COMBAT MEDIC SPECIALIST FIELDCRAFT

Fieldcraft II



COMBAT MEDIC SPECIALIST FIELDCRAFT

Fieldcraft II

PART 3 OF A 3 PART SERIES

FIRST EDITION

Senior Editor

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BORDEN INSTITUTE

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Message from the Surgeon General

COMBAT MEDICS are ubiquitous in the Army's medical footprint, providing outstanding care from sick call through tactical combat casualty care. These highly skilled and compassionate medics are deserving of the trust they earn from the service members they support. In turn, they deserve the best training available throughout their careers. The *Combat Medic Specialist Fieldcraft* textbook adds a critical tool through which the Army's second-largest Military Occupational Specialty will train to extend its lifesaving capabilities across the spectrum of conflict. Through multi-platform publishing and global availability, this textbook provides a single, comprehensive, and updatable resource for Combat Medics everywhere.



Raymond S. Dingle
Lieutenant General, US Army
The Surgeon General and
Commanding General. USAMEDCOM

Combat Medic Specialist Fieldcraft

IS DEDICATED TO

Sergeant First Class Benjamin L. Sebban and All Our Brave Combat Medics Through History

SERGEANT FIRST CLASS (SFC) BENJAMIN L. SEBBAN exemplified the combat medic ethos. He served with great honor throughout his United States Army career. During Operation Iraqi Freedom, he was the senior medic for the 73rd Cavalry Regiment (Airborne Reconnaissance). It was here that his training, love for his Soldiers, and courage all came together in a great act of heroism that cost him his life.

SFC Sebban was known for his attentiveness to the paratroopers in his unit. He constantly patrolled with them, ensuring everyone was cared for and had what they needed to succeed in combat. He roved about the patrol base, checking to make sure everyone had clean socks, caring for blistered feet, or just talking to weary paratroopers just off mission. SFC Sebban also prioritized the medics assigned to him. As a master trainer, he pushed them to be masters of their craft by providing realistic, tough, and effective training. It was common to see the medics working in the aid station with night vision goggles to practice critical skills, such as vascular access, in conditions that mirror combat environments.

On 17 March 2007, SFC Sebban was on duty in Diyala Province, Iraq, when he saw a civilian truck laden with explosives accelerating toward a combat outpost. Stepping from behind a Humvee, SFC Sebban moved toward the vehicle and warned his fellow paratroopers of the impending attack, yelling three times, until the vehicle explosion knocked him down. Although mortally wounded by shrapnel injuries to his abdomen, groin, and legs, SFC Sebban immediately moved to the aid station and treated his fellow wounded paratroopers until he collapsed and succumbed to his wounds. SFC Sebban's valiant actions safeguarded the lives of 86 paratroopers and caused enemy insurgent forces to retreat. SFC Sebban's courageous actions that day earned him the Silver Star Medal for gallantry in battle.

Medics like SFC Sebban are the reason Soldiers run headlong into a gunfight to engage the enemy or to help a fellow soldier. Soldiers know that if they or their battle buddies are injured, a combat medic will be with them to provide world-class treatment at the point of injury. The US Army has the best-trained medics in the world and, just like SFC Sebban, they will give their all to treat, care for, and serve those around them with the highest dedication to duty.

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Foreword

THE CRY "MEDIC!" may be the most emboldening sound on the battlefield. It has been screamed by thousands of Soldiers during past wars, and Combat Medics will continue to respond in future conflicts. It is the privilege of my Army career to move toward that cry and earn the title "Doc" from the Soldiers I served with, was deployed with, and fought alongside.

This text, *Combat Medic Specialist Fieldcraft*, codifies the foundational concepts every Army Combat Medic must understand and employ on demand. However, it represents a mere fraction of what is truly required to excel in this critical wartime specialty. After 11B (Infantryman), 68W is the second largest military occupational specialty (MOS) in the Army. As warfighters, we go wherever the fight takes us—by land, sea, or air. Combat Medics remain ready to shoot, move, communicate, and survive on today's complex Multi-Domain Operations (MDO) battlefield while performing our critical medical tasks. This means that we must prioritize and practice holistic health and fitness (H2F) daily to ensure we possess the physical, mental, and moral resilience to deliver lifesaving care at the point of need. Contrary to popular belief, we rarely "rise to the occasion" when chaos ensues. Instead, we revert to our highest level of training, so we must train as we intend to fight. Combat Medics must be tactically and technically proficient. Both skill sets are perishable and require tough, realistic, and routine training to achieve the status of expert and professional.

The Army is in an era of extensive modernization. The Army of 2028 must be capable of conducting MDO and Large-Scale Combat Operations (LSCO) as part of an integrated Joint Force in a single theater, and it must be ready to do so in multiple theaters by 2035. Army Medicine plays a crucial role in the ability to deploy, fight, and win the nation's wars across all domains. We endeavor to remain relevant by modernizing "how we fight, what we fight with, and who we are." This means your education, as a Combat Medic, will not end when you close this textbook upon completion of Advanced Individual Training (AIT). In fact, that moment begins the next chapter of your journey and requires you to seek further knowledge in triage, damage control resuscitation, and Prolonged Casualty Care (PCC). Military medicine is a rapidly evolving discipline that requires adaptability, intellectual curiosity, and dedication.

The new generation of Combat Medics cannot expect timely casualty evacuation or rely upon the "Golden Hour" experienced in Iraq and Afghanistan during the Global War on Terrorism. Future conflicts require a robust system of ground evacuation and capable, highly trained Combat Medics with the attributes required to conserve the fighting strength for extended periods of time.

The title "Doc" comes with enormous responsibility and a legacy of courageous men and women who willingly put their lives on the line to save others. Their motivation was not for fortune, fame, or glory, but simply for the love that defines brotherhood and sisterhood—a bond that defies reason and propels Soldiers to heroic acts beyond comprehension. 68W is not only an MOS; it is a calling. You are inheriting a tradition of honor, expertise, and selfless sacrifice, and I want to thank you for answering the call.

Army Medicine is Army Strong!

Diamond D. Hough
Command Sergeant Major, US Army
US Army Medical Command

Preface

DURING TRAINING, sweat and dedication save lives and reduce despair on the battlefield. Warfighters are effective because they trust in the skills and abilities of their embedded healthcare providers, Combat Medics. Army Medical professionals and pre-hospital trauma subject matter experts analyzed, updated, and packaged the most current clinical practice guidelines to best instruct the next generation of 68Ws to provide medical overmatch at the point of injury and wherever else necessary. The continuum of care reinforcing readiness begins long before kinetic operations with routine sick call and progresses through care under fire toward individual resilience and recovery. This edition covers a myriad of topics ranging from providing care, preventing infection, and handling casualties to documenting actions under the overarching principles of tactical combat casualty care. Chapters begin with key terms and core concepts, then transition to review questions and step-by-step skill drills. Combat Medics must be competent and confident in their abilities to preserve life even in the most challenging and austere conditions. Army Medicine is committed to providing world-class training for all professionals who Conserve Fighting Strength.

Army Medicine Starts Here!

Clark J. Charpentier
Command Sergeant Major
US Army Medical Center of Excellence

Introduction

THIRTY YEARS AGO, my MOS 91B Combat Medic book consisted of a paper-bound, black-and-white, 400-page book with grainy, barely legible illustrations. The content mirrored books published for the National Registry Emergency Medical Technicians (NR-EMT) course, as well as treatment regimens gleaned from the Korean and Vietnam Wars. This book touched on diseases, injuries, and various treatment methods, with a medium focus on combat care. It also contained in-depth studies into the anatomy and physiology of the human body. Today's combat-focused 68W MOS is drastically different and changes every year to keep up with advances in both technology and science.

68Ws represent the second largest enlisted specialty in the US Army, with approximately 36,000 medics. Currently, a 68W student receives 10 different specialty books during training. There is no single, unified textbook that can be updated and accessed worldwide. Combat Medics cannot immediately retrieve material that is being taught at the proponency. Until now! The solution was to develop an official, approved training textbook for the 68W Combat Medics. The Borden Institute (the Medical Center of Excellence publishing arm) in collaboration with the Department of Combat Medic Training and the Department of Combat Medic Education (now the Combat Medical Specialist Training Program in the Department of Operational Medicine) energetically produced a 30-chapter text, which covers limited primary care to tactical combat casualty care.

This new 68W Combat Medic textbook will position all medics worldwide to provide the best possible care to our Warfighters, care that saves lives! Input will focus on quality, currency, and usability. This publication will be available as a spiral-bound book and online, enabling Soldiers and authorized users access everywhere the Army is located. I can also ensure that it will support initial, sustainment, and readiness training, and it will enhance overall operational readiness. The new 68W Combat Medic textbook will focus on the following areas: Tactical, Technical, and Clinical. In an effort to remain highly relevant to our Combat Medics, this text also draws material from other Combat-Medicine-centric courses such as Brigade Combat Trauma Team Training (BCT3), Joint Forces Combat Trauma Management Course (JFTCMC), and Tactical Combat Medical Care Course (TCMC). Other advantages to the publication and distribution of this book include efforts to align all 68W Combat

Medic training globally, with updates synchronized around the 68W MOS Program of Instruction cycle. In addition, it should be adaptable to all US Military services. This is especially important to our Navy Corpsmen and Air Force Medics as we attempt to move forward toward a joint medic concept. Last, and I think most significant, is that this book is written by you! It is a compilation of all relevant and up-to-date 68W tasks developed by Combat Medic subject matter experts with extensive field and clinical experience. Updates will be available to accommodate the most current medical advances and ensure that the most current information is always available.

I hope that everyone out in the force is as excited as we are (at the Medical Center of Excellence) about this book. It will have a high impact on Combat Medic training effectiveness as well as operational readiness!

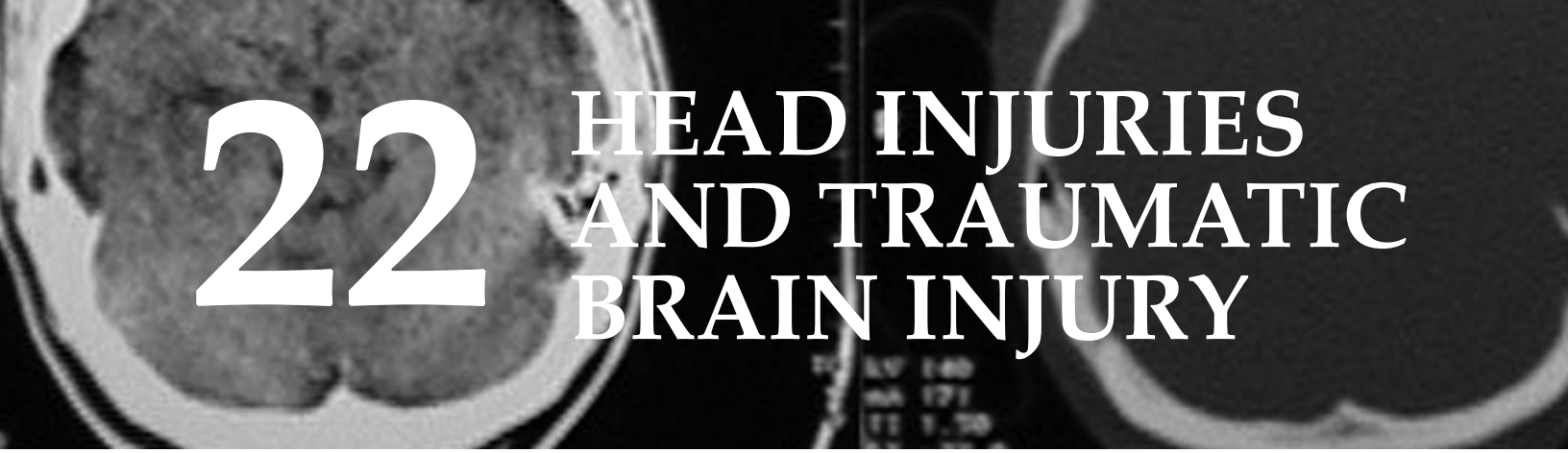
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Sergeant Major Musnicki currently serves as the sergeant major of academic affairs to the Office of the Commandant, US Army Medical Center of Excellence.

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NEUTRAL LANGUAGE. Unless this publication states otherwise, masculine nouns and pronouns do not refer exclusively to men.



22 HEAD INJURIES AND TRAUMATIC BRAIN INJURY

CORE CONCEPTS

- Review the anatomy of the head.
- State the signs and symptoms of a head injury.
- Recognize a traumatic brain injury.
- Describe the Military Acute Concussion Evaluation 2 examination.
- Treat a casualty with a head injury.

INTRODUCTION

In warfare, the types of injuries found on the battlefield are mostly the direct result of the types of weapons used. Head injuries range from minor wounds to life-threatening trauma. Improvised explosive devices, rocket-propelled grenades, and vehicle accidents have increased in recent conflicts, leading to increased traumatic brain injuries (**TBIs**). Protective equipment plays a role in the types of head injuries seen in combat as well. The standard Kevlar™ (DuPont, Wilmington, DE) helmet stops flying shrapnel but is not designed for absorbing the concussive impacts that cause TBIs. TBI rates increased so dramatically in recent conflicts, that many call them the "signature wound" of the wars in Iraq and Afghanistan. TBI was diagnosed in about 22% of surviving combat casualties from Iraq and Afghanistan who were treated at Landstuhl Regional Medical Center, although the actual percentage is believed to be higher.[1] The Department of Defense prioritized identification and treatment of TBI. As a result of this focus, combat-related TBI diagnoses doubled between 2010 and 2011.[2]

Soldiers also incur many noncombat-related head injuries, so combat medics may encounter them in a variety of settings. For perspective, between 2000 and 2022 Quarter 3, there have been 468,424 service members diagnosed with TBI from all causes.[3]

ANATOMY OF THE HEAD

The outermost portion of the head is the scalp (the skin covering the skull). The scalp bleeds profusely when lacerated, which may lead to significant blood loss if hemorrhage is prolonged. The skull, or cranium, encases and protects the brain tissue (Figure 22-1). The skull is formed by fusion of the parietal, temporal, ethmoid, sphenoid, frontal, and occipital bones. The bones of the anterior cranium connect to facial bones. These include the mandible (lower jaw), maxillae (fused bones of the upper jaw), zygomatic

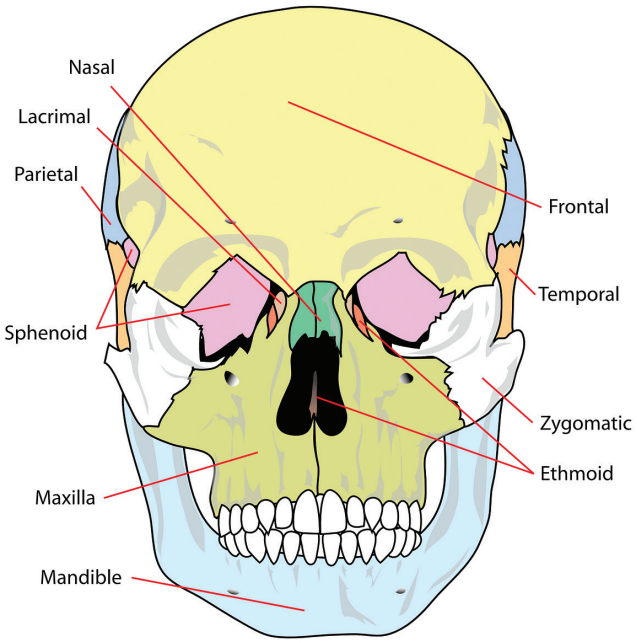


Figure 22-1. The bones of the skull. Reproduced from pixabay.com. https://pixabay.com/vectors/skull-diagram-labelled-human-41552/

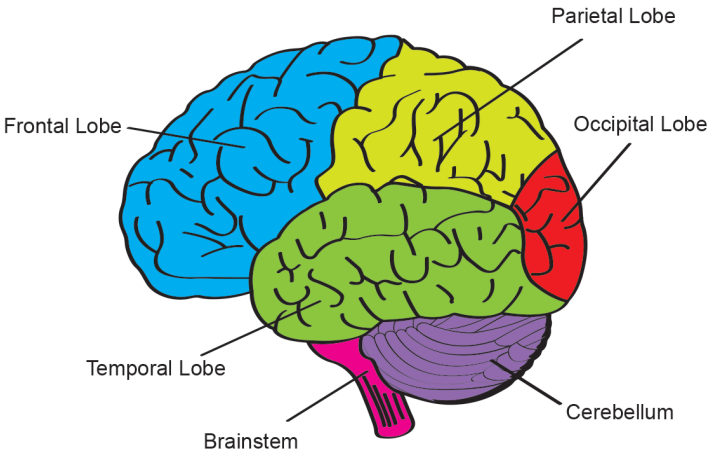


Figure 22-2. Basic brain anatomy.

bones (cheekbones), and nasal bones (part of nose structure). The foramen magnum, the circular opening at the base of the skull through which the spinal cord passes, is the primary opening for release of pressure.

The brain (Figure 22-2) controls all body functions and processes. The meninges, the three membranes that protect the cranial nerves and spinal cord, cover the brain and include the pia mater (thin, innermost membrane), arachnoid (center layer), and dura mater (outermost, most resilient membrane). The brain has two hemispheres: the cerebrum, which is the largest part of the brain and controls higher brain functions; and the cerebellum, which controls primitive functions, coordination, and balance. The brainstem controls vital body functions, such as those of the cardiorespiratory system.

Cerebrospinal fluid (**CSF**) is the nutrient fluid that bathes and protects the brain and spinal cord. It is constantly created within the ventricles of the brain and reabsorbed by the arachnoid membrane, which covers the brain and spinal cord. Obstruction of CSF will create an accumulation of spinal fluid within the brain, resulting in an increase in intracranial pressure (**ICP**).

TYPES OF HEAD INJURIES

Head injuries can range from mild bruises or superficial lacerations (which typically do not cause TBIs) to open or closed skull fractures (which usually cause TBIs). Therefore, not all head injuries result in a TBI, but all TBIs are a result of a head injury. Combat medics must ascertain the severity of a head injury during their evaluation to ensure the casualty receives appropriate treatment. Significant injuries to the face, neck, and orbit are usually associated with TBI, so combat medics should always maintain a high index of suspicion.

Scalp Injuries

The scalp is highly vascularized (the head and face are densely populated with capillaries); therefore, a large quantity of blood may be lost through a scalp wound. Lacerations, abrasions, avulsions, and degloving injuries are serious injuries to the scalp.

Skull Injuries

Skull fractures can be caused by blunt or penetrating trauma. Types of fractures include linear nondisplaced fractures, compound fractures, and depressed fractures (Figure 22-3).

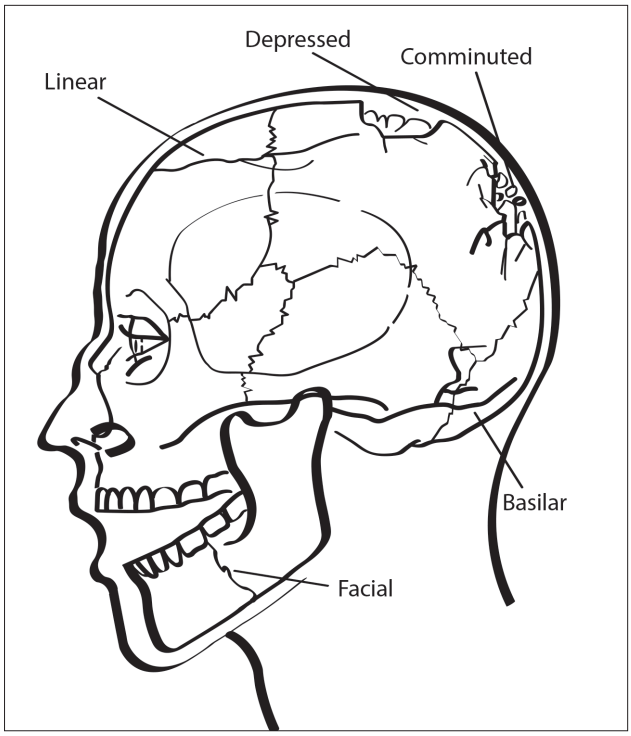


Figure 22-3. Types of skull fractures.

Linear Skull Fracture

Linear skull fractures are the most common, accounting for about 80% of skull fractures. These breaks extend through the full thickness of the skull, usually without bone displacement.

Depressed Skull Fracture

Depressed skull fractures may be open or closed. They have bone fragments driven toward or into the underlying brain tissue. Closed depressed skull fractures increase the risk of intracranial hematoma. Open depressed skull fractures may serve as an entry point for bacteria.

Basilar Skull Fracture

These are fractures in the floor of the cranium. Suspect basilar skull fractures if CSF is draining from the ear or nose. Periorbital ecchymosis (raccoon eyes) and ecchymosis over the mastoid behind the ears (Battle's sign) often occur, though it may take several hours after the injury to become apparent. Crepitus may be noted. In adults with large contusions or darkened scalp swelling, suspect underlying skull fracture.

Facial Fracture

Bleeding (epistaxis), edema, ecchymosis, and palpable abnormalities (crepitus) indicate nasal fractures. With mandible fractures, casualties commonly report that their teeth no longer "fit together" correctly (malocclusion). Figure 22-4 shows one type of mandible fracture. Crepitus or step-off may be noted. Consider airway management if the casualty is supine, as the tongue may occlude the airway. A casualty's face may appear asymmetrical or flattened in the case of a midface fracture. There may be an inability to close the mouth. Conscious casualties may complain of facial pain and numbness.

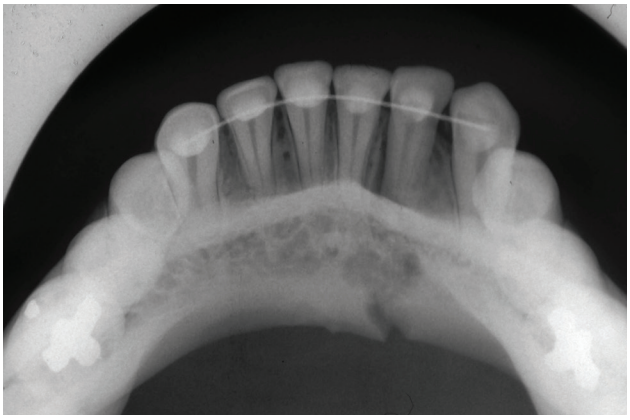


Figure 22-4. Mandible fracture. Occlusal radiograph of a mandibular parasymphysis fracture. Image by Coronation Dental Specialty Group. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Occlusal_view_symphsis_fracture.jpg

Warning: Facial fractures may cause airway compromise.

Traumatic Brain Injuries

TBIs are any injuries that disrupt the normal functioning of the brain. Trauma may cause bleeding or bruising of brain tissue (primary injury), followed by edema and increased ICP (secondary injury). TBI is a major cause of life-long disability and death. It is an injury to the brain resulting from an external blow, sudden acceleration, deceleration, blast, or penetrating trauma. Mechanisms of injury include blasts, projectiles, falls, direct impact, or motor vehicle accidents. Usually, casualties with TBI will also have face, neck, and orbit injuries.

IDENTIFICATION OF TRAUMATIC BRAIN INJURY

Early and appropriate diagnosis, evaluation, and treatment of a TBI will shorten the time it takes for a service member to return to duty or the highest level of activity possible to continue their mission. In addition, delayed management of a TBI increases long-term cognitive and neurological deficits. You must be able to identify the events that prompt evaluation, recognize the signs and symptoms, and be prepared to respond immediately to patients who have RED FLAGS of TBI.

Assess anyone with trauma to the head that results in a variable period of unconsciousness or confusion, followed by a return to normal consciousness, for TBI. Loss of consciousness is not required to diagnose TBI. An injured casualty shows a transient alteration in neurologic function, which causes a change in mental status. This results in the temporarily related onset of symptoms, including the following:

- altered mental status,
- headache,
- nausea,
- vomiting,
- dizziness and balance problems,
- fatigue,
- insomnia and sleep disturbances,
- drowsiness,
- sensitivity to light and noise,
- blurred vision,
- difficulty remembering, and
- difficulty concentrating.

Injured casualties may also display the following signs:

- vacant stare,
- delayed verbal response,
- confusion and inability to focus attention,
- disorientation,
- slurred or incoherent speech,
- lack of coordination,
- inappropriate emotions to circumstances,
- short-term memory deficits (casualty repeats the same questions), and
- inability to memorize and recall.

Note: Signs and symptoms of TBI may co-occur.

There are three levels of TBI: mild, moderate, and severe. The signs and symptoms of each level are similar; therefore, it is almost impossible to determine the level of injury in a prehospital setting. **Computed tomography** (**CT**) or **magnetic resonance imaging** (**MRI**), in addition to clinical findings, is required to make a definitive diagnosis.

Mild Traumatic Brain Injury

Combat medics commonly see soldiers with mild TBI (also known as mTBI or concussion). Mild TBI can occur in any setting. It is a secondary injury and is often missed or overlooked. Signs and symptoms range from asymptomatic to temporary confusion or amnesia. When concussed, an injured casualty shows a transient alteration in neurologic function. Loss of consciousness is not required to diagnose concussion.

The following criteria can assist you in identifying casualties with mild TBI:

- confusion or disorientation lasting **less than** 24 hours,
- loss of consciousness for **up to** 30 minutes, and
- memory loss lasting **less than** 24 hours.

Caution: Unidentified concussions and mild brain injuries put soldiers at risk for sustaining more than one injury because they are sent back into the fight without treatment.

A CT or MRI scan shows normal structural brain results. The casualty can usually return to normal activity within weeks after the injury.

Moderate Traumatic Brain Injury

Moderate TBI typically requires casualties to be admitted or observed because of the potential for deterioration. The following criteria can assist you in identifying casualties with moderate TBI:

- confusion or disorientation lasting **more than** 24 hours;
- loss of consciousness for **more than** 30 minutes but **less than** 24 hours; and
- memory loss lasting **more than** 24 hours but **less than** 7 days.

A CT or MRI scan can show normal or abnormal structural brain results.

Severe Traumatic Brain Injury

Severe TBI can be closed or open (injury in which the dura mater, the outer layer of the meninges, is penetrated). Examples of severe TBI include intracranial hemorrhage (eg, **epidural hematoma**, **subdural hematoma**, and **subarachnoid hemorrhage**) and cerebral contusions (Figure 22-5). The following criteria can assist you in identifying casualties with severe TBI:

- confusion or disorientation lasting **more than** 24 hours,
- loss of consciousness for **more than** 24 hours, and
- memory loss lasting **more than** 7 days.

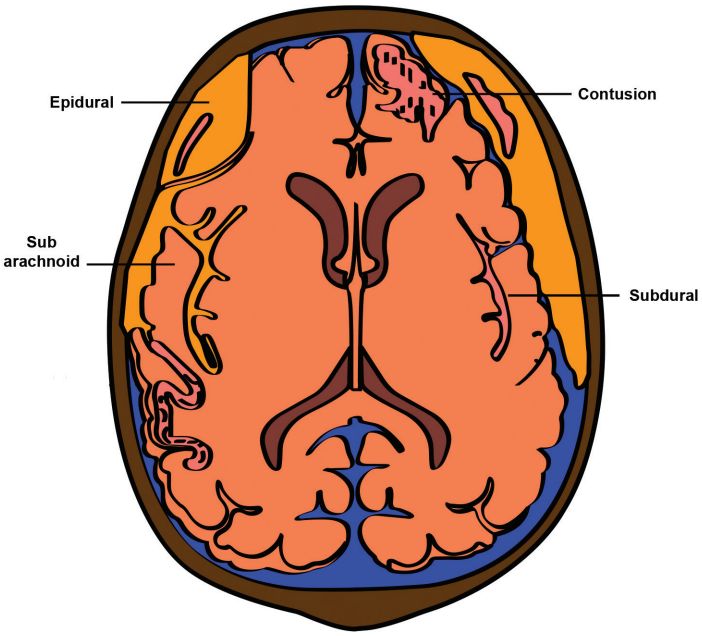


Figure 22-5. Types of severe TBI: intracranial hemorrhage and cerebral contusion.

A CT or MRI scan can show normal or abnormal structural brain results.

Severe TBI constitutes roughly 8% of head injuries. From 2004 to 2014, severe TBI patients who had open or penetrating injuries had a 25% mortality rate, with 75% of those deaths occurring within the first week after injury.[4]

RED FLAGS for Traumatic Brain Injury

RED FLAGS for immediate referral to a medical officer or transport include the following:

- witnessed loss of consciousness,
- two or more blast exposures within 72 hours,
- amnesia or memory problems,
- unusual behavior (eg, unnecessarily combative),
- unequal pupils,
- seizures,
- repeated vomiting,
- double vision or loss of vision,
- worsening headache,
- weakness on one side of the body,
- inability to recognize people or disorientation to place, and
- unsteady on feet.

Long-Term Effects of Traumatic Brain Injury

Brain trauma can cause a broad range of physical, cognitive, emotional, and social problems for casualties. Long-term disability is common. Early detection and treatment are the keys to preventing long-term effects. Postconcussion complaints include:

- decreased memory, attention, and concentration;
- slower thinking;
- irritability;
- depression;
- impaired vision;
- mood swings;
- equilibrium imbalance;
- headaches; and
- nausea.

In addition to experiencing these long-term signs and symptoms, people who have suffered brain trauma are also at greater risk for a variety of other problems, such as seizures, sleep disorders, appetite changes, chronic pain, personality changes, reduced tactile sensations, problems with executive functions, hearing loss or tinnitus, and partial paralysis. Individuals who suffered moderate or severe TBI may have difficulty functioning in everyday life. Some may be unable to work or maintain healthy family and social relationships. Others may turn to drugs or alcohol. After inpatient rehabilitation, many affected individuals will require long-term therapy and rehabilitation, and some may never fully recover to their preinjury state.

Check on Learning

1. What is the primary sign of a scalp injury?
2. State the levels of TBI.
3. Is a loss of consciousness required to diagnose concussion?
4. List six signs a casualty may display if suffering from a TBI.
5. List all the RED FLAGS of TBI.

ASSESSMENT OF HEAD TRAUMA

Massive hemorrhage control, airway, respiration, circulation, and hypothermia or head injury (MARCH) assessment and management take priority. When assessing for vital signs, use the **AVPU** (alert, verbal, pain, unresponsive) scale as a baseline assessment of mental status. The hallmark of a brain injury is an altered level of consciousness (**LOC**). If the casualty's mental status or mechanism of injury suggests the possibility of a head injury, assess the casualty's LOC by using appropriate tools (eg, pen light to assess pupils, **Glasgow Coma Scale** [**GCS**], **Military Acute Concussion Evaluation 2** [**MACE 2**]).

After identifying and treating life-threatening injuries, follow the steps below to complete the secondary assessment:

1. Obtain a baseline GCS score using Figure 22-6. The highest score possible is 15; the lowest is 3. The GCS scoring criteria cover eye opening, verbal, and motor responses. For intubated casualties, calculate the overall GCS using only eye and motor scales. Add a "T" to the score to note the inability to assess the verbal response (eg, 7T).
2. Identify posturing abnormalities.
    a. Decorticate posturing may occur if the injury is at the level of the upper midbrain. In this position, the casualty has hyperextended legs, flexed arms and elbows, and hands placed in toward the center (core) of the body (Figure 22-7).
    b. Decerebrate posturing usually is caused by severe injury involving the central midbrain. In this position, the casualty

Behavior	Response	Points
 Best eye opening response	Spontaneous Response to speech Response to pain None	4 3 2 1
 Best verbal response	Oriented Confused Inappropriate Incomprehensible None	5 4 3 2 1
 Best motor response	Obeys commands Localizes pain Withdraws to pain Abnormal flexion Abnormal extension None	6 5 4 3 2 1

Figure 22-6. Glasgow Coma Scale.

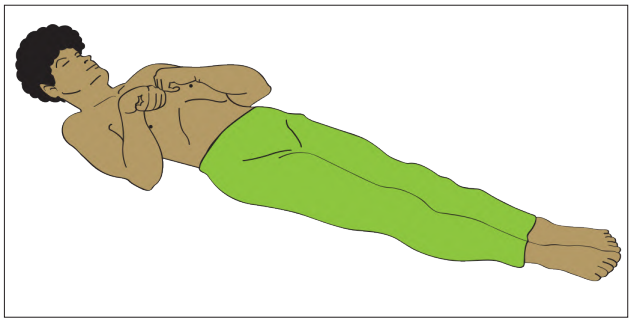


Figure 22-7. Decorticate posturing.

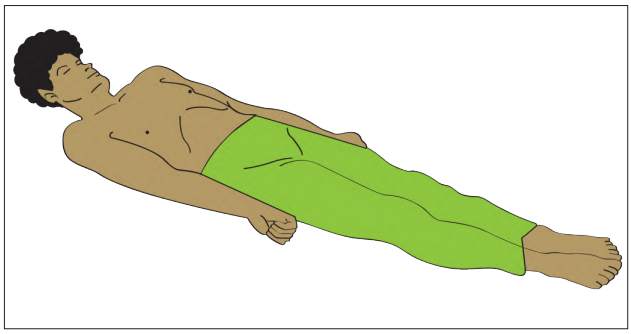


Figure 22-8. Decerebrate posturing.

has the head and neck arched backward, the teeth clenched, the arms and legs extended, toes pointed down, and the wrists flexed (Figure 22-8).

Warning: A GCS score that deteriorates by more than 2 points is a significant finding; these casualties are at high risk for an ongoing pathologic process, such as increased ICP.

3. Reassess GCS often during casualty assessment and transport.
4. Inspect and palpate for deformities, contusions, abrasions, penetrations, burns, tenderness, lacerations, swelling, instability, and crepitus.
5. Inspect the mouth, nose, and ears for bleeding or other fluids. If clear or bloody fluid is leaking from the ear or nose, determine if it is CSF.
    a. Look for a "halo" or "target" sign.
        i. Allow a drop of blood to fall onto a bed sheet or gauze.
        ii. In a positive test, CSF will diffuse and form a halo ring around the blood.

Caution: In a prehospital setting, do not use a negative halo or target test to rule out serious injury.

    b. Swelling or bruising behind the ear (Battle's sign) or around both eyes ("raccoon eyes") can indicate a basilar skull fracture.
6. Assess pupil size and reactivity.
    a. A difference of greater than 1.0 mm in pupil size is considered abnormal, as is a sluggish or nonreactive pupil.
    b. Brainstem injury is probable if both pupils are dilated and do not react to light.
    c. If pupils are dilated but reactive to light, injury is often reversible.

Note: Dilated pupils that may or may not react to light may be caused by reasons other than a head injury, such as hypothermia, **anoxia**, lightning strike, optic nerve injury, direct trauma to the eye, and drug effects.

7. If the casualty has a normal LOC, the dilated pupils are not due to head injury. Reassess and look for other causes.
8. Suspect cervical spine injuries for all nonpenetrating head, face, and neck wounds. Initiate spinal precautions if the tactical environment allows.
9. Pinch the casualty's fingers and toes. Normal or minimally impaired brain function is probable if the casualty withdraws or experiences localized pain.
10. Repeatedly assess vital signs.
    a. Changes in vital signs may indicate changes in the status of ICP.
    b. Increasing ICP causes Cushing's triad (or Cushing's phenomenon). This manifests as an increase in blood pressure (hypertension); a decrease in pulse rate (bradycardia); and a respiratory rate that increases, decreases, or becomes otherwise irregular.
    c. Hypovolemic shock does not result from an isolated head injury; look for another cause of the hypovolemia.

Warning: Low blood pressure (hypotension) caused by a head injury is usually a terminal event.

11. Reassess and record the casualty's LOC using GCS, pupil size and reactivity to light, and vital signs.

Make decisions in casualty management based on changes in all parameters of the physical and neurological examination. Establish baseline neurological status, because future treatment decisions depend on baseline evaluations and observed changes.

Check on Learning

6. Why is it important to take serial GCS assessments (initial assessment and multiple reassessments) throughout casualty care?
7. You assess your casualty's pupils as dilated and nonreactive to light. What does this tell you?
8. The casualty opens her own eyes and can hold up two fingers when you tell her to but does not understand who you are or what happened. What is her GCS score?
9. Upon reassessment, the same casualty slaps your hand away when you pinch the back of her arm. She looks at you only if you yell to get her attention but gives inappropriate responses. She will not show you two fingers. What does this casualty's GCS score tell you about her condition?

MILITARY ACUTE CONCUSSION EVALUATION 2

To improve management of TBI, first-tier health care providers (combat medics, corpsmen, and initial providers) have two critical tools, the MACE 2 and the Concussion Management in Deployed Settings clinical algorithms. These tools help you quickly identify and get appropriate treatment for casualties suffering from TBI. Use the MACE 2 to evaluate acute concussion**.** The Concussion Management in Deployed Settings is the algorithm combat medics follow when treating a casualty with a suspected head injury. The algorithm for garrison concussion management mirrors theater policy; the majority of all TBIs among soldiers occurred in garrison.

The MACE was developed by the Defense and Veterans Brain Injury Center to evaluate a casualty in whom a concussion is suspected. It was first distributed for clinical use by military personnel in 2006. The 2018 update (MACE 2) includes current state-of-the-science information. MACE 2 is currently the only standardized (and most widely used) method for evaluating acute mTBI in military operational settings.

MACE 2 is not performed in the care under fire or tactical field care phases of medical treatment; rather, it is performed in the combat theater of operations, usually at the battalion aid station or higher. MACE 2 is most effective when used as close to the time of injury as possible. Repeat MACE 2 to evaluate recovery.

Note: Prior to deployment, give soldiers the MACE 2 evaluation to obtain a baseline evaluation. Document the results in the soldier's medical records.

Requirements for Military Acute Concussion Evaluation 2

The following events mandate prompt command and medical concussion evaluation, event reporting, and a 24-hour rest period:

- any service member in a vehicle associated with a blast event, collision, or rollover;
- any service member within 50 m of a blast (inside or outside);
- any service member who sustains a direct blow to the head; and
- any service member directed to receive MACE 2 by the commander, including those who have sustained repeated exposures.

