Spinal Cord Injury Management within the Military Healthcare System (MHS)

Purpose:

The purpose of this document is to help clarify to a civilian audience the realities of treating and managing spinal cord injury (SCI) while deployed. Many civilian researchers are unfamiliar with the realities our Service Members face, either as patients or practitioners. Having a document that outlines how medical support is organized, what resources are available at each level of care, and where to access MHS clinical practice guidelines and standard operating procedures (SOPs) may help increase the relevance to military health for applications to Spinal Cord Injury Research Program (SCIRP) funding opportunities. Furthermore, a better understanding of the current needs, priorities, and landscape of care within the MHS as they relate to SCI may help applicants tailor their research with those needs in mind, potentially facilitating SCIRP-funded research transition to other Defense Health Agency/Defense Health Program-supported opportunities or utilization by the MHS.

Future Combat Assumptions:

Current wartime operations assume that the United States and our allies will maintain air, land, maritime, space, and cyber superiority, which has highly supported advanced medical care and transport in combat. However, these advantages held by the U.S. are expected to be highly challenged or compromised in future conflicts against peer and near-peer adversaries.[*,†]

Future combat will require an alternate strategy for casualty management that is more independent, and not as reliant on land and air evacuation, cyber communication, and centralized control. Deployment of current technologies for treatment of SCI in the future battlespace will result in poor prognosis for casualties. To maintain casualty care, SCI treatment must be modernized, with operational constraints in mind. The following are assumptions of what the future battlespace may look like and how that could impact SCI care:

- Temporary loss of air support could significantly delay evacuation times up to 72 hours (h), requiring casualties to be maintained in the field. Currently fielded technologies are not capable of objectively diagnosing, monitoring, treating, or maintaining SCI casualties.
- Changes in cyber capabilities and critical infrastructure have the potential to lead to disruption of communication, which will reduce the ability of forces to request and/or receive medical re-supply. Further, current and future telemedicine solutions for SCI management in the field may be unavailable, highlighting the need for medical technologies that can expand the typical skills of the combat medic and other far-forward medical personnel.
- Technology advancements may create a more lethal battlefield, resulting in increased injury severities compared to recent conflicts. Severe SCI with polytrauma, such as fractures, hemorrhage, shock, and traumatic brain injury (TBI) will complicate SCI

[*] The U.S. Army in Multi-Domain Operations 2028
[†] A Design for Maintaining Maritime Superiority

casualty care. Development of technologies to stop progression of secondary SCI and reversing primary damage while promoting healing of peripheral damage will be crucial.

- Increased battlefield lethality could result in higher casualty volumes. Multiple casualties per medic are expected, increasing the need for simple, self- or buddy-administered treatments. Introduction of small, portable, automated, closed-loop SCI maintenance technologies has the potential to reduce the medical burden when treating multiple casualties during combat and prolonged field situations.

Future medical capabilities must be highly mobile to enable medical intervention in the future battlespace, and temporary treatment facilities must be lightweight and agile. Further, treatment facilities may be positioned further distances from the engagement areas, increasing the time required to reach and care for casualties. Technologies that can push higher Role of Care (ROLE) treatments (see table below) further forward will improve casualty care in future combat operations. Prevention tools and preparation techniques may help to minimize casualty volume or improve biomedical/psychosocial outcomes after trauma. Diagnosis, treatment, monitoring, and maintenance of SCI casualties in the acute setting can significantly improve long-term functional outcomes and reduce injury severity. Development of diagnosis and treatment interventions to reduce injury severity and improve casualty maintenance employable at point of injury or over the course of the subsequent 3 days following injury at a Battalion Aid Station (BAS, ROLE 1) or Forward Resuscitative and Surgical Detachment (FRSD, ROLE 2) (see table below) will facilitate reductions in permanent spinal cord damage, better Warfighter care, and improved return-to-duty times. Current technologies will not suffice in the future battlespace.

