AUSTERE, REMOTE AND DISASTER MEDICINE-KEEPING EVERYBODY SAFE

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ABSTRACT

Medical care in resource-limited environments ("austere" settings) can occur in the context of a disaster, wilderness, or a tactical field operation. Regardless of the type of environment, there are common organizational themes in most successful humanitarian missions that occur in harsh environmental conditions, be they natural, or man-made. These principles prioritize the initiation and execution of any given deployment in austere or remote settings, diverging from priorities that would occur in a situation where the medical structure is intact and operating well. Attention to these priorities not only helps providers with delivering medical care to the needy during a period of resource limitations, they also can keep a provider, teams, the public, and a patient safe during, and after a deployment.

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INTRODUCTION

Recent world catastrophic events and humanitarian crises have called for more assistance from relief workers than ever before. Physicians and other health care workers desire to answer the call more than ever, due to a sense of social responsibility, commitment to service, and increased educational offerings in humanitarian health [1]. However, some participants may not comprehend the difficulties inherent in working in austere environments. "Austere medicine" is often used in the context of operational medicine, associated with combat, hazardous or tactical operations [2]. Austere medicine also encompasses resource-limited settings, where advanced hospital technology is not readily available, be it in a health care clinic in an underdeveloped region **(Figure 1)**, in an air ambulance setting, during a wilderness expedition or wilderness rescue situation, during an in-flight or space mission emergency, or in a disaster


Figure 1: Healthcare clinic in an underdeveloped setting

Figure 2: Simulation training in stressful environment

situation [3-6]. In the latter instance, many well-developed pre-existing disaster response organizations throughout the world, might assume that critically ill patients will be managed in fixed facilities, as most disaster preparedness focuses on rescue, stabilization, and transport. This assumption becomes challenged when hospitals become overwhelmed with casualties, or cannot function due to downed power grids, in areas where sophisticated medical services do not exist, or in areas where epidemic or terroristic events overwhelms the health care and public safety sectors [6;7]. Disasters are not simply defined by the casualty numbers, but rather by the event, and the venue [8].

Natural events, such as earthquakes, extreme heat, floods, hurricanes, landslides, tornadoes, tsunamis, volcanoes, wildfires, or winter weather can cause, or worsen disasters [9]. Knowledge of environmental factors, and an appreciation of personal preparedness, has long been a priority in search and rescue operations since the formation of the United States Mountain Rescue Association (MRA) in 1959 [10], and is now beginning to be emphasized among disaster medical team training with the Department of Health and Human Services online courses [11]. The material emphasizes an organized response for mass casualties and pandemics along with nuclear, biological, chemical, and radiological catastrophes. Although the MRA is not typically involved in major disasters, there seems to be a common organizational theme within most wilderness rescues, tactical operations, and disaster responses that occurs during an "austere" mission.

COMMON ORGANIZATIONAL THEMES IN AUSTERE MEDICINE

The initial task of performing medical care in an austere setting can be daunting to a medical professional lacking previous experience, or who may have expertise in one of the above disciplines without having had experience in other aspects. The authors, experienced in all the above-mentioned disciplines in austere medicine, have empirically observed that many successful austere medical deployments share seven common themes, regardless of the situation, which can give a provider a simple framework regarding proper mission initiation and execution. Many of the initial phases are pre-hospital oriented, but apply to almost any resource-limited clinical or hospital environment worldwide. These phases follow a "7 P'S" mnemonic, initially derived from the "4 P'S" of rescue priorities by David Johnson MD, president and medical director of the Wilderness Medical Associates (personal communication, March 10, 2004). This expanded mnemonic, adapted by the authors, includes preparation, plans (for deployment), personal safety, partner or group safety, public safety, patient rescue (or treatment), prognosis of the patient or mission, and situational awareness at all times. These seven phases were presented to an emergency medicine rescue consensus group at the First Global Network of Emergency Medicine-Dubai, in January, 2012, and was felt to be a valid summary of the planning and execution phases of an austere medical mission. Those involved in the consensus were 50 emergency physicians from the United States, France, Italy, the Netherlands, Turkey, Lebanon, The United Arab Emirates, Saudi Arabia, and Pakistan, who are regularly engaged in disaster medicine, combat and tactical medicine, or wilderness medicine and mountain rescue.