Note: The MACE 2 assessment can be initiated in the absence of RED FLAGS for traumatic brain injury.

Using Military Acute Concussion Evaluation 2

MACE 2 comes with step-by-step instructions and consists of six major categories: (1) RED FLAGS and concussion screening; (2) cognitive exam, part 1; (3) neurologic exam; (4) cognitive exam, part 2; (5) vestibular/ocular-motor screening (**VOMS**) for concussion instructions; and (6) exam summary. Throughout MACE 2, additional guidance and information are provided on the card as needed. Critical information is highlighted in red, bold text. Follow the instructions for filling out each required section.

RED FLAGS

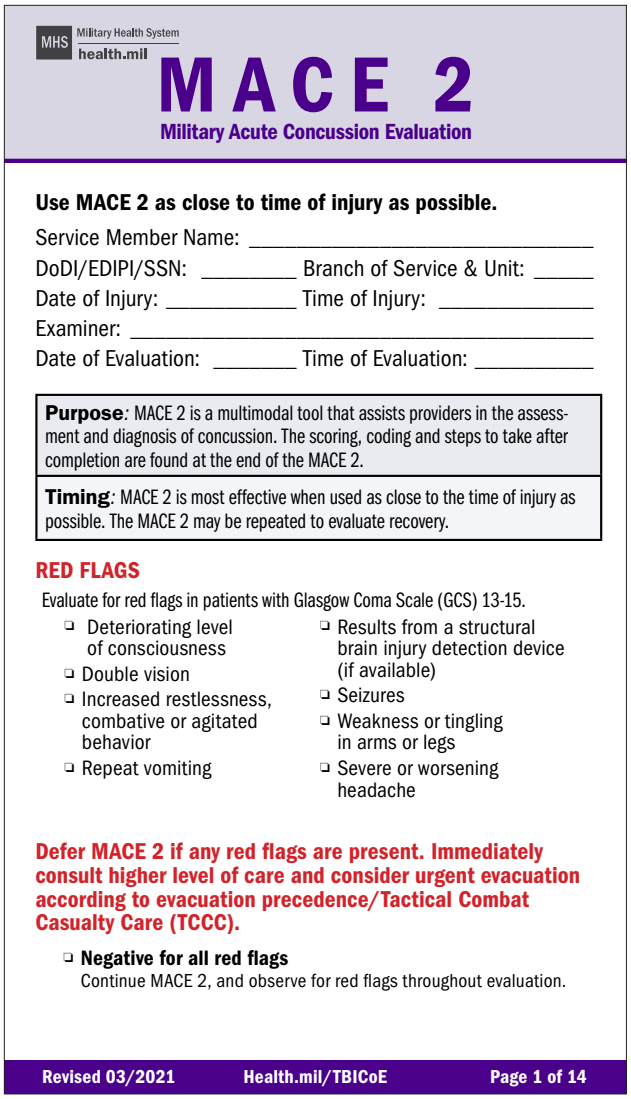
The card starts with a short administrative data portion and some usage information, followed by the RED FLAGS section (Figure 22-9). RED FLAGS will be the first critical evaluation in patients with a GCS score of 13 to 15. Use the checklist on the card to determine presence or absence of RED FLAGS.

If no RED FLAGS are present, continue MACE 2 and observe for RED FLAGS throughout the evaluation.

Caution: Defer the MACE 2 if any red flags are present, immediately consult a higher level of care, and consider urgent evacuation according to evacuation precedence and tactical combat casualty care guidance.

Military Acute Concussion Screening

The Military Acute Concussion Screening must be completed to determine if there was an injury event



MHS Military Health System health.mil

MACE 2

Military Acute Concussion Evaluation

Use MACE 2 as close to time of injury as possible.

Service Member Name: _____

DoDI/EDIPI/SSN: _____ Branch of Service & Unit: _____

Date of Injury: _____ Time of Injury: _____

Examiner: _____

Date of Evaluation: _____ Time of Evaluation: _____

Purpose: MACE 2 is a multimodal tool that assists providers in the assessment and diagnosis of concussion. The scoring, coding and steps to take after completion are found at the end of the MACE 2.

Timing: MACE 2 is most effective when used as close to the time of injury as possible. The MACE 2 may be repeated to evaluate recovery.

RED FLAGS

Evaluate for red flags in patients with Glasgow Coma Scale (GCS) 13-15.

- ❑ Deteriorating level of consciousness
- ❑ Double vision
- ❑ Increased restlessness, combative or agitated behavior
- ❑ Repeat vomiting
- ❑ Results from a structural brain injury detection device (if available)
- ❑ Seizures
- ❑ Weakness or tingling in arms or legs
- ❑ Severe or worsening headache

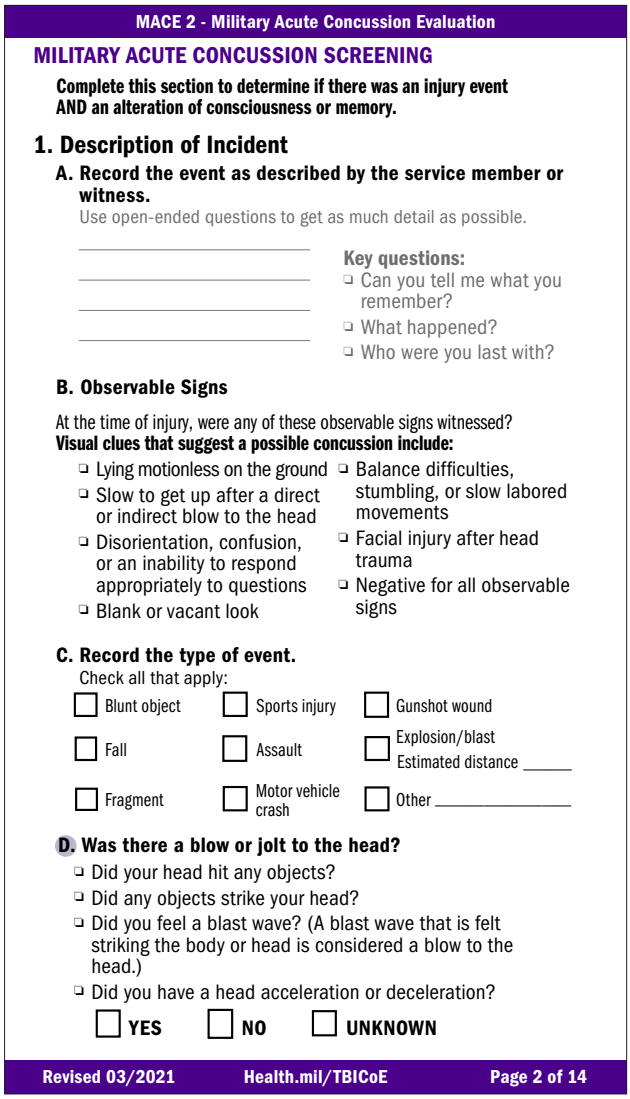
Defer MACE 2 if any red flags are present. Immediately consult higher level of care and consider urgent evacuation according to evacuation precedence/Tactical Combat Casualty Care (TCCC).

- ❑ **Negative for all red flags**
  Continue MACE 2, and observe for red flags throughout evaluation.

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Figure 22-9. Military Acute Concussion Evaluation II, page 1.

and an alteration of consciousness or memory. It begins on MACE 2, page 2 (Figure 22-10), and covers part 1, the description of the incident (a record of the event, observable signs, the type of event, and whether there was a blow or jolt to the casualty's head). In part 1, section A, describe the event in as much detail as possible, as provided by the casualty or witness. Avoid asking yes-or-no questions. If there was a witness, use the checklist in part 1, section B, to document any observable signs of a possible concussion at the time of the injury. Negative for all observable signs is a valid response. Document the type of event in part 1, section C. Select all options that apply for the type of event. If an event was a blast, record the distance of the blast from the soldier. If there was



MACE 2 - Military Acute Concussion Evaluation

MILITARY ACUTE CONCUSSION SCREENING

Complete this section to determine if there was an injury event AND an alteration of consciousness or memory.

1. Description of Incident

A. Record the event as described by the service member or witness.

Use open-ended questions to get as much detail as possible.

_____
_____
_____
_____

Key questions:
- Can you tell me what you remember?
- What happened?
- Who were you last with?

B. Observable Signs

At the time of injury, were any of these observable signs witnessed?
Visual clues that suggest a possible concussion include:
- Lying motionless on the ground
- Slow to get up after a direct or indirect blow to the head
- Disorientation, confusion, or an inability to respond appropriately to questions
- Blank or vacant look
- Balance difficulties, stumbling, or slow labored movements
- Facial injury after head trauma
- Negative for all observable signs

C. Record the type of event.

Check all that apply:

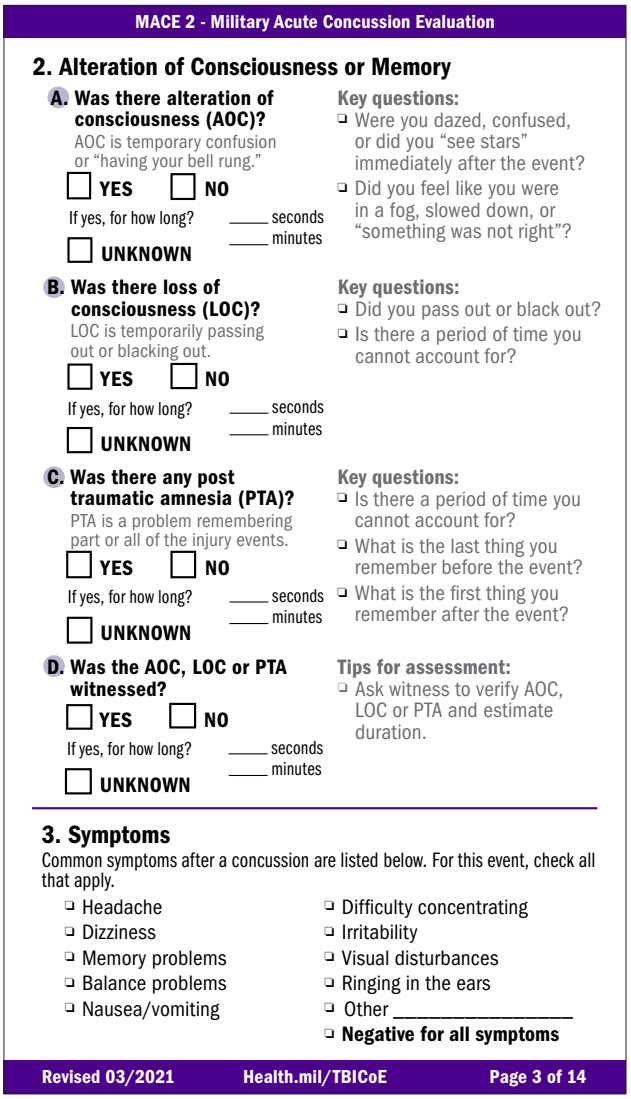
☐ Blunt object ☐ Sports injury ☐ Gunshot wound
☐ Fall ☐ Assault ☐ Explosion/blast Estimated distance _____
☐ Fragment ☐ Motor vehicle crash ☐ Other _____

D. Was there a blow or jolt to the head?
- Did your head hit any objects?
- Did any objects strike your head?
- Did you feel a blast wave? (A blast wave that is felt striking the body or head is considered a blow to the head.)
- Did you have a head acceleration or deceleration?

☐ **YES** ☐ **NO** ☐ **UNKNOWN**

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Figure 22-10. Military Acute Concussion Evaluation II, page 2.



MACE 2 - Military Acute Concussion Evaluation

2. Alteration of Consciousness or Memory

A. Was there alteration of consciousness (AOC)?
AOC is temporary confusion or "having your bell rung."

☐ **YES** ☐ **NO**
If yes, for how long? ____ seconds ____ minutes
☐ **UNKNOWN**

Key questions:
- Were you dazed, confused, or did you "see stars" immediately after the event?
- Did you feel like you were in a fog, slowed down, or "something was not right"?

B. Was there loss of consciousness (LOC)?
LOC is temporarily passing out or blacking out.

☐ **YES** ☐ **NO**
If yes, for how long? ____ seconds ____ minutes
☐ **UNKNOWN**

Key questions:
- Did you pass out or black out?
- Is there a period of time you cannot account for?

C. Was there any post traumatic amnesia (PTA)?
PTA is a problem remembering part or all of the injury events.

☐ **YES** ☐ **NO**
If yes, for how long? ____ seconds ____ minutes
☐ **UNKNOWN**

Key questions:
- Is there a period of time you cannot account for?
- What is the last thing you remember before the event?
- What is the first thing you remember after the event?

D. Was the AOC, LOC or PTA witnessed?

☐ **YES** ☐ **NO**
If yes, for how long? ____ seconds ____ minutes
☐ **UNKNOWN**

Tips for assessment:
- Ask witness to verify AOC, LOC or PTA and estimate duration.

3. Symptoms

Common symptoms after a concussion are listed below. For this event, check all that apply.
- Headache
- Dizziness
- Memory problems
- Balance problems
- Nausea/vomiting
- Difficulty concentrating
- Irritability
- Visual disturbances
- Ringing in the ears
- Other _____
- **Negative for all symptoms**

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Figure 22-11. Military Acute Concussion Evaluation II, page 3.

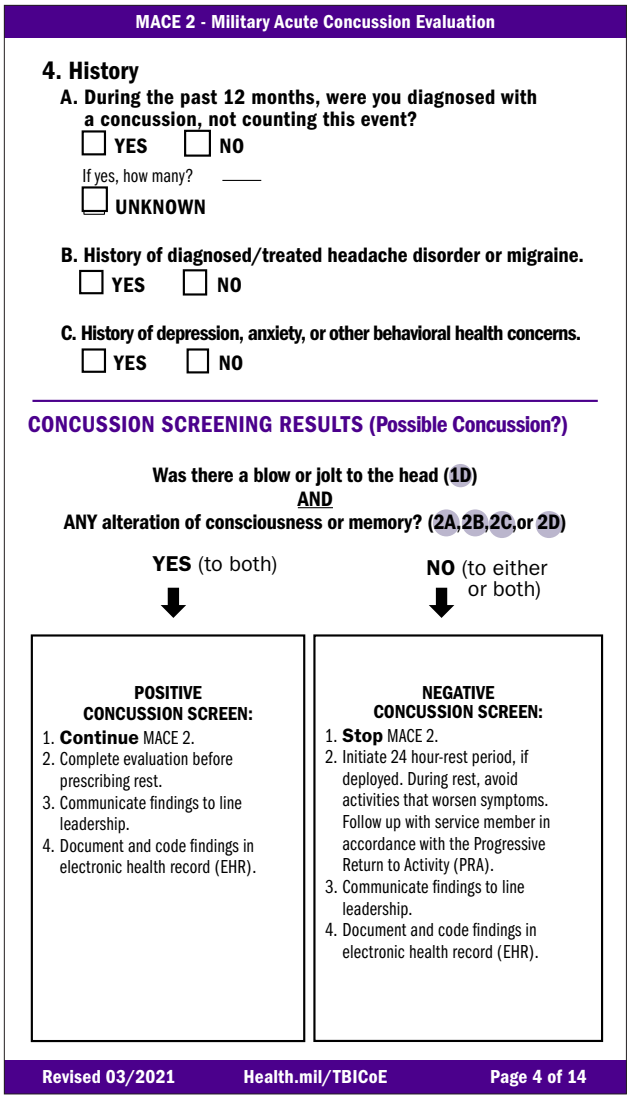
another type of event that is not listed, check the "other" box and write it in on the line. Part 1, section D, should be answered by the casualty. Ask if there was a blow or jolt to the casualty's head. If yes, use the checklist to gather more details about the blow. If the casualty does not know, mark the box labeled "unknown."

Part 2, alteration of consciousness or memory, and part 3, symptoms, are covered on MACE 2, page 3 (Figure 22-11). Use the key questions provided on the right side of the card to address part 2, sections A through D. Try to get time estimates for each of the sections. For part 2, section D, see if a witness can verify the casualty's alteration of consciousness or loss of memory, and have them estimate the duration.

Part 3 lists common symptoms of concussion. Check off all symptoms that apply and remember to ask if there are other symptoms not on the list. If so, check the "other" box and write the symptoms. A negative for all symptoms is a valid answer.

MACE 2, page 4, completes the concussion screening with part 4, history, and provides a results flow chart that indicates whether there was a possible concussion (Figure 22-12). The section 4 history questions look for previous concussions or complicating factors.

Concussion screening results are simply positive or negative. If there was a blow or jolt to the head (part 1, section D) *and* any alteration of consciousness or memory (part 2, sections A–D), the screen is



MACE 2 - Military Acute Concussion Evaluation

4. History

A. During the past 12 months, were you diagnosed with a concussion, not counting this event?

☐ YES ☐ NO

If yes, how many? ____

☐ UNKNOWN

B. History of diagnosed/treated headache disorder or migraine.

☐ YES ☐ NO

C. History of depression, anxiety, or other behavioral health concerns.

☐ YES ☐ NO

CONCUSSION SCREENING RESULTS (Possible Concussion?)

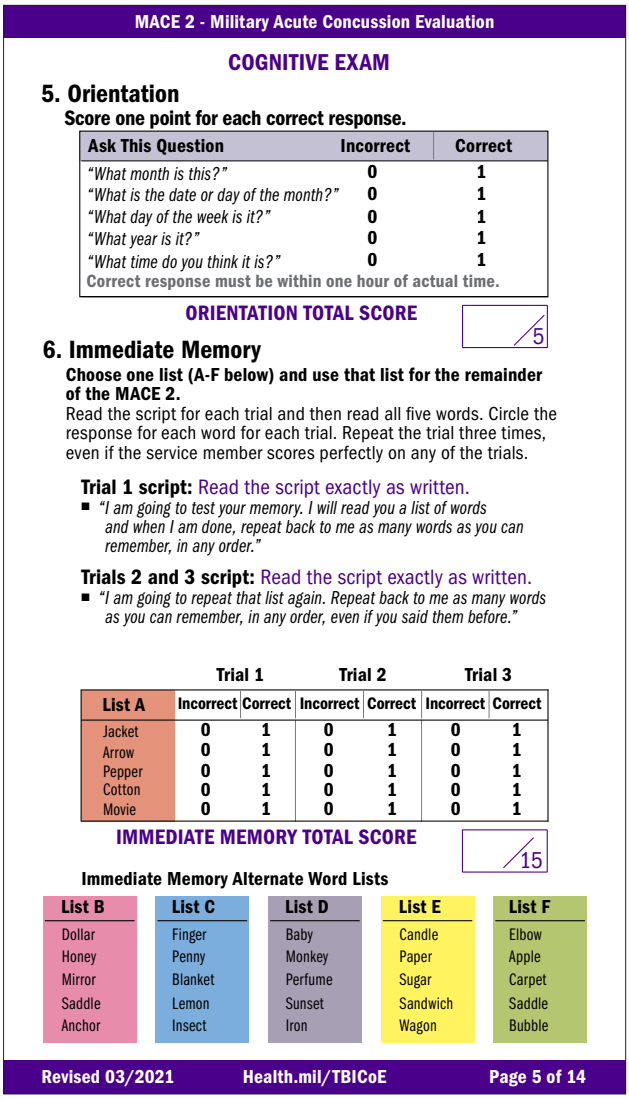
Was there a blow or jolt to the head (1D)
AND
ANY alteration of consciousness or memory? (2A,2B,2C,or 2D)

YES (to both) → **POSITIVE CONCUSSION SCREEN:**
1. **Continue** MACE 2.
2. Complete evaluation before prescribing rest.
3. Communicate findings to line leadership.
4. Document and code findings in electronic health record (EHR).

NO (to either or both) → **NEGATIVE CONCUSSION SCREEN:**
1. **Stop** MACE 2.
2. Initiate 24 hour-rest period, if deployed. During rest, avoid activities that worsen symptoms. Follow up with service member in accordance with the Progressive Return to Activity (PRA).
3. Communicate findings to line leadership.
4. Document and code findings in electronic health record (EHR).

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Figure 22-12. Military Acute Concussion Evaluation II, page 4.



MACE 2 - Military Acute Concussion Evaluation

COGNITIVE EXAM

5. Orientation

Score one point for each correct response.

Ask This Question	Incorrect	Correct
"What month is this?"	0	1
"What is the date or day of the month?"	0	1
"What day of the week is it?"	0	1
"What year is it?"	0	1
"What time do you think it is?"	0	1

Correct response must be within one hour of actual time.

ORIENTATION TOTAL SCORE ___/5

6. Immediate Memory

Choose one list (A-F below) and use that list for the remainder of the MACE 2.

Read the script for each trial and then read all five words. Circle the response for each word for each trial. Repeat the trial three times, even if the service member scores perfectly on any of the trials.

Trial 1 script: Read the script exactly as written.
- *"I am going to test your memory. I will read you a list of words and when I am done, repeat back to me as many words as you can remember, in any order."*

Trials 2 and 3 script: Read the script exactly as written.
- *"I am going to repeat that list again. Repeat back to me as many words as you can remember, in any order, even if you said them before."*

	Trial 1		Trial 2		Trial 3	
List A	Incorrect	Correct	Incorrect	Correct	Incorrect	Correct
Jacket	0	1	0	1	0	1
Arrow	0	1	0	1	0	1
Pepper	0	1	0	1	0	1
Cotton	0	1	0	1	0	1
Movie	0	1	0	1	0	1

IMMEDIATE MEMORY TOTAL SCORE ___/15

Immediate Memory Alternate Word Lists

List B	List C	List D	List E	List F
Dollar	Finger	Baby	Candle	Elbow
Honey	Penny	Monkey	Paper	Apple
Mirror	Blanket	Perfume	Sugar	Carpet
Saddle	Lemon	Sunset	Sandwich	Saddle
Anchor	Insect	Iron	Wagon	Bubble

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Figure 22-13. Military Acute Concussion Evaluation II, page 5.

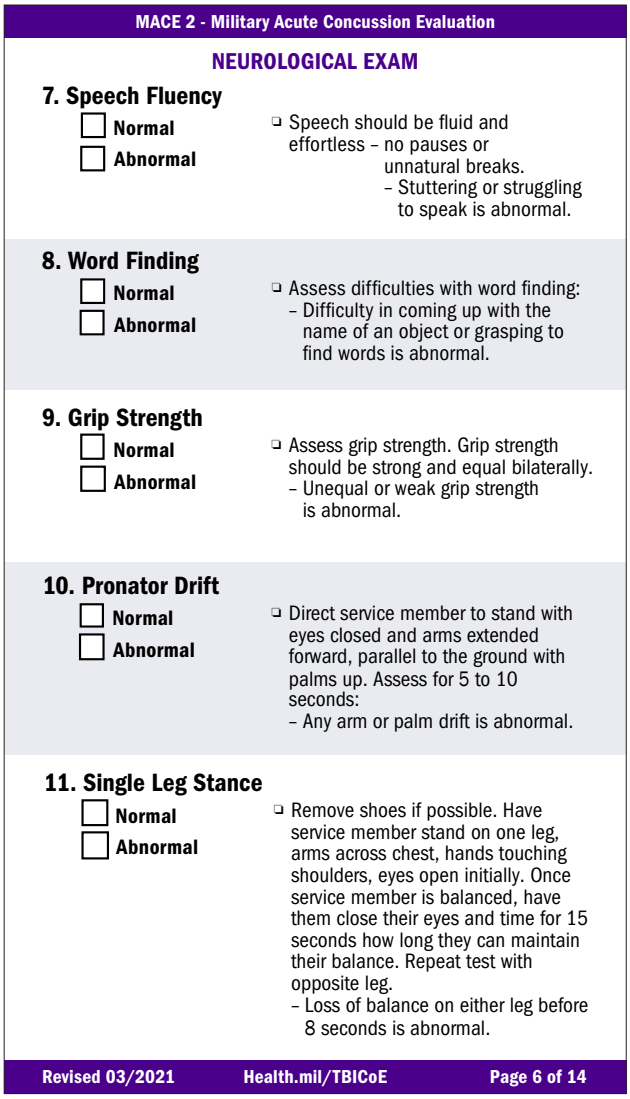
considered positive for concussion. Continue MACE 2 and follow the instructions in the left (positive) results box. If there was *neither* a blow or jolt to the head *nor* an alteration of consciousness, the concussion result is negative. If the casualty either has a blow or jolt to the head or alteration of consciousness or memory, but *not both*, the test is also negative. The only positive test occurs when the answer to both questions is yes. If the test is negative, discontinue MACE 2 and follow the instructions in the right (negative) results box.

Cognitive Exam 1

The cognitive exam is administered in two separate areas of the MACE 2. The Cognitive Exam 1 is on MACE 2, page 5, and covers part 5, orientation, and part 6, immediate memory (Figure 22-13).

Orientation comprises several time and date questions to ask the casualty. Score each correct answer 1 point and each incorrect answer 0 points. Write the sum of correct answers (out of 5 possible points) in the box.

Before starting the immediate memory section, choose any one of the six word lists (A–F) shown in colored boxes. Use only this list for the rest of the MACE 2. The lists are color coded and named with a letter to help you remember which list to use for the rest of the MACE 2. The memory test consists of three trials. For the first trial, read the trial 1 script to the casualty and then read the list of words you selected. Mark each



MACE 2 - Military Acute Concussion Evaluation

NEUROLOGICAL EXAM

7. Speech Fluency
☐ Normal
☐ Abnormal
❑ Speech should be fluid and effortless – no pauses or unnatural breaks.
– Stuttering or struggling to speak is abnormal.

8. Word Finding
☐ Normal
☐ Abnormal
❑ Assess difficulties with word finding:
– Difficulty in coming up with the name of an object or grasping to find words is abnormal.

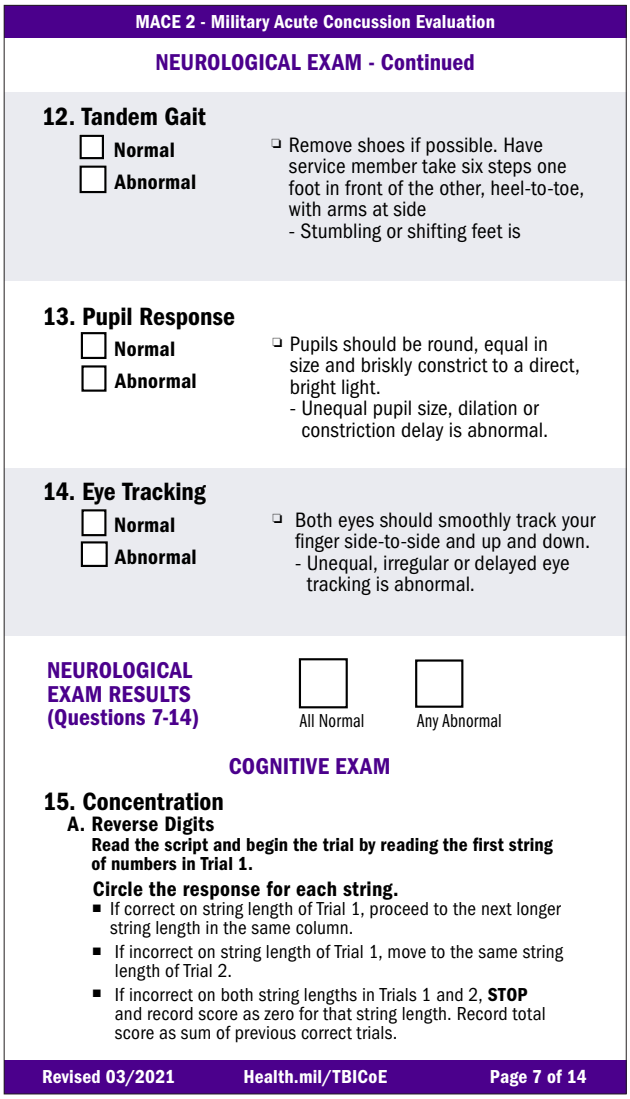
9. Grip Strength
☐ Normal
☐ Abnormal
❑ Assess grip strength. Grip strength should be strong and equal bilaterally.
– Unequal or weak grip strength is abnormal.

10. Pronator Drift
☐ Normal
☐ Abnormal
❑ Direct service member to stand with eyes closed and arms extended forward, parallel to the ground with palms up. Assess for 5 to 10 seconds:
– Any arm or palm drift is abnormal.

11. Single Leg Stance
☐ Normal
☐ Abnormal
❑ Remove shoes if possible. Have service member stand on one leg, arms across chest, hands touching shoulders, eyes open initially. Once service member is balanced, have them close their eyes and time for 15 seconds how long they can maintain their balance. Repeat test with opposite leg.
– Loss of balance on either leg before 8 seconds is abnormal.

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Figure 22-14. Military Acute Concussion Evaluation II, page 6.



MACE 2 - Military Acute Concussion Evaluation

NEUROLOGICAL EXAM - Continued

12. Tandem Gait
☐ Normal
☐ Abnormal
❑ Remove shoes if possible. Have service member take six steps one foot in front of the other, heel-to-toe, with arms at side
- Stumbling or shifting feet is

13. Pupil Response
☐ Normal
☐ Abnormal
❑ Pupils should be round, equal in size and briskly constrict to a direct, bright light.
- Unequal pupil size, dilation or constriction delay is abnormal.

14. Eye Tracking
☐ Normal
☐ Abnormal
❑ Both eyes should smoothly track your finger side-to-side and up and down.
- Unequal, irregular or delayed eye tracking is abnormal.

NEUROLOGICAL EXAM RESULTS (Questions 7-14)
☐ All Normal ☐ Any Abnormal

COGNITIVE EXAM

15. Concentration
A. Reverse Digits
Read the script and begin the trial by reading the first string of numbers in Trial 1.
Circle the response for each string.
- If correct on string length of Trial 1, proceed to the next longer string length in the same column.
- If incorrect on string length of Trial 1, move to the same string length of Trial 2.
- If incorrect on both string lengths in Trials 1 and 2, **STOP** and record score as zero for that string length. Record total score as sum of previous correct trials.

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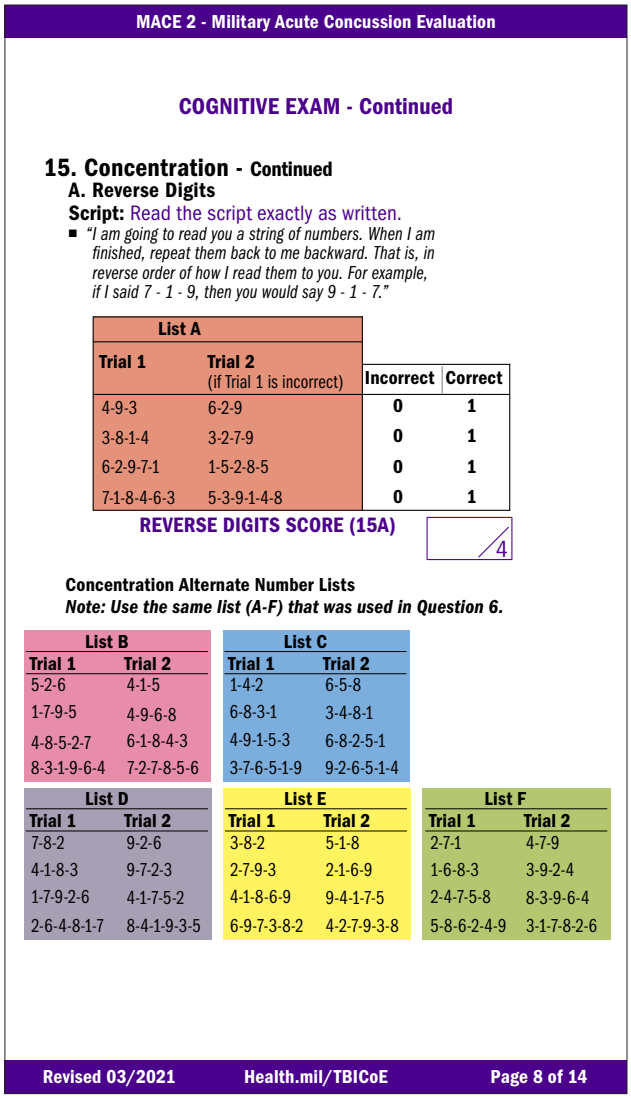
Figure 22-15. Military Acute Concussion Evaluation II, page 7.

correct word under trial 1 in the scoring box. Read the second script for trials 2 and 3. Mark the correct answers in the respective score boxes. Write the sum of correct answers for all three trials (out of 15 possible points) in the scoring box. Remember that the order of words recalled by the casualty does not matter (only the number of correct answers is required).

Neurological Exam

The neurological exam consists of eight parts, beginning on MACE 2, page 6. Parts 7 through 11 are covered on this page (Figure 22-14). This is an assessment of speech fluency, word finding, grip strength, **pronator drift**, and single leg stance. Follow the instructions on the right, which also give brief descriptions of abnormal responses. Mark each activity box with your assessment (normal or abnormal) of the casualty's performance.

The neurological exam continues on MACE 2, page 7, with the remaining parts (12–14) and the scoring (Figure 22-15). The pattern is the same as for the first 11 parts: assess the activities for **tandem gait**, pupil response, and eye tracking using the instructions and descriptions of abnormality on the right side of the card. To score the neurological exam, add the number of normal responses for questions 7 through 14 and put the number in the "all normal" box. Then add the number of abnormal responses and put the number in the "any abnormal" box.



MACE 2 - Military Acute Concussion Evaluation

COGNITIVE EXAM - Continued

15. Concentration - Continued

A. Reverse Digits

Script: Read the script exactly as written.

- *"I am going to read you a string of numbers. When I am finished, repeat them back to me backward. That is, in reverse order of how I read them to you. For example, if I said 7 - 1 - 9, then you would say 9 - 1 - 7."*

List A			
Trial 1	**Trial 2** (if Trial 1 is incorrect)	**Incorrect**	**Correct**
4-9-3	6-2-9	0	1
3-8-1-4	3-2-7-9	0	1
6-2-9-7-1	1-5-2-8-5	0	1
7-1-8-4-6-3	5-3-9-1-4-8	0	1

REVERSE DIGITS SCORE (15A) ___/4

Concentration Alternate Number Lists

Note: Use the same list (A-F) that was used in Question 6.

List B	
Trial 1	**Trial 2**
5-2-6	4-1-5
1-7-9-5	4-9-6-8
4-8-5-2-7	6-1-8-4-3
8-3-1-9-6-4	7-2-7-8-5-6

List C	
Trial 1	**Trial 2**
1-4-2	6-5-8
6-8-3-1	3-4-8-1
4-9-1-5-3	6-8-2-5-1
3-7-6-5-1-9	9-2-6-5-1-4

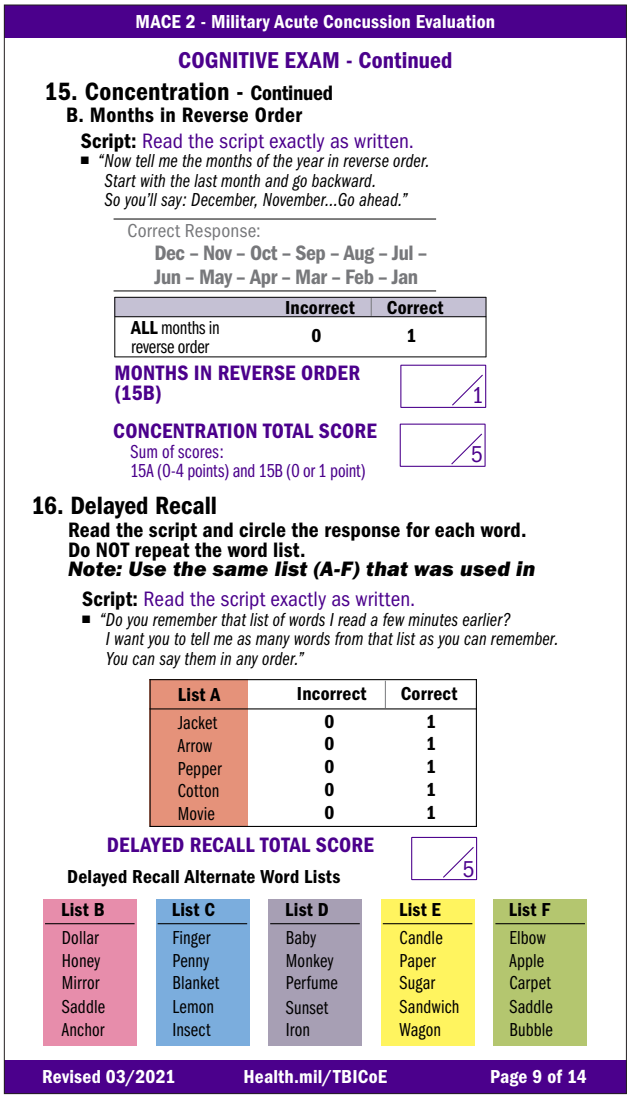
List D	
Trial 1	**Trial 2**
7-8-2	9-2-6
4-1-8-3	9-7-2-3
1-7-9-2-6	4-1-7-5-2
2-6-4-8-1-7	8-4-1-9-3-5

List E	
Trial 1	**Trial 2**
3-8-2	5-1-8
2-7-9-3	2-1-6-9
4-1-8-6-9	9-4-1-7-5
6-9-7-3-8-2	4-2-7-9-3-8

List F	
Trial 1	**Trial 2**
2-7-1	4-7-9
1-6-8-3	3-9-2-4
2-4-7-5-8	8-3-9-6-4
5-8-6-2-4-9	3-1-7-8-2-6

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Figure 22-16. Military Acute Concussion Evaluation II, page 8.



MACE 2 - Military Acute Concussion Evaluation

COGNITIVE EXAM - Continued

15. Concentration - Continued

B. Months in Reverse Order

Script: Read the script exactly as written.