Current Levels of Care Within the MHS:

Health support capabilities that encompass health service support and force health protection are employed during all military operations. These capabilities span the operational area from Point of Injury/illness to definitive care, with an overall goal of treating all potentially survivable injuries. The U.S. military trauma system and care continuum is currently organized into four "roles" or "echelons" of care, with increasing capabilities within each higher role number. Key elements regarding the care capabilities, available medical assets, and environmental factors associated with each role of care are described in the table below:

Echelon/Role of Care		Estimated Length of Stay	Available Provider of Care	Typical Physical Environment	Types of Care Provided
ROLE 1	POI (Point of Injury)	Up to 72h, depending on EVAC capability.	Self; buddy; combat lifesaver (non-medical team member trained in enhanced first-aid); combat medic or corpsman trained in tactical combat casualty care (TCCC).	Combat environment. Both austere/ remote or dense urban environments (DUE)‡ provide unique challenges.	First aid and immediate lifesaving measures, including massive hemorrhage; managing airway, respiration, and circulation and preventing or treating hypothermia and shock; protecting wounds; immobilizing fractures; and other emergency measures, as indicated.
ROLE 1	Emergency first responder and TCCC (i.e., BAS).	Up to 72h, depending on EVAC capability.	Up to physician, physician assistant (PA), or equivalent, supported by medics.	100% mobile. Not much electricity, little/no refrigeration, dusty/damp (not isolated from the ambient environment); very limited footprint. No patient holding capability.	Triage, treatment, evaluation. No surgical capacity.
ROLE 2	Forward Resuscitative Care (i.e., Medical Company, FRSD, Fleet Surgical Team, Medical Battalion, Expeditionary Medical Support).	Up to 72h, depending on EVAC capability.	Physicians, surgeons, PAs, and registered nurses (RNs) supported by independent duty corpsmen and medics.	100% mobile. Limited inpatient bed space.	Basic primary care and further triage, treatment, and evaluation of combat casualties. Has capability to deliver packed red blood cells, limited X-ray, clinical lab, dental support, stress control, preventive medicine. Has surgical capabilities (damage control surgery) when augmented by additional surgical teams, but generally does not have neurosurgical capabilities.

‡**Austere/Remote Environment:** Environments where access to clean water, electricity, and to a fixed or mobile medical facility is significantly degraded or denied and where diagnostic and treatment resources and medical personnel are unavailable or limited for extended periods of time. **DUE:** Unique battle conditions that include: High population density, channelization of forces, dispersed forces, high number of casualties, severely degraded communications, rubble, congestion, high-rise buildings and sub-terrain, high voltage lines, fires, debris, inhalation hazards, urban canyons, and confined spaces.

Echelon/Role of Care		Estimated Length of Stay	Available Provider of Care	Typical Physical Environment	Types of Care Provided
ROLE 3	Theater Hospitalization (i.e., Field Hospital [FH], Hospital Ship, Expeditionary Medical Facility).	2-4 weeks	MDs, PAs, CRNAs, CRNPs,[§] RNs supported by medics. Neurosurgeon and neurointensivist *may be* available if an FH is augmented by a head & neck/neuro team.	Scalable configurations up to 176-bed. Includes other Service's theater hospitals and Hospital Ships USNS Mercy and USNS Comfort (999-bed).	Care to all categories of patients, including resuscitation, initial wound surgery, damage control surgery, and postoperative treatment. ROLE 3 facilities represent the highest level of care that may be available in the combat theater.
ROLE 4	Definitive Care (i.e., Fixed Medical Treatment Facilities [MTF]).	Indefinite until recovery or transition out of the MHS.	Typically equivalent resources to similarly sized civilian hospitals with multiple specialties available.	CONUS-based[**] hospitals and OCONUS-based[††] hospitals, typically a long distance from engagement areas; may include VA[*] and other long-term care facilities.	Care to all categories of patients, including chronic, rehabilitative, and long-term care.