FIRST P – PREPARATION

This phase consists of frequent training in a simulated environment similar to the anticipated stressful environment where care will be delivered **(Figure 2)**. In periods of stress **(Figure 3)**, elevated glucocorticoid levels act on excitatory amino acids, causing hippocampal atrophy and short-term memory loss; in combat veterans, hippocampal volume reduction correlates with verbal memory deficits [12;13]. The mental effects of the stress response appear to stimulate the amygdala, promoting the fear response [13] which might result in operator inaction or error. Helton suggests that cognitive disruption and inattention appears after a large earthquake, even when subjects were controlled for earthquake-induced anxiety, depression, gender, and sleep amount [14]. In mass casualty events, rescue personnel can be overwhelmed by immense destruction and casualty numbers, exhibited by dissociative emotional states and post-traumatic stress disorder [15]. Combat related stress inhibits performance,

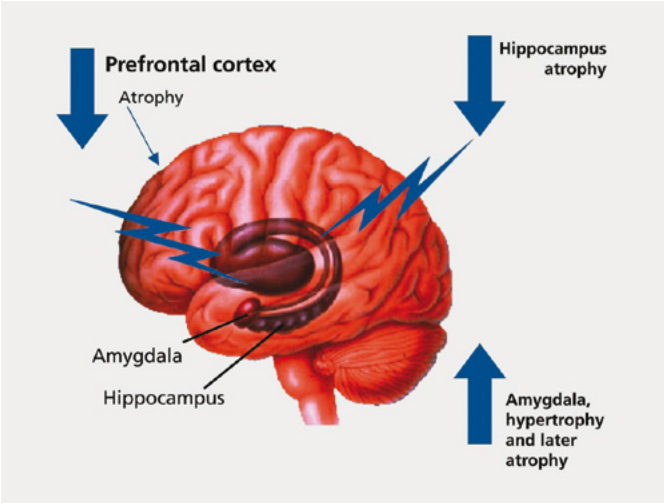

Figure 3: The brain under stress: structural remodeling

vigilance, planning, situational awareness, judgment, and ideal decision making [16].The degree of this impairment during a military training exercise in highly motivated, elite soldiers undergoing sleep deprivation and continuous physical activity in the heat, as well as caloric restriction found a 20% prolongation in reaction time in the subjects, exceeding the effects of a 0.10% blood alcohol level [13]. Furthermore, the prefrontal cortex seems to play a role in task organization and completion, which is compromised by fatigue. Continuous fatigue then results in disorganization and persistent erroneous behaviors (which may be fatal) [13]. These cognitive disruptions could be deleterious to a mission, and are linked to later post-traumatic stress disorder [12-16]. Educators cite the need to train medical personnel to manage stress, and reduce treatment errors [17]. Incremental exposure to simulated stress in an educational setting best prepares an individual for stressful situations, improving coping skills [13;18]. This exposure, termed stress inoculation, is promoted through role-playing, imagery, and graded stress exposure [18]. A meta-analysis demonstrated that desensitization reduces performance anxiety and physiological anxiety, and can improve task performance, especially for repeated sessions [19;20]. Simulated laboratory experiences can be equivalent to a field experience, especially with virtual reality training [13;16-18]. Nevertheless, most studies fail to quantify these improvements, or are limited methodologically. A small study of physician residents in a simulated emergency department trauma room showed significant improvement in team leadership skills and confidence in managing simulated patients [19].

Likewise, organizations involved in austere missions regularly train in the anticipated environmental condition, be it quarterly, monthly, or weekly [20], with drills, simulated rescues, and patient simulations **(Figure 4)**. This training appears to improve teamwork and skill levels, when given under clear, concise and precise training standards for that particular discipline [20].

Additionally, maintaining good physical conditioning to carry out the job is stressed in many of these organizations [10;11;22]. Proper physiological acclimation to the anticipated climactic condition is emphasized in many programs [23], some carried out to physical exhaustion [25]. Logistical training appears to also be of value, including the use of leadership, incident command, communication, triage and resource allocation, procurement of food, water and housing for rescuers, and transport, is also valuable in training a team [11]. We therefore believe that proper physical, mental, and leadership training under graded stress is essential for future mission success.