- *"Now tell me the months of the year in reverse order. Start with the last month and go backward. So you'll say: December, November...Go ahead."*

Correct Response:
Dec – Nov – Oct – Sep – Aug – Jul – Jun – May – Apr – Mar – Feb – Jan

	Incorrect	Correct
ALL months in reverse order	0	1

MONTHS IN REVERSE ORDER (15B) ___/1

CONCENTRATION TOTAL SCORE ___/5
Sum of scores:
15A (0-4 points) and 15B (0 or 1 point)

16. Delayed Recall

Read the script and circle the response for each word. Do NOT repeat the word list.
Note: Use the same list (A-F) that was used in

Script: Read the script exactly as written.

- *"Do you remember that list of words I read a few minutes earlier? I want you to tell me as many words from that list as you can remember. You can say them in any order."*

List A	Incorrect	Correct
Jacket	0	1
Arrow	0	1
Pepper	0	1
Cotton	0	1
Movie	0	1

DELAYED RECALL TOTAL SCORE ___/5

Delayed Recall Alternate Word Lists

List B	List C	List D	List E	List F
Dollar	Finger	Baby	Candle	Elbow
Honey	Penny	Monkey	Paper	Apple
Mirror	Blanket	Perfume	Sugar	Carpet
Saddle	Lemon	Sunset	Sandwich	Saddle
Anchor	Insect	Iron	Wagon	Bubble

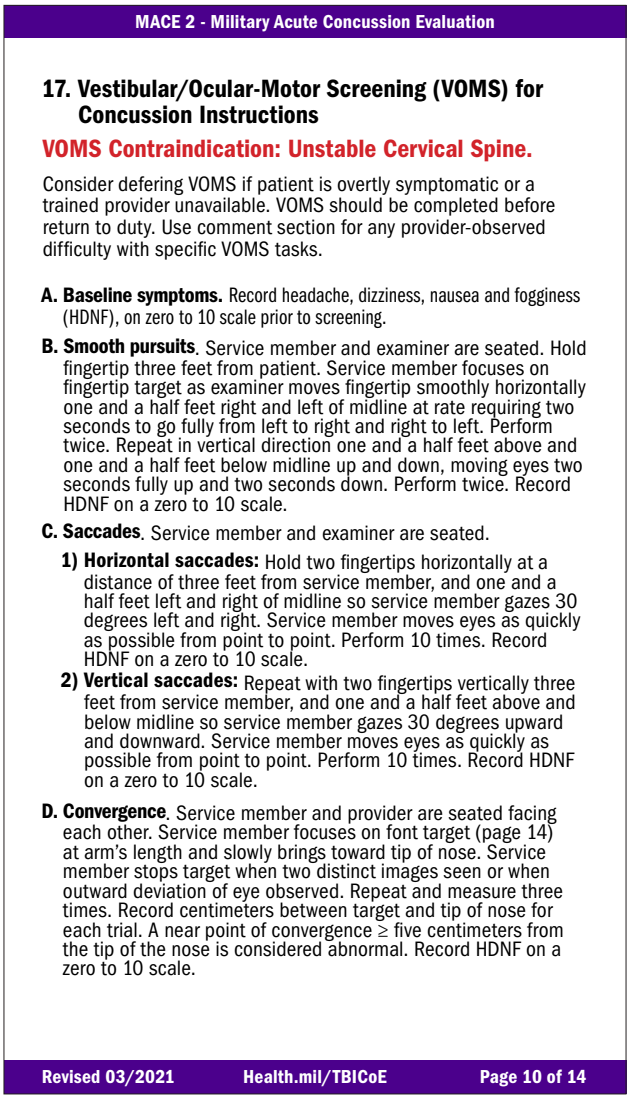
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Figure 22-17. Military Acute Concussion Evaluation II, page 9.

Cognitive Exam 2

The cognitive exam 2 begins on MACE 2, page 7 (see Figure 22-15), with part 15, concentration. Part 15, section A, checks the casualty's ability to recall a string of digits in reverse order. To conduct this test, find the script and the list of number strings on MACE 2, page 8 (Figure 22-16). Remember to use the same list (color and letter) as previously selected for cognitive exam 1. Read the script to the casualty and then read the first string on trial 1. Ask the soldier to tell you the numbers in reverse order. If the casualty is correct, move to the next string. If the casualty gets a string wrong, read the same string from the trial 2 column and have the casualty try again. If the casualty gets a string right, circle the number in the correct column aligned with the string they used. If the casualty answers incorrectly on trials 1 or 2, circle the zero in the incorrect column aligned with the string. Once the casualty completes all four strings, tally the score and annotate in the reverse digits score block provided on MACE 2, page 8 (see Figure 22-16).

Part 15, section B, of cognitive exam 2 is on MACE 2, page 9 (Figure 22-17). It checks the casualty's ability to remember months in reverse order. Read the script to the casualty and have them start at December and go backward. They must get all months right to get a point for this section. Mark zero (one or more incorrect months) or one (all months correct in reverse order) in the months in reverse order box. Now, add the



MACE 2 - Military Acute Concussion Evaluation

17. Vestibular/Ocular-Motor Screening (VOMS) for Concussion Instructions

VOMS Contraindication: Unstable Cervical Spine.

Consider defering VOMS if patient is overtly symptomatic or a trained provider unavailable. VOMS should be completed before return to duty. Use comment section for any provider-observed difficulty with specific VOMS tasks.

A. Baseline symptoms. Record headache, dizziness, nausea and fogginess (HDNF), on zero to 10 scale prior to screening.

B. Smooth pursuits. Service member and examiner are seated. Hold fingertip three feet from patient. Service member focuses on fingertip target as examiner moves fingertip smoothly horizontally one and a half feet right and left of midline at rate requiring two seconds to go fully from left to right and right to left. Perform twice. Repeat in vertical direction one and a half feet above and one and a half feet below midline up and down, moving eyes two seconds fully up and two seconds down. Perform twice. Record HDNF on a zero to 10 scale.

C. Saccades. Service member and examiner are seated.

1) Horizontal saccades: Hold two fingertips horizontally at a distance of three feet from service member, and one and a half feet left and right of midline so service member gazes 30 degrees left and right. Service member moves eyes as quickly as possible from point to point. Perform 10 times. Record HDNF on a zero to 10 scale.

2) Vertical saccades: Repeat with two fingertips vertically three feet from service member, and one and a half feet above and below midline so service member gazes 30 degrees upward and downward. Service member moves eyes as quickly as possible from point to point. Perform 10 times. Record HDNF on a zero to 10 scale.

D. Convergence. Service member and provider are seated facing each other. Service member focuses on font target (page 14) at arm's length and slowly brings toward tip of nose. Service member stops target when two distinct images seen or when outward deviation of eye observed. Repeat and measure three times. Record centimeters between target and tip of nose for each trial. A near point of convergence ≥ five centimeters from the tip of the nose is considered abnormal. Record HDNF on a zero to 10 scale.

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Figure 22-18. Military Acute Concussion Evaluation II, page 10.

points for part 15, sections A and B, and put them in the concentration total score box showing 5 possible points. This completes part 15.

Part 16, delayed recall, is also on MACE 2, page 9 (see Figure 22-17). The list of words for this test is the same used in cognitive test 1. Make sure to use the same list (identified by color and letter). Read the script to the casualty and mark the number of words they remember out of five total. Mark the score in the delayed recall total score box.

Vestibular/Ocular-Motor Screening for Concussion

Part 17, VOMS, covers several pages, but it begins on MACE 2, page 10 (Figure 22-18). The VOMS test may be deferred if the patient has overt symptoms or if there is no available trained provider. Complete VOMS before return to duty.

> **Warning:** Unstable cervical spine is a contraindication for VOMS (see Figure 22-17).

Before beginning the screening exam, collect baseline data for headache, dizziness, nausea, and fogginess (**HDNF**) on a 0-to-10 scale (section 17.A). Record the results for each symptom on the VOMS score card, located on MACE 2, page 12 (Figure 22-19).

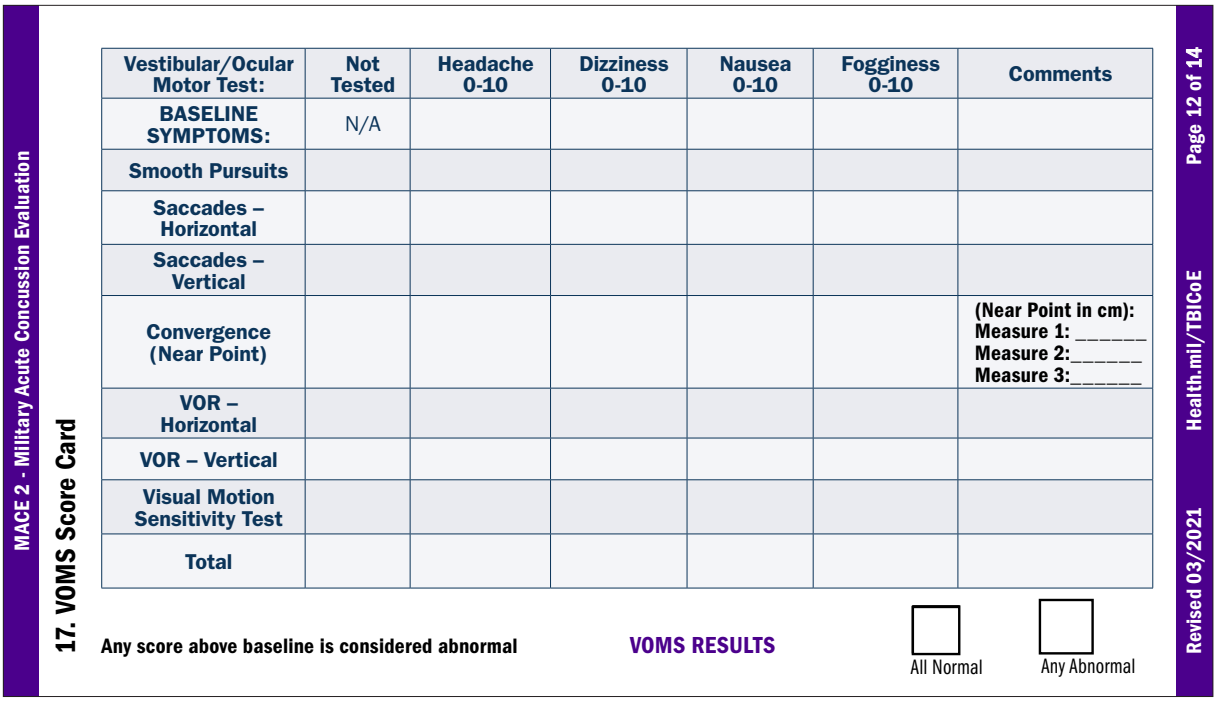
The remainder of the VOMS test will comprise assessment and recording of HDNF on the VOMS scorecard after the casualty performs specified tasks. The number of times the casualty is required to perform a test before HDNF assessment is completed varies, so be sure to follow the instructions carefully. Use the comments section on the VOMS scorecard to record any provider-observed difficulty with completing the tasks.

Part 17, section B, smooth **pursuits**; part 17, section C, **saccades**; and part 17, section D, **convergence**, are explained on MACE 2, page 10 (see Figure 22-17). Be sure to follow the instructions exactly as stated. Part 17, sections B and C, require testing pursuits on both horizontal and vertical planes, although only for saccades are the results recorded separately for vertical and horizontal tests. The convergence test (part 17, section D) requires a centimeter scale to measure distance. A scale is included on MACE 2, page 14 (Figure 22-20).

The remainder of part 17, VOMS testing, is on MACE 2, page 11 (Figure 22-21). It covers part 17, section E, vestibular-ocular reflex (**VOR**) test; and part 17, section F, visual motion sensitivity (**VMS**) test. A metronome is required to conduct this testing. The VOR test requires the font target from MACE 2, page 14 (see Figure 22-20). Use the font target as a focus point for the casualty during the repetitions of the test. Record both horizontal and vertical scores for the VOR test on the VOMS scorecard. Conduct the VMS test in a location where the casualty can face a busy area. After all repetitions are completed, record HDNF assessment on the VOMS score card.

Exam Summary

The exam summary (MACE 2, page 13) compiles all numeric data gathered during the assessment (Figure 22-22). Fill out the summary with the results from each of the previous five areas of the MACE 2.



MACE 2 - Military Acute Concussion Evaluation

17. VOMS Score Card

Vestibular/Ocular Motor Test:	Not Tested	Headache 0-10	Dizziness 0-10	Nausea 0-10	Fogginess 0-10	Comments
BASELINE SYMPTOMS:	N/A					
Smooth Pursuits						
Saccades – Horizontal						
Saccades – Vertical						
Convergence (Near Point)						(Near Point in cm): Measure 1: _____ Measure 2:_____ Measure 3:_____
VOR – Horizontal						
VOR – Vertical						
Visual Motion Sensitivity Test						
Total						

Any score above baseline is considered abnormal

VOMS RESULTS ☐ All Normal ☐ Any Abnormal

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Figure 22-19. Military Acute Concussion Evaluation II, page 12.

The MACE 2 cognitive assessment algorithm provides a numerical score with a maximum of 30 points. Nonconcussed individuals are those with a mean total score of 28/30 or better. A score of less than 28 does not imply that a concussion occurred; however, in the absence of baseline testing, a score of 25 or below is the best indicator for true cognitive impairment resulting from a concussion.

After completing MACE 2, there are several additional tasks:

- Document MACE 2 results in the electronic health record with coding instructions from MACE 2, page 14 (see Figure 22-20).
- Initiate a 24-hour rest period for the patient.
- Refer to the Concussion Management Tool for recommendations based on MACE 2 results.
- Initiate the Progressive Return to Activity (PRA) clinical recommendation beginning with initial concussion management, including 24-hours rest (see Figure 22-22).

Additional Uses

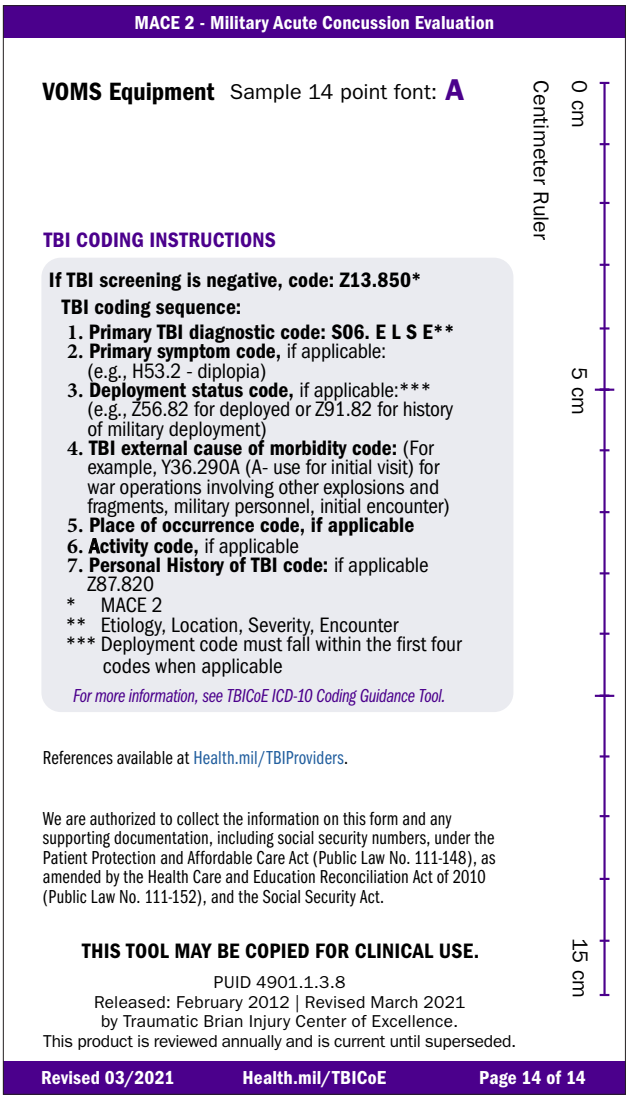
The concussion screening results can be used to determine whether further evaluation for TBI is indicated. Based on the casualty's signs and symptoms, the screening results will help medical providers determine if evacuation to a higher level of care is necessary.

Check on Learning

10. For which casualties should MACE 2 be performed?
11. Where and when should MACE 2 be performed?

TREAT A CASUALTY WITH A SUSPECTED HEAD INJURY

For casualties with head injuries, combat medics should focus on MARCH and then treat scalp, skull, and facial injuries. In combat situations, casualties with head injuries usually will be transported to higher roles of care. Managing TBI is difficult in a garrison environment; and in combat conditions, identification and treatment are even harder. Many of these injuries are overlooked initially because they are secondary to another injury. Primary injuries are usually obvious. Secondary injuries are harder to identify because they can take up to 36 hours to present.



MACE 2 - Military Acute Concussion Evaluation

VOMS Equipment Sample 14 point font: **A**

Centimeter Ruler 0 cm 5 cm 15 cm

TBI CODING INSTRUCTIONS

If TBI screening is negative, code: Z13.850*

TBI coding sequence:

1. **Primary TBI diagnostic code: S06. E L S E****
2. **Primary symptom code,** if applicable: (e.g., H53.2 - diplopia)
3. **Deployment status code,** if applicable:*** (e.g., Z56.82 for deployed or Z91.82 for history of military deployment)
4. **TBI external cause of morbidity code:** (For example, Y36.290A (A- use for initial visit) for war operations involving other explosions and fragments, military personnel, initial encounter)
5. **Place of occurrence code, if applicable**
6. **Activity code,** if applicable
7. **Personal History of TBI code:** if applicable Z87.820

* MACE 2
** Etiology, Location, Severity, Encounter
*** Deployment code must fall within the first four codes when applicable

For more information, see TBICoE ICD-10 Coding Guidance Tool.

References available at Health.mil/TBIProviders.

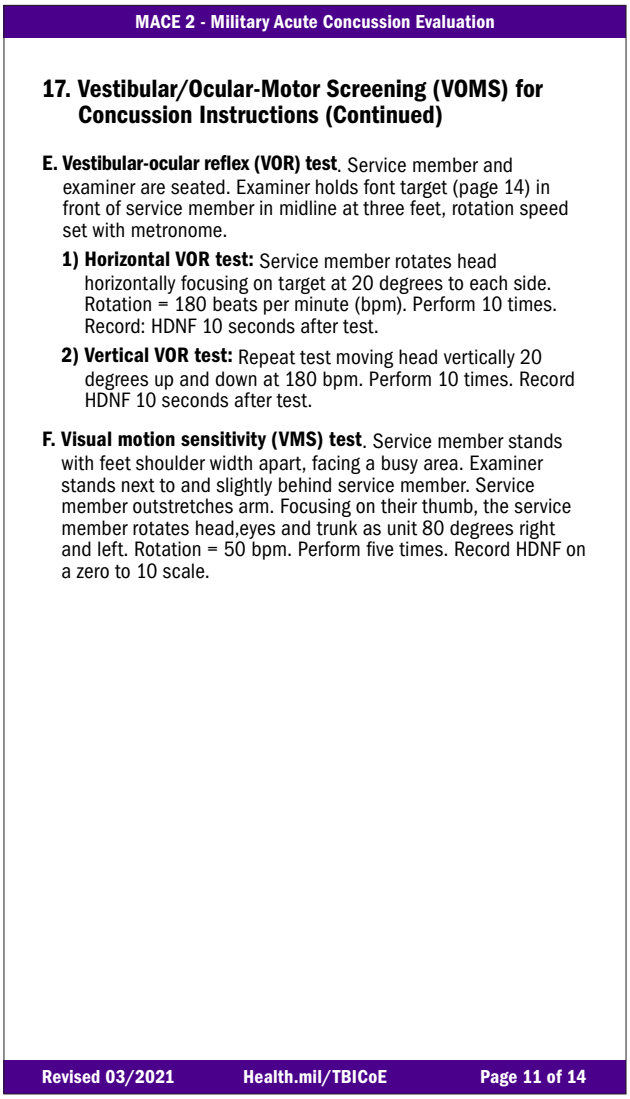
We are authorized to collect the information on this form and any supporting documentation, including social security numbers, under the Patient Protection and Affordable Care Act (Public Law No. 111-148), as amended by the Health Care and Education Reconciliation Act of 2010 (Public Law No. 111-152), and the Social Security Act.

THIS TOOL MAY BE COPIED FOR CLINICAL USE.

PUID 4901.1.3.8
Released: February 2012 | Revised March 2021
by Traumatic Brian Injury Center of Excellence.
This product is reviewed annually and is current until superseded.

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Figure 22-20. Military Acute Concussion Evaluation II, page 14.



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17. Vestibular/Ocular-Motor Screening (VOMS) for Concussion Instructions (Continued)

E. Vestibular-ocular reflex (VOR) test. Service member and examiner are seated. Examiner holds font target (page 14) in front of service member in midline at three feet, rotation speed set with metronome.

1) Horizontal VOR test: Service member rotates head horizontally focusing on target at 20 degrees to each side. Rotation = 180 beats per minute (bpm). Perform 10 times. Record: HDNF 10 seconds after test.

2) Vertical VOR test: Repeat test moving head vertically 20 degrees up and down at 180 bpm. Perform 10 times. Record HDNF 10 seconds after test.

F. Visual motion sensitivity (VMS) test. Service member stands with feet shoulder width apart, facing a busy area. Examiner stands next to and slightly behind service member. Service member outstretches arm. Focusing on their thumb, the service member rotates head,eyes and trunk as unit 80 degrees right and left. Rotation = 50 bpm. Perform five times. Record HDNF on a zero to 10 scale.

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Figure 22-21. Military Acute Concussion Evaluation II, page 11.

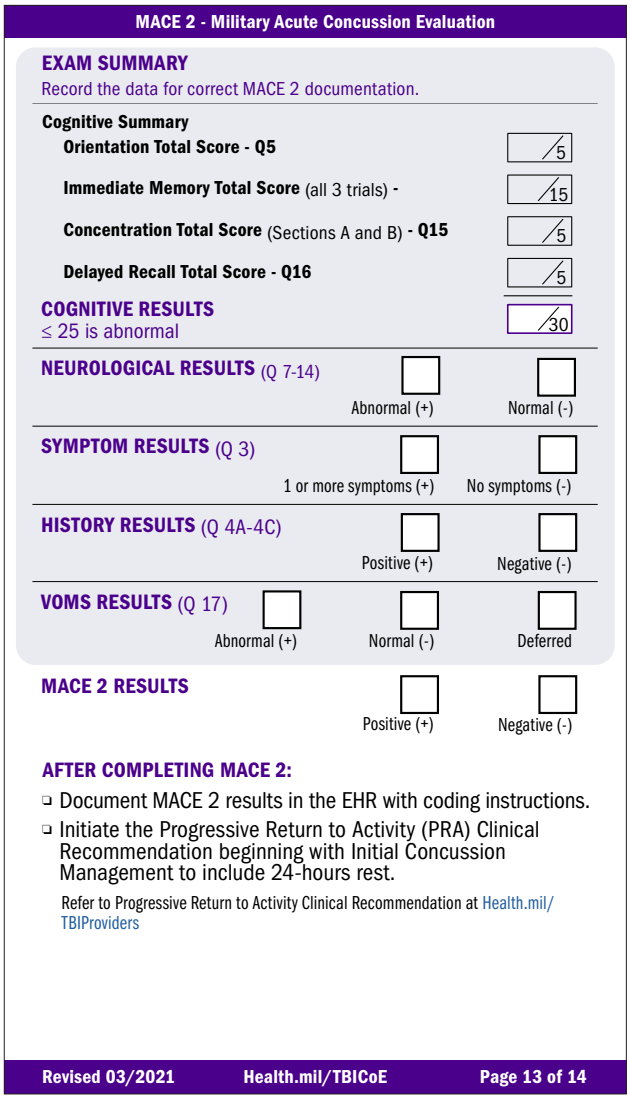
Special Considerations

- Suspect brain or cervical spine injuries for all head, face, and neck wounds.
- Do not attempt to clean the surface of a scalp wound. To do so may cause additional bleeding.
- Do not remove impaled objects; stabilize them in place.
- Gently palpate for depressions.
- Facial trauma can be associated with alterations in consciousness and severe trauma to the brain.

Treatment

Caution: Do not lift or attempt to wrap the head of a casualty who is lying down if there are signs of a spinal injury or if the mechanism of injury was a motor vehicle crash, a fall greater than 15 ft, or an **IED** blast involving an **MRAP**. Neck movement may worsen a spinal injury.

1. Control life-threatening hemorrhage.
2. If the tactical situation allows, protect for possible neck and spinal injuries.



MACE 2 - Military Acute Concussion Evaluation

EXAM SUMMARY

Record the data for correct MACE 2 documentation.

Cognitive Summary

Orientation Total Score - Q5 ☐ /5

Immediate Memory Total Score (all 3 trials) - ☐ /15

Concentration Total Score (Sections A and B) - **Q15** ☐ /5

Delayed Recall Total Score - Q16 ☐ /5

COGNITIVE RESULTS ☐ /30
≤ 25 is abnormal

NEUROLOGICAL RESULTS (Q 7-14) ☐ Abnormal (+) ☐ Normal (-)

SYMPTOM RESULTS (Q 3) ☐ 1 or more symptoms (+) ☐ No symptoms (-)

HISTORY RESULTS (Q 4A-4C) ☐ Positive (+) ☐ Negative (-)

VOMS RESULTS (Q 17) ☐ Abnormal (+) ☐ Normal (-) ☐ Deferred

MACE 2 RESULTS ☐ Positive (+) ☐ Negative (-)

AFTER COMPLETING MACE 2:

- ❑ Document MACE 2 results in the EHR with coding instructions.
- ❑ Initiate the Progressive Return to Activity (PRA) Clinical Recommendation beginning with Initial Concussion Management to include 24-hours rest.

Refer to Progressive Return to Activity Clinical Recommendation at Health.mil/TBIProviders

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Figure 22-22. Military Acute Concussion Evaluation II, page 13.

3. Manage the airway.

Warning: A nasopharyngeal airway is contraindicated if there is any evidence of a head injury that includes basal skull fracture; maxillofacial trauma; exposed brain matter; or CSF draining from nose, mouth, or ears.

   a. Consider manual maneuvers; if those are unsuccessful, take more invasive action.
   b. Be prepared to suction. The airway may be compromised by either structural changes resulting from trauma or from fluid or objects in the airway. Trauma to the face can cause fractures or displacement of teeth into the airway; TBI and hypovolemic shock may lead to vomiting that will also compromise the airway.
   c. Use normal tidal volume (350–500 mL) and ventilation rates when assisting appropriate ventilation:
      i. Adults: 10 breaths per minute.
      ii. Children: 20 breaths per minute.
      iii. Infants: 25 breaths per minute.
4. Manage breathing.
   a. If the casualty shows signs of increased ICP, ventilate at a rate of approximately 20 breaths per minute.
   b. If available, administer supplemental oxygen.
   c. Maintain oxygen saturation of 90% or greater.

Caution: Hyperventilation can worsen the outcome of casualties with head injuries.

5. Manage circulation.
   a. Do not apply pressure dressings to depressed or open skull fractures. If significant hemorrhage is present, use only sufficient pressure to stop the flow of blood.
   b. For soft-tissue injuries, control bleeding with pressure on the edges of the wound.
   c. For complex scalp wounds, several gauze pads held in place by an elastic roller bandage creates an effective pressure dressing to control bleeding.
   d. Hemostatic gauze may be effective in controlling bleeding.
   e. Do not attempt to clean the surface of a scalp wound; it may cause additional bleeding.
6. Manage shock. Follow the fluid resuscitation algorithm presented in Chapter 20, Shock.
   a. If the casualty has an altered mental status due to suspected TBI and has a weak or absent radial pulse, resuscitate as necessary to restore and maintain a normal radial pulse.
   b. If blood pressure monitoring is available, maintain a target systolic pressure of at least 90 mmHg.
   c. Do not delay transport to establish intravenous access.

Note: The combination of hypoxia and hypotension is associated with a mortality rate of about 44%.[5]

7. Administer pain control as required.
   a. Due to morphine's effect on ICP and pupillary response, it is **not** recommended in patients with suspected brain injury.

Note: The respiratory depressant effects of morphine and its potential to cause carbon dioxide retention may cause vasodilation, which increases cerebrospinal fluid pressure. Morphine produces effects that may obscure neurologic signs of increased ICP and makes it difficult to do a neurologic assessment, which includes pupillary response.

   b. Both ketamine and fentanyl could make moderate to severe TBI worse but can be used with mTBI. If the casualty is aware and able to vocalize pain, then the TBI is likely not too severe to prevent their use.
8. Conduct a detailed physical exam (secondary assessment).
   a. Inspect for **DCAP-BTLS** and palpate **TIC**.
   b. Treat any wounds not previously addressed.

Note: Ketamine has fewer cognitive adverse side effects than morphine, but it is still an effective analgesic that also allows you to better assess for signs of increased ICP. While it may increase ICP and cause respiratory depression, it is far less likely to occur than with morphine. Fentanyl is an opioid and is likely to cause respiratory depression. However, fentanyl is more effective, has a rapid onset, is easier to administer, and is safer (less likelihood of overdosing).

Note: An increase in ICP can crush brain tissue, shift brain structures, and restrict blood flow, which could cause an intracranial hematoma.

      i. Do not apply pressure dressings to depressed or open skull fractures; use only sufficient pressure to stop the flow of blood.
      ii. A "donut" can keep pressure off a depressed or open skull fracture.
      iii. Hemostatic gauze may be effective in controlling bleeding scalp lacerations.
      iv. Avoid wrapping gauze or dressings around the casualty's eyes and ears.

Note: Do not pack depressed or open skull fractures with a hemostatic agent.

      v. Ensure the airway is not compromised.
   c. Inspect the casualty's mouth, nose, and ears.
   d. Look for CSF and for clear or bloody fluid from the ears or nose.
   h. If you see swelling or discoloration behind the ear (Battle's sign), consider basal skull fracture.
   i. If you see swelling or discoloration around both eyes (raccoon eyes), consider basal skull fracture.
   j. Look at the pupils.
      i. A difference of greater than 1.0 mm in pupil size is considered abnormal.
      ii. Development of a sluggish or nonreactive pupil is considered abnormal.
      iii. Brainstem injury is probable if both pupils are dilated and do not react to light.
      iv. If the pupils are dilated but react to light, the injury is often reversible.
      v. Dilated pupils that may or may not react to light may be caused by reasons other than a head injury. These include hypothermia, anoxia (total or near total lack of oxygen), lightning strike, optic nerve injury, trauma to the eye, and drug effects.
      vi. If the patient has a normal LOC, dilated pupils are not due to head injury. Look for other causes—reassess the casualty.

Make decisions on casualty management based on changes in all parameters of the physical and neurological examination. Future decisions on treatments depend on baseline evaluations and observed changes.

PREPARE A CASUALTY WITH A SUSPECTED HEAD INJURY FOR TRANSPORT

The casualty will require transport to a medical treatment facility with neurosurgical capabilities. The casualty is an Urgent Surgical priority. If possible, relay the fact that the Urgent Surgical priority is due to a neurological issue. The steps to prepare a casualty for transportation are as follows:

1. Prepare the casualty to prevent hypothermia.
2. Place the casualty in a supine position on an evacuation device.
3. If a facial wound is present, tilt the casualty toward the side of the injury to allow for drainage.
4. Although elevating the head (reverse Trendelenburg) may decrease ICP, it may jeopardize cerebral perfusion, especially when the head is elevated greater than 30 degrees.
5. Do not delay transport to gain vascular access.
6. Reassess the casualty.
7. Obtain vital signs and document them.
8. Reassess until MEDEVAC is complete.
    a. Taking several sets of vital signs and looking for trends are important. Changes in vital signs may indicate changes in ICP.
    b. Increasing ICP causes Cushing's triad (Cushing's phenomenon): increase in blood pressure (hypertension), decrease in pulse rate (bradycardia), and changed respiratory rate (increase, decrease, and/or become irregular).

Warning: Low blood pressure (hypotension) caused by a head injury is usually a terminal event. Hypovolemic shock does not result from an isolated head injury; look for another cause of the hypovolemia.

Note: Do not delay transport to gain vascular access.

Check on Learning

12. Should you hyperventilate a casualty with a head injury?
13. How should you transport a casualty with a head injury?
14. What is the definitive treatment facility for a casualty suffering from a head injury?
15. How should you manage a casualty with a head injury who is in shock due to the trauma?
16. A casualty with a head injury exhibits increasing ICP. What do you expect the casualty's vital signs to do?

SUMMARY

Head injuries occur in all situations, from recreational accidents to combat injuries, and may be life threatening. You must know that the most important principles of managing head-injured casualties are rapid assessment, adequate MARCH management, treatment of decreased LOC, rapid transport to the appropriate echelon of care, and frequent reassessment. Quick action can save lives and reduce the risk of long-term impacts.

KEY TERMS AND ACRONYMS

Anoxia. An absence of oxygen.

AVPU. Alert, verbal, pain, or unconscious.

Computed tomography. A diagnostic imaging test that creates detailed 3-dimensional images of organs, soft tissue, bones, and blood vessels. Computed tomography uses narrow beams of ionizing radiation that are rotated around the body to generate the image. Known as CT or CAT scan.

Convergence. The ability to focus on a near object (less than 5 cm from the tip of the nose) without having double vision.

CSF. Cerebrospinal fluid.

CT. Computed tomography.

DCAP-BTLS. Deformities, contusions, abrasions, penetrations, burns, tenderness, lacerations, and swelling.

Epidural hematoma. An accumulation of blood between the skull and the outer covering of the brain.

GCS. Glasgow Coma Scale.

Glasgow Coma Scale. The GCS is a quick, descriptive assessment of the level of consciousness in a casualty who has suffered TBI.

HDNF. Headache, dizziness, nausea, and fogginess.

ICP. Intracranial pressure.

LOC. Level of consciousness.

MACE 2. Military Acute Concussion Evaluation 2.

Magnetic resonance imaging. A diagnostic imaging test that creates detailed 3-dimensional images, particularly of soft tissues. MRIs produce clearer images of the brain and spinal cord than CT scans. MRIs use magnetic fields and radiofrequency currents rather than ionizing radiation.

Military Acute Concussion Evaluation 2. The standardized method for evaluating acute mild TBI in military operational settings.

MRI. Magnetic resonance imaging.

Pronator drift. A part of the MACE 2 neurological exam that identifies abnormal palm or arm movement.

Pursuits. Smooth eye movements that occur while watching a moving object, such as tracking cars moving through an intersection.

Saccades. Rapid eye movements that shift focus between fixed objects. A familiar example is the movement your eyes make from word to word during reading.

Subarachnoid hemorrhage. Bleeding between the brain and the meninges (tissues) that cover the brain.

Subdural hematoma. A collection of blood on the surface of the brain.

Tandem gait. Walking or moving heel to toe in a straight line.

TBI. Traumatic brain injury.

TIC. Tenderness, instability, and crepitus.

VMS. Visual motion sensitivity. A part of the VOMS test that evaluates visual motion sensitivity (HDNF) when the patient changes body positions.

VOMS. Vestibular/ocular-motor screening. A test that helps detect concussion by evaluating the patient's integration of vision, balance, and movement.

VOR. Vestibular-ocular reflex. A part of the VOMS test that evaluates the patient's ability to stabilize their vision (does not experience HDNF) after moving their head vertically or horizontally.

CHECK ON LEARNING ANSWERS

1. What is the primary sign of a scalp injury?

   Profuse bleeding.

2. State the levels of TBI.

   Mild (mTBI), moderate, and severe.

3. Is a loss of consciousness required to make a possible diagnosis of a concussion?

   No.

4. List 6 signs a casualty may display if suffering from a TBI.

   Any six of the following: vacant stare, delayed verbal response, confusion and inability to focus attention, disorientation, slurred or incoherent speech, lack of coordination (stumbling or dizziness), inappropriate emotions to the circumstances, short-term memory deficits (casualty repeats the same questions), and inability to memorize and recall.

5. List all the RED FLAGS of TBI.

   Witnessed loss of consciousness, two or more blast exposures within 72 hours, amnesia or memory problems, unusual behavior (eg, unnecessarily combative), unequal pupils, seizures, repeated vomiting, double vision or loss of vision, worsening headache, weakness on one side of the body, inability to recognize people or disorientation to place, and unsteady on feet.

6. Why is it important to take serial GCS assessments (initial assessment and multiple reassessments) throughout casualty care?

   To establish a baseline LOC and to be able to identify the hallmark signs of a brain injury.

7. You assess your casualty's pupils as dilated and nonreactive to light. What does this tell you?

   A brainstem injury is probable.

8. Your casualty opens her own eyes and can hold up two fingers when you tell her to but does not understand who you are or what happened. What is her GCS score?

   14 (E:4, V:4, M6).

9. Upon reassessment, the same casualty slaps your hand away when you pinch the back of her arm. She looks at you only if you yell to get her attention but gives inappropriate responses. She will not show you two fingers. What does this casualty's GCS score tell you about her condition?

   Her condition is deteriorating. Her GCS score is now 11 (E:3, V3, M5).

10. For which casualties should MACE 2 be performed?

    Any service member who was in a vehicle associated with a blast event, collision, or rollover; was within 50 m of a blast (inside or outside); sustained a direct blow to the head; or was directed to receive MACE 2 by the commander, including those who sustained repeated exposures.

11. Where and when should MACE 2 be performed?

    At a battalion aid station (or higher) as soon as possible after the injury. It is not performed during care under fire or during tactical field care phases.

12. Should you hyperventilate a casualty with a head injury?

    No. It can worsen the outcome.

13. How should you transport a casualty with a head injury?

    Protected from hypothermia and in a supine position.

14. What is the definitive treatment facility for a casualty suffering from a head injury?

    A medical facility with neurosurgical capabilities.

15. How should you manage a casualty with a head injury, who is in shock due to the trauma?

    Follow the fluid resuscitation algorithm (see Chapter 20, Shock). If the casualty has an altered mental status due to suspected TBI and has a weak or absent radial pulse, resuscitate as necessary to restore and maintain a normal radial pulse. Do not delay transport to establish IV access.