Evacuation, Transportation, and En Route/Pre-Hospital Care:

En route care is the maintenance of treatment initiated prior to evacuation and sustainment of the patient's medical condition during evacuation. This capability can take one of three forms:

- **Casualty evacuation (CASEVAC):** The movement of a casualty from the POI to medical treatment by *nonmedical* personnel. Casualties transported under these circumstances *may not* receive en route medical care. Any medical capabilities and equipment are supplied by available medical personnel.
- **Medical evacuation (MEDEVAC):** The timely, efficient movement and en route care provided by *medical* personnel to the wounded being evacuated from the battlefield using medically equipped/designated vehicles or aircraft. This term also covers the transfer of patients from the battlefield to an MTF or from one MTF to another by medical personnel, such as from ship to shore.
- **Aeromedical evacuation (AE):** Generally utilizes U.S. Air Force fixed-wing aircraft to move sick or injured personnel within the theater of operations or between two theaters, such as moving a casualty from the Middle East to Germany. This is a regulated system in which care is provided by AE crewmembers. The AE crews may be augmented with Critical Care Air Transport Teams to provide ICU-level care.

[§] MD: Medical Doctor; CRNA: Certified Registered Nurse Anesthetist; CRNP: Certified Registered Nurse Practitioner
[**] Continental United States
[††] Outside the Continental United States
[*] U.S. Department of Veterans Affairs

In combat areas, ambulances or dedicated medical evacuation vehicles may not be available, either because they are too few in number or incapable of evacuating patients over certain types of terrain. In these cases, nonmedical military vehicles, both air and ground, could be used for CASEVAC. Standard patient handling systems (e.g., standard litter, backboard, etc.) in these cases, may be lacking or incompatible. Additionally, even though evacuation of injured personnel using aerial vehicles greatly decreases transport time, the aeromedical environment creates unique stresses on the injured patient regardless of evacuation form (i.e., CASEVAC, MEDEVAC, AE).

Transition from MHS to VA:

It is important to note that SCIs correspond to a major cause of medical discharge from military service and thus, prompt the transition of patients out of the MHS to the VA or civilian health care system. SCI casualties are often transferred out of the MHS to a VA TBI/SCI center or civilian TBI/SCI rehabilitation center as soon as clinically stable. This can sometimes be within a week or two of arriving at an MTF within the United States.

Guidelines Directing Care in the MHS:

Tactical Combat Casualty Care Guidelines: The TCCC is updated with input from the Joint Trauma System (JTS), which is the Department of Defense Center of Excellence for Trauma. The mission of the JTS is to improve trauma readiness and outcomes through evidence-driven performance improvement. The intent of the TCCC guidelines is to provide the standard of care for the modern battlefield. It addresses pre-hospital medicine topics including: Care Under Fire, Tactical Field Care, and Tactical Evacuation Care. https://learning-media.allogy.com/api/v1/pdf/0ea4945b-d7f0-495a-9c92-d505c442ff74/contents.

JTS Clinical Practice Guidelines (JTS-CPGs): The JTS also produces CPGs to be used after the TCCC. They begin where the TCCC ends.

- CPGs specific to spine injury are located here: https://jts.amedd.army.mil/assets/docs/cpgs/Cervical_Thoracolumbar_Spine_Injury_19_Jun_2020_ID15.pdf.
- All current JTS CPGs can be found at: https://jts.amedd.army.mil/index.cfm/PI_CPGs/cpgs, including Analgesia and Sedation Management (CPG ID: 61); Acute Traumatic Wound Management (CPG ID: 62); Airway Management of Traumatic Injuries (CPG ID: 39), and Radiology: Imaging Trauma Patients in a Deployed Setting (CPG ID: 01)

Additional medical guidelines and SOPs developed in collaboration with the JTS are also available for prehospital professionals. These include:

- U.S. Army Aeromedical Evacuation Critical Care Flight Paramedic Standard Medical Operating Guidelines: https://jts.amedd.army.mil/assets/docs/cpgs/Standard_Medical_Operating_Guidelines_(SMOG)_for_Critical_Care_Flight_Paramedics_2021.pdf
- Naval Aviation Medical Treatment Protocols: https://jts.amedd.army.mil/assets/docs/cpgs/Naval_Aviation_Medical_Treatment_Protocols_Apr_2019.pdf