SECOND P – PLANS (FOR DEPLOYMENT)

Thoughtful planning for a deployment is essential. Participant availability should be known ahead of time. Understanding the geography and existing infrastructure of a region where an event occurred, a building where a hostage situation may be unfolding, or an familiarization of mountain topography for a high angle rescue influences mobilization plans. International deployments based on first world logistics may not apply when caring for casualties in resource-constrained settings [26]. Anticipating public health needs after an event is necessary in large casualty events [27], and ideally, with a pre-planned collaboration with the receiving institution [28]. This may involve participating in efforts to improve institutional surge capacity [29], or for planning transfer of patients to a pre-hospital transport provider, where coordinating transfers to the appropriate facility should be designed into limit overwhelming a receiving institution [30]. Having an alternate plan is vital if unanticipated problems occur [31]. In remote conditions with limited organized infrastructure, tactical medicine principles can help mission planning and execution succeed [32].

THIRD P – PERSONAL PROTECTION

Traditional medicine teaches that patient needs are the priority. In austere or hostile environments, this thinking must be challenged, since a jeopardized health care provider can endanger a patient. The provider should be in optimal condition for the task at hand;

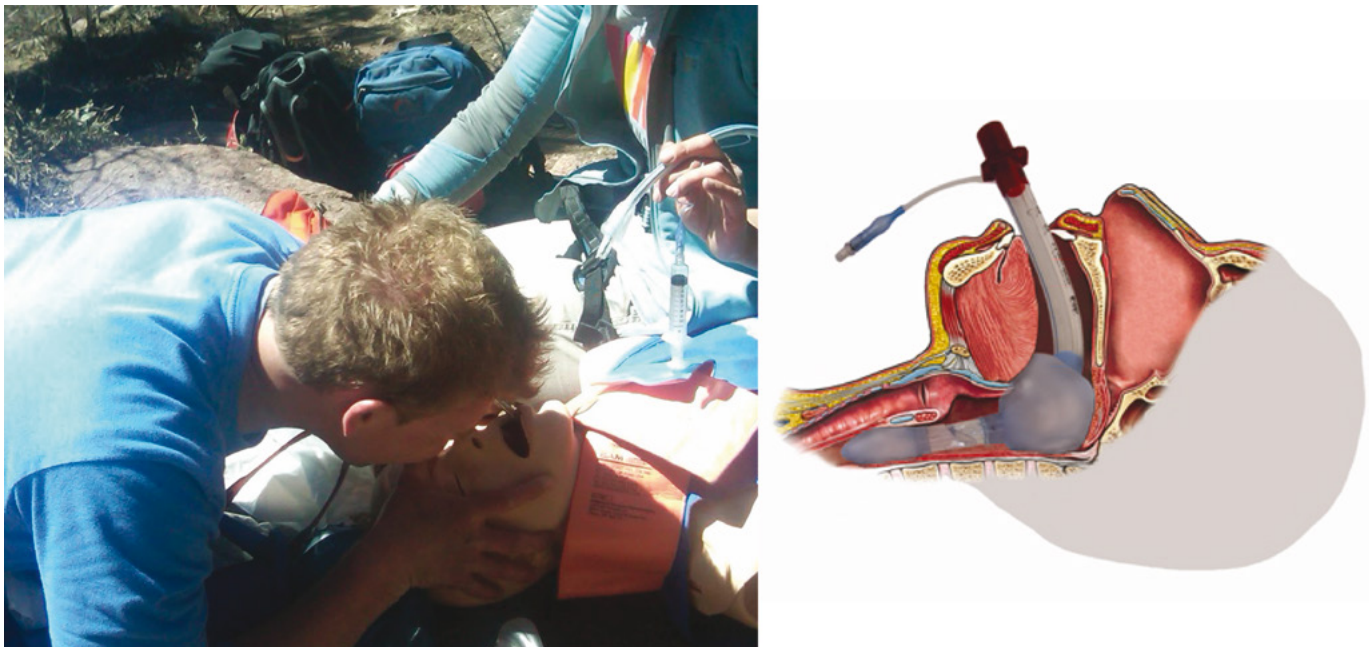

Figure 4: Simulation training on airway management

the individual should have undergone proper physical and mental training, and should have the proper technical expertise (such as proficiency in rope rescue **(Figure 5)**, wilderness travel, survival skills, and navigation, in order to get to the patient), if applicable. Personal physical and emotional limitations should be addressed and controlled before participation in a relief effort, and medications appropriate for the environment (such as vaccinations or anti-infective medication) should have been addressed. Inadequate personal preparation, though infrequently publicized, can result in the provider becoming a patient, competing for resources, and potentially endangering the team. According to one observer deployed to Haiti immediately after the 2010 earthquake, a medical team deployed was all too eager to deliver medical care; a key figure on the rescue team soon became ill thereafter, consuming time and resources intended for the injured (personal communication with Zachary Child, MD, March 2, 2010). A provider must therefore ensure his or her own personal safety with proper precautions, and proper safety equipment for the environment; rescue operation accidents are replete of ill-prepared rescuers over-enthusiastic to arrive at a scene [32]. Personal protection may also incur the need for additional security personnel or self-defense devices, in order to prevent injury [33].

FOURTH P – PARTNER PROTECTION

Partner, or scene safety can be established once personal matters are arranged. Ignoring partner safety can also have catastrophic consequences, usually from inadequate preparation or miscommunication [34;35]. Thus, team members should adhere the mission's goals, and to follow a well-planned rescue under established leadership (under an incident commander or recognized chain of command). Ideally, partners should have involvement in deployment decisions with other partners or commanders, since participants are potentially incurring risk. Such procedures may not be possible in a tactical or military application, yet in tactical medicine and certain high-risk disaster situations, providing rescuer security in a danger zone cannot be overstated [33]. Many disparate groups participating in the 2010 Haiti deployments attempted to deliver medical aid without proper leadership, or partnership accountability. Many of these were poorly organized but well-intentioned small NGO's. The author (DM) observed such events transpire in Port-au-Prince, when certain aid workers outside of our disaster medical group became lost, ill, or assaulted; these events were potentially preventable, had group accountability been maintained.

