold for 4 seconds
- Repeat x 4



A 2016 research article utilizing tactical breathing during intubation found that, although the mean intubation times between the groups were not significantly different, the overall success rate of intubation in the simulated stressful situation with tactical breathing was 100%, with the majority of participants agreeing that tactical breathing improved their success rate¹³.

Consolidation and Reorganization

After a mission or goal is completed, you are vulnerable to miss-steps as your stress response is decreasing and we are more relaxed. After securing an objective, it is important to automatically re-organize yourself and return to the goal/patient. Immediately after completing a task, you may waste a large amount of time determining what you should do next, or even start performing tasks which do not need to be performed. Once completing a high-stress task immediately re-evaluate your patient and situation. After intubation, return to your ABCs and determine the next most important task. After placing a traction splint, return to your ABCs and determine the next step. Consistently re-evaluating your situation will allow you to provide the most efficient patient care while maintaining situational awareness⁸.

Stress Inoculation Training

Stress inoculation training, also called Resilience training, helps mitigate stress during and after an event by increasing the preparation and skill sets of participants. Stress Inoculation Training typically places participants in a simulated emergency that allows participants to perform procedures and patient care as if in a real response. During SIT, individuals encounter situations similar to future real experiences, allowing the participant to become familiar with potentially high-stress situations. Data shows that the appraisal of a situation plays an

important role in the stress response; if the demands of a situation are perceived to outweigh the resources of the individual, then there is a higher stress response¹⁴. In future real-life events, SIT can increase the participant's perception of the event as under control, which in turn reduces the deleterious effects of the resulting stress. In this way, SIT goes beyond just skills practice and is providing unconscious stress response control. When exposed to hypothetical situations, people are more likely to analyze more effectively and experience lower levels of physiologic arousal in future stressful situations¹⁵.

Training utilizing SIT is not just about being in a simulation lab. The training itself must place the participant in a mental state similar to real-life situations. The National Association of EMS Educators notes several short comings in current EMS simulation programs¹⁶. One major concern is that most programs do not provide realistic training experiences. Recommend creating simulations in realistic, dynamic field settings that provides a more psychologically realistic training situation. Additionally, many faculty or educators are not fully trained to provide simulation training, such as a fellowship-trained simulation physician.

The Office of Naval Research is currently trialing a software-based SIT program, which utilizes a game-based framework to help participants identify stress effects and utilize biofeedback to decrease heart rate variability and perceived stress.

- **Use simulation in realistic settings**
- **Provide educated faculty to provide simulations**
- **Make simulation part of core-curriculum, not add-ons or annual events.**

Hicks' Law

The time it takes to make a decision is a result of the number of possible choices available. I.E. the more choices you have, the exponentially longer time it will take to decide. By providing yourself with just a few choices, you will decide faster. One example is decreasing the options for Rapid Sequence Intubation (RSI) drugs. Inside the hospital we have many drugs that we use to intubate and sedate patients, however in many EMS systems, there is one option to provide RSI, which limits the options, but decreases the on-scene time and decreases the time to intubation. In recent research, color coded syringes helped decrease time to medication administration and significantly reduced critical dosing errors by paramedics during simulated prehospital pediatric resuscitations¹⁷.

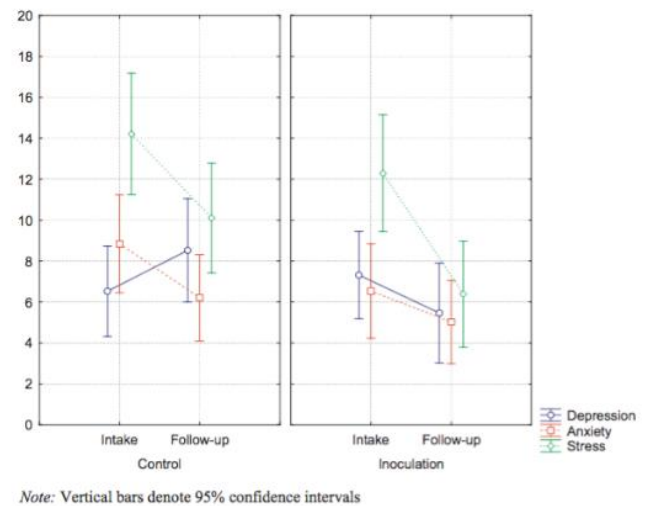
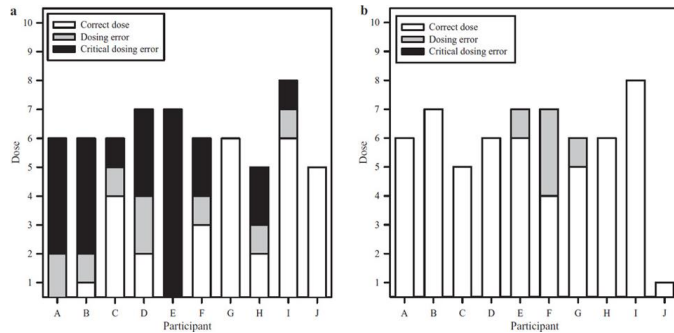


Fig. 1. DASS21 scores over time between the two conditions.



Conclusions

The stressful nature of EMS places workers at increased risk for increased stress response, burnout, and PTSD. EMS personnel are known to suffer higher rates of suicidal thoughts and successful suicide attempts than the general public and military. Despite this, the current EMS training curriculum has little to no training on the acute management of stress. Acutely stressful events can severely inhibit an individual's response to a situation, including trouble with decision making, memory formation, and poor patient care. By understanding and manipulating our stress response we can control our acute response, provide better patient care, and potential decrease the future risk of burnout and PTSD.

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