16. A casualty with a head injury exhibits increasing ICP. What do you expect the casualty's vital signs to do?

    Blood pressure increases; pulse rate decreases; and respiratory rate increases, decreases, and/or becomes irregular.

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23 OCULAR INJURIES

CORE CONCEPTS

- Assess a casualty with an eye injury.
- Identify various ocular injuries.
- Evaluate and manage a ballistic eye injury.
- Describe the steps to irrigate an eye injury.
- Treat an ocular injury.

INTRODUCTION

On the battlefield, combat medics may encounter a casualty with an injury to the eye or surrounding soft tissues. The immediate goals in treatment of ocular injuries are protecting the intact portions of the visual system while avoiding further injury and accurately assessing the extent of injury. Refer these casualties to a medical officer (MO) for evaluation. Obtaining a detailed history is important. Categorize symptoms such as vision loss or eye pain, report signs such as a change in appearance of the eye, and document the extent of trauma. One example of the importance of a good history is when a soldier informs you that the eye pain started while hammering metal on metal. This would suggest a projectile injury to the cornea or an intraocular foreign body. You must also be a source of information on ocular injury prevention for fellow soldiers.

ANATOMY AND PHYSIOLOGY OF THE EYE

The eyes are delicate organs that provide vision (Figure 23-1). They are protected by the skull, eyelids, eyelashes, and tears. Their shape is maintained by fluid contained within the eye (**vitreous** and **aqueous humor**). The **sclera** (white of the eye) is the tough outer layer that protects the inner structure of the eye and helps maintain the eye's shape. The sclera is connected to six muscles that allow the eye to look up, down, and side to side. The mucous membrane that lines the eyelid is called the **conjunctiva.** This mucous membrane extends from the eyelid to the front of the eyeball and covers the anterior portion of the sclera. **Lacrimal glands** (tear glands) are located in the upper-outer aspect of each upper eyelid. The lacrimal glands prevent infection and moisten the eye. Lacrimal fluid drains through the lacrimal ducts into the nasal cavity.

The inner layer of the eye that contains cells for vision is known as the **retina**. The retina contains two types of vision cells—rods and cones. The cone cells are used for daytime vision, and the rods are used at night or in low-light conditions. During dusk and dawn, a combination of rods and cones is used. **Macula** is a medical term for a small spot or colored area. In the retina, there exists a small oval-shaped, highly pigmented yellow spot near the center and approximately 2 mm lateral to the exit of the optic nerve known as the macula lutea retinae. The macula lutea retinae contains the area that is responsible for the most acute vision, the **fovea centralis retinae.**

The fovea is the center of the macula and is made up of cone cells. The fovea provides the sharp central vision necessary for reading, watching television, driving, and other activities where visual detail is of primary importance.

The **cornea** is the tough, transparent, colorless, and fibrous outer layer of the eye that covers the pupil and iris. Injuries to the cornea may cause opacity and stop light rays from entering the eye. The colored part of the eye located between the cornea and lens is the **iris**. It controls the amount of light entering the eye. The **pupil** is the circular opening in the iris and it is often referred to as the window of the eye. Light passes to the lens and the retina through this opening. The **lens** is a circular structure filled with a jelly-like substance; it adjusts to focus both near and far objects.

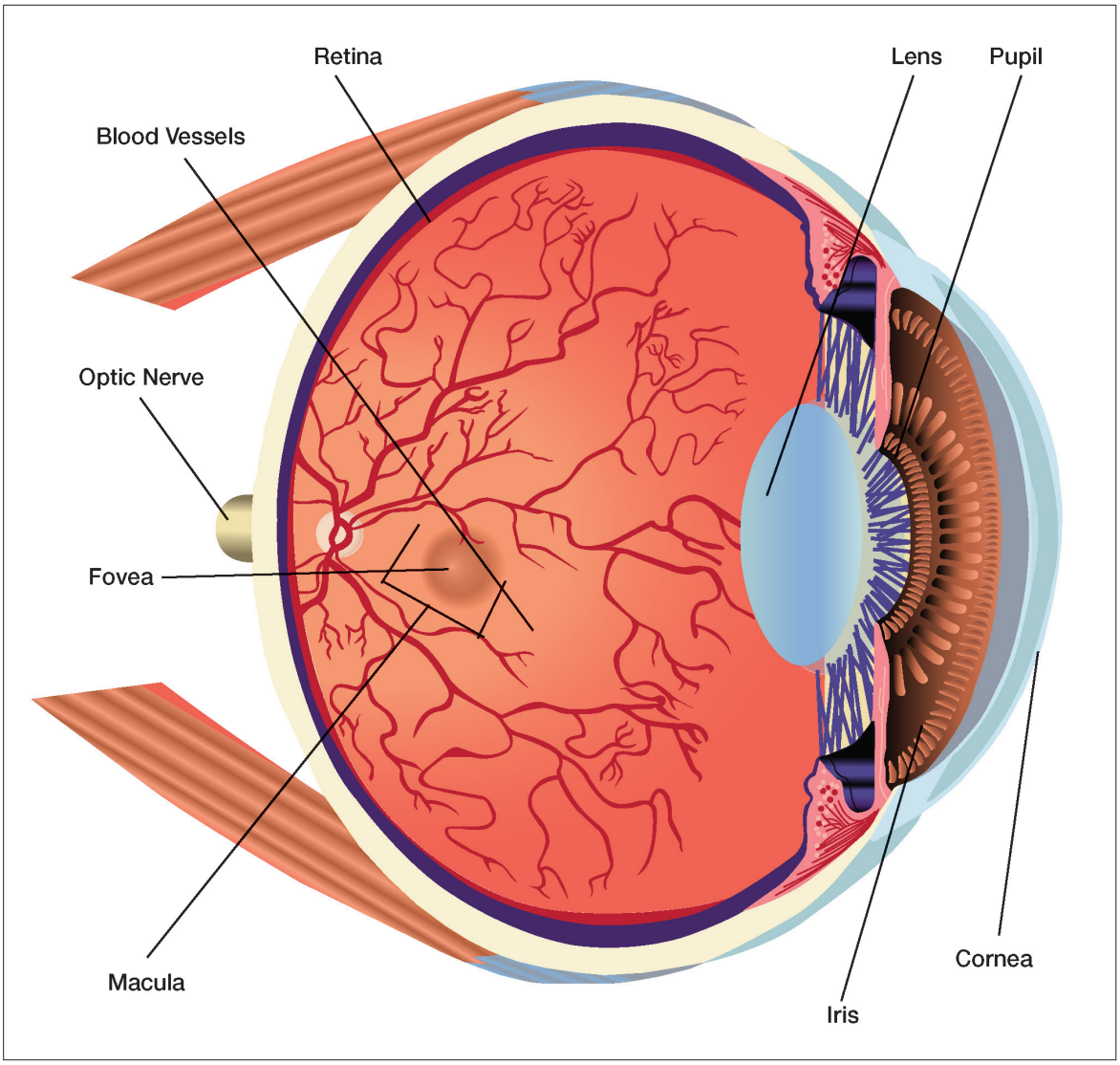


Figure 23-1. Anatomy of the eye.

When a person is looking at an object, light passes through the cornea and the pupil. The iris constricts or dilates to control the amount of light passing through the pupil. In low-light conditions, the pupil will dilate to allow more light to enter the eye. In high-ambient-light conditions, the pupil will constrict to reduce the amount of light entering the eye. This reduces overstimulation of the cells in the retina and prevents the photoreceptor cells from dying. After light passes through the pupil, it shines on the lens, which is positioned directly behind the pupil. The lens inverts the light image shining on it and directs the light to the retina. The light then stimulates the photoreceptor cells (cones and rods), creating electrical impulses that travel via neurons to the optic nerve. The optic nerve transmits these electrical impulses to the brain, which interprets the visual image.

Check on Learning

1. Identify the eight main structures of the eye.
2. Define the function of the conjunctiva.

ASSESSING A CASUALTY FOR AN EYE INJURY

Injuries to the eyes can occur as a result of blunt trauma, penetrating trauma, burns, or chemical exposure. When treating an eye injury, be sensitive to

the fact that the injury may be very frightening to the casualty. The thought of becoming blind, even in one eye, can be a major concern. An accurate history helps establish a possible cause for the eye problem. Ask the following:

- Is there a history (**Hx**) of eye disease (eg, **glaucoma**) or previous eye trauma or surgery?
- What was the mechanism of injury (if there is a history of injury)?
  - The extent of injury is directly related to the mechanism of injury (eg, a small shard of metal can cause a laceration or abrasion to the conjunctiva or cornea, but shrapnel is likely to cause a much more significant injury).
- Was the trauma blunt or penetrating?
  - Blunt trauma injury to the eye may cause swelling and bleeding into the soft tissues surrounding the orbit, resulting in a contusion or hematoma (also known as a black eye).
  - Penetrating trauma to the eye can be caused by large objects, such as sticks, or small objects, such as small shards of metal.
- Was there a projectile or missile injury (eg, glass from a motor vehicle accident)?
- Was there a thermal, chemical, or laser burn?
- Does the casualty wear glasses or contact lenses?

Note: "Contact lenses will not be worn during basic training, field exercises, gas chamber exercises, deployments, or combat."[1] Wearing of contact lenses will worsen chemical exposures of the eyes and corneal injuries such as corneal foreign bodies, lacerations, ulcers, or infections.

- Is there eye pain or loss of vision? If yes, is it in one eye (OD: right eye; OS: left eye) or both (OU: both eyes)?

The most important step in evaluating ocular problems is determining **visual acuity**. All casualties with eye complaints should have some type of visual acuity test performed. Compare sight in the injured eye to the uninjured eye. In the case of chemical ocular burns, flush the eyes first. Once the mechanism of the burn has been eliminated, conduct the visual acuity screening.

If you are in a clinic, use a standard Snellen chart (Figure 23-2). When equipment, light, or space does not permit the use of a Snellen chart, a gross vision examination is recommended. A gross vision examination entails having the casualty read any printed

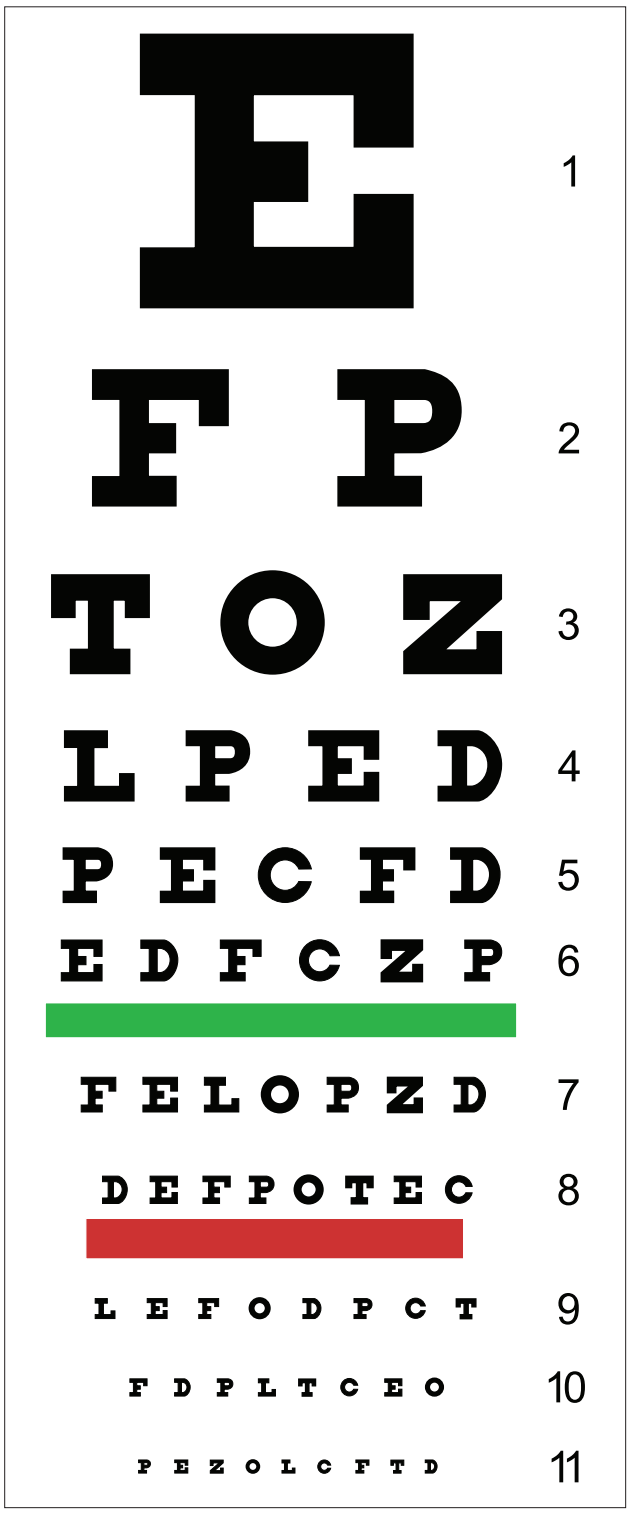


Figure 23-2. A Snellen chart—used to assess a person's visual acuity. Reproduced from Cho RI, Savitsky E. Ocular trauma. In: Savitsky E, Eastridge B, eds. *Combat Casualty Care, Lessons Learned from OEF and OIF*. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute; 2012: 214, fig 9.

material, try to determine how many fingers you are holding up, or see if they can distinguish between light and dark.

General physical examination techniques include inspection and palpation in adequate lighting (see Chapter 7, Eyes, Ears, Nose, and Throat Primary Care). **Hyphema** refers to blood or blood clots in the **anterior chamber**. Hyphemas are traumatic or spontaneous. A traumatic hyphema usually results from bleeding from a ruptured vessel in the eye (Figure 23-3). Avoid putting pressure on the globe while performing the examination. Assess for underlying head injuries. Never assume an injury to the eye is isolated strictly to the eye. Assess and reassess mental status. Perform baseline and repeated **Glasgow Coma Scale (GCS)** assessments (Table 23-1).

Check on Learning

3. What type of visual acuity assessment can be completed in an environment with limited equipment, light, and space?
4. What is the first step in treating a chemical burn to the eye?
5. When assessing a casualty with an ocular injury, what other type of injuries should you consider and assess?



Figure 23-3. Hyphema (blood in the anterior chamber of the eye). Reproduced from Cho RI, Savitsky E. Ocular trauma. In: Savitsky E, Eastridge B, eds. *Combat Casualty Care, Lessons Learned from OEF and OIF*. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute; 2012: 315, fig 21.

PREVENTION

While ballistic eye protection will guard against penetrating injuries, lasers, and burns to the eye, glasses and sunglasses do not provide adequate eye protection in tactical environments. Authorized

Table 23-1. Glasgow Coma Scale.

BEHAVIOR TO STIMULI	RESPONSE	SCORE
EYE OPENING RESPONSE	Spontaneous	4
	To Speech	3
	To Pain	2
	No Response	1
VERBAL RESPONSE	Oriented (A&OX4)	5
	Confused	4
	Inappropriate Words	3
	Incomprehensible Speech	2
	No Response	1
MOTOR RESPONSE	Obeys Commands	6
	Localizes Pain	5
	Withdraws from Pain	4
	Flexion (Decorticate)	3
	Extension (Decerebrate)	2
	No Response	1
TOTAL SCORE	BEST RESPONSE	15
	COMPLETELY UNRESPONSIVE	3

A&Ox4: alert and oriented times 4 (to person, place, time, and event).



Figure 23-4. First Lieutenant Anthony Aguilar wears the ballistic protective eyewear that prevented a bomb-fragment from possibly damaging his eyes when an IED detonated near his Stryker vehicle while on patrol in Mosul. Photograph by Company C, Task Force 2-1. https://www.dvidshub.net/image/22317/eye-protection

ballistic eye protection is listed on the Army's Authorized Protective Eyewear list (APEL) at http://www.peosoldier.army.mil/equipment/eyewear/. For eye injuries, the best treatment is prevention (Figure 23-4).

Laser Injuries

At low energy levels, lasers may produce temporary reduction in visual performance in critical tasks, such as aiming weapons or flying aircraft. At higher energy levels, they may produce serious long-term vision loss and even permanent blindness. Passive protection consists of taking cover and wearing ballistic eye protection. Active protection consists of the following:

- scanning battlefields with one eye,
- minimizing use of binoculars in areas known to have lasers in use,
- using built-in or clip-on filters, and
- using battlefield smoke screens.

Laser protective eyewear will prevent ocular injury from laser radiation emitted by low-energy laser rangefinders and target designators. Ballistic and laser protective eyewear will protect the eye against ballistic fragments and specified fixed wavelength laser hazards (Figure 23-5). Risk of laser injury increases with the use of night vision goggles (NVGs).

In the retina, laser injury can include burns and hemorrhage that result in vision loss. In the cornea, laser injury can include burns, vision loss, corneal scarring, and corneal perforation. Burns of the cornea and skin are treated similarly to other types of thermal burns. The main symptom of laser injury is reduction in visual acuity; another symptom may be pain.

Suspect laser exposure when a casualty reports seeing bright flashes of light, experiences eye discomfort and poor vision, and feels unexplained heat. Obvious lesions include corneal burns, retinal injury and hemorrhage, and burns to the skin. You might confuse the use of invisible lasers with chemical agents, which also irritate the eyes and skin. Spontaneous fires and unexplained damage to optical instruments are additional evidence that laser devices or weapons have been employed.



Figure 23-5. Retinal injury caused by a laser range finder. Reproduced from Hollifield RD. Ocular laser injuries. In: Thach AB, ed. *Ophthalmic Care of the Combat Casualty*. In: Lounsbury DE, Bellamy RF, Zajtchuk R, eds. *Textbook of Military Medicine*. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute; 2003: 436, Fig 25-5(b).

EYE INJURY TREATMENT

Combat medics play an important role in preventing permanent eye injury or vision loss. Table 23-2 summarizes treatments and contraindications for different types of eye injuries. More detail for each type of eye injury is presented below.

Foreign Bodies of the Eye or Eyelid

If a foreign body is superficial (eg, dirt or dust), irrigate the eye and cover it with a rigid eye shield. Penetrating eye trauma presents a problem, especially on the battlefield. These injuries can deteriorate without proper care. Avoid placing pressure on the eye,

Table 23-2. Eye Injury Treatment Chart.*

	STOP BURNING PROCESS	IRRIGATE	VISUAL ACUITY / GROSS VISION TEST	STABILIZE OBJECT	RIGID EYE SHIELD	DRY STERILE DRESSING	MOIST 4 × 4 COVERING	CWMP	EVACUATE
Foreign Bodies	N/A	YES (If Superficial)	YES	N/A	YES	NO	NO	YES	YES
Impaled Object	N/A	NO	YES	YES	YES (if possible)	NO	NO	YES	YES
Eyelid Laceration	N/A	NO	YES	N/A	YES	NO	NO	YES	YES
Corneal Abrasion	N/A	YES	YES	N/A	YES	NO	NO	YES	YES
Ocular Extrusion	N/A	NO	YES	N/A	Rigid cup only; no pressure on globe	NO	YES	YES	YES
Orbital Fracture	N/A	N/A	YES	N/A	YES	N/A	N/A	YES	YES
Thermal Burns	YES	NO	YES	N/A	N/A	YES	N/A	Pain med only	YES
Chemical Burns	YES	YES	NO (Irrigate first)	N/A	N/A	N/A	N/A	YES	YES
Laser Injury	N/A	NO	YES	N/A	YES	NO	N/A	Pain med only	YES

*Cells highlighted in yellow represent treatment that is detrimental if performed for the specific condition.
Cells highlighted in blue represent treatment that must be performed for the specific condition. N/A represents treatment that is not applicable.
CWMP: combat wound medication pack

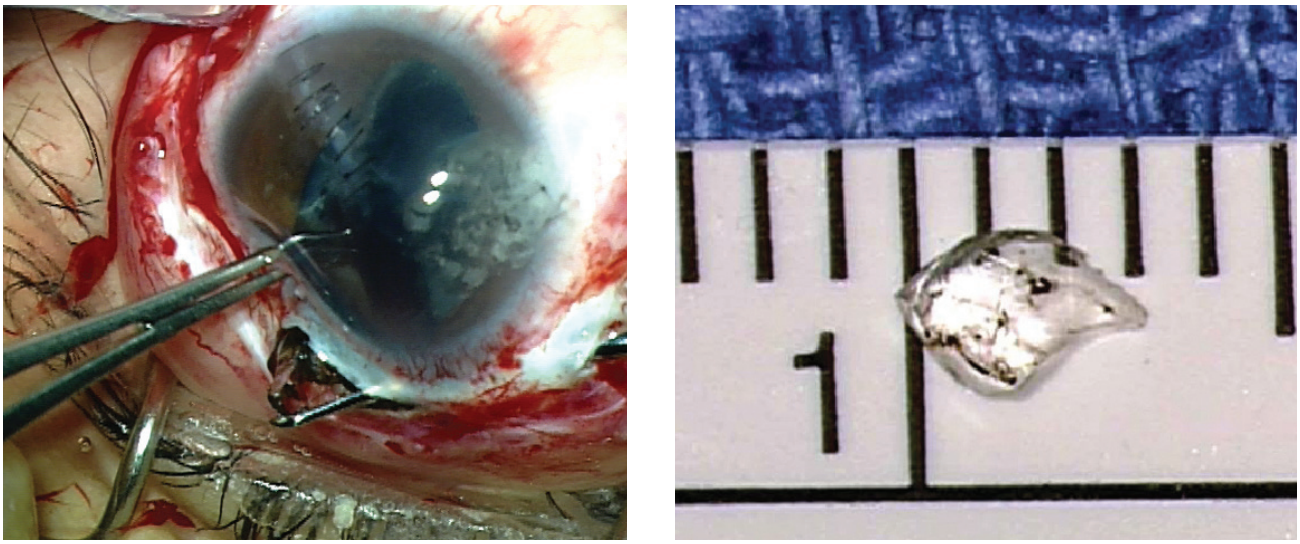


Figure 23-6. Foreign bodies being surgically removed from a casualty's eye. Reproduced from Cho RI, Savitsky E. Ocular trauma. In: Savitsky E, Eastridge B, eds. *Combat Casualty Care, Lessons Learned from OEF and OIF*. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute; 2012: 338, Fig 43.

which could cause the internal contents of the eye to be pushed out. If the foreign body is embedded or penetrating, do not attempt to remove it, but instead, stabilize the object if necessary. The object will only be removed in a surgical environment by properly trained medical providers (Figure 23-6).

Warning: Do not apply any dry or moist dressing or bandage to the eye. This could result in permanent loss of vision.

If a casualty experiences a foreign body in the eye, treat as follows:

- irrigate (if superficial like dirt and no ocular penetration),
- perform a visual acuity or gross vision test,
- apply a rigid eye shield (Figure 23-7),
- administer the combat wound medication pack (**CWMP**), and
- evacuate the casualty (with their glasses if applicable).

Note: When preparing a casualty with an ocular injury for evacuation, ascertain whether or not the casualty wears eyeglasses and if so, evacuate the casualty with their glasses.

Note: If a rigid eye shield is not available, an improvised eye shield may be fashioned from a structural, aluminum, malleable splint (**SAM splint** [Wilsonville, OR]) or other rigid material that protects the eye from direct pressure against the globe.



Figure 23-7. Shown is a Fox Eye Shield (Sklar Instruments, West Chester, PA; used with permission) being applied to a casualty with a simulated eye injury.

Eyelid Lacerations and Corneal Abrasions

Eyelid injuries often result in marked **ecchymosis**, making examination of injuries to the globe and lid difficult (Figure 23-8). Corneal abrasions result in pain, foreign body sensation, photophobia, and decreased visual acuity (Figure 23-9). When a corneal abrasion occurs, the injured cornea is much more susceptible to bacterial infection, particularly if the casualty wears contact lenses. If a casualty experiences a corneal abrasion and is wearing contact lenses, remove the contact lens and cover the eye with a rigid eye shield. Avoid eye patches because it places the casualty at higher risk of developing a bacterial corneal ulcer. If a casualty experiences an eyelid laceration, treat as follows:

- perform a visual acuity or gross vision test,
- apply a rigid eye shield,
- administer the CWMP, and
- evacuate the casualty (with their glasses, if applicable).

If a casualty experiences a corneal abrasion, treat as follows:

- irrigate,
- perform a visual acuity or gross vision test,
- apply a rigid eye shield,
- administer the CWMP, and
- evacuate the casualty (with their glasses, if applicable).

Impaled Object

Treating a casualty with an impaled object in the eye is similar to the treatment for a foreign body in the eye with some slight differences. Do not irrigate the eye. If possible, stabilize the object to reduce further injury to the eye. If a casualty experiences an impaled object to the eye, treat as follows:

- perform a visual acuity or gross vision test,
- stabilize the object,
- apply a rigid eye shield if possible,
- administer the CWMP, and
- evacuate the casualty (with their glasses, if applicable).

Orbital Fractures

Orbital fractures can present in several different ways. A fractured orbit can involve the medial area of the face (behind the nose), which may present with **subcutaneous emphysema**, sometimes exacerbated by sneezing or blowing the nose. Orbital fractures can also involve the inferior wall of the orbit (behind the eye), which may cause an entrapment of the eye muscles, possibly causing restriction of upward gaze and **diplopia** of the affected eye. This entrapment of

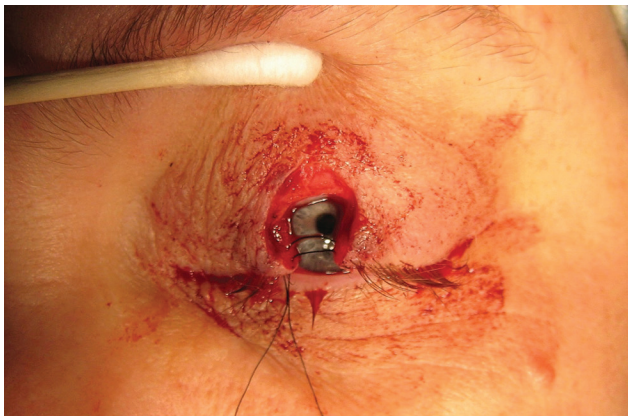


Figure 23-8. Eyelid laceration being repaired with sutures. Reproduced from Cho RI, Savitsky E. Ocular trauma. In: Savitsky E, Eastridge B, eds. *Combat Casualty Care, Lessons Learned from OEF and OIF*. In Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute; 2012: 327, Fig 28.

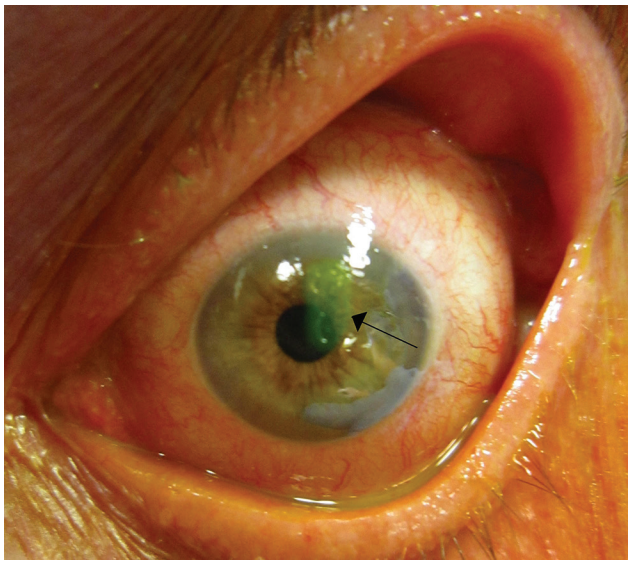


Figure 23-9. Corneal abrasion with fluorescein staining to show the site of injury. The arrow shows the injury site. Photograph by James Heilman, MD. Reproduced from Wikimedia Commons. http://en.wikipedia.org/wiki/File:Human_cornea_with_abrasion_highlighted_by_fluorescein_staining.jpg



Figure 23-10. The patient was kneed in the left eye while playing soccer. The orbital fracture is entrapping the medial tissues behind the eye, which results in the uneven tracking, known as horizontal diplopia. Reproduced from Mazzoli RA, Ainbinder DF, Hansen EA. Orbital trauma. In: Thach AB, ed. *Ophthalmic Care of the Combat Casualty*. In: Lounsbury DE, Bellamy RF, Zajtchuk R, eds. *Textbook of Military Medicine*. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute; 2003: 368, Fig 20-40(a).



Figure 23-11. A modified SAM (Wilsonville, OR) splint being used as an eye shield for a simulated casualty with an eye injury.

the eye muscles, resulting in the eyes looking in different directions, may result in double vision. Due to the nature of the injury, a casualty with an orbital fracture may not be able to move the eye or focus on objects (Figure 23-10). If a casualty experiences an orbital fracture, treat as follows:

- perform a visual acuity or gross vision test,
- apply a rigid eye shield,
- administer the CWMP, and
- evacuate the casualty (with their glasses, if applicable).

Ocular Extrusion

If a casualty's eye is protruding from the socket (**ocular extrusion**), DO NOT attempt to force the eye back into the socket. Instead, shield and gently cup the avulsed eye with moist 4 × 4 gauze pads and cover with a loose, moist dressing. If a casualty experiences an ocular extrusion, treat as follows:

- perform a visual acuity or gross vision test,
- apply a rigid cup that WILL NOT apply pressure to the globe (Figure 23-11),
- cover the eye with a moist 4 × 4 gauze pad,
- administer the CWMP, and
- evacuate the casualty (with their glasses, if applicable).

Thermal Burns

In cases of thermal burns, first stop the burning process. Thermal burns more commonly affect eyelids than the globe because of the **blink reflex**. Cover the affected eye with a dry sterile dressing, then follow burn assessment and treatment protocols. Consider administering pain management and withholding the CWMP if the casualty suffers exclusively from burns (Figure 23-12). If a casualty experiences a thermal burn to an eye, treat as follows:

- stop the burning process,
- perform a visual acuity or gross vision test,
- apply a dry sterile dressing over the eye,
- administer the analgesic ONLY from the CWMP, and
- evacuate the casualty (with their glasses, if applicable).

Chemical Burns

Warning: IRRIGATE FIRST! Do not perform visual acuity, gross visual exam, or physical assessment first for chemical burns to the eyes. Burning and tissue damage will continue to occur as long as any substance is left in the eye, even if that substance is diluted.

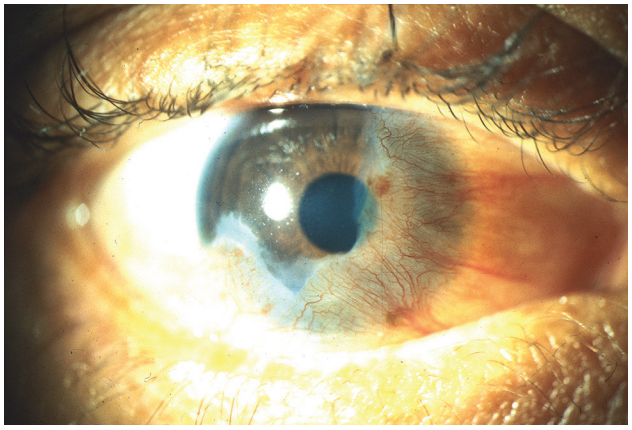


Figure 23-12. Corneal scarring from a boiling water thermal burn to the eye. Reproduced from Trudo EW, Rimm W. Chemical injuries of the eye. In: Thach AB, ed. *Ophthalmic Care of the Combat Casualty*. In: Lounsbury DE, Bellamy RF, Zajtchuk R, eds. *Textbook of Military Medicine*. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute; 2003: 117, Fig 7-1.



Figure 23-13. Soldier medics practicing irrigating debris from a soldier's eye with IV fluid.

Chemical burns to the eye are a true emergency. Complications of chemical burns to the eye include scarring of the cornea with permanent loss of vision and loss of the eye due to corneal perforation. Immediately provide copious and continuous irrigation until all irrigation supplies are exhausted or until the casualty reaches the medical treatment facility. Do not conduct an eye examination or testing until irrigation is complete.

If a casualty experiences a chemical burn to the eye, treat as follows:

- stop the burning process,
- irrigate continuously until reaching the medical treatment facility (Figure 23-13),
- administer the CWMP, and
- evacuate the casualty (with their glasses, if applicable).

Caution: During irrigation of the eye, direct the flow of the water or saline so the solution does not come in contact with the other eye.

Injuries Produced by Lasers

Injuries sustained from laser exposure include retina burns, hemorrhage (causing loss of vision), and cornea burns. Cornea burns can cause vision loss, corneal scarring, and perforation of the cornea. Treatment of these injuries is similar to treatment for other types of thermal burns. If a casualty experiences a laser injury to the eye, treat as follows:

- perform a visual acuity or gross vision test,
- apply a rigid eye shield,
- administer the CWMP, and
- evacuate the casualty (with their glasses, if applicable).

Note: The antibiotic in the CWMP (moxifloxacin) is one of the few antibiotics that is effective in preventing or treating infections to the eye.

Caution: A casualty with both eyes covered is rendered defenseless against the enemy and is completely dependent on others.

Check on Learning

6. What is special about the antibiotic found in a CWMP?
7. Eyes should be irrigated for how long?

SUMMARY

Ocular injuries can be devastating to a casualty, and your actions can have direct, permanent results on the casualty's quality of life. Since the implementation of the tactical combat casualty care program, the methods of treating ocular injuries have changed significantly. Prevention programs in the past were nonexistent; however, today the US military researches and issues ballistic eyewear that is resistant to fragmentation ocular injuries. Since the Department of Defense directed use of APEL-approved eyewear, the total number of ocular casualties has decreased in both peacetime and war. With the introduction of rigid, malleable, lightweight eye shields and battlefield antibiotics, secondary ocular injury through trauma and infection has decreased, resulting in more soldiers being returned to duty and more eyesight being saved.

KEY TERMS AND ACRONYMS

Anterior chamber. The space between the cornea and iris of the eye.
Aqueous humor. The clear, watery fluid in the anterior and posterior chambers of the eye.
Blink reflex. Sudden closing of the eyelids in response to head turning, loud noises, bright lights, or visual threats.
Conjunctiva. The mucous membrane that lines the eyelids and is reflected onto the eyeball.
Cornea. The transparent anterior portion of the sclera (the fibrous outer layer of the eyeball); about one-sixth of its surface.
CWMP. Combat wound medication pack.
Diplopia. Two images of an object seen at the same time.
Ecchymosis. A bruise caused by superficial bleeding in the skin or mucous membrane.
Fovea (fovea centralis retinae). The pit in the middle of the macula lutea that contains only a layer of closely packed cones and functions as the area of most acute vision.
Glasgow Coma Scale (GCS). A standardized system used to determine a patient's level of consciousness.
Glaucoma. A group of eye diseases characterized by increased intraocular pressure resulting in atrophy of the optic nerve and possibly leading to blindness.
Hx. History.
Hyphema. Blood in the anterior chamber of the eye, in front of the iris.
Iris. The colored contractile membrane suspended between the lens and the cornea in the aqueous humor of the eye. It separates the anterior and posterior chambers of the eyeball and is perforated in the center by the pupil.
Lacrimal glands. Glands that produce tears, which prevent infection and moisten the eye. Tears drain through ducts located in the eyelids.
Lens. A circular structure filled with jelly-like substance, which adjusts to focus both near and far objects.
Macula (macula lutea retinae). A yellow spot in the center of the retina approximately 2 mm lateral to the exit of the optic nerve. It contains the fovea centralis.
Ocular extrusion. The eye is protruding from the socket.
Pupil. The contractile opening at the center of the iris of the eye. It is constricted when exposed to strong light and when the focus is on a near object. It is dilated in the dark and when the focus is on a distant object.
Retina. The innermost layer of the eye, it contains the rods and cones and receives images transmitted through the lens.
SAM splint. Structural aluminum malleable splint.
Sclera. The outer layer of the eyeball; made of fibrous connective tissue and visible as the white portion of the eye.
Subcutaneous emphysema. The presence of gas or air in the subcutaneous tissue.
Visual acuity. A measure of the resolving power of the eye; usually determined by one's ability to read letters of various sizes at a standard distance from a test chart.
Vitreous humor. The colorless, transparent jelly that fills the eyeball posterior to the lens and is enclosed by delicate hyaloid membranes.

CHECK ON LEARNING ANSWERS

1. Identify the eight main structures of the eye.

   Iris muscles, pupil, cornea, lens, conjunctiva, retina, sclera, and optic nerve.

2. Define the function of the conjunctiva.

   It is the mucous membrane that lines the eyelid and extends from the eyelid to the front to the eyeball. It covers the anterior portion of the sclera.

3. What type of visual acuity assessment can be completed in an environment with limited equipment, light, and space?

   A gross vision examination.

4. What is the first step in treating a chemical burn to the eye?

   Flush the affected eye to eliminate the mechanism of injury.

5. When assessing a casualty with an ocular injury, what other type of injuries should you also assess for?

   A head injury, which may present with an altered level of consciousness and a finding on the Glasgow Coma Scale of less than 15.

6. What is special about the antibiotic found in a CWMP?

   Moxifloxacin is one of the few antibiotics that is effective in treating infections of the eye.

7. Eyes should be irrigated for how long?

   Irrigation should be maintained for as long as supplies will allow or until the casualty reaches a medical treatment facility.

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24 ABDOMINAL TRAUMA

CORE CONCEPTS

- Identify the anatomy and physiology of abdominal organs.
- Assess a casualty with a suspected abdominal injury in a combat environment.
- Treat a casualty with a suspected abdominal injury in a combat environment.

INTRODUCTION

Abdominal injuries are difficult to evaluate in the military treatment facility (MTF) and even more so in the field. Immediate surgical intervention is needed for all penetrating abdominal injuries. Blunt injuries may be more subtle in their presentation but may be just as deadly. Regardless of their cause, abdominal injuries present two life-threatening dangers: infection and hemorrhage. Stay alert to the danger of early shock in casualties with abdominal injuries. Infection can be fatal, but with prompt recognition of abdominal injury and rapid evacuation of the casualty, field intervention will not be required. This lesson will provide an understanding of the anatomy of the abdomen and the types of injuries that may be encountered. You will learn the principles of abdominal injury assessment and casualty stabilization.