FIFTH P – PUBLIC PROTECTION

Well-intended rescues could still endanger public safety, either from public lack of awareness of a rescue situation, or being involved as curious bystanders or simply "wanting to help" with relief efforts. Rescue operators, such as ambulances, have been occasionally implicated as the cause of significant automobile crashes [36]. Thus, proper rescue control and crowd control can mitigate additional casualties, and facilitate (rather than impede) relief operations [37].

SIXTH P – PATIENT CARE AND PROTECTION

After the above sequences are fulfilled, patient triage, rescue, and initial stabilization can occur. Many of the methodologies of triage (such as the START methodology) and of stabilization (implementing models such as to Basic or Advanced Cardiac or Trauma Life Support versus Tactical and Combat Casualty Care) will not be discussed here. As previously discussed, classical disaster planning assumes that once patients are triaged and resuscitated, there should be ample medical resources thereafter, provided that evacuation can take place [6;7]. In austere environments, prolonged contact with the patient, without the benefit of a "disposition", is the rule, taking place for hours, days, or weeks. Expertise in acute emergency and on-going critical care is necessary, commensurate with the skill level of the provider. Ancillary medical tools depend on the nature of the mission; in austere environments, practitioners must often improvise because of limitations of transporting equipment reserved for hospital use, be it from the limitations of powering up machines, equipment size, or due to adverse environmental conditions [6] **(Figure 6)**. Familiarity with diagnostic adjuncts, such as point-of-care laboratory testing devices or portable ultrasound, has been used to facilitate patient care decisions and

Figure 5: Rope rescue training

Figure 6: Poor handling of patient in austere environment

evacuation plans [6;38;39]. Ensure that a patient is adequately protected from the elements, from further injury and illness, or from security threats, during a mission.

SEVENTH P – PROGNOSIS

The degree of patient care in a harsh environment holds import, depending on patient condition, the provider's training level, the wellbeing of the provider or providers, and environmental circumstances. Though advanced life support can be carried out in such conditions [40]; advanced life support may not alter mortality in selected wilderness settings [41]. Guidelines for a particular search and rescue group, disaster medicine team, or operational medical unit vary, and should be consulted for direction. Executing a plan to extract a viable patient from ta scene should be done expeditiously, for the sake of patients, rescuers, and the limited resources. Aircraft or boats can facilitate evacuation when roads do not exist. Rescuers should have a means of communication with the evacuation service, and establish an easily located and safe rendezvous point, away from objective dangers or crowds; ground crews should ensure a safe landing zone and patient transfer. Ground crews must have good navigation skills, and must adequately understand technical map reading and coordinates, in order to direct an evacuation crew to an appropriate meeting point. Communication with the receiving facility, either by a pre-planned agreement, or via live communication, is also essential.