ANATOMY AND PHYSIOLOGY

Boundaries

The abdominal cavity is inferior to (below) the thoracic cavity and superior to (above) the pelvic cavity. Its boundaries are pelvic bones, the spinal column, and muscles of the abdomen and flanks. When identifying the source of pain in the abdomen, use the quadrant arrangement.

The four quadrants of the abdomen include the right upper quadrant (RUQ), left upper quadrant (LUQ), right lower quadrant (RLQ), and left lower quadrant (LLQ). The diaphragm is the upper abdominal cavity boundary and, when relaxed, is level with the 4th thoracic vertebrae (T4). Figure 24-1 shows the abdominal quadrants and their associated organs.

Physiology

The liver stores about 10% of a person's total blood volume. It metabolizes carbohydrates (sugars), fat, and protein and stores vitamins and iron. The liver forms various blood-clotting factors, as well as bile, which breaks down fat for digestion and serves as a means for excreting certain waste products from the blood. The liver is also responsible for detoxifying, excreting, and metabolizing many different drugs.

The **gallbladder** stores bile formed by the liver. It empties bile into the **duodenum** (first part of the small intestine). If stones form in the gallbladder, they may obstruct the drainage system (**bile duct**) to the small intestine.

The **pancreas** produces and secretes digestive enzymes into the first part of the small intestine via the **pancreatic duct**. It also produces and secretes hormones (insulin and glucagon) that regulate the blood-sugar (glucose) level into the blood. Insulin promotes glucose entry into most cells of the body, decreasing blood glucose levels. Glucagon increases the release of glucose from the liver into the circulating body fluids, increasing blood glucose levels.

Carbohydrates, proteins, and fats are absorbed in the small intestine, as are ions (sodium, chloride, bicarbonate, calcium, iron, and potassium) and the water that accompanies the ions. However, most water is absorbed in the **colon** (large intestine). Water and electrolytes (up to 7 L/day) are absorbed in the colon. The colon also stores fecal matter until it can be expelled.

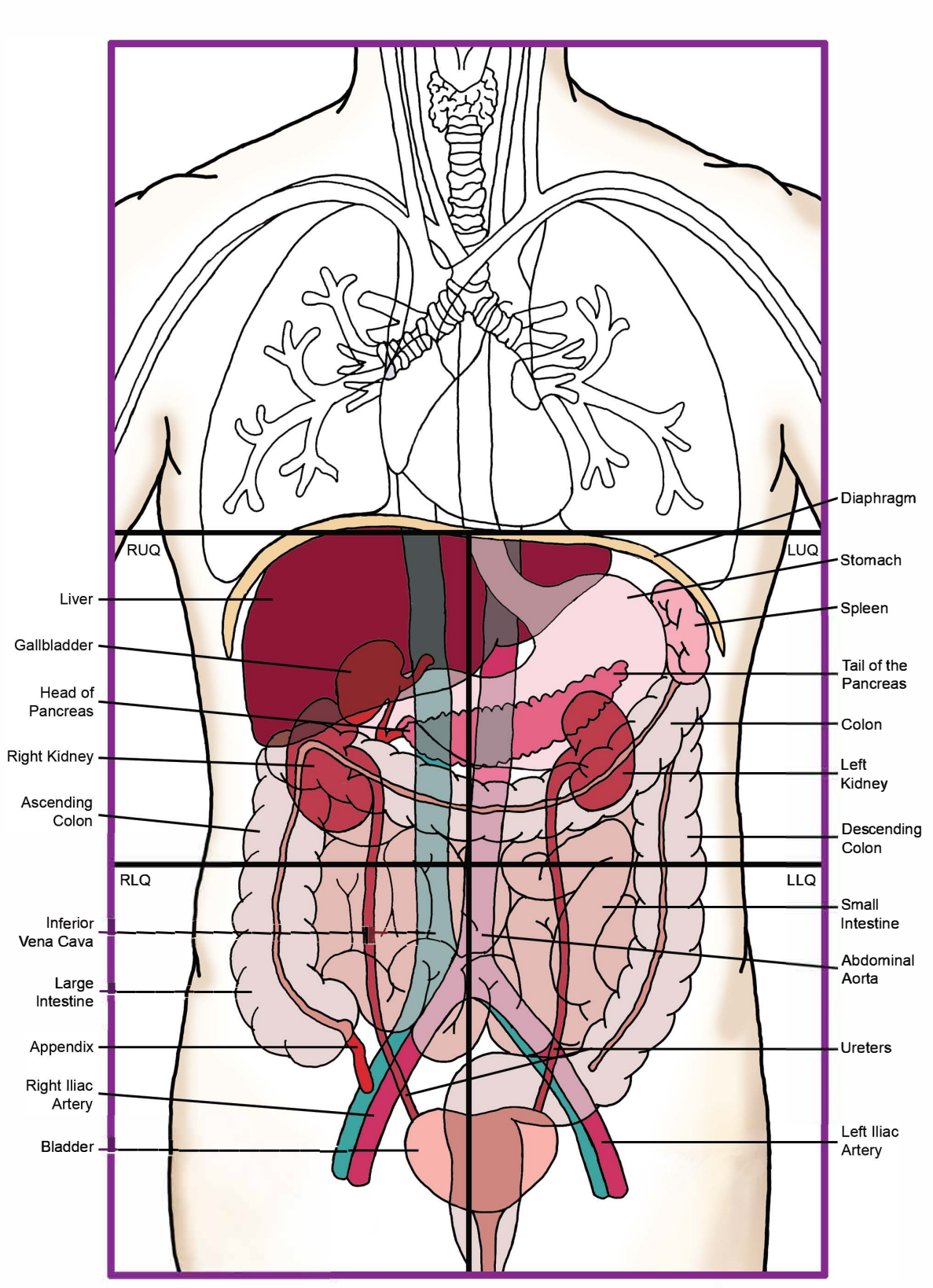


Figure 24-1. Abdominal quadrants and their associated organs.

The stomach stores food until it can be converted into chyme (the semifluid, creamy material produced by digestion of food) and then emptied into the duodenum. It secretes digestive enzymes and is poor at absorption except for highly lipid-soluble substances like alcohol and medications (eg, aspirin).

The **spleen** is an organ of the lymphatic system. It contains the largest amount of lymphatic tissue in the body. It stores red blood cells and platelets and removes ones that are worn out or defective. The spleen carries out immune functions and contains cells involved in fighting infections. It is a highly vascular organ that, if injured, may result in massive hemorrhaging.

Note: The spleen may become inflamed and enlarged in patients with infectious mononucleosis ("mono"). These patients should be advised to avoid contact sports for up to 6 weeks after diagnosis due to a remote possibility of splenic rupture.

Most of the end products of bodily metabolism are excreted by the kidneys via blood filtration and urine formation. The kidneys regulate the water, electrolyte, and acid-base content of the blood.

Solid and Vascular Organs

The liver, spleen, aorta, and vena cava bleed into the abdominal cavity when injured. Blood loss into the peritoneal cavity, regardless of the source, will contribute to hypovolemic shock. A casualty's entire circulating volume can be lost into the abdominal cavity.

Hollow Organs

The intestine, gallbladder, and urinary bladder may spill their contents into the peritoneal cavity and retroperitoneal space upon injury. Release of digestive acids, enzymes, bacteria, and chyme into the peritoneal cavity causes **peritonitis** (inflammation of the peritoneum or lining of the abdominal cavity) and **sepsis** (a massive systemic infection that includes hypotension, decreased urine output, and altered mental status). Bleeding from an intestinal injury is typically minor unless larger vessels of the **mesentery** are damaged.

Due to the proximity of the thoracic and abdominal regions, a wound that started out in the abdomen may end up in the chest, or the other way around. Any penetrating thoracic injury below the nipple line, which is also level with the fourth thoracic vertebrae (T4), may involve abdominal structures (Figure 24-2).

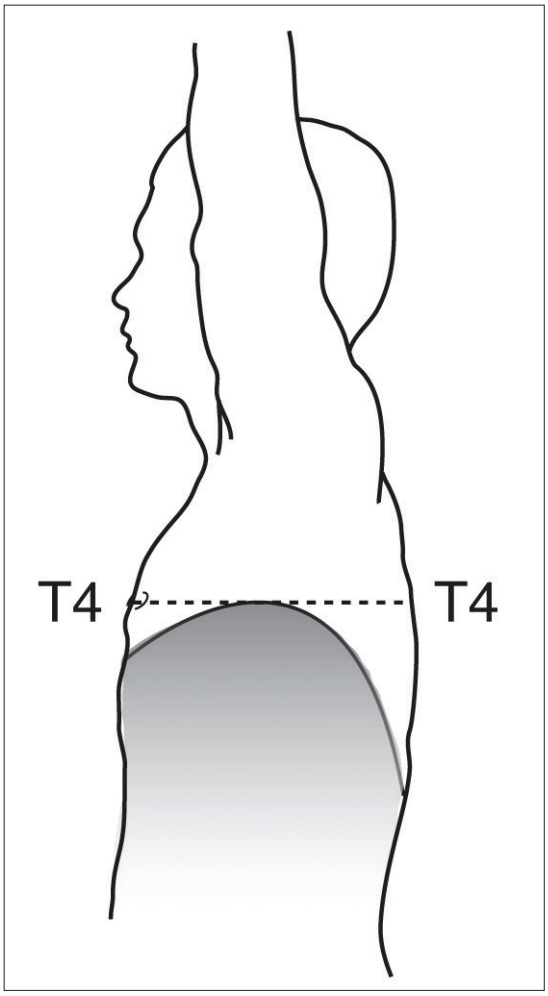


Figure 24-2. Penetrating thoracic injuries below the T4 level (nipple line) have a high probability of involving abdominal structures. Reproduced from Nissen SC, Lounsbury DE, Hetz SP, eds. *War Surgery in Afghanistan and Iraq 2003–2007*. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute; 2008: Chap IV.4, Fig 4.

ASSESSING ABDOMINAL TRAUMA

Penetrating Trauma

Mentally visualize the path of all penetrating trauma of the abdomen and thorax; never probe penetrating or abdominal wounds with fingers or instruments. Trauma to the thorax or abdomen may continue into a different cavity depending on the position of the diaphragm on impact. Penetrating wounds to the flanks or buttocks may involve organs of the abdominal cavity.

Penetrating trauma in the gluteal area is associated with significant intra-abdominal trauma in up to 50% of cases. In penetrating trauma, the casualty may not initially appear to be in shock unless the object or projectile penetrates a major vessel or organ (Figure 24-3).



Figure 24-3. M16 entry and exit wounds to the abdomen. Reproduced from Nissen SC, Lounsbury DE, Hetz SP, eds. *War Surgery in Afghanistan and Iraq 2003–2007*. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute; 2008: Chap V.1, Fig 1.

Blunt Trauma

Blunt trauma poses a greater threat to life than penetrating trauma. It is difficult to diagnose, and objective evidence of blunt trauma may not appear on the casualty for hours. The mechanism of injury, such as that depicted in Figure 24-4, and the casualty's complaints of pain may be the only signs of an underlying injury.

Compression injuries are a type of blunt trauma in which organs are crushed between solid objects. Shearing injuries occur when tearing forces are exerted against the supporting ligaments of solid organs and vessels. Deceleration injuries are common and may

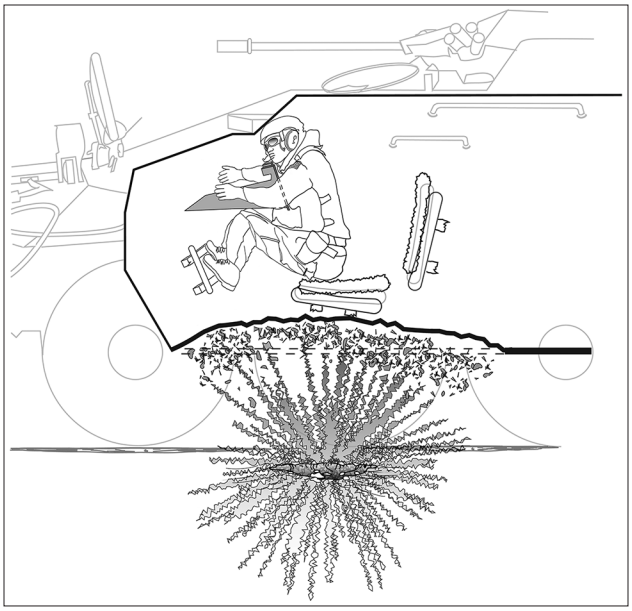


Figure 24-4. How blunt trauma occurs to crewmembers after their armored vehicle is struck by an improvised explosive device.

be caused by restraining devices such as seat belts, gunner's harnesses, and litter straps.

Kinematics

The mechanism of injury and a high index of suspicion play important roles in identifying possible life-threatening abdominal injuries. For example, approximately 15% of stab wounds (low energy) require surgical intervention, whereas approximately 85% of gunshot wounds (medium and high energy) require surgical intervention. Fragmentation wounds are the most common cause of penetrating injuries in combat.

The following are key indicators of abdominal injuries:

- obvious signs of trauma,
- signs of hypovolemic shock without obvious cause,
- degree of shock greater than would be expected by other injuries,
- presence of peritoneal signs, and
- mechanism of injury.

The primary factor in assessing abdominal trauma is not the accurate diagnosis of the injury but rather the determination that an abdominal injury exists. This and the resulting delay of treatment are the major causes of morbidity and mortality in abdominal trauma.

History

When obtaining a casualty's history, there are several key factors to consider. If the individual has been involved in an automobile accident, determine the position of the vehicle, extent of vehicle damage, and position of the casualty within the vehicle. Find out if there was an explosion that threw the victim against immobile objects or transmitted blast pressure to organs inside the abdomen. Keep in mind that overpressure can rupture hollow organs and leave no sign of external injury; ruptured eardrums may signify hollow organ rupture from overpressure. If the injury was caused by a weapon, determine the type of weapon used and the casualty's distance from the weapon. Consider fragmentation wounds. In each case, determine whether safety equipment, such as vehicle seat belts, helmets, or body armor, was used.

Physical Examination

The most reliable indicator of intra-abdominal bleeding is the presence of hypovolemic shock. Look for signs and symptoms of compensated, and later decompensated, shock (see Chapter 8, Shock). Do not waste time auscultating the abdomen in a combat environment; your findings will not alter casualty treatment before reaching the MTF. Inspect for soft-tissue injuries and distention. Soft-tissue injuries due to blunt trauma may not be apparent for hours after the injury; the adult peritoneal cavity can hold up to 1.5 L of fluid before evidence of distention is apparent.

For combat-related abdominal injuries, lightly palpate each quadrant to assess for tenderness and rigidity. Pain or rigidity in any quadrant requires surgical exploration. Avoid deep or aggressive palpation because it may dislodge blood clots, exacerbate existing hemorrhage, and increase spillage of gastrointestinal tract contents. Note any voluntary guarding (ie, the casualty seems to tense up) and involuntary guarding (ie, spasms of the abdominal wall muscles that remain even when the casualty is distracted). Palpate the pelvis for instability in three steps: (1) press posteriorly on the iliac crest, (2) press inward on the iliac crest, and (3) press posteriorly on the symphysis pubis.

Check on Learning

1. What type of physical examination should be completed on a combat casualty with an abdominal injury?
2. What is the most reliable indicator of intra-abdominal bleeding?
3. Why are soft-tissue injuries a poor indication of intra-abdominal bleeding?

MANAGING ABDOMINAL TRAUMA

Casualty Management

Once an abdominal injury is identified, the casualty should be evacuated to an MTF as soon as possible. Evacuating a casualty to an MTF that does not have surgical capabilities defeats the purpose of rapid evacuation. Categorize these casualties as urgent surgical for evacuation precedence.



Figure 24-5. Simulated casualty presenting with penetrating trauma to the abdomen. The casualty's knees are flexed to relieve pain.

Position the casualty for transport with knees bent when possible (Figure 24-5). Manage conditions associated with hemorrhage, airway, breathing, and circulation (HABCs). Establish vascular access with a saline lock. Follow fluid resuscitation protocols (see Chapter 8, Shock) for combat casualties in hemorrhagic shock. You must achieve the delicate balance of maintaining perfusion to the vital organs without restoring a normal blood pressure that will increase internal bleeding. Provide oral or intravenous antibiotics, depending on availability and the casualty's condition.

Special Considerations

Treatment of abdominal trauma can be complicated by many factors. Some significant considerations are addressed below.

Impaled Objects

Do not move or remove impaled objects; leave that task to the surgeon. Instead, stabilize the object either manually or mechanically with built-up bulky dressing. Apply direct pressure with the flat of the hand to control bleeding around the edges of the wound if necessary. Do not palpate the abdomen (Figure 24-6).



Figure 24-6. A 22-year-old male impaled by a 5-ft iron bar due to a traffic accident. The patient fully recovered after the bar was removed. Photograph by Dr Biplab Mishra. Reproduced with permission from http://www.trauma.org/index.php/main/image/754/. License at https://creativecommons.org/licenses/by-nc-sa/2.5/legalcode

Evisceration

Focus your efforts on protecting the protruding segment of intestine or other organs from further damage. Most abdominal contents require a moist environment. Apply a clean or sterile dressing that has been moistened with saline (normal saline intravenous fluid can be used). Do not attempt to replace the protruding segment in the abdominal cavity. Any action that increases intra-abdominal pressure, such as crying, screaming, coughing, or bearing down, can force more of the organs outward (Figure 24-7).



Figure 24-7. Wound showing evisceration of the small intestine. Reproduced from Nissen SC, Lounsbury DE, Hetz SP, eds. *War Surgery in Afghanistan and Iraq 2003–2007*. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute; 2008: Chap V.5, Fig 1.

Pregnancy

Until about the 12th week of gestation, the uterus remains protected by the pelvis. Injury to the uterus can include rupture, penetration, **abruptio placentae**, and premature rupture of the membranes. The placenta and uterus are highly vascular and can hemorrhage profusely. Additionally, hemorrhage can be concealed for a period of time within the uterus. A casualty with vaginal bleeding secondary to trauma should be evacuated urgently.

By the third trimester, the mother's heartbeat increases by 15 to 20 beats per minute. By the 36th week of pregnancy, the mother's blood volume has increased by about 50%. Because of increases in cardiac output and blood volume, a pregnant casualty may lose 30% to 35% of total blood volume before showing signs of hypovolemia. Systolic and diastolic blood pressure drop 5 to 15 mmHg during the second trimester but will return to normal by term. Ask the casualty about issues with pregnancy that may complicate your assessment and management.

The best way to ensure the survival of the mother and fetus is to provide the mother with aggressive resuscitation and transport. Treatment and transport of a pregnant casualty are similar to that of any other casualty. First, manage conditions associated with



Figure 24-8. Injury to the kidney. Reproduced from: Nissen SC, Lounsbury DE, Hetz SP, eds. *War Surgery in Afghanistan and Iraq 2003–2007*. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute; 2008: Chap V.4, Fig 2.

HABCs. Then transport the casualty on her left side, tilt the right side of the spine board, and elevate the casualty's right leg or manually displace the uterus to the left to relieve supine hypotension.

Genitourinary Injuries

Damage to the kidneys, ureters, and bladder often presents with hematuria, which will not be noted unless the casualty has a urinary catheter (unlikely in a combat environment). Injuries to external genitalia result in soft-tissue hemorrhage, significant pain, and psychological concern. Given the supplies available on the battlefield, control hemorrhage with direct pressure or pressure dressings and manage amputated genital body parts as you would any other amputated body part on the battlefield (Figure 24-8).

Check on Learning

4. What are your options when treating an abdominal evisceration?
5. How should an obviously pregnant female be transported?
6. What is the proper way to manage an impalement?

SUMMARY

Uncontrolled hemorrhage and time are the enemies of the abdominal trauma casualty, and both have immediate consequences to life. You must promptly recognize abdominal injury and the early onset of shock in these casualties. The keys to survival for those suffering from abdominal injuries are early recognition, stabilization, and rapid evacuation.

KEY TERMS

Abruptio placentae. Premature detachment of the placenta.
Bile duct. Any of the intercellular passages that convey bile from the liver to the hepatic duct, which joins the duct from the gallbladder (cystic duct) to form the common bile duct (ductus choledochus) and which enters the duodenum about 3 inches below the pylorus.
Colon. The large intestine from the end of the ileum to the anal canal.
Duodenum. The first part of the small intestine, between the pylorus and the jejunum; it is 8 to 11 inches long. The duodenum receives hepatic and pancreatic secretions through the common bile duct.
Gallbladder. A pear-shaped, gray-blue sac that stores bile from the liver and aids in digestion.
Mesentery. The peritoneal fold that encircles the small intestine and connects it to the posterior abdominal wall.
Pancreas. A compound acinotubular gland that performs multiple functions and is considered both an exocrine and endocrine organ. The exocrine secretions of the pancreas consist of enzymes that digest food in the small intestine. The endocrine cells produce hormones such as glucagon, which raises blood glucose, and insulin, which assists cells of the body to uptake glucose.
Pancreatic duct. The duct that conveys pancreatic juice to the common bile duct and duodenum.
Peritonitis. Inflammation of the serous membrane that lines the abdominal cavity and its viscera.

Sepsis. A systemic inflammatory response to infection, in which there is fever or hypothermia, tachycardia, tachypnea, and evidence of inadequate blood flow to internal organs.

Spleen. A dark red, oval lymphoid organ, located in the left upper abdominal quadrant, that aids in the removal of cell debris; microorganisms; and cells that are old, damaged, abnormal, or coated with antibodies. The spleen also produces white blood cells.

CHECK ON LEARNING ANSWERS

1. What type of physical examination should be completed on a combat casualty with an abdominal injury?

   For combat-related abdominal injuries, lightly palpate each quadrant to assess for tenderness and rigidity. Pain or rigidity in any quadrant of a combat casualty requires surgical exploration. Avoid deep or aggressive palpation because it may dislodge blood clots, promote existing hemorrhage, and increase spillage of contents of the gastrointestinal tract.

2. What is the most reliable indicator of intra-abdominal bleeding?

   The presence of hypovolemic shock from an unexplained source.

3. Why are soft-tissue injuries a poor indication of intra-abdominal bleeding?

   They may not be apparent for hours after the injury.

4. What are your options when treating an abdominal evisceration?

   Focus on protecting the protruding segment of intestine or other organs from further damage. Because most abdominal contents require a moist environment, apply a clean or sterile drssing that has been moistened with saline (eg, normal saline IV fluid). Do not try to replace the protruding segment back into the abdominal cavity.

5. How should an obviously pregnant female be transported?

   Transport the casualty on her left side, tilt the right side of the spine board, and elevate the casualty's right leg or manually displace the uterus to the left to relieve supine hypotension.

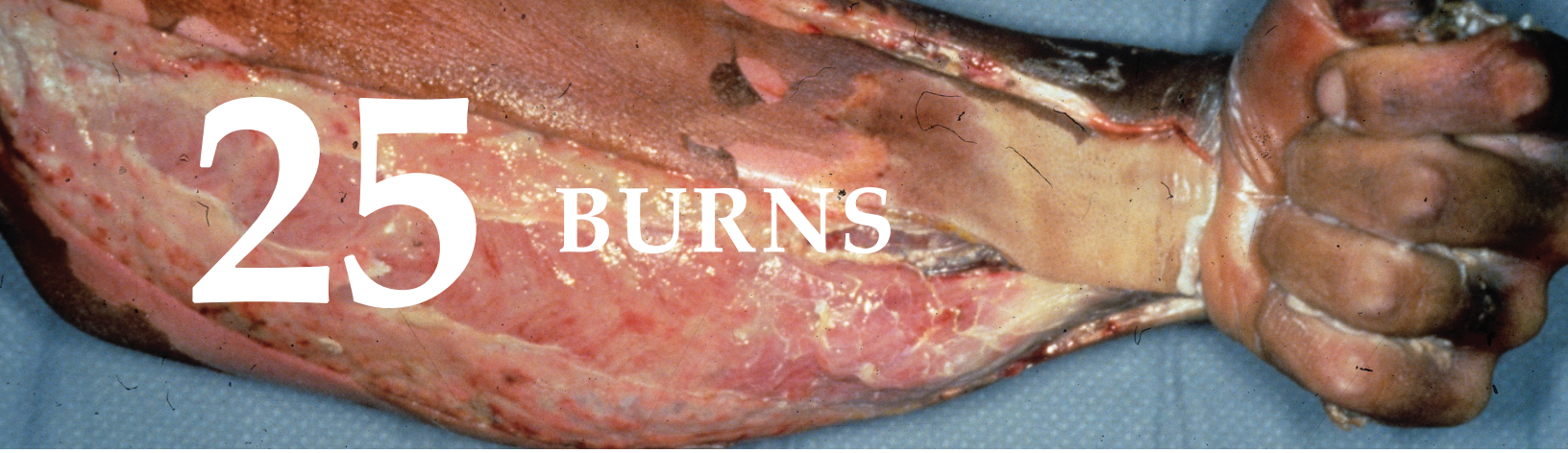
6. What is the proper way to manage an impalement?

   Do not move or remove the impaled object. Stabilize it either manually or mechanically with a bulky dressing and apply direct pressure with the flat of your hand to control bleeding around the edges of the wound if necessary.

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25 BURNS

CORE CONCEPTS

- Define various depths of burns.
- Estimate burn size using the Rule of Nines or Rule of Palm.
- Discuss the Rule of Ten for burn resuscitation.
- Discuss the four causes of burn injury and treatment of each.

INTRODUCTION

Burns can cause devastating injuries involving the skin and other organ systems. Patients suffering from significant burns require special critical care. Burn casualty evaluation is often complicated by the dramatic presentation of other types of traumatic injuries. Casualties whose only wounds are major burns rarely die in the short-term period after acquiring the injury itself. Casualties who die shortly after being badly burned die as a consequence of related trauma or associated conditions, such as airway compromise or smoke inhalation. During emergency medical technician training, each combat medic establishes a foundation for treating burn casualties; however, the ability to perform more advanced interventions will save more soldiers' lives.

ANATOMY AND PHYSIOLOGY OF THE SKIN

The skin is the largest organ of the body and is made up of three layers: the epidermis, the dermis, and subcutaneous tissue (Figure 25-1). The epidermis is the outermost layer of skin and is made up of epithelial cells without blood vessels. The epidermis is nourished by capillaries located in the dermis. The dermis is a thick layer of collagen connective tissue that is positioned below the thin layer of the epidermis. The dermis contains important support structures and sensory nerves, such as hair follicles, sweat glands, and oil glands. The subcutaneous layer of skin is composed of adipose tissue that helps insulate the body from the outside environment. The skin acts as a barrier between the body and the environment and covers underlying tissues, protecting them from dehydration and injury. The skin helps regulate body temperature by controlling the amount of heat lost (through vasodilation and constriction of capillaries, as well as perspiration) and is the site of many nerve endings. Skin tissue temporarily stores fat, glucose, water, and salts. The skin has properties that allow for absorption of certain drugs and other chemical substances (see Chapter 12, Skin Disease Primary Care).

BURN ASSESSMENT

Assessment of burns to determine type and severity is important for effective and successful treatment. You must evaluate the severity or depth and size of the burn as a percentage of body surface area. Working knowledge of these assessment criteria and tools are critical skills for combat medics.

Burn Causes

Assessing the cause of a burn injury will assist you in making appropriate treatment and evacuation decisions. In some cases, understanding the cause of the burn enables you to protect yourself from injury as well. The following forms of transmitted energy and physical agents can cause burns:

- thermal (heat or fire),
- electrical,
- radiation, or
- chemical.

Each of these types of burns requires specific treatments.

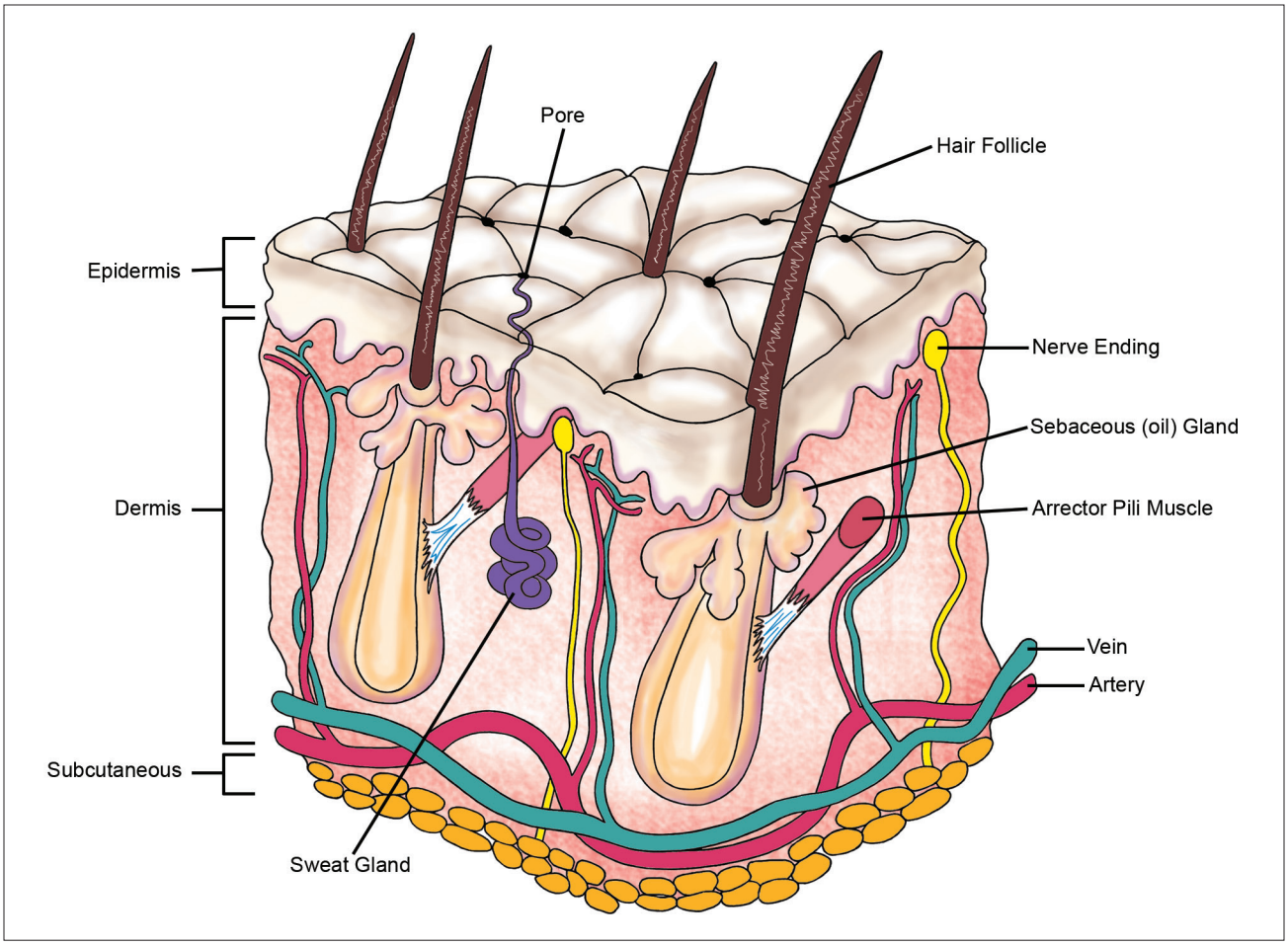


Figure 25-1. The three layers of the skin and other important structures.

Burn Depth

First-degree Burns

Minor tissue damage that reddens only the epidermis and heals in 3 to 6 days is known as a superficial, or first-degree, burn (Figure 25-2). First-degree burns can be painful, but pain management with ibuprofen or acetaminophen, as well as aloe vera gel that contains lidocaine (local anesthetic), usually is the only treatment necessary.

Second-degree Burns

A partial-thickness, or second-degree, burn causes damage through the epidermis and into the dermis (Figure 25-3). In second-degree burns, the skin appears mottled (blotchy) and red, with weeping (oozing) blisters. These burns are painful and typically heal in 2 to 4 weeks, depending on their depth. Surgical repair or skin grafting may be necessary to facilitate healing of large second-degree burns. A skin graft involves surgically removing a partial thickness of skin from an unburned area and placing it over the burned area to "reseed" it with new skin tissue.

Third-degree Burns

Full-thickness, or third-degree, burns extend through the epidermis and dermis and appear charred, translucent, or pearly white, with a surface that is dry and has **thrombosis** (Figure 25-4). Third-degree burns are not normally painful because the nerve endings in the dermis have been destroyed. However, third-degree burns are also associated with second- and first-degree partial-thickness burns on the outer borders of a full-thickness burn, which results in pain. Surgical repair with skin grafting and rehabilitation is necessary for casualties with deep partial-thickness and full-thickness burns. The term fourth-degree burn

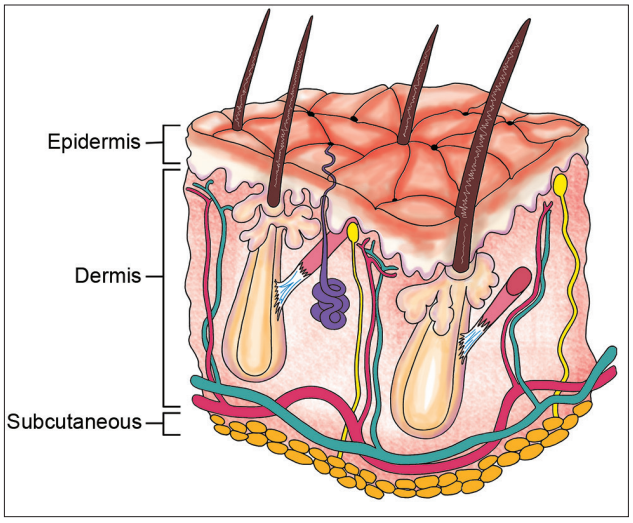


Figure 25-2. First-degree burns involve only the epidermis.

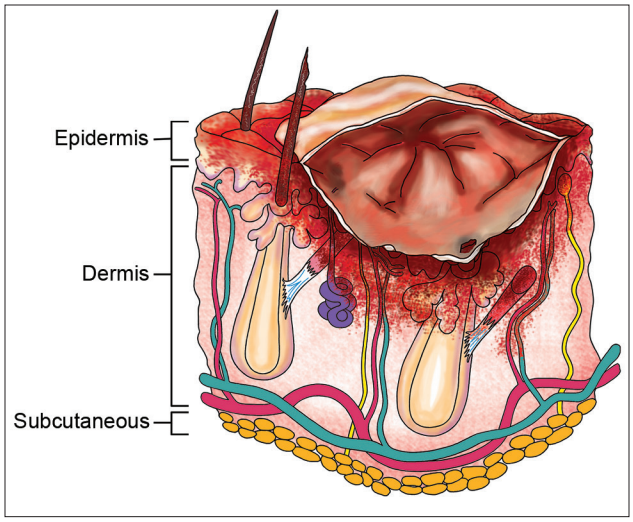


Figure 25-3. Second-degree burns involve the epidermis and dermis.

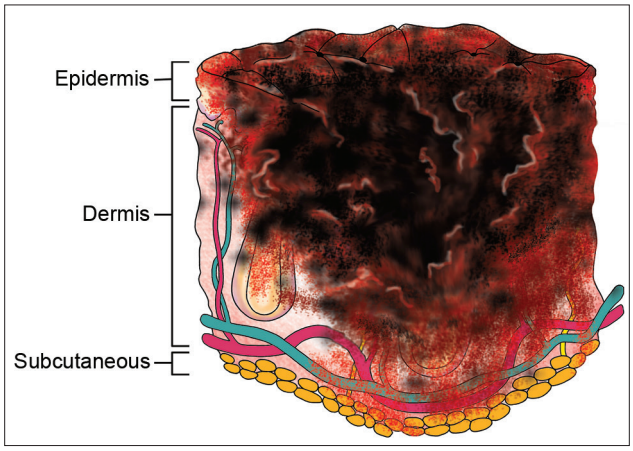


Figure 25-4. Third-degree burns involve all three layers of skin.

is sometimes used to describe burns that involve underlying layers of fat, muscle, or bone.

Burn Size

The **Rule of Nines** describes a quick way to estimate burn size. When using the Rule of Nines, major body parts are assigned percentages as shown in Figure 25-5, and the percentages for each burned body part are added. By applying this rule, you can determine the percentage of total body surface area (**TBSA**) burned. Pediatric assessments are different than adult assessments; children have larger heads (18%) and smaller extremities (14% each leg). If the burn areas are scattered or irregularly dispersed, use the **Rule of Palm:** estimate the TBSA using the palm surface of the casualty's hand to represent approximately 1% of the skin surface.

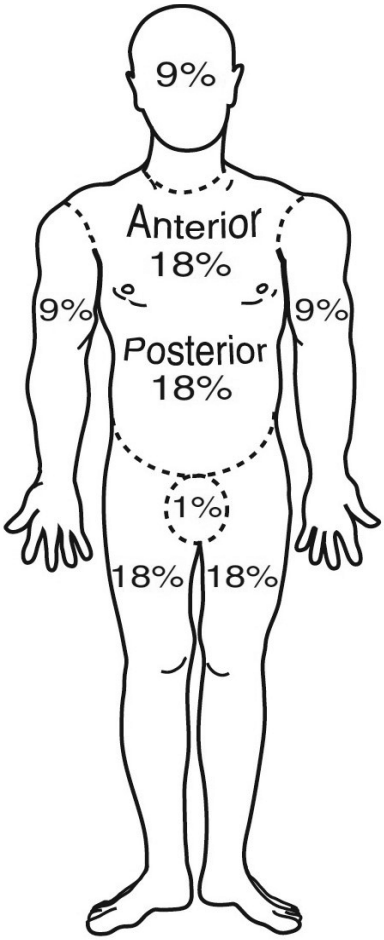


Figure 25-5. The Rule of Nines breakdown of body area percentages. Reproduced from: Cubano MA, Lenhart MK, eds. *Emergency War Surgery*. 4th ed. Washington DC: Department of the Army, Office of The Surgeon General, Borden Institute; 2013: 381.