S – SITUATIONAL AWARENESS

Situational awareness is an understanding what is going on around you [42]. The information gathered may be related to using human sensory data to assess danger (with rescuers observing the potential for avalanche, landslide, rockfall, floods or earthquake aftershocks, for example), information gathered previously, or from computerized surveillance networks (hospital patient alert networks, surge capacity networks, the CDC Health Alert Network, or other similar sources [42]. A mission, rescue, or evacuation must be alert for any environmental or man-made changes that could endanger patient or crew. During emergencies, the tendency is to focus on the immediate needs, often at the expense of ignoring peripheral circumstances. In mountain and similar environments, the lack of situational awareness has resulted in helicopter crashes. One investigator found that nearly 1 in 3 EMS/search and rescue helicopter accidents occur due to bad weather and/or poor visibility [34]. The ill-fated "606" search and rescue mission outside of Santa Fe, New Mexico highlighted poor visibility during inclement weather with a large risk-to-benefit threat, in which a police helicopter pilot initiated a search for a lost, uninjured hiker; the mission ended in preventable fatalities [35;43]. Complex operations such as helicopter EMS has a significant requirement for situational awareness in the name of expedient patient care, and should not be called upon lightly for a rescue.

The data for rescue accidents conclusively demonstrates that our greatest risk for failure is the failure of the human element [35;44], which are factors that unfavorably lead to operator error performing poor risk analysis (taking "chances"), perhaps resulting in fatalities [44]. There are several documented cases of these erroneous calculations in the context of "rescue fever;" a rescuer ignores simple safeguards, or ignores external environmental cues in order to not deviate from a given task, only to end in tragedy. Emotions, fatigue, obligations, and poor training are among the underlying circumstances that minimize good risk assessment and situational awareness.

Dangerous external situations are also well known in disasters. A news report detailed some of the urban threats in the aftermath of Hurricane Katrina, with New Orleans experiencing man-made threats as a result of the catastrophe, and possibly from the initial rescue efforts. Attempted shootings and rape were reported, as relief efforts ensued to free residents entrapped by floodwaters, corpses, and human waste. Charity Hospital, in an attempt to evacuate patients, was forced to halt efforts after coming under sniper fire [45].

Civil chaos is possible during or after a disaster; thus, situational awareness and risk assessments must be anticipated commensurate with actual conditions during humanitarian aid. Other potential threats, which may be obvious in calm situations, might evade notice during chaos. In the aftermath of the 2001 New York terrorist attacks, many health care providers were sent to Ground Zero without taking precautions for possible involvement of nuclear, biologic, or chemical weapons, or even for the toxic byproducts of combustion [46]. After the SARS outbreak of 2003, a high percentage of the patients were health care workers, illustrating how insufficient infection control practices can be lethal [47].

Employing good situational awareness and risk assessment appears to involve three stages [48]. Observing actual conditions (information gathering) is first, where attentiveness to type and frequency of situations are noted. Continuous vigilance, boredom, or fatigue can threaten awareness must be recognized during this stage. During the second stage, previous training and experience are implemented to interpret a potential threat. The final stage of situational awareness is anticipatory in nature, projecting how the information already gained could affect rescue efforts in the near future. Hypotheses are formed and reformed as the situation changes, often in a "worse case" scenario [48]. Proper action must occur at any time, and continuous reassessment of circumstances is a priority. In reality, situational awareness is not simply the last step after the seventh P: situational awareness occurs from the beginning to the end of a deployment. Good leadership will ensure that such awareness occurs every step of the way.

CONCLUSIONS

Participation in an austere mission is complex, and success is predicated on the ability to safely confront inherent challenges in a resource-limited environment. Although the mnemonic "7 P'S" described may not completely describe the steps necessary to undertake all humanitarian missions, hopefully the "7 P'S" will permit a better understanding of the basic steps necessary to undertake a deployment in a wilderness, tactical, disaster, or other resource-limited setting, while appreciating the need for rescuer and patient safety measures. A future prospective study is warranted in order to validate this suggested framework.

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