COMBAT CASUALTY ASSESSMENT

During care under fire, the first priority is to gain fire superiority, and then control life-threatening extremity hemorrhage with hasty tourniquets (see Chapter 16, Combat Casualty Assessment). During tactical field care, the priority for badly burned casualties is to remove the patient from the burn source and stop the burning process. Burn casualties are often trauma casualties as well, and they may have sustained injuries other than thermal trauma, such as blunt or penetrating trauma. Follow the steps below to evaluate a burn casualty and perform initial treatments:

1. Evaluate the casualty's level of consciousness (see Chapter 16, Combat Casualty Assessment).
2. Check for hemorrhage by performing a blood sweep (see Chapter 16, Combat Casualty Assessment).
3. Ensure airway patency. Hot gases and flames can cause edema of the airway above the vocal cords and may occlude the airway, so early airway control is essential (Figure 25-6). For more information see Chapter 18, Airway Management. Always assume an inhalation injury when the casualty was injured in an enclosed-space fire, such as in a vehicle or building. Confusion or agitation, facial or chest burns, singed eyebrows, carbonaceous sputum, and hoarseness or stridor are all signs of an inhalation burn.

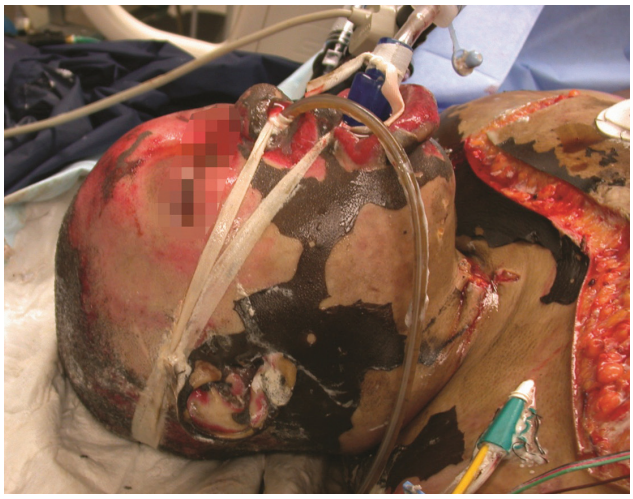


Figure 25-6. A combat casualty with inhalation burns. Reproduced from: Renz EM, Cancio LC. Acute burn care. In: Savitsky E, Eastridge B, eds. *Combat Casualty Care, Lessons Learned from OEF and OIF*. Washington DC: Department of the Army, Office of The Surgeon General, Borden Institute; 2012: 600.

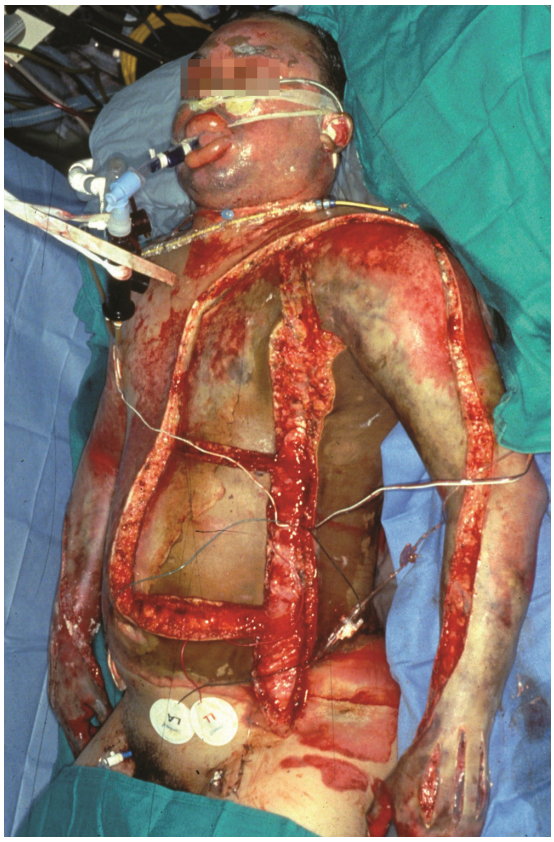


Figure 25-7. A combat casualty with circumferential burns around chest. Note that escharotomies have been performed to allow the movement of the chest during inspiration. Reproduced from: Renz EM, Cancio LC. Acute burn care. In: Savitsky E, Eastridge B, eds. *Combat Casualty Care, Lessons Learned from OEF and OIF*. Washington DC: Department of the Army, Office of The Surgeon General, Borden Institute; 2012: 599.

4. Check breathing. A circumferential chest burn (Figure 25-7) can constrict the chest wall to such a degree that the casualty suffocates from the inability to inhale deeply. Categorize all casualties with circumferential chest burns as "urgent surgical" and evacuate to a military treatment facility with oxygen supplementation (if available) adjusted to maintain an oxygen saturation of at least 92%.
5. Evaluate the casualty's circulation needs by assessing radial pulses and establishing vascular access. For casualties who have sustained burns covering more than 20% of the TBSA, first establish intravenous (IV) access and provide fluid resuscitation. Avoid gaining vascular access through burned tissue, unless no other sites are available.

If IV access cannot be established after two attempts, place an intraosseous (IO) catheter and immediately begin fluid resuscitation following the **Rule of Ten** if radial pulses are present (see Fluid Resuscitation for a Burn Casualty in this chapter). If the casualty is in shock and radial pulses are not present, the shock fluid resuscitation protocol should be followed (see Chapter 20, Shock).

6. Expose the casualty completely and inspect the entire body for any other possible life-threatening injuries (see Chapter 16, Combat Casualty Assessment).

Check on Learning

1. A TBSA greater than or equal to _____% requires intravenous fluid resuscitation.
2. What are the signs or symptoms of an inhalation burn?

BURN WOUND CARE

The goals of burn wound care are to prevent shock and infection and to minimize disfiguration. Cover the casualty's burn in dry, sterile dressings. Dry, sterile sheets or towels are sufficient to use before transporting the casualty. Place several layers of blankets over the casualty to prevent hypothermia. Then, place the casualty in a hypothermia prevention kit or place air-activated heating cells inside blankets with the casualty.

Note: Elevating burned extremities during evacuation will assist in decreasing tissue edema in the first 48 hours of burn management.

Provide fluid resuscitation (see Fluid Resuscitation for a Burn Casualty in this chapter). Use tactical combat casualty care pain management guidelines for pain control (see Chapter 3, Pharmacology). Adverse effects of fentanyl and morphine include respiratory depression, nausea, and vomiting; monitor the casualty closely.

In cases of inhalation burns, stay alert for behavioral changes. Altered mental status is a sign that the brain is not receiving enough oxygen. If breathing becomes more difficult, be prepared to perform a surgical cricothyroidotomy (see Chapter 18, Airway Management).

Do not apply ointments or solutions until the casualty has been evaluated by a medical officer. Do not open blisters, and do not open eyelids if they are thermally burned. An escharotomy may be required to release pressure from swelling in the case of a circumferential burn (see Figure 25-7 and Figure 25-8). This procedure would be performed by a medical officer at a battalion aid station or higher level of care, NOT by a combat medic.

Remove nonadherent clothing, jewelry, and watches. Frequently monitor extremity pulses in circumferential burns to legs and arms. Edema formation beneath the elastic eschar may gradually constrict the venous outflow and, ultimately, arterial inflow. Frequently monitor an extremity's pulse in circumferential burns to the legs and arms.



Figure 25-8. Right hand escharotomies. The burned skin is incised to the subcutaneous level, providing decompression while avoiding deeper structures. Reproduced from: Renz EM, Cancio LC. Acute burn care. In: Savitsky E, Eastridge B, eds. *Combat Casualty Care, Lessons Learned from OEF and OIF*. Washington DC: Department of the Army, Office of The Surgeon General, Borden Institute; 2012: 614.

For casualties who have sustained burns alone, with no other injury, antibiotics are not indicated because a thermal injury that destroys the skin also destroys cutaneous bacterial flora. For those suffering from a combination of burns and penetrating trauma, antibiotics are indicated (as with any other combat trauma casualty).

Burn casualties are not able to control their own body temperature effectively and are susceptible to hypothermia, even in warm or hot environments. Preserve body temperature with blankets, clothing, or whatever is available

Electrical Burns

If a casualty has sustained an electrical burn from a wire source, **do not** attempt to remove wires unless you

are trained to do so. Objects commonly thought to be safe for moving a wire or casualty (eg, wooden sticks, rope, and firefighting gloves) may actually conduct electricity, resulting in the rescuer being electrocuted. If possible, turn off the source of electricity before any rescue attempt is made.



Figure 25-9. Electrical burn to left upper extremity. Reproduced from: Cioffi WG, Loring WR, Buescher TM, Pruitt BA. The management of burn injury. In: Bellamy RF, Zajtchuk R, eds. *Conventional Warfare: Ballistic, Blast, and Burn Injuries*. In: Zajtchuk R, Jenkins DP, Bellamy RF, eds. Washington, DC: Department of the Army, Office of The Surgeon General, Borden Institute; 1991: 374.



Figure 25-10. Urine from a person with myoglobinuria resulting from muscle tissue destruction. Photograph by James Heilman, MD. Reproduced from: Wikimedia Commons. https://commons.wikimedia.org/wiki/File%3ARhabdoUrine.JPG

Electrical burns (Figure 25-9) are usually more serious than they appear on the skin surface because the current burns deep tissue along an unpredictable path or can cause heartbeat problems (dysrhythmias). The most common dysrhythmia encountered after electrocution is an abnormal heartbeat such as premature ventricular contractions and ventricular fibrillation (pulseless). If the casualty has no pulse, and the tactical situation permits, start cardiopulmonary resuscitation and treat the casualty with an automated external defibrillator. These casualties usually have normal healthy hearts and the chances for resuscitation are excellent. Electrical injuries and crush injuries have many similarities and may both result in **myoglobinuria** (Figure 25-10) and associated complications (see Chapter 26, Musculoskeletal Trauma). Other injuries associated with electricity include ruptured tympanic membranes and fractures to multiple areas of the spine and long bones (resulting from intense and sustained muscle contractions).

Radiation Burns

Many of the treatment interventions for radiation casualties are the same as for other types of burns. Remove the casualty from the burning source and treat immediately life-threatening injuries. Remove contaminated clothing and irrigate the injury with water. Provide fluid resuscitation; if IV fluids are not available, consider providing oral fluids. Irradiated casualties may experience nausea and vomiting, thus increasing the need for fluids. The most devastating effects of radiation poisoning in casualties who survive the initial exposure will not appear until a few hours after the exposure.

Chemical Burns

Chemicals are not always easy to detect, either on a casualty or in the environment. Some chemicals may also be absorbed into the body and cause internal organ failure. In the past, rescuers have sustained severe chemical burns when they attempted to treat burn casualties who were contaminated with an unknown chemical agent. Remove the casualty's clothing to remove a possible source of continuing contamination and to better determine the type and TBSA of the burn.

If a dry chemical is seen on the skin, brush it away and then irrigate with copious amounts of water. Take care to prevent skin contact with any dry chemical while brushing. Remove liquid chemicals from a burn casualty (including burns to the eyes) by flushing

the area with as much water as possible to dilute the concentration and wash away remaining chemicals.

Caution: Ensure that enough water is used to wash the chemical (wet or dry) completely off the skin. If too little water is used, it is possible to spread the chemical over a wider area of the body, increasing the TBSA burned.

Injuries from white phosphorus are occasionally seen in military settings. White phosphorus is a chemical substance that will ignite and burn when exposed to oxygen (Figure 25-11). Grenades, shells, or bombs that contain white phosphorus can cause severe thermal and chemical burns. Cover white phosphorus burns with anything that seals the white phosphorus from the air (eg, water, saline, a wet cloth, or mud). The seal must be maintained until the phosphorus is removed to prevent retained particles from reigniting and burning further.



Figure 25-11. A US Air Force Douglas A-1E Skyraider drops a white phosphorus bomb on a Viet Cong position in South Vietnam in 1966. Author: US Air Force. Reproduced from: Wikimedia Commons. https://commons.wikimedia.org/wiki/File:A-1E_drops_white_phosphorus_bomb_1966.jpg

Fluid Resuscitation for a Burn Casualty

IV or IO fluids prevent a burn casualty from going into hypovolemic shock (see Chapter 20, Shock). The objective is to determine an appropriate rate or amount of fluid to prevent hypovolemia after the burn injury. Initiate fluid resuscitation as soon as IV or IO access is established. Ringer solution is the fluid of choice, if available. If the casualty is in shock secondary to other injuries, resuscitation may be started with Hextend (Hospira, Inc, Lake Forest, IL). Do not give more than 1,000 mL of Hextend to a casualty. Estimate the initial IV/IO rate using the Rule of Ten. Historically, overhydration with IV fluids has been a problem for burn casualties. Massive amounts of IV fluids are no longer the standard of care. Estimate the initial IV or IO rate using the US Army Institute of Surgical Research Rule of Ten for burn resuscitation of adults:

% TBSA burned × 10 = initial hourly IV fluid infusion rate.

Steps for calculating IV fluid rate:

1. Estimate the TBSA burned to the nearest 10% using the Rule of Nines or Rule of Palm.
2. For the initial rate, multiply the TBSA (to the nearest 10%) by 10 mL/h for adults weighing 88 to 175 lb (40–80 kg).
   For example, for a 170 lb (77 kg) male who has burned approximately 30% of his body:
   30 × 10 mL/h = 300 mL/h
3. For patients weighing 176 to 200 lb (80–91 kg), increase the initial rate by 100 mL/h. (For every 25 lb [11 kg] above 175 lb [40 kg], increase the initial rate by 100 mL/h.)
   For example: a 195 lb (88 kg) male has burned approximately 50% of his body.
   50 × 10 mL/h = 500 mL/h + 100 mL/h = 600 mL/h
4. If the casualty weighs 201 to 225 lbs (91–102 kg), increase the initial rate by 200 mL/h.
   For example: a 210 lb (95 kg) male has burned approximately 50% of his body.
   50 × 10 mL/h = 500 mL/h + 200 mL/h = 700 mL/h
5. If the casualty weighs 226 to 250 lbs (103–113 kg), increase the initial rate by 300 mL/h.
   For example: a 230 lb (104 kg) male has burned approximately 50% of his body.
   50 × 10 mL/h = 500 mL/h + 300 mL/h = 800 mL/h

Table 25-1 summarizes how to calculate the fluid volume infusion rate when applying the Rule of Ten.

Table 25-1. Fluid Requirements for Burn Victims

Burn victim's weight (lb)	Initial infusion rate per hour	Added volume per hour
88–175 lb (40–80 kg)	TBSA % x 10 = mL/hour	None
176–200 lb (80–91 kg)	Same	100 mL
201–225 lb (91–102 kg)	Same	200 mL
226–250 lb (103–113 kg)	Same	300 mL

Once IV access is established, secure the IV catheter by suturing or stapling it to the skin. Adhesive tapes or dressings will not secure the catheter when the skin is burned.

If in a battalion aid station or military treatment facility, placing a urinary catheter and monitoring urine output are essential for ensuring the effectiveness of burn fluid resuscitation. Titrate fluids until the urine output is 30 to 50 mL/h for catheterized patients. Burns to the genitalia or perineal region are not contraindications for urinary catheterization. However, patients with trauma to the pelvis should not be catheterized without direct medical provider oversight.

Special Considerations

The very young and very old respond poorly to burn injuries. The death rate in burn casualties over the age of 65 is three times that of the overall burn population. The leading cause of death in fires is not thermal injury but the inhalation of toxic smoke. The three elements of smoke inhalation are thermal injury, asphyxiation, and toxin-induced lung injury (delayed effects). Always assume there is an inhalation injury in an enclosed-space fire.

Check on Learning

3. How do circumferential burns complicate casualty care?
4. What type of dressing is used on a burn?
5. What should you do if a casualty develops increased difficulty breathing?
6. How are white phosphorus burns treated?
7. In combat, you are called to a small vehicle fire. Your patient has partial-thickness thermal burns to his anterior trunk, anterior arms, anterior legs, and groin. His estimated weight is 180 lb (82 kg).
   a. Using the Rule of Nines, calculate the percentage of TBSA burned.
   b. Calculate the casualty's fluid resuscitation needs using the Rule of Ten.
8. Sergeant First Class Romero went to the beach and fell asleep on the sand. When he awoke, he noticed his posterior trunk, posterior arms, and posterior legs were painful, red, and blistered. He went to the battalion aid station for care. SFC Romero's body weight is 189 lb.
   a. What classification of burn does this soldier have?
   b. Using the Rule of Nines, calculate the percentage of TBSA burned.
   c. Calculate the casualty's fluid resuscitation needs using the Rule of Ten.

TRANSPORTATION CONSIDERATIONS

Once the casualty has been assessed, formulate an evacuation plan. The following conditions are classified as urgent surgical:

- inhalation injury;
- partial-thickness burns greater than 20% TBSA;
- full-thickness burns;
- burns on the face, hands, feet, genitalia, perineum, or major joints (hips, knees, ankles, shoulders, elbows, or wrists);
- electrical burns (including from lightning);
- radiation burns —
  - considered hazardous materials burns,
  - priorities are to remove patient from contamination source and decontaminate them;
- chemical burns —
  - chemicals may be absorbed into the body and cause internal organ failure,
  - casualties require prompt evacuation; and
  - medical personnel can be harmed if casualties are not properly decontaminated;
- significant thermal injuries in patients with preexisting medical conditions (eg, diabetes, cancer, immune deficiency, obesity, or poor circulation due to vascular disease).
- combined burns and trauma (lightning, explosions, and other impact forces may throw a casualty some distance from the original injury location); and

- pediatric burns (where there are no qualified pediatric personnel and equipment).

Check on Learning

9. Which type of burn injuries should be considered a priority for transport?
   a. electrical burns
   b. partial thickness burns to 10% of TBSA
   c. noncircumferential partial-thickness burns to both anterior forearms
   d. first-degree burns to the entire back

SUMMARY

Burns are often serious injuries requiring urgent care. Critical problems that require immediate interventions are airway compromise, the presence of major injuries, or hemorrhage in addition to the burn. Clues that may indicate life-threatening problems include a history of being confined in a closed-space fire, inhalation burn, electrical burn, chemical burn, and radiation burn. Understanding each type of burn and its complexities in treatment will give the casualty a better chance of survival, a faster recovery, and better quality of life after the burn injury.

KEY TERMS AND ACRONYMS

Myoglobinuria. Myoglobin (a protein found in muscle cells) in the urine.
Rule of Nines. A formula for estimating percentage of body surface areas, particularly helpful in judging the portion that has been burned.
Rule of Palm. A method of calculating the body surface area of burns that uses the size of the patient's palm as an approximate representation of 1% of the body surface area.
Rule of Ten. An adult burn fluid resuscitation protocol created by the US Army Institute of Surgical Research that rounds up the casualty's total body surface area to the nearest 10 and then uses the casualty's body weight in calculating the amount of fluid to be administered.
TBSA. Total body surface area.
Thrombosis. A blood clot in the vascular system.

CHECK ON LEARNING ANSWERS

1. A TBSA greater than or equal to_____% requires intravenous fluid resuscitation.

   20%.

2. What are the signs or symptoms of an inhalation burn?

   The burn occurred in a confined space; confusion or agitation; burns to face or chest, singeing of eyebrows or nasal hair, or soot in the sputum; hoarseness or loss of voice; stridor.

3. How do circumferential burns complicate casualty care?

   They lead to an increased chance of compromise to distal circulation due to edema.

4. What type of dressing is used on a burn?

   A dry, sterile dressing.

5. What should you do if a casualty develops increased difficulty breathing?

   Secure the airway with a surgical cricothyroidotomy.

6. How are white phosphorus burns treated?

   Cover the area with water, saline, a wet cloth, or wet mud. Keep the area covered to exclude air and prevent any retained particles from reigniting.

7. In combat, you are called to a small vehicle fire. Your patient has partial-thickness thermal burns to his anterior trunk, anterior arms, anterior legs, and groin. His estimated weight is 180 lb (82 kg).

   a. Using the Rule of Nines, calculate the percentage of TBSA burned.

   47% BSA.

   b. Calculate the casualty's fluid resuscitation needs using the Rule of Ten.

   600 mL/h.

8. Sergeant First Class Romero went to the beach and fell asleep on the sand. When he awoke, he noticed his posterior trunk, posterior arms, and posterior legs were painful, red, and blistered. He went to the battalion aid station for care. SFC Romero's weight is 189 lb.

   a. What type of burn does this soldier have?

   Second-degree (partial thickness).

   b. Using the Rule of Nines, calculate the percentage of TBSA burned.

   45%.

   c. Calculate the casualty's fluid resuscitation needs using the Rule of Ten.

   600 mL/h.

9. Which type of burn injuries should be considered a priority for transport?

   Electrical burns.

SOURCES

Prehospital Trauma Life Support. Military 8th ed. Jones and Bartlett; 2016.

War Surgery in Afghanistan and Iraq: A Series of Cases, 2003-2007. Department of the Army, Office of the Surgeon General, Borden Institute; 2008.

Emergency War Surgery. Fourth United States Revision, Department of the Army, Office of the Surgeon General, Borden Institute; 2013.



26 MUSCULOSKELETAL TRAUMA

CORE CONCEPTS

- Recognize appendicular skeletal injuries and relate their classification to priority of care.
- State trauma assessment procedures for injuries of the appendicular skeleton.
- Describe hemorrhage in both open and closed fractures of the long bones, pelvis, and ribs.
- Discuss mechanisms of injury, clinical findings, and management of femur fractures.
- State the purpose and procedures of amputations.

INTRODUCTION

Musculoskeletal injuries are common in tactical and garrison environments. Combat-related trauma can result in shattered bones and torn muscles. Many musculoskeletal injuries also occur during physical training and recreational sports. Injuries sustained during impromptu sports (eg, football, basketball, and ultimate Frisbee) are significant contributors to soldiers being placed on a nondeployable status. Through knowledge of the underlying anatomy and physiology (see Limited Primary Care, Chapter 10, Orthopedic Primary Care), **kinematics**, and appropriate medical and trauma management techniques, combat medics can manage new injuries and prevent further injuries or permanent disability.

ASSESSING AND MANAGING MUSCULOSKELETAL INJURIES

Assess and manage life-threatening hemorrhage and injuries that affect the casualty's airway, breathing, and circulation first. When assessing a musculoskeletal extremity injury, consider the mechanism of injury (MOI). Visualize possible primary injuries (most obvious) and secondary injuries (less obvious). The MOI provides important clues to the type and severity of musculoskeletal injuries. The presence of non-life-threatening musculoskeletal injuries may be an indicator of more serious problems. Do not allow musculoskeletal injuries to distract you from assessing for life-threatening injuries. Consider the following possibilities for musculoskeletal injuries:

- If enough force was delivered to **fracture** the humerus, there may also be damage to the chest and lungs.
- A rib fracture or bruising may be signs of serious injury to the thorax or upper abdomen.
- Life-threatening injury may be present if the casualty has lacerations or fractures to the face.

Place musculoskeletal injuries in one of three categories, to help you understand the priority of care:

1. Multisystem, life-threatening trauma with non-life-threatening musculoskeletal trauma (ie, life-threatening injuries and limb fractures).
2. Life-threatening musculoskeletal trauma (ie, pelvic and femur fractures with life-threatening blood loss).
3. Isolated, non-life-threatening musculoskeletal trauma (ie, isolated limb fractures).

After completing the primary survey using MARCH (massive hemorrhage, airway, respirations, circulation, head injuries-hypothermia), and depending on the tactical situation and time until evacuation, proceed to your secondary survey and assess the extremities. If not done during the primary survey, remove the casualty's clothing if the environment allows.

Pain, weakness, or abnormal extremity sensation occurs in most patients with significant musculoskeletal injury. Use DCAP-BTLS (deformities, contusions, abrasions, punctures/penetrations, burns, tenderness,

lacerations, and swelling, [Figure 26-1]) for further evaluation.



Figure 26-1. Swelling and bruising still present one month after a grade III high ankle sprain.

Fractures

Combat medics may encounter open (compound) or closed long bone fractures. Open fractures of long bones occur when a high-energy transfer event like a vehicle accident, gunshot wound, or fall breaks a long bone and causes the jagged edges of the bone to pierce through the soft tissue (skin) (Figure 26-2). A closed fracture of long bones can also occur following a high-energy event. In this case, the fractured bone does not pierce through the skin (Figure 26-3). Open fractures have a higher risk of infection. Closed fractures still could be life threatening because the jagged edges of the long bone could sever a major vessel (artery) within that extremity. For example, a femur fracture could result in the loss of 1 to 2 L of blood. Likewise, pelvic fractures can cause severe hemorrhage and may be fatal if a rapid assessment for the presence of a fracture is not complete.

The signs and symptoms of a fracture will vary based on the extent of the injury but will most likely include a combination of the following:

- swelling,
- deformities,
- crepitus,
- limited range of motion,
- pain, and
- loss of distal pulses.

Do not take additional or repetitive steps to reproduce a sign or symptom. By reproducing signs and symptoms of an injury, you could possibly dislodge clots or cause further injury.

Extremity fractures are generally evident in the prehospital setting because of the shortening, deformity, and swelling. Control bleeding with direct pressure or



Figure 26-2. An open fracture with the tibia and fibula emerging from a wound. Photograph by Saltanat. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Open_fracture_01.JPG

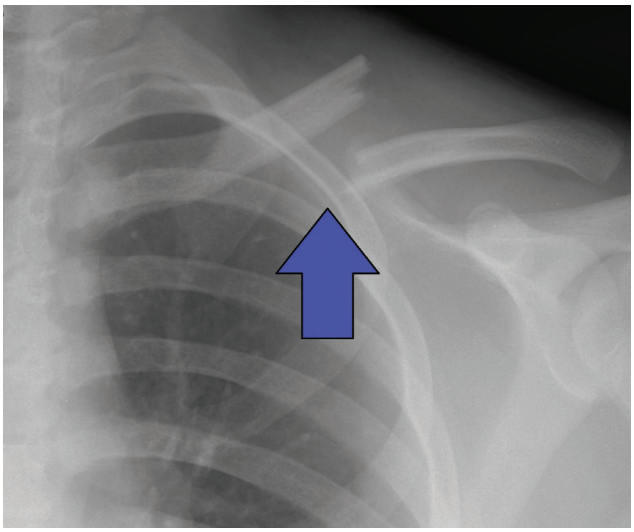


Figure 26-3. A closed fracture of the clavicle. Radiograph by Majorkev, CC BY 3.0. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Clavicle_Fracture_Left.jpg

tourniquet as indicated. Stabilize or immobilize fractures as soon as possible. Complete a neurovascular pulses, motor, and sensory (PMS) assessment distal to all extremity injuries before and after splinting the extremity. Loss of motor and sensory function usually indicates a nerve injury, while loss of motor and sensory function and pulses indicates a serious arterial and nerve injury.

Midshaft femoral fractures are generally seen in younger patients secondary to high-energy trauma; associated traumatic injuries are common. Muscle contractions can cause bone ends to ride over each other. Clinical features include pain, swelling, deformity, and shortening. Stabilize the fracture by applying gentle pressure with a traction splint to realign the bone. A traction splint will help reduce pain, prevent further fracture comminution, and minimize blood loss. Maintain traction until the patient reaches a higher echelon to prevent further injuries within the limb.

Note: Traction splints are contraindicated in cases of pelvic fracture or in suspected knee or vascular injury. For the latter, splint without traction.

Treat pelvic fracture with a pelvic binder (Figure 26-4), which prevents movement of the pelvis and reduces the possibility of the jagged ends of the bones severing major vessels within the pelvis.



Figure 26-4. A pelvic binder.

Multisystem Trauma

When faced with a severely wounded casualty with extremity injuries, life takes precedence over limb. Focus on maintaining vital functions first by treating life-threatening injuries. Limit measures to address musculoskeletal injuries of the extremities until after all treatable life-threatening injuries are managed.

Amputations and Avulsions

Amputation refers to a severed body part, usually a digit or extremity. A partial amputation refers to a body part that has not been completely detached from the body. Amputation can result from ripping, crushing, or cutting of the tissue, and can cause life-threatening hemorrhage. Avulsions refer to a flap of skin and possible underlying tissue, such as muscle, that have been partially removed or completely torn off. Amputations (Figure 26-5) occur because of high-energy events like exposures to an improvised explosive device (IED) blast. If left untreated, an amputation will lead to death due to hemorrhagic shock.



Figure 26-5. A soldier places a tourniquet on a simulated amputation. Photograph by Sergeant Arjenis Nunez. Reproduced from NARA & DVIDS Public Domain Archive. https://nara.getarchive.net/media/soldiers-with-the-3rd-infantry-division-fasten-a-simulated-a75226



Figure 26-6. A hasty tourniquet.



Figure 26-7. A deliberate tourniquet.

The best approach to treating an amputation is to apply a tourniquet. Tourniquet choice is based on the situation (current phase of tactical combat casualty care) and the severity of the amputation. Place a hasty tourniquet as high on the limb as possible and over the uniform (Figure 26-6). Place a deliberate tourniquet on the skin, 2 to 3 inches above the wound, or 2 to 3 inches above the joint if the joint space falls within 2 to 3 inches above the wound (Figure 26-7).

Note: Amputations require surgical intervention, so place the casualty in the urgent surgical priority for tactical evacuation.

Note: Amputations may not immediately bleed due to vascular spasms of the injured vessels. Always place a tourniquet to control bleeding because when spasms subside, bleeding will occur.

Compartment Syndrome

In compartment syndrome, pressure is exerted against the muscle fascia (the dense connective tissue that envelops the muscles) compartments within the extremity. Muscle fascia has minimal ability to stretch, so increasing pressure in the compartment crushes structures and impairs capillary flow. Tissue served by the impaired capillaries becomes ischemic. Nerves are the most vulnerable and the first to become injured.

Acute compartment syndrome usually results from trauma when arterial blood flow continues into an extremity, but venous flow is restricted from returning to the system. However, a chronic compartment syndrome can also occur and is often seen in athletes with insidious onset of pain.

Consider compartment syndrome if there is a causative MOI and the patient's pain is out of proportion to the injury sustained. Assess the injury using the "classical Ps" to further support and confirm your diagnosis. The classical Ps aid in diagnosing a suspected compartment syndrome in conjunction with a tense, swollen compartment (an early sign). Check for the following:

- **Pain** out of proportion with the injury during passive stretching, or extreme tenderness (early symptom);
- **Pressure** and pain with passive stretch (an early symptom);
- **Paresthesia**—the sensation of pins and needles;
- **Pallor** and **pulselessness**—pale skin or poor capillary refill and diminished or absent pulses in the injured extremity (late signs);
- **Paralysis** or the inability to move (a late sign).

The earliest indicator of developing compartment syndrome is severe pain. Pain that is difficult to control and/or pain that is present with passive stretching are hallmarks of compartment syndrome. Not all classical Ps need to be present to suspect and treat for compartment syndrome.

If you suspect compartment syndrome, loosen tightly applied splints or dressings and reassess for presence of a distal pulse. Tighten tourniquets or apply a second tourniquet directly above the first until the distal pulse becomes undetectable. If possible, administer oxygen (eg, on evacuation platforms, Role 1 or higher).

Note: Hypotensive patients do not tolerate elevated compartment pressure as well as normotensive patients. Correct hypotension and elevate the affected limb to the level of the heart.

Note: The definitive treatment for compartment syndrome is surgical fasciotomy (Figure 26-8), usually done by a medical provider.



Figure 26-8. A surgical fasciotomy with skin transplant performed to relieve the swelling and pressure of compartment syndrome. Photograph by Sarte, CC BY-SA 3.0. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Fasciotomy_leg.jpg

Crush Syndrome

Crush syndrome (Figure 26-9) occurs when a body part sustains a high degree of force or pressure, usually after being squeezed between two heavy objects.

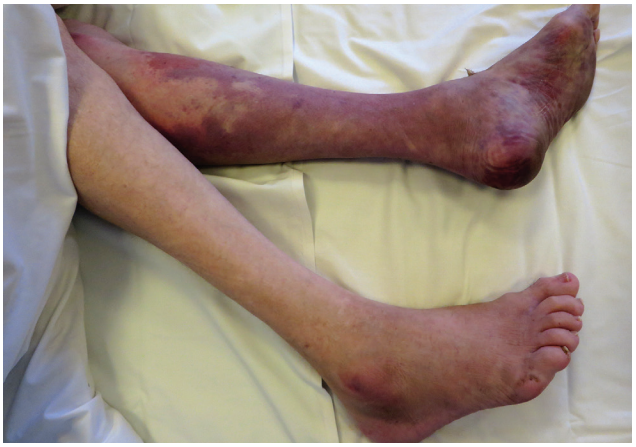


Figure 26-9. A crush injury resulting in tissue necrosis. Photograph by AfroBrazilian, CC-BY-SA-4.0. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Crush_syndrome_03.JPG

Damaged muscle tissue releases myoglobin and potassium. Crush syndrome is a reperfusion injury that leads to traumatic **rhabdomyolysis**. Myoglobin is a storage site for oxygen within muscle tissue. When released from damaged muscle tissue, myoglobin can damage the kidneys. Elevated potassium levels can cause cardiac arrhythmias. The free myoglobin released during muscle breakdown causes **myoglobinuria**, indicated by dark or cola-colored urine. When the crush pressure is relieved and the injury is reperfused, new blood washes the old blood and accumulated toxins into the circulatory system.

Little may be done for these casualties, especially if the affected body part is still trapped. If possible, achieve vascular access before extrication and provide aggressive fluid resuscitation. Start intravenous (IV) or intraosseous (IO) IV crystalloids IMMEDIATELY (before extrication). Administer an initial 2 L bolus and adjust to the urine output, with a goal of 100 to 200 mL/h. The best way to achieve this is by placing a foley catheter. If a foley catheter is not available, you can improvise and capture urine in a premade or improvised graduated cylinder or canteen.

Contact a medical officer (MO) as soon as possible, even prior to extrication. Tourniquets may delay the life-threating complications of a reperfusion injury if immediate fluid resuscitation or monitoring is not initially available. Consider tourniquet placement for crush injury before extrication if the length of entrapment exceeds 2 hours.

Rhabdomyolysis

Rhabdomyolysis (rhabdo) is a skeletal muscle injury that results in cellular death with resultant leakage of intracellular contents. Common cellular contents that leak include myoglobin, creatinine kinase, and potassium, but there are many more.

The MOI should raise suspicion for rhabdo. Consider compartment syndrome, prolonged muscular compression (eg, crush injury), prolonged immobilizations (eg, backboard), excessive muscular activity (eg, ruck marches and marathon running), strenuous exercise (eg, power lifting, CrossFit), heatstroke, and electrical injuries as potential causes of rhabdo. In addition, alcohol and drugs play a role in up to 80% of rhabdo cases.



Figure 26-10. Secondary blast injuries to the lower extremities. There are two Combat Application Tourniquets on each leg. Reproduced from O'Brien PJ, Cox MW. Stents in tents: endovascular therapy on the battlefields of the global war on terror. *J Surg Radiol*. 2011;Jan 1;2(1). CC BY-SA 3.0, via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Blast_injury-lower_extremities.PNG

Typical signs and symptoms include common muscle aches and stiffness, malaise, muscle tenderness, and myoglobinuria. Nausea, vomiting, abdominal pain, and tachycardia are signs and symptoms of severe cases.

Achieve vascular access and conduct aggressive fluid resuscitation with normal saline prior to evacuation. Definitive diagnosis for this injury requires laboratory studies that assess creatine kinase levels. Patients with rhabdo typically have potassium levels five times higher than normal.

Mangled Extremities

Mangled extremities are significant injuries involving skin, muscle, tendons, bones, vessels, and nerves due to high energy transfer (Figure 26-10). The primary focus is still on addressing life-threatening conditions. Apply tourniquets to control hemorrhage and evacuate the casualty as an urgent surgical priority.

Check on Learning

1. During a fractured extremity assessment, when should you assess distal neurovascular function? What findings indicate a nerve injury and an arterial injury?
2. What is the most common cause of acute compartment syndrome in combat casualties?
3. List the classical Ps of compartment syndrome.
4 Define crush syndrome.
5. What are five common causes of rhabdomyolysis?
6. Your patient has a traumatic amputation of his left leg below the knee from an IED explosion. She has significant blood loss with signs of shock. What is her evacuation category?

IMMOBILIZING BONES AND JOINTS

Before splinting a fractured extremity, manage life-threatening hemorrhage and injuries that affect MARCH. The objective of splinting is to prevent motion in broken bone ends. The nerves that cause the most pain in a fractured extremity lie in the membrane surrounding the bone (periosteum). The broken bone ends irritate these nerves, causing a very deep and distressing type of pain. Splinting not only decreases pain but also eliminates further damage to muscles, nerves, and blood vessels and helps control hemorrhage.

Generally, you should return a fractured extremity to its normal anatomical position before applying a splint. If necessary, use traction to realign an extremity to its normal length (within reasonable clinical judgment). A fracture that is in normal anatomical alignment is easier to splint.

Splinting Considerations

In a life-threatening situation, splint injuries while the patient is being transported. In a hostile environment, there may not be time to splint an injury.

If the tactical situation allows, expose the injury and check distal pulses, movement, and sensation before and after splinting. When an initial assessment is completed and pulses are located, you may mark them with a pen to identify where (radial, dorsalis pedis, posterior tibial) and when they were last checked. If distal pulses are absent, attempt to realign the injured extremity by applying gentle traction. This assists in returning perfusion. However, realigning an extremity to regain a distal pulse should not be the focus of your management. If resistance is encountered, splint the extremity in the position in which it was found.

Caution: An absent pulse distal to an extremity wound is a surgical emergency.

Splints must be long enough to immobilize the joint above and the joint below the injury and rigid enough to keep the bone from moving (Figure 26-11). If possible, use at least four ties (two above and two below the fracture) with nonslip knots to secure the splints (Figure 26-12). If splinting material is not available, use swaths or a combination of swathes and slings to immobilize an extremity with an anatomic splint. Also, consider using elastic bandages for support.

Caution: Do not attempt to place a fractured bone back into the wound. This could cause further injury by cutting into muscle tissue or vessels.



Figure 26-11. A splint. Photograph by Corporal Juan D. Alfonso. Reproduced from DVIDS Hub. https://www.dvidshub.net/image/164074/afghanistan-deployed-corps-men-sharpen-life- saving-skills



Figure 26-12. Correct use of ties on a splint.

Common Splinting Techniques

There are multiple ways to splint upper extremity injuries. Two of the most common splinting techniques for upper extremity injuries are the sugar tong arm splint and the ulnar gutter splint. However, there are various splinting techniques you can use, depending on the location of the injury.

Sugar Tong Arm Splint

The sugar tong arm splint is used for distal radius and ulna fractures. Use the items listed below to apply a sugar tong arm splint:

- lightweight, flexible splint (eg, SAM splint)
- elastic bandage
- cravats
- 3-inch tape
- trauma shears

Use the following steps to apply a sugar tong splint:

1. Gather and check the required equipment.
2. Don body substance isolation (BSI) items, gloves at a minimum.
3. Remove clothing and equipment as needed to expose the casualty's injury.
4. Visually inspect the casualty's injured forearm against the uninjured forearm and note any abnormalities that would indicate the use of a sugar tong splint.
5. Fold a flexible splint in half.
6. Place the folded splint against the casualty's uninjured arm as a template and adjust the length as necessary.
7. Place the folded splint around the casualty's uninjured elbow so the end of the top half extends past the knuckles.
8. Fold the bottom half down, even with the top.
9. Form a C curve in each half and extend the C curve no more than two-thirds the length of each half. If folded further, it will limit the ability to fold the splint around the elbow.
10. Check the radial pulse of the casualty's injured arm before placing the splint.
11. Apply the splint to the casualty's injured arm.
12. Pinch and fold any excess gap at the bottom of the splint around the casualty's injured elbow to ensure a snug fit.

13. Wrap the casualty's injured arm to secure splinting material in place with an elastic bandage.
    a. Starting at the knuckles, wrap the casualty's fingers together on first wrap.
    b. Wrap around thumb on second wrap, working your way toward the casualty's elbow.
    c. Leave a window in the wrap to provide access for radial pulse assessment.
14. Cover all splint material with the wrap and secure it with 3-inch tape.
15. Check the casualty's pulse once again to ensure proper circulation.

Ulnar Gutter Splint

The ulnar gutter splint is used to immobilize fractures of the 4th and 5th metacarpal (hand). Use the items listed below to apply a sugar tong arm splint:

- lightweight, flexible splint (eg, SAM splint)
- elastic bandage
- cravats
- 3-inch tape
- trauma shears

Use the following steps to apply an ulnar gutter splint:

1. Gather and check equipment.
2. Don BSI, gloves at a minimum.
3. Remove clothing and equipment as needed to expose the casualty's injury.
4. Visually inspect the casualty's injured hand against the uninjured hand and note any abnormalities that would indicate the use of an ulnar gutter splint.
5. Fold the flexible splint in half lengthwise.
6. Extend the splint from the casualty's little finger to the elbow on the uninjured arm.
7. Mold the splint around the casualty's uninjured arm as a template.
8. Have the casualty position their injured arm out, with thumb toward the ceiling.
9. Check radial pulse of the casualty's injured arm before placing the splint.
10. Place the molded splint so that it extends from the tip of the casualty's little finger to the elbow.
11. Make any necessary adjustments to ensure a snug fit and ensure stability.
12. Wrap the casualty's injured arm to secure splinting material in place with an elastic bandage.
    a. Start wrapping at casualty's little finger.
    b. Wrap proximally to the elbow and leave a window in the wrap for access to the casualty's radial pulse.
13. Cover all splinting material and secure the wrap with 3-inch tape.
14. Check the casualty's pulse once again to ensure proper circulation.

Upper Extremity Sling and Swath

A sling and swath may reduce pain and stabilize the injured arm and shoulder more than the splint alone by securing the injured arm in a position close to the body and with little movement allowed. This technique is used for casualty transport and for other situations to further stabilize and reduce painful movement of the injured limb.

Gather two cravats and use the following steps to apply a sling and swath:

1. Unfold one cravat.
2. Tie a small knot in the 90° corner of the material.
3. Ask the casualty to use their uninjured hand to support their injured hand across their chest at about a 45° angle.
4. Place the knot of the cravat at the back of the casualty's elbow (injured arm) to create a pocket for the arm to rest in the sling.
5. Run the inside corner of the cravat under the casualty's arm, straight up over the shoulder of the injured arm, and around the back of the casualty's neck.
6. Run the other corner of the cravat over the outside of the arm and over the shoulder of the casualty's uninjured arm.
7. Tie the two ends together behind the casualty's neck and make sure the knot is not over the casualty's cervical spine.
8. Fold another cravat into a 2-inch band (most cravats come folded this way in the package).
9. Run the cravat circumferentially around the casualty's torso, just above the elbow of the injured arm and extending around the chest of the casualty's uninjured side.
10. Secure the cravat in place with a knot and make sure the knot is not over the casualty's spine.

Pelvic Binder

Pelvic fractures are associated with mortality rates ranging from 9% to 20%. The greatest immediate concern associated with a pelvic fracture is blood loss due to internal bleeding. This is difficult to manage or control, and close monitoring is essential. Treat the casualty for shock as indicated. If a pelvic fracture is suspected, apply a pelvic binder.

The items required to apply a pelvic binder include the following:

- commercial pelvic binder (eg, SAM pelvic sling, SAM Medical, Tualatin, OR)
- cravat
- 3-inch tape

Use the following steps to apply a pelvic binder:

1. Gather and check equipment.
2. Don BSI, gloves at a minimum.
3. Expose the injury site, assess the injury, and check for an exit wound.
4. Slide the belt underneath the casualty's lower back and slide it down until it is centered over the greater trochanter.
5. Route the black strap through the buckle assembly and pull it completely through.
6. Pull the two handles away from each other until you hear an audible click.
7. Fasten excess belt material in place by pressing it down on the hook-and-loop fastener (you may hear a second click once the belt is secure).
8. Secure the device with a nonslip knot by applying a cravat from one handle to the other and extending it around the casualty's back. Secure the tails with tape.

Note: Combat medics may overtighten pelvic binders when in high-stress environments. Use pelvic binders with integrated limits on compression force (eg, no more than 33 lb) to avoid further harming the casualty.

Traction Splint

When a femoral shaft fracture is suspected based on the MOI or exam, a traction splint is indicated. Femoral fractures, like pelvic fractures, can be deadly, due to the severe blood loss associated with this type of injury. You must suspect hemorrhage and monitor the patient for signs of hemodynamic instability and shock and treat appropriately. Contraindications for a traction splint include the following:

- pelvic fracture;
- ipsilateral fracture;
- avulsion or amputation of the ankle, foot, and or lower leg; and
- ipsilateral knee injury.

Note: Although traction is beneficial for femur fracture management, it can harm fractures or ligaments of injuries distal to the femur.

Use the items listed below to apply a traction splint:

- traction pole
- ankle hitch
- ischial strap
- 3 elastic straps
- 3-inch tape

Use the following steps to apply a traction splint:

1. Gather and check equipment.
2. Don BSI.
3. Remove the boot and sock from the casualty's injured leg.
4. Check the pedal pulse of the casualty's injured leg.

Note: If a second rescuer is available, they should support and stabilize the casualty's injured leg to minimize movement while the ankle hitch is applied. When the ankle hitch is applied, they can apply gentle traction to realign the extremity.

5. Apply the ankle hitch tightly around the casualty's injured leg, slightly above the ankle bone.
6. Tighten the stirrup by pulling the green-tabbed strap until the stirrup is snug under the casualty's heel.
7. Apply the ischial strap by sliding the male buckle under the casualty's injured leg at the knee.
8. Move the strap back and forth upward until it is positioned in the casualty's groin area.

Note: The angle of the strap must be at least 45° to apply proper countertraction on the pubic symphysis.

9. Insert the male end of buckle into the female end until a click is heard, signifying the buckle is locked.
10. Cinch the strap until the traction pole receptacle is positioned at the casualty's belt line or pelvic crest.
11. Extend the traction pole. Make sure that each joint of the pole is securely seated.
12. Use the casualty's uninjured leg to measure the proper length for the traction pole.
13. Place the traction pole along the injured leg so that the red marking on the bottom section of the tubing is lined up at or below the bottom of the casualty's foot. This length allows enough space for application of constant traction.

Note: "Before Traction" is sewn into the fabric of a SAM pelvic binder.

14. Insert the pole end into the traction pole receptacle.
15. Secure an elastic strap around the casualty's knee.
16. Place the yellow tab of the ankle hitch over the dart end of the traction pole.
17. Apply traction by pulling the red tab of the ankle hitch.
18. Apply traction smoothly by simultaneously pushing up on the bottom of the traction splint and pulling down on the red tab (with equal pressure).
19. Reassess the casualty's pedal pulse.
20. Use 3-inch tape to secure the red, yellow, and green tabs together to prevent the straps from slipping after traction is applied.
21. Apply a thigh elastic strap and shin elastic strap. Splint as required to further stabilize the injured leg using available options, such as a long spine board, litter, or the uninjured leg.

Note: "After Traction" is sewn into the fabric of a SAM pelvic binder's thigh and shin straps.

8 and U Splint

Ankle fractures or dislocations are common injuries among soldiers. There are numerous ways to immobilize an ankle. Apply a splint and instruct the casualty to avoid bearing weight on the injured ankle until cleared by a medical provider.

Use the items listed below to apply an 8 and U splint:

- 2 lightweight flexible splints
- elastic bandage
- 3-inch tape
- trauma shears

Use the following steps to apply an 8 and U splint:

1. Gather and check equipment.
2. Don BSI, gloves at a minimum.
3. Remove the boot on the casualty's injured foot to access the dorsalis pedis artery.

Note: If the casualty's boot will remain on, cut the boot laces and slide your fingers down the side of the tongue to check the posterior tibial pulse.

4. Obtain a pulse check before applying a lightweight, flexible splint.
5. Use the casualty's uninjured leg as a template to start forming the 8 and U splint.
6. Form the 8 by first forming a U with the splint placed directly under the heel of the casualty's uninjured foot, then form the 8 by folding the splint in opposite directions. Remove the formed 8 and place aside.
7. Using another flexible splint, form a U shape under the casualty's uninjured heel, extending up the lateral and medial aspect of the leg.
8. Transfer both formed splints to the casualty's injured ankle.
9. Apply the 8 over the casualty's foot or boot and secure it in place with a strip of 3-inch tape.
10. Apply the U around the casualty's heel and secure it in place with 3-inch tape. Fold the sides down to adjust if necessary.
11. Using the elastic bandage, place a knot just above the ankle, leaving a tail.
12. Wrap the bandage around the casualty's ankle to create an anchor point. Make sure you leave a window to access the pulse.
13. Use a figure 8 wrap to secure the splinting material in place and secure the wrap with 3-inch tape.

14. Recheck the casualty's pulse after splinting is complete.

Splinting Materials in the Tactical Environment

Commercial splints come in many varieties, but you can improvise splints if necessary. Commercial devices include rigid splints, pressure splints, traction splints, formable splints, vacuum splints, sling and swathe, and long backboards. Improvised splints can be made from boards, poles, sticks, rolled magazines, newspapers, cardboard, blankets, or pillows (Figure 26-13 and 26-14). Avoid using narrow materials such as wire or cord to secure a splint in place. If raw materials are not available, use anatomical splints. Use the casualty's chest wall to immobilize a fractured arm (Figure 26-15). Use the casualty's uninjured leg to immobilize a fractured leg (Figure 26-16). Pad splints to prevent pressure points on bony prominences (see Figure 26-16). You may improvise padding from items such as clothing, blankets, ponchos, and poncho liners.



Figure 26-13. Service members provide aid to an injured hiker by applying an improvised splint using sticks and 550 cord. Note: In general, do not use narrow materials for holding a splint in place. Photograph by Staff Sergeant Alan Ricker. Modified from https://www.dvidshub.net/image/7344165/airmen-sailor-assist-injured-hiker



Figure 26-14. Example of an improvised leg splint using duct tape, wood, and the uninjured leg. Photograph by Joe Loong, CC BY-SA 2.0. Reproduced from flickr.com. https://www.flickr.com/photos/joelogon/13410875953/in/photostream/



Figure 26-15. An arm-to-chest anatomical splint.



Figure 26-16. An anatomical leg splint with padding placed between the injured and uninjured leg.

Check on Learning

7. What are the correct length and consistency of a splint?
8. When treating a casualty with an extremity fracture, you find the distal pulse is absent. What should you do?
9. One of the vehicles in your convoy rolled while trying to avoid an improvised explosive device in the road. One soldier in the vehicle has a closed mid-shaft femur fracture with edema and an absent distal pulse. What is the objective of splinting broken bones in this case?

MEDICATIONS

Analgesic Pain Management

Once the injury is splinted and stabilized, the casualty should experience significant pain relief. Analgesics are recommended for isolated joint and limb injuries but not for patients who have any of the following contraindications:

- unconscious,
- respiratory compromise,
- altered mental status,
- hypoperfusion, or
- known morphine allergies.

Always use the least sedating pain control medication first, provided it is effective. Tactical Combat Casualty Care (TCCC) guidelines give the following analgesic options[1]:

Option 1

Treat mild to moderate pain in casualties who are still able to fight with the pill pack from the TCCC Combat Wound Medication Pack (CWMP). The pill pack includes:

- acetaminophen—500 mg tablet, 2 per os every 8 hours and
- meloxicam—15 mg per os once per day.

Option 2

Treat mild to moderate pain in casualties who are NOT in shock or respiratory distress AND NOT at significant risk of developing either condition with:

- oral transmucosal fentanyl citrate (OTFC)—800 μg and
- a repeated dose after 15 minutes if pain remains uncontrolled.

Option 3

Treat moderate to severe pain in casualties who ARE in hemorrhagic shock or respiratory distress OR ARE at significant risk of developing either condition with:

- ketamine (low dose)—20 to 30 mg (or 0.2–0.3 mg/kg) slow IV or IO push and
  - repeat doses every 20 minutes as needed for IV or IO.
  - The end point for low-dose ketamine is control of pain or development of nystagmus (rhythmic back-and-forth movement of the eyes).
- ketamine (high dose)—50 to 100 mg (or 0.5–1 mg/kg) intramuscular (IM) or intranasal (IN) and
  - repeat doses every 20 to 30 minutes as needed for IM or IN administration.
  - The end point for high dose ketamine is sleepiness.

If acetaminophen and meloxicam are not effective, and the patient status allows, use fentanyl as the next analgesic. Ketamine is the preferred medication for moderate to severe pain with a combat casualty. Morphine may be available in some circumstances. It is effective in patients who are not at risk of respiratory distress or developing hemorrhagic shock; however, it is no longer part of the current recommendations. Defer to local standard operating procedures or the MO.

Narcotic drugs can cause severe adverse effects, such as respiratory depression. In addition, they are metabolized by the liver and excreted through the kidneys; therefore, use these drugs cautiously in those with hepatic or renal impairment. Finally, because they increase intracranial pressure, these drugs are contraindicated in patients with severe head trauma. Do not give narcotic analgesics without having naloxone (eg, Narcan® nasal spray [Emergent Biosolutions, Plymouth Meeting, PA]) available to reverse the respiratory depression, if required. Remember to document the effect of any drugs given to a casualty.

Antibiotics

Infection is an important cause of morbidity and mortality in battlefield wounds. Assume all open wounds on the battlefield are infected and treat them with antibiotics. Choose antibiotics that cover a broad spectrum of organisms, with specific medications based on available delivery routes. If the casualty is conscious and able to swallow, administer one 400 mg moxifloxacin tablet by mouth each day. If the casualty is unable to take oral medications (due to shock or unconsciousness), administer ertapenem 1 g, IV, IO, or IM once per day.

Check on Learning

10. List the five contraindications for administering analgesics to casualties with musculoskeletal trauma.

SUMMARY

In patients with musculoskeletal trauma, focus first on identifying and managing all life-threatening injuries, including internal or external hemorrhage in the extremities. Then evaluate for distal neurovascular function and support the area of injury. Immobilize injuries to bones and joints (above and below the injury site) prior to moving the casualty. If the casualty is a high priority for evacuation, immobilize the whole casualty on a long spine board. Re-evaluate the injured extremity after immobilization for changes in distal neurovascular function. Provide pain management as needed with attention to the responsiveness, airway, spontaneous ventilation, and cardiovascular function of the casualty; always save a life over a limb.

SUGAR TONG SPLINT



STEP 1: Gather and check the required equipment.



STEP 2: Don body substance isolation (BSI) items.



STEP 3: Remove clothing and equipment as needed to expose the casualty's injury.



STEP 4: Visually inspect the casualty's injured forearm against the uninjured forearm and note any abnormalities that would indicate the use of a sugar tong splint.



STEP 5: Fold a flexible splint in half.



STEP 6: Place the folded splint against the casualty's uninjured arm as a template and adjust the length as necessary.

SUGAR TONG SPLINT, CONT.



STEP 7: Place the folded splint around the uninjured elbow so the end of the top half extends past the knuckles.



STEP 8: Fold the bottom half down, even with the top.



STEP 9: Form a C curve in each half and extend the C curve no more than two-thirds the length of each half.



STEP 10: Check the radial pulse on the casualty's injured arm before placing the splint.



STEP 11: Apply the splint to the casualty's injured arm.



STEP 12: Pinch and fold any excess gap at the bottom of the splint around the casualty's injured elbow to ensure a snug fit.

SUGAR TONG SPLINT, CONT.



STEP 13a: Wrap the casualty's injured arm to secure splinting material in place with an elastic bandage. Starting at the knuckles, wrap the casualty's fingers together on first wrap.



STEP 13b: Wrap around the thumb on the second wrap, working your way toward the casualty's elbow.



STEP 13c: Leave a window in the wrap to provide access for radial pulse assessment.



STEP 14: Cover all splint material with the wrap and secure it with 3-inch tape.



STEP 15: Check the casualty's radial pulse once again to ensure proper circulation.

ULNAR GUTTER SPLINT



STEP 1: Gather and check the required equipment.



STEP 2: Don BSI.



STEP 3: Remove clothing and equipment as needed to expose the casualty's injury.



STEP 4: Visually inspect the casualty's injured hand against the uninjured hand and note any abnormalities that would indicate the use of an ulnar gutter splint.



STEP 5: Fold the flexible splint in half lengthwise.



STEP 6: Extend the splint from the casualty's little finger to the elbow on the uninjured arm.

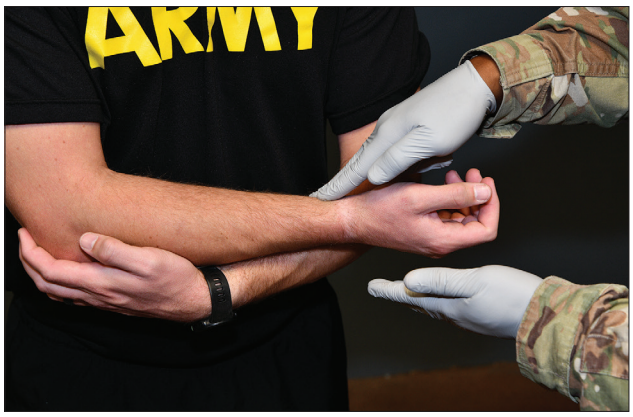
ULNAR GUTTER SPLINT, CONT.



STEP 7: Mold the splint around the casualty's uninjured arm as a template.



STEP 8: Have the casualty position their injured arm out, with the thumb toward the ceiling.



STEP 9: Check radial pulse of the casualty's injured arm before placing the splint.



STEP 10: Place the molded splint so that it extends from the tip of the casualty's little finger to the elbow.



STEP 11: Make any necessary adjustments to ensure a snug fit and stability.



STEP 12a: Wrap the casualty's injured arm to secure splinting material in place with an elastic bandage, starting at the little finger.

ULNAR GUTTER SPLINT, CONT.



STEP 12b: Wrap proximally to the elbow and leave a window in place to access the casualty's radial pulse.



STEP 13: Cover all splinting material and secure the wrap with 3-inch tape.



STEP 14: Check the casualty's pulse once again to ensure proper circulation.

UPPER EXTREMITY SLING AND SWATH



STEP 1: Unfold one cravat.



STEP 2: Tie a small knot in the 90° corner of the material.



STEP 3: Ask the casualty to use their uninjured hand to support their injured hand across their chest at about a 45° angle.



STEP 4: Place the knot of the cravat at the back of the casualty's elbow (injured arm) to create a pocket for the arm to rest in the sling.

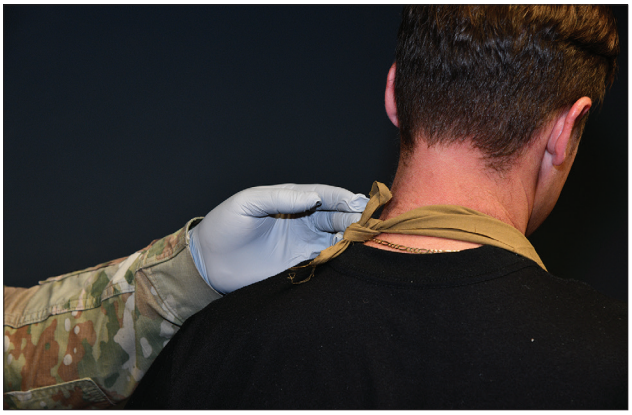


STEP 5: Run the inside corner of the cravat under the casualty's arm, straight up over the shoulder of the injured arm, and around the back of the casualty's neck.



STEP 6: Run the other corner of the cravat over the outside of the arm and over the shoulder of the casualty's uninjured arm.

UPPER EXTREMITY SLING AND SWATH, CONT.



STEP 7: Tie the two ends together behind the casualty's neck and make sure the knot is not over the casualty's cervical spine.



STEP 8: Fold another cravat into a 2-inch band (most cravats come folded this way in the package).



STEP 9: Run the cravat circumferentially around the casualty's torso, just above the elbow of the injured arm and extending around the chest of the casualty's uninjured side.



STEP 10: Secure the cravat in place with a knot and make sure the knot is not over the casualty's spine.

PELVIC BINDER



STEP 1: Gather and check equipment.



STEP 2: Don BSI.



STEP 3: Expose the injury site, assess the injury, and check for an exit wound.



STEP 4: Slide the belt underneath the casualty's lower back and slide it down until it is centered over the greater trochanter.



STEP 5: Route the black strap through the buckle assembly and pull it completely through.



STEP 6: Pull the two handles away from each other until you hear an audible click.

PELVIC BINDER, CONT.



STEP 7: Fasten excess belt material in place by pressing it down on the hook-and-loop fastener (you may hear a second click once the belt is secure).



STEP 8: Secure the device with a nonslip knot by applying a cravat from one handle to the other and extending it around the casualty's back. Secure the tails with tape.

TRACTION SPLINT



STEP 1: Gather and check equipment.



STEP 2: Don BSI.



STEP 3: Remove the boot and sock from the casualty's injured leg.



STEP 4: Check pedal pulse of the casualty's injured leg.



STEP 5: Apply the ankle hitch tightly around the casualty's injured leg, slightly above the ankle bone.



STEP 6: Tighten the stirrup by pulling the green-tabbed strap until the stirrup is snug under the casualty's heel.

TRACTION SPLINT, CONT.



STEP 7: Apply the ischial strap by sliding the male buckle under the casualty's injured leg at the knee.



STEP 8: Move the strap back and forth upward until it is positioned in the casualty's groin area.



STEP 9: Insert the male end of the buckle into the female end until a click is heard, signifying the buckle is locked.



STEP 10: Cinch the strap until the traction pole receptacle is positioned at the casualty's belt line or pelvic crest.



STEP 11: Extend the traction pole. Make sure that each joint of the pole is securely seated.



STEP 12: Use the patient's uninjured leg to measure the proper length for the traction pole.

TRACTION SPLINT, CONT.



STEP 13: Place the traction pole along the injured leg so that the red marking on the bottom section of the tubing is lined up at or below the bottom of the casualty's foot.



STEP 14: Insert the pole end into the traction pole receptacle.



STEP 15: Secure an elastic strap around the casualty's knee.



STEP 16: Place the yellow tab of the ankle hitch over the dart end of the traction pole.



STEP 17: Apply traction by pulling the red tab of the ankle hitch.



STEP 18: Apply traction smoothly by simultaneously pushing up on the bottom of the traction splint and pulling down on the red tab (with equal pressure).

TRACTION SPLINT, CONT.



STEP 19: Reassess the casualty's pedal pulse.



STEP 20: Use 3-inch tape to secure the red, yellow, and green tabs together to prevent the straps from slipping after traction is applied.



STEP 21: Apply a thigh elastic strap and shin elastic strap. Splint as required to further stabilize the injured leg.

8 & U SPLINT



STEP 1: Gather and check equipment.



STEP 2: Don BSI.



STEP 3: Remove the boot on the casualty's injured foot to access the dorsalis pedis artery.



STEP 4: Obtain a pulse check before applying a light-weight, flexible splint.



STEP 5: Use the casualty's uninjured leg as a template to start forming the 8 and U splint.



STEP 6: Form the 8 by first forming a U with the splint placed directly under the heel of the casualty's uninjured foot, then form the 8 by folding the splint in opposite directions. Remove the formed 8 and place aside.

8 & U SPLINT, CONT.



STEP 7: Using another flexible splint, form a U shape under the casualty's uninjured heel, extending up the lateral and medial aspect of the leg.



STEP 8: Transfer both formed splints to the casualty's injured ankle.



STEP 9: Apply the 8 over the casualty's foot or boot and secure it in place with a strip of 3-inch tape.



STEP 10: Apply the U around the casualty's heel and secure it in place with 3-inch tape. Fold the sides down to adjust if necessary.



STEP 11: Using the elastic bandage, place a knot just above the ankle, leaving a tail.



STEP 12: Wrap the bandage around the casualty's ankle to create an anchor point. Make sure you leave a window to access the pulse.

8&U SPLINT, CONT.



STEP 13: Use a figure 8 wrap to secure the splinting material in place and secure the wrap with 3-inch tape.



STEP 14: Recheck the casualty's pulse after splinting is complete.

KEY TERMS AND ACRONYMS

Fracture. A disruption of bone tissue. Fractures may be caused by an application of force exceeding the strength of the bone, repetitive stress, or an invasive process that undermines the bone's integrity.

Kinematics. The study of motion and its required forces. This includes the different forces at work during the movement of a single part of the body and more complex movements such as running and climbing.

Myoglobinuria. Myoglobin (a muscle protein) in urine.

Rhabdomyolysis. A skeletal muscle injury that results in cellular death with resultant leakage of intracellular contents.

CHECK ON LEARNING ANSWERS

1. During a fractured extremity assessment, when should you assess distal neurovascular function? What findings indicate a nerve injury and an arterial injury?

   Assess before and after splinting. Loss of motor and sensory function usually indicates a nerve injury, and loss of distal neurovascular function usually indicates arterial or nerve injury.

2. What is the most common cause of acute compartment syndrome in combat casualties?

   Trauma or interventions placed, such as a tourniquet, that cause the arterial blood flow to continue into an extremity, but venous flow is restricted from returning to the system.

3. List the "classical Ps" of compartment syndrome.

   Pain, pressure, paresthesia, pallor, pulselessness, and paralysis.

4. Define crush syndrome.

   A reperfusion injury leading to traumatic rhabdomyolysis. Damaged muscle tissue releases myoglobin that can damage kidneys and potassium that can cause arrhythmias.

5. What are five common causes of rhabdomyolysis?

   Any five of the following: compartment syndrome, prolonged muscular compression, prolonged immobilization, excessive muscular activity, strenuous exercise, heatstroke, or electrical injuries.

6. Your patient has a traumatic amputation of his left leg below the knee from an IED explosion. She has significant blood loss with signs of shock. What is her evacuation category?

   Urgent surgical.

7. What are the correct length and consistency of a splint?

   Splints must be long enough to immobilize the joint above and below the injury to keep the bones from moving.

8. When treating a casualty with an extremity fracture, you find the distal pulse is absent. What should you do?

   Apply gentle traction in an attempt to realign it. If there is resistance, splint the extremity in the position found.

9. One of the vehicles in your convoy rolled while trying to avoid an improvised explosive device in the road. One soldier in the vehicle has a closed mid-shaft femur fracture with edema and an absent distal pulse. What is the objective of splinting broken bones in this case?

   Splinting decreases pain; eliminates further damage to muscles, nerves, and blood vessels; and helps control hemorrhage.

10. List the five contraindications for administering analgesics to casualties with musculoskeletal trauma.

    Unconscious, respiratory compromise, altered mental status, hypoperfusion, and known morphine allergies.

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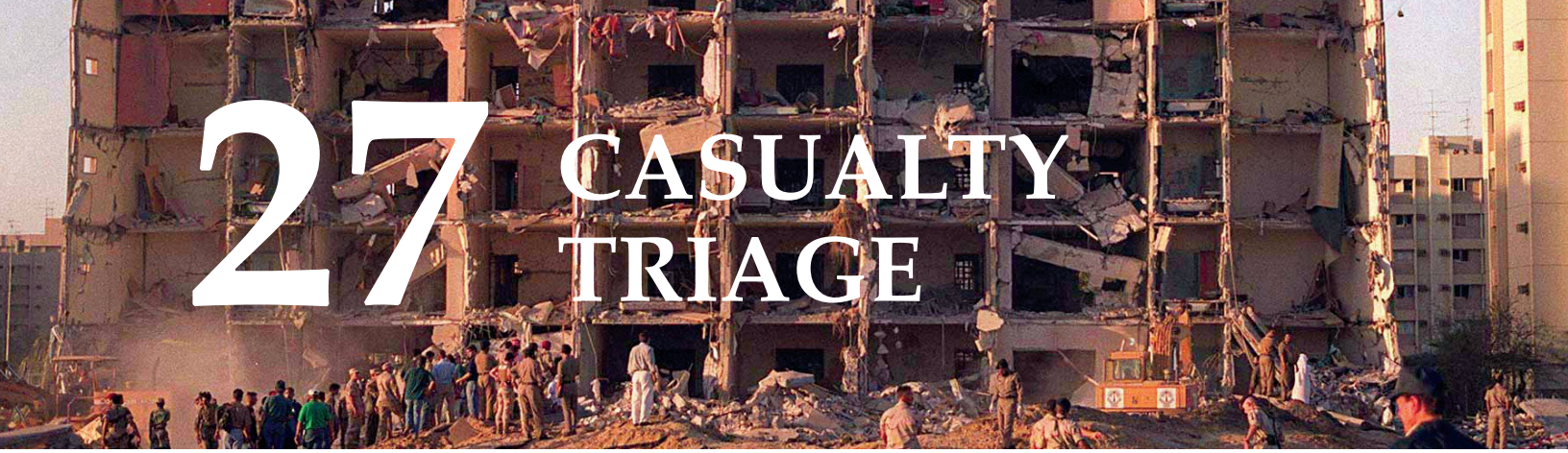
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27 CASUALTY TRIAGE

CORE CONCEPTS

- Discuss the principles of triage.
- Describe triage categories.
- Apply triage principles to casualties in battlefield scenarios.
- Explain how to establish a casualty collection point.

INTRODUCTION

Combat medics operating in a combat theater may be overwhelmed with casualties, whether soldiers are lined up for daily sick call or incapacitated after an explosion. Therefore, a process of sorting these casualties must be established. Medics must know whom to treat first, who has the most severe wounds, and who is most likely to survive. Familiarity with the tactical situation and the overall mission, as well as available resources, will help guide decisions. **Triage** is an attempt to impose order during chaos and make an initially overwhelming situation manageable. Triage ensures that medical resources are used to provide care that affords the greatest number of casualties the best chance of survival. Triage is a dynamic process that continues as a casualty moves through the different roles of care.

TRIAGE OVERVIEW

On a battlefield with multiple casualties, the casualty with the most severe injury or the greatest threat to life is not necessarily the one who receives first priority for treatment; the casualty's likelihood of survival must be evaluated.

There are three triage principles that form the foundation of casualty care and treatment priorities:

1. Triage is the medical sorting of casualties according to the type and seriousness of the injury, likelihood of survival, and the priorities of treatment and evacuation.
2. Triage ensures that medical resources are used to provide care for the greatest benefit to the largest number of casualties.
3. Triage affords the greatest number of casualties the greatest chance of survival.

The overall goal of casualty triage is to treat and return to duty the greatest number of soldiers in the shortest possible time. This returns the highest number of soldiers to combat effectiveness, giving the commander more assets with which to defeat the enemy. Familiarity with the principles of casualty triage will help you render vitally important emergency medical care to soldiers promptly and will reduce the number of soldiers who may die of wounds. It is essential to realize that you will not always be able to bring everyone home. Using triage principles can help mitigate that reality.

Triage is critical and always applied in mass casualty (**MASCAL**) situations, when the number of casualties exceeds the available medical capacity to treat and evacuate them rapidly (Figure 27-1). The actual number of casualties varies from situation to situation, and the approach to treating them depends on the tactical situation, mission, and available resources. Technically, a MASCAL situation occurs if a combat medic has more than one seriously wounded soldier to manage at one time. It can occur in multiple locations with varying resources—at a major medical center with full medical capabilities, on a forward operating base with a military treatment facility (MTF), or at a combat outpost with minimal resources. Every situation is different, and casualty care priorities depend on various



Figure 27-1. A MASCAL event. A terrorist attack on the Khobar Towers housing complex on June 25, 1996, using a vehicle-borne improvised explosive device. The attack killed 19 people, including many US military members, and injured countless others. Courtesy of Air Force Installation and Mission Support Center Public Affairs. https://www.dvidshub.net/image/4488391/khobar-towers-saudi-arabia

factors, such as the number of self-aid and buddy-aid personnel, available medical supplies, and the number of casualties. The commitment of resources should be based on the mission and immediate tactical situation first, and then by medical necessity, regardless of a casualty's nationality or combatant status.

MASCAL situations rapidly overwhelm multiple levels of care and evacuation capacity. During MASCAL situations, where an active threat still exists, medical personnel may be alone in their efforts to treat casualties while nonmedical personnel are actively engaging the enemy. This lack of assistance during a firefight will increase stress levels on combat medics and can result in a MASCAL situation. MASCAL scenarios demand a rapid transition to critical thinking and prioritizing of personnel and resources to benefit the largest number of casualties. The transition requires assessment of site and evacuation capabilities. Use of a MASCAL response plan guides transition and helps ensure that all requirements are met.

Combat medics have critical duties in casualty triage. You must survey and classify casualties for the most efficient use of available resources (medical personnel, supply capabilities, and evacuation assets) and evaluate the likely outcome of an individual casualty before committing limited medical resources. Your duties include the following:

- Observe the number and location of the casualties and then assess the severity of injuries. Keep in mind that time constraints may not allow time-intensive procedures (eg, cardiopulmonary resuscitation).
- Use any assistance available, such as self aid, buddy aid, combat lifesaver, other medical personnel, and even minimally injured casualties, prior to their return to duty.
- Determine the number of injuries by type (eg, litter or ambulatory).

- Identify evacuation resources with respect to time, distance, and terrain (eg, ground or air assets).
- Assess resupply capabilities and requirements with respect to time, available medical equipment, and supplies.

Direct treatment first toward the casualties who have the best likelihood of survival by assigning each one an appropriate triage category. Locate troops with minor wounds and return them to duty. You have a major role in returning the greatest possible number of soldiers to combat as quickly as possible, while preserving life, limb, or eyesight for others.

Note: Triage establishes the order of treatment, not whether treatment is given, regardless of the injury. Triage is usually the responsibility of the senior medical person present. Casualties may not always fit into one clear triage category. It is incumbent upon senior medical personnel to triage to the best of their ability and medical experience.

Your triage responsibilities may change depending on location. If you are working at a Role 1 battalion aid station (BAS) or at an MTF, you may have limited triage responsibility. The senior medical person is responsible for the base or area of operation's MASCAL plan. Coordinate and rehearse the MASCAL plan with your tactical leadership prior to a MASCAL. If you are working in an isolated area (eg, at a combat outpost, on a tactical patrol, or in a convoy operation), you may be the primary decision maker who must perform many triage, treatment, and evacuation tasks.

Check on Learning

1. What is a MASCAL situation?
2. What are the main responsibilities of medical personnel during triage?

TRIAGE CATEGORIES

Casualties with conventional wounds and injuries are sorted into four triage categories or priorities: (1) immediate, (2) delayed, (3) minimal, and (4) expectant. Because triage is an ongoing process of reassessment, a casualty's category may change.

Immediate

Casualties in this category are the highest priority. Their conditions demand immediate resuscitative treatment to save their lives. Casualties in this category present with severe, life-threatening wounds. Generally, the procedures used to correct these conditions are of short duration and are economical in terms of medical resources. Stabilize all immediate casualties first, before treating injuries that are not life- or limb-threatening. Salvage of life takes priority over salvage of limb. Examples of injuries in the immediate category include the following:

- massive, uncontrolled external bleeding (eg, amputations or junctional wounds);
- threat of loss of limb (eg, risk of amputation or multiple extremity amputations);
- hypovolemic (hemorrhagic) shock;
- airway obstruction or potential compromise;
- open pneumothorax (sucking chest wound) with respiratory distress;
- tension pneumothorax;
- torso, neck, or pelvis injuries with shock;
- head injury requiring immediate decompression (eg, intracranial hemorrhage);
- **retrobulbar hematoma**;
- unstable abdominal wounds with shock; and
- any burns of the face, neck, hands, feet, perineum, or genitalia.

Delayed

Casualties in the delayed category are those who have less risk of losing life or limb if treatment is withheld for a period. This group includes those who require surgery but whose general condition permits a delay in treament without unduly compromising the likelihood of a successful outcome. When medical resources are overwhelmed, soldiers in this category are held until care is provided to the immediate cases. Sustaining measures will be required for casualties while they are waiting (eg, fluid resuscitation, fracture stabilization, administration of antibiotics, pain relief). Examples of injuries in the delayed category include:

- maxillofacial wounds without airway compromise;
- open chest wounds without respiratory distress;
- blunt or penetrating torso injuries without signs of shock;

- eye and central nervous system injuries;
- soft-tissue wounds requiring **debridement** and without significant bleeding (all combat wounds will require some form of debridement);
- fractures;
- burns that cover 20% or more total body surface area (TBSA);
- survivable burns without an immediate threat to life (airway, respiratory) or limb; and
- genitourinary tract disruption.

Minimal

Casualties in the minimal, or ambulatory, category are also called the "walking wounded." Patients in this group have relatively minor injuries (eg, minor lacerations, abrasions, fractures of small bones, and minor burns). They can adequately care for themselves or require minimal medical care, such as would cleansing, minimal debridement under local anesthesia, administration of tetanus toxoid, and first-aid dressings. Often they can be managed by self aid or buddy aid. These casualties may also be able to assist with movement or care of other injured personnel.

Minimal casualties must quickly be directed away from the triage area to uncongested areas, where first aid and nonspecialty medical personnel are available. Casualties in this category usually are not evacuated to an MTF.

If a MASCAL incident occurs near an MTF, these will likely be the first casualties to arrive, bypassing or circumventing the casualty evacuation chain. Such casualties may inundate the facility, leading to early commitment and ineffective use of resources. It is imperative to secure and strictly control access to the MTF immediately when notified of a MASCAL event to prevent such occurrences.

Most casualties fall into the minimal category. Examples of injuries in the minimal category are:

- minor lacerations or abrasions;
- contusions;
- sprains and strains;
- minor combat stress reactions;
- first- or second-degree burns under 20% TBSA and not involving critical areas such as hands, feet, face, genitalia, or perineum;
- upper extremity fractures without neurovascular compromise;
- suspicion of blast injury (eg, ruptured tympanic membrane); and
- symptomatic but unquantified radiation exposure.

Expectant

Expectant casualties are those so critically injured that even advanced and prolonged treatment is unlikely to save their lives. This group, given the situation and resource constraints, is considered unsalvageable. During a MASCAL situation, they would require an unjustifiable expenditure of limited resources that are best used for saving the lives of several other soldiers. Separate expectant casualties from the view of other casualties; however, do not abandon them. Above all, attempt to make them comfortable by whatever means necessary and attend to their palliative needs. Examples of injuries in the expectant category include:

- unresponsive casualties with penetrating head wounds and signs of impending death;
- absence of vital signs;
- mutilating explosive wounds involving multiple anatomical sites and organs;
- profound shock with multiple injuries;
- open pelvic injury with uncontrolled bleeding;
- agonal respirations;
- convulsions and vomiting within 24 hours after radiation exposure;
- burns, mostly third degree, covering more than 85% TBSA (80% or more of TBSA when resources are limited);
- cervical (high) spinal cord injuries; and
- transcranial gunshot wounds with coma.

Note: Casualties with cardiorespiratory arrest on the battlefield would likely be classified as expectant, contingent on mission, battlefield situation, number of casualties, available support, and other factors.

CATEGORIES OF EVACUATION PRECEDENCE

After performing casualty triage and treatment, place the casualty in one of four evacuation categories: urgent and urgent surgical, priority, routine, or convenience. Casualties will be evacuated to ensure the greatest survivorship and to maximize resources available at the triage area. These categories are also used to ensure that the right assets are allocated for casualty transportation.

Urgent (Priority I)

The urgent evacuation category is assigned to emergency cases that should be evacuated as soon as possible and within a maximum of 1 hour to save life, limb, or eyesight; to prevent complications of serious illness; and to avoid permanent disability.

Urgent Surgical (Priority Ia)

The urgent surgical evacuation category is a subclassification of a priority I surgical evacuation. It requires far forward surgical intervention to save life, limb, or eyesight. Casualties must be stabilized prior to being evacuated to a higher role of care. The time for evacuation for urgent surgical evacuation is the same as for urgent, priority I (within a maximum of 1 hour).

Priority (Priority II)

The priority evacuation category is assigned to sick and wounded personnel requiring prompt medical care. It is used when the individual should be evacuated within 4 hours, or if their medical condition could deteriorate to such a degree that they will become elevated to an urgent category. Casualties or patients who require special treatments not available locally, or who are suffering unnecessary pain or disability, are also evacuated under the priority category.

Routine (Priority III)

The routine evacuation category is assigned to sick and wounded personnel requiring evacuation; however, their condition is not expected to deteriorate significantly. The sick and wounded in this category should be evacuated within 24 hours.

Convenience (Priority IV)

The convenience evacuation category is the lowest evacuation level. It is assigned to patients whose evacuation is a matter of medical convenience rather than necessity, and there is no time limit.

Check on Learning

3. What are the four categories of triage used for conventional battlefield casualties?

TRIAGE ASSESSMENT

There are several different triage approaches. Determining which to use may depend on the current tactical situation or on an organization's standard operating procedures. The modified simple triage and rapid treatment approach (START) is one approach that depends on whether or not the casualty can walk (ambulate), is responsive, is breathing, and has a palpable radial pulse. This technique does not work well when there is low light or excessive noise.

In the first decision step, ask all casualties who are able to get up and walk to a designated area for eventual secondary triage. Categorize these casualties as minimal.

Next, assess casualties in the order in which they are encountered. Check for responsiveness to shaking and shouting. If the casualty is conscious, assess the radial pulse and ease of breathing. A conscious casualty with no radial pulse (hemorrhagic shock) and respiratory distress is immediate; perform life-saving interventions immediately. A conscious casualty with a palpable radial pulse and comfortable breathing (unassisted) is delayed.

In the unconscious casualty who is breathing, address the airway with simple maneuvers. A casualty with a patent airway (with or without simple maneuvers) and spontaneous respirations is minimal. An unconscious casualty who is breathing but has a guarded airway that requires a supraglottic airway (eg, i-gel® [Intersurgical Inc, East Syracuse, NY]), endotracheal tube, or cricothyroidotomy is categorized as expectant.

Note: START is a technique for initial triage. All casualties must be continually reassessed for a potential change in category. Time, resources, and arrival of evacuation assets and personnel can quickly move an expectant casualty to an immediate category.

APPLYING TRIAGE IN COMBAT

Triage During Care Under Fire

When providing triage during care under fire, return fire as required or directed. Casualties should also return fire if they are able. Once fire superiority is achieved, and it is safe to do so, triage casualties. Determine the scene safety and security and the number of

casualties (for the squad leader ammunition/casualties/equipment [ACE] report).

Give a command such as "If you can hear my voice and can walk, move to this area now," to sort out the minimal casualties. Then give a command such as "If you can hear my voice but cannot walk, raise your hand to let me know," to determine which casualties can be considered delayed. Request additional help; call for squad members and combat lifesavers to assist.

Those who remain are immediate, expectant, or deceased. Distinguish between the remaining casualties by assessing massive hemorrhage, airway, respirations, circulation, and hypothermia or head injury (MARCH). First, stop life-threatening hemorrhage using tourniquets.

Perform or direct an assistant to perform immediate treatments and move casualties to a secure area (eg, a previously established casualty collection point [**CCP**]). Airway and breathing management is best deferred until you are behind cover and no longer under the threat of effective hostile fire (tactical field care). Perform a MARCH assessment at the triage point of the CCP to account for the casualties who have already been treated.

Check on Learning

4. You are presented with the following casualties:
   a. A conscious casualty with airway obstruction.
   b. A casualty with an injured forearm and second-degree burns to 9% TBSA.
   c. An unconscious casualty with severe burns to the hands.
   d. A casualty with a closed femur fracture and no signs of shock.
   e. A casualty with a transcranial gunshot wound.

   Place each casualty in the appropriate triage category.

Casualty Collection Points

A CCP location is dependent on the unit location, the tactical situation, and the number of casualties to be evacuated. When combat units are executing combat operations, the company's first sergeant, with guidance from the company or platoon combat medics, determines where to set up the company CCP. Normally, the location of a company or platoon CCP is in the rear of the formation, in a position of cover and concealment.

During combat operations, treat casualties at or near the point of injury (**POI**) as tactical conditions allow and then move them to a platoon or company CCP. On arrival at the CCP, casualties will be triaged and placed in the appropriate treatment area for additional medical care and preparation for evacuation to the Role 1 BAS or higher, as needed.

Note: Doctrinally, a Role 1 BAS is set up approximately 1 to 4 km and/or one or two terrain features behind the lines of the units supported.

Removing the casualties from the POI is crucial, and getting them to a CCP begins the triage process. Movement of the casualty from the POI to the CCP can be accomplished with field-expedient means such as individual manual carries or drags, casualty litters, medical evacuation (MEDEVAC) vehicles, or nonstandard casualty evacuation (CASEVAC) vehicles. Use the unit's tactical standard operating procedures (TSOPs) for guidance on how to move the casualty from the POI to the CCP. The company first sergeant coordinates the casualty flow between the platoon CCPs and the company CCP, while the company senior medic conducts triage.

Shortly after the casualty arrives at the CCP, the combat medic will relay specific information to the platoon sergeant and platoon leader so that the 9-line MEDEVAC request can be completed and forwarded. Triage is ongoing and occurs through all levels of care in the tactical field care setting. Evacuate casualties to the next level of care in an order that ensures the highest survivability of casualties while optimizing use of available resources at the triage area. If evacuation vehicles are en route, determine who needs evacuation and who can be treated at the triage area. These decisions facilitate efficient triage and treatment.

Triage, Treatment, and Evacuation at the Casualty Collection Point

A triage area should be set up for efficient casualty flow (Figure 27-2). As the triage area is being set up, a triage point must be established, which will create a single entry and exit point into and out of the CCP (for tracking casualties and controlling access). Each casualty flows into the CCP and undergoes a rapid evaluation by the initial triage officer. After initial triage, they are taken to their triage category area. Each triage area's category (immediate, delayed, minimal,

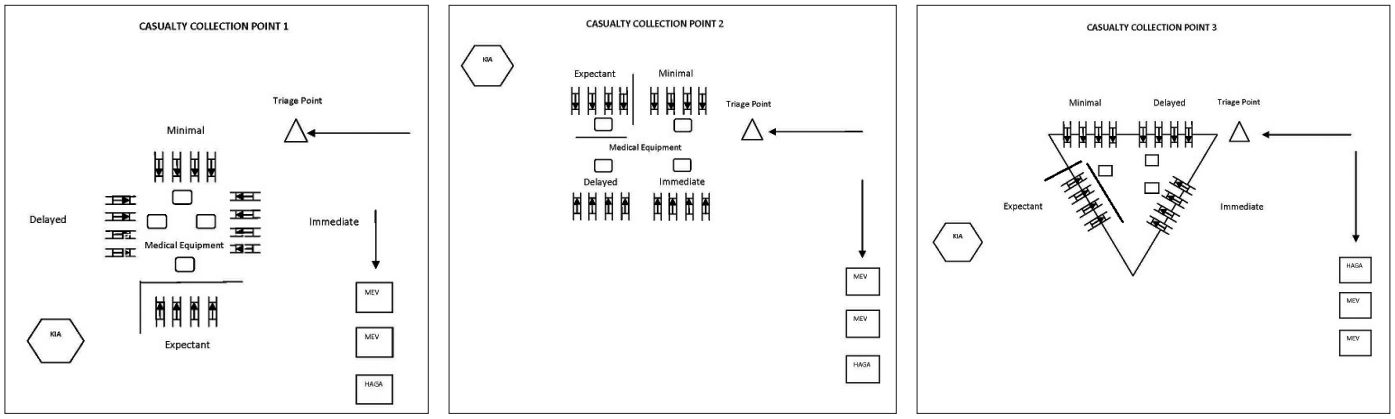


Figure 27-2. Three examples of casualty collection point layouts. Each has a single triage point and is set up for clear and efficient patient flow.

and expectant) should be marked with a day and night marking system as shown in the following examples:

- Immediate—red day marking and single infrared chemlight for night tactical.
- Delayed—yellow day marking and two infrared chemlights for night tactical.
- Minimal—green day marking and three infrared chemlights for night tactical.
- Expectant—black day marking and four infrared chemlights for night tactical.

Markings may differ among units (eg, colored or infrared chemlights or specific markings for chemical, biological, radiation, or nuclear casualties), and each will use the marking system outlined in its TSOP.

Ideally, each section will have at least one combat medic on duty. Sections should set up unidirectional flow to prevent clogging the system. Treatment should be limited in the triage area to hemorrhage control, maintaining airways, and needle decompressions. An ideal triage area will have the following features:

- Close proximity to the receiving area—a clearing where a helicopter landing zone can be established, a site suitable for ground evacuation, and decontamination areas. This will reduce the distance litter bearers must travel.
- Separate triage areas for contaminated casualties.
- One-way flow into and out of the triage and treatment areas.
- A well-lit, covered, and spacious area for easy access, evaluation, and transport of incoming and outgoing casualties.
- A designated area and one-way flow for vehicles dropping off and picking up casualties.
- Casualty recorders available to identify, tag, and record initial triage or disposition.
- Sufficient litter bearers controlled by someone other than the designated triage combat medic.
- A medical resupply area that has a robust supply of emergency medical equipment.

Establish the expectant area away from all other treatment areas to reduce stress and anxiety among casualties and the other attending combat medics. Do not leave casualties in the expectant area alone. A combat medic should be available to provide pain control. Chaplain's staff should also have quick, easy access. Treat all other casualties and then retriage these casualties and initiate the appropriate treatments.

Note: When setting up a CCP, be sure to identify an area away from the other casualties for any individuals killed in action.

Check on Learning

5. For a large MASCAL situation, how many treatment categories are necessary?
6. What treatment can be performed in the triage areas?
7. When are expectant casualties treated?
8. Place the following casualties into one of the four triage categories.
   a. Painful leg and ankle.
   b. A conscious casualty with no radial pulse, but a present carotid pulse.
   c. A conscious casualty with a palpable radial pulse and comfortable breathing.
   d. A casualty with burns to his face, neck, and hands.

e. A casualty who is curled up in a ball and crying.
f. A casualty with an obvious open abdominal evisceration, palpable radial pulse, and no breathing difficulty.

DISPOSITION OF THE DEAD

Death is one of the most challenging and emotional experiences you will encounter. Under normal circumstances, the physician is responsible for declaring a person dead, and is required to sign the death certificate. US laws require a death certificate for each soldier who dies on the battlefield.

When a soldier is killed in action and subsequently identified, a spot report is generated, identifying the location of the remains. When the battle is over, the remains are recovered and turned over to mortuary affairs. The transportation and disposition of remains are a quartermaster function. Air and ground ambulance personnel do not clear the battlefield of remains, nor do they carry remains in their dedicated medical vehicles or aircraft. Medical units do not accept remains or provide temporary morgues in which to hold remains for other units until they can be transferred to mortuary affairs sites or personnel.

The only remains a medical unit handles are those of its own unit members, casualties who are dead on arrival, or those who died of wounds while in its care. Whenever a medical unit must establish a temporary morgue it should be out of sight of the triage and treatment areas (eg, behind a natural barrier such as a stand of trees), or set off by using a tent and tarps. This area will not be an actual morgue because it has neither the required equipment nor staff. It is only a temporary holding area until the quartermaster can assume custody of the remains.

AMBULANCE SHUTTLE SYSTEM

The ambulance shuttle system is an effective and flexible method of employing ambulances during operations. The ambulance shuttle system includes:

- Ambulance loading point—a point in the shuttle system where one or more ambulances are stationed and ready to receive patients for evacuation.
- Ambulance relay point—a point in the shuttle system where one or more empty ambulances are stationed to advance to a loading point or to the next relay post to replace departed ambulances.
- Ambulance control point (if necessary)—a station usually located at a crossroad or road junction, where ambulances are directed to loading points and MTFs.

These components are echeloned forward from the principal group of ambulances, the company location, or basic relay points as tactically required.

Note: The need for ambulance control points are dictated by the situation; they are more necessary in forward areas.

In the establishment of the ambulance shuttle system, relay points are designated, and the required number of ambulances are stationed at each point. If the tactical situation permits, the ambulances may be delivered to the relay points by convoy.

Advantages of the ambulance shuttle system are the following:

- Facilitates ambulance placement at CCPs and BASs as needed.
- Permits a steady flow of patients through the system to the MTFs.
- Avoids unnecessary massing of transport in forward areas.
- Minimizes the danger of damage to ambulances by the enemy.
- Permits the commander or platoon leader to control their elements and enables them to extend their activities without advancing the headquarters.
- Facilitates administration and maintenance of ambulances.
- Maximizes the use of small command elements (sections or platoons) to operate the shuttle without employing the entire parent unit.
- Provides for flexible use of other ambulance assets for specific situations.
- Facilitates medical resupply (blankets, litters, and patient movement items [PMI]) through staffed ambulance relay, loading, and control points.
- Facilitates communication of important information to ambulance crews at each point in the system.

AMBULANCE EXCHANGE POINT

An ambulance exchange point (**AXP**) is defined as a location where a patient is transferred from one ambulance to another en route to an MTF. This reduces the distance the forward deployed ambulance must drive because it does not have to go all the way to the MTF. This allows them to make shorter, more frequent trips to pick up additional casualties at the Role 1 BAS. AXPs are normally preplanned and a part of the health service support appendix to the operation plan (OPLAN).

AXPs are used for both ground and air ambulances. For example, casualty transport using both ground and air ambulances may be the best option when the enemy antiaircraft threat is very high. In this case, the Role 1 BAS ambulance drives the casualty out just beyond the enemy's antiaircraft reach, sets up, and transfers the casualty to an air ambulance. The air ambulance then transports the casualty to the next level of care. An AXP between two air ambulances is another casualty transport option. Combat planners will determine the need for an AXP between two air ambulances when there is a long distance between the combat units and the MTF.

Caution: AXPs established in the forward areas are at great risk of enemy attack. Their locations should be frequently changed to preclude attracting enemy fire.

Check on Learning

9. The transportation and disposition of the dead are a function of what group?
10. What is a temporary morgue?

SUMMARY

Casualty triage comprises a set of important skills that enable combat medics to maximize scarce resources while providing prioritized medical care. Not all casualties will return home, but the principles discussed in this chapter will give you the best chance to help both people and mission. Knowing the steps of performing casualty triage will enable you to make wise decisions, giving the greatest number of casualties the greatest chance of survival.

KEY TERMS AND ACRONYMS

AXP. Ambulance exchange point.
CCP. Casualty collection point.
Debridement. The medical removal of damaged tissue or foreign objects from a wound.
MASCAL. Mass casualty. When the number of casualties exceeds the available medical capacity to treat and evacuate them rapidly.
POI. Point of injury.
Retrobulbar hematoma. A condition that involves blood congestion deep in the soft tissue of the posterior orbital septum.
Triage. The medical sorting of casualties according to the type and seriousness of the injury, likelihood of survival, and the priorities of treatment and evacuation.

CHECK ON LEARNING ANSWERS

1. What is a MASCAL situation?

   When the number of casualties exceeds the available medical capability to treat and evacuate them rapidly.

2. What are the main responsibilities of medical personnel during triage?

   If you are working at a Role 1 BAS or at an MTF, you may have limited triage responsibility, but you will still work as a member of a treatment or evacuation team. If you are working in an isolated area (eg, at a combat outpost, on a tactical patrol, or in a convoy operation), you may be the primary decision maker who must perform many triage, treatment, and evacuation tasks.

3. What are the four categories of triage used for conventional battlefield casualties?

   Immediate, delayed, minimal, and expectant.

4. You are presented with the following casualties:
   a. A conscious casualty with airway obstruction,
   b. A casualty with an injured forearm and second-degree burns to 9% TBSA,
   c. An unconscious casualty with severe burns to the hands,
   d. A casualty with a closed femur fracture and no signs of shock, and
   e. A casualty with a transcranial gunshot wound.

   Place each casualty in the proper triage category

   Immediate: Casualties a and c.

   Delayed: Casualty d.

   Minimal: Casualty b.

   Expectant: Casualty e.

5. For a large MASCAL situation, how many treatment categories are necessary?

   Four: immediate, delayed, minimal, and expectant.

6. What treatment can be performed in the triage areas?

   Hemorrhage control with deliberate tourniquets or hemostatic agents, airway establishment (cricothyroidotomy), and needle decompression.

7. When are expectant casualties treated?

   After all other casualties are treated, retriage expectant casualties and initiate treatment if appropriate.

8. Place the following casualties into one of the four triage categories.
   a. Painful leg and ankle—*minimal.*
   b. A conscious casualty with no radial pulse but a present carotid pulse—*immediate.*
   c. A conscious casualty with a palpable radial pulse and comfortable breathing—*minimal.*
   d. A casualty with burns to his face, neck, and hands—*immediate.*
   e. A casualty who is curled up in a ball and crying—*minimal.*
   f. A casualty with an obvious open abdominal evisceration, palpable radial pulse, and no breathing difficulty—*delayed.*

9. The transportation and disposition of the dead are a function of what group?

   Transportation and disposition of remains are a quartermaster function.

10. What is a temporary morgue?

    A temporary holding area for remains. It does not have the required equipment or staff of an actual morgue.

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28 SUICIDE PREVENTION

CORE CONCEPTS

- Explain the historical issues that led to today's Army Suicide Prevention Program.
- Describe suicide prevention, intervention, and postvention.
- Identify suicide risk factors.
- Recognize suicide myths versus facts.
- Identify immediate warning signals of impending suicide.
- Outline appropriate actions to take when confronted with a suicidal individual.

INTRODUCTION

Suicide prevention is a continuum of prevention, intervention, and postvention to save lives. The Army Suicide Prevention Program has a commitment to reduce suicidal behavior across the Army enterprise. The goal of prevention is to develop healthy, resilient soldiers who do not view suicide as an option. You must be aware of your role in preventing suicide, ensuring you properly respond to individuals who may be in danger of attempting suicide, and safeguarding those who express suicidal thoughts.

HISTORICAL ISSUES REGARDING SUICIDE AND SUICIDE PREVENTION

Suicide among those who serve in our armed forces and among our veterans is a matter of national concern that calls for action and commitment. The Department of Defense (DOD) tracks and compiles all statistics annually, with regard to suicide activity throughout the armed forces. The DOD publishes all information that it tallies throughout the calendar year in an annual report titled "Department of Defense Suicide Event Report" (Figure 28-1), implemented in 2008. The reports showed the following suicide rates among soldiers for consecutive calendar years:

- 2013–300 soldiers (121 active duty, rate: 22.7 per 100,000 soldiers)[1]
- 2014–245 soldiers (126 active duty, rate: 24.6 per 100,000 soldiers)[2]

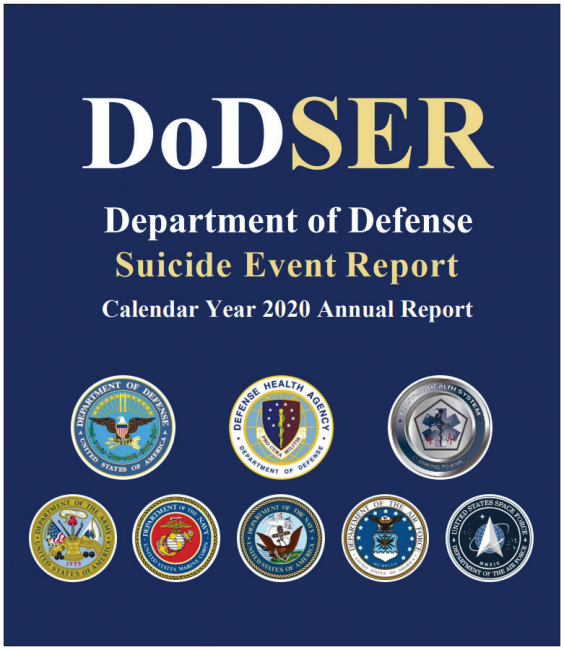


Figure 28-1. The Department of Defense Suicide Event Report is an annual publication that provides rates of suicide for each of the components (active duty, reserves, National Guard) and each of the services (Army, Marine Corps, Navy, Air Force). The report also provides the annual totals of suicide deaths and attempts recorded for the military, the mechanisms of injury for those events, and descriptive summaries of risk and contextual factors present among service members who engaged in suicidal behaviors that year. Reproduced from https://health.mil/Military-Health-Topics/Centers-of-Excellence/Psychological-Health-Center-of-Excellence/Department-of-Defense-Suicide-Event-Report

- 2015–279 soldiers (120 active duty soldiers, rate: 24.4 per 100,000 soldiers)[2]
- 2016–280 soldiers (130 active duty, rate: 27.4 per 100,000 soldiers)[3]
- 2017–295 soldiers (114 active duty, rate: 24.3 per 100,000 soldiers)[3]
- 2018–305 soldiers (139 active duty, rate: 29.5 per 100,000 soldiers[4]

From 2013 to 2018, the suicide rate for the Active Component across all services increased from 18.5 to 24.8 suicides per 100,000 service members. This increase reflected small increases in the number of suicide deaths across all services.

There is one important caveat to the reported data, according to the 2018 DOD report. After controlling for differences in age and sex between military and civilian populations, military suicide rates are comparable to civilian suicide rates.[4] While this information adds perspective, it does not lessen the urgency with which the DOD is addressing suicide among the armed forces.

For many years, suicide prevention training focused on stress management; however, this is only one available tool. The military has a proactive annual mandatory training program that provides soldiers with alternatives to suicide. The biggest push has been toward removing the stigma attached to reporting suicidal thoughts or seeking mental health care. The stigma suggests that soldiers who have thoughts of suicide are weak or could face negative career impacts.

Admiral Jeremy M. Boorda (Figure 28-2) was the Chief of Naval Operations and the first American sailor who started his career as an enlisted man and progressed through the ranks to Admiral and Chief of Naval Operations. Admiral Boorda was investigated by the media for wearing two "V" devices, which he was not authorized to wear, on two of his military ribbons. The year before the media started its investigation, the Navy informed Admiral Boorda that he was not authorized to wear the devices, and he immediately removed them. However, when the investigation began, Admiral Boorda committed suicide because he felt that his good-faith uniform error had tarnished the reputation of the Navy.



Figure 28-2. Admiral Jeremy M. Boorda (November 26, 1939–May 16, 1996). Reproduced from Naval History and Heritage website. https://www.history.navy.mil/browse-by-topic/people/chiefs-of-naval-operations/admiral-jeremy-m-boorda.html

In 1996, following Admiral Boorda's suicide, the Assistant Secretary of Defense for Health Affairs called for an analysis of the DOD suicide prevention programs. This study showed that suicide within the military was not primarily associated with current stress in an individual's life; rather, it frequently appeared to be associated with a diagnosable psychiatric disorder, such as depression or substance abuse. Of the 277 soldiers who committed suicide in 2016, 71 (25.6%) had been diagnosed with a mental health issue, and of the 586 soldiers who attempted suicide, 366 (62.5%) were also diagnosed with a mental health issue.[2] These data show a higher percentage of attempted (but not completed) suicides among soldiers diagnosed with a mental health issue. This difference shows how prevention efforts may be affected by complex suicidal motivations and potential underlying causes.

Another study showed that a person who experienced adverse events as a child has up to a fivefold increased risk of attempting suicide.[5] Adverse events may include mental, physical, or sexual abuse; neglect; witnessed domestic violence; having a family member with mental illness; having a family member who attempted or completed suicide; substance abuse in the family; incarceration of a family member; and divorce or separation of parents or guardians. As a result, affected individuals may come from homes that have not adequately prepared them to cope with crises in a positive way.

Check on Learning

1. In the DOD, who has the duty of suicide prevention?
2. Select the statement about suicide in the Army that is NOT correct.
   a. In 2018, the Army suicide rate dropped significantly due to effective prevention.
   b. The suicide rate in the Army has increased over the past several years.
   c. Adverse events in childhood may increase a soldier's suicide attempt risk.
   d. Suicide prevention efforts are complicated by complex suicidal motivations and underlying causes.

THE UNITED STATES ARMY SUICIDE PREVENTION PROGRAM

Many suicides are preventable. This is why Army leadership took an aggressive stance on developing a suicide prevention program, making it an essential part of wellness. Comprehensive programs train both leaders and individuals in recognizing and appropriately responding to troubled soldiers or their family members to discover alternatives to suicide. The Army Suicide Prevention Program is based on command policy and action, positive leadership, deep concern by supervisors, and risk reduction. Even under the best circumstances, individuals may still commit suicide. Therefore, the Army recognizes the importance of suicide risk reduction, which consists of reasonable steps taken to lower the odds of an individual engaging in self-destructive behavior.

FACTORS THAT MITIGATE SUICIDE RISKS AND IMPACTS

Prevention

Prevention focuses on preventing normal life stressors from turning into life crises. Prevention concentrates on equipping soldiers, army civilians, and family members with coping skills to handle overwhelming life circumstances. Prevention refers to all efforts that build resilience, reduce stigma, and build awareness of suicide and related behaviors. Prevention includes early screening to establish baseline behavioral health and to offer specific remedial programs before dysfunctional behavior occurs.

Prevention is dependent on caring and proactive unit leaders and managers who make the effort to know their personnel. These leaders will more adequately be able to estimate how their subordinates handle stress and will be in a better position to offer a positive, cohesive environment that nurtures and develops coping skills. These "gatekeepers" serve as the first line of defense to mitigate risk.

Suicide prevention was once recognized as a leadership responsibility. Now it is everyone's duty, including leaders, supervisors, soldiers, and civilian employees. Your role in suicide prevention includes the following:

- identify high-risk individuals,
- be proactive and care for individuals,
- encourage help-seeking behavior,
- promote positive life coping skills to deal with life crises,
- be aware of suicidal thoughts and behavior in individuals,
- know the community-wide and operational resources for referring individuals demonstrating self-destructive behavior, and
- ensure that an individual's problems are properly addressed (be an advocate for the individual).

Intervention

Intervention includes addressing the conditions that produced the current crisis, treating underlying psychiatric disorders that may have contributed to suicidal thoughts, and providing follow-up care. This includes ensuring the individual at risk of suicide is safe, through the use of a buddy system or Unit Watch. Commanders play an integral part during this phase, as it is their responsibility to ensure access to appropriate health care and ensure the safety of assigned personnel.

Postvention

Postvention is required when an individual has attempted or completed a suicide. After an attempt, commanders, noncommissioned officers (NCOs), and installation gatekeepers should take steps to secure and protect such individuals before they can cause additional harm to themselves or others. After a completed suicide, postvention activities also include unit-level interventions to minimize psychological reactions to the event, prevent or minimize potential for suicide contagion, strengthen unit cohesion, and promote continued mission readiness.

IDENTIFY RISK FACTORS ASSOCIATED WITH SUICIDE

Suicide is an equal opportunity destroyer—it cuts across rank, race, and gender. Soldiers must be able to recognize service members who display behaviors that might identify them as high risk for attempting suicide. It is important that you know your soldiers so that you can better recognize those with past or present adverse events, emotional pain, or a psychiatric disorder. These factors may interfere with adequate coping skills and may increase suicide risk.

Individuals who have difficulty coping with intense feelings or emotions may consider taking drastic measures as a solution to their problem. Intense feelings that may lead to suicide include loneliness,

worthlessness, hopelessness, helplessness, and guilt. Strategies to address suicide risk should include mitigating the negative effects of intense emotions and addressing the circumstances provoking these emotions.

Life coping skills can mitigate the negative effects of strong emotions. Some people, however, have genetic predispositions that may influence the effectiveness of their coping skills. These include a vulnerability to develop alcohol or substance abuse and/or a psychiatric illness (eg, depression). Developmental history (eg, childhood trauma, abuse, neglect, parental abandonment) and/or the current environment (eg, work and home conditions) are also factors that may affect an individual's ability to cope with adversity.

Only a small percentage of those affected pursue medical treatment or assistance for psychological issues, and many deny an issue exists. It is vital that you know the signs and symptoms of depression and understand risk factors leading to contemplation of suicide. Using knowledge of signs, symptoms, and risk factors to identify soldiers who may be at risk is only the first step in combating this issue. You must also be aware of appropriate steps in ensuring the individual's immediate safety, and procedures to establish care and effective treatment.

MYTHS AND FACTS ABOUT SUICIDE

It is unclear why some people contemplate suicide and others do not. As previously discussed, psychiatric disorders and substance abuse do play a large role in the number of suicides in the DOD, but they may not be the sole determinants. In the Army in 2017, 56% of those who completed suicide had been diagnosed with a mental health disorder, including substance abuse and adjustment, mood, and anxiety disorders.[3] However, other simultaneous contributing factors may complicate analysis of the reasons for suicide.

Suicidal people tend to feel a tremendous sense of loneliness and isolation. They feel helpless, hopeless, and worthless. Often, they believe that it does not matter if they live or die and that no one would miss them if they were gone.

Younger soldiers may tend to resort to suicide if they lack effective coping skills and are faced with relationship problems, financial problems, pending civilian legal action, or Uniform Code of Military Justice disciplinary action. Poor coping skills combined with these types of external stressors may force them beyond their tolerance level. Older soldiers tend to resort to suicide when facing negative life transitions, such as divorce or being passed over for promotion. Some individuals may suffer from chronic substance abuse or mood disorders. Isolation and loneliness are common feelings among all ages.

A review of cases in the Army in 2017 revealed that failed or failing relationships topped the list of adverse events correlated with completed suicides (35.1%).[3] Other adverse events associated with completed suicide included the following[3]:

- pending, completed, or adjudicated administrative or legal problems (26.1%);
- workplace issues (23.1%); and
- financial difficulties (9%).

Other specific events that may be associated with suicide include:

- a bad evaluation for an enlisted soldier or officer,
- the breakup of a close relationship,
- the anniversary of the suicide of a close friend or family member,
- leaving old friends,
- being alone with concerns about self or family,
- a new military assignment (but being deployed is not associated with suicide risk[4]),
- death (including suicide) of a loved one (spouse, child, parent, sibling, friend, or pet),
- loss of esteem or status,
- humiliation,
- rejection (job loss, failed promotion, discharged), and
- retirement.

At times, a person's misconceptions about addressing people who may be suicidal or their thoughts about discussing suicide may become a barrier to overtly reaching out to people who may be in danger. Several common myths contribute to misconceptions about suicide:

Myth: People who talk about suicide rarely attempt or commit suicide.

Fact: Nearly 19.3% of service members who commit suicide attempted to communicate their intentions prior to the act. For those who attempted but failed to commit suicide, 25.3% gave some warning of their intentions. When people talk about committing suicide, they may be giving a warning that should not be ignored.[2]

Myth: Talking to people about their suicidal feelings will cause them to commit suicide.
Fact: Talking to people about their suicidal feelings usually makes them feel relieved that someone finally recognizes their emotional pain, and they feel safer talking about it.[4]

Myth: All suicidal people want to die, and there is nothing that can be done about it.
Fact: Most suicidal people are undecided about living or dying. They may gamble with death, leaving it to others to rescue them. Often, they call for help before and after a suicide attempt.[4]

Myth: Suicide is an impulsive act with no prior planning.
Fact: With regard to completed suicides, 40.5% are carefully planned and thought about for weeks.[4]

Myth: A person who attempts suicide will not try again.
Fact: Most people who commit suicide have made previous attempts (80%).[7]

Myth: Improvement in a suicidal person means the danger is over.
Fact: Most suicides occur within about 3 months following the beginning of improvement, when the individual has the energy to act on suicidal thoughts and feelings. More than 62% had seen or had been treated by a medical professional within 90 days prior to completing suicide.[2]

Myth: Suicidal individuals suffer from a mental health condition.
Fact: Many people who complete suicide have not been diagnosed with a mental health condition, and many people who have been diagnosed with a mental health condition do not commit suicide.[8]

Myth: Because it includes the holiday season, December has the highest number of suicides.
Fact: Nationally, December has the lowest suicide rate of any month. During the holiday season, depressed individuals may feel a sense of belonging and believe things will get better. Statistics show that the majority of suicides tend to occur in spring and fall.[9]

Check on Learning

3. What is one genetic vulnerability that could increase suicide risk in an individual?
4. Myth or fact? December is the most common month for suicide due to the holiday season.

DANGER SIGNALS AND ACTIONS

Signals of Imminent Suicide Attempt

When one or more of the following signs are observed in a person, suicidal behavior may be imminent:

- talking about one's own death or hinting at suicide;
- giving away important possessions or making a will in connection with disposal of personal property;
- obsession with death, sad music, or sad poetry; themes of death in letters or artwork;
- uncharacteristic behaviors or withdrawal from social activities;
- significant change in performance;
- access to lethal means and specific plans to commit suicide; and
- buying a firearm in connection with any of the above signs.

If a person demonstrates imminent behavior and has experienced some life stress events associated with suicide, appears to be depressed, or has a history known to cause an increased suicide risk, the chances of suicide increase even more.

APPROPRIATE ACTIONS WHEN CONFRONTED WITH A SUICIDAL INDIVIDUAL

When confronted with what you believe to be an imminently suicidal person, the Army recommends following the Ask, Care, Escort (ACE) suicide prevention model. First, remove any potential means of self-harm (eg, firearms, knives, pills). Ask directly if they are thinking about suicide or taking their life. If they answer yes, follow up by asking what has happened to lead to that decision and how they plan to accomplish it. If you suspect a person is suicidal, begin asking open-ended questions such as "How are you doing?" Getting the individual to talk about it is a positive step; be a good listener.

Take all suicide threats seriously. The warning signs can be subtle; you must trust your suspicions. Don't

be afraid to discuss suicide with the person; doing so will not encourage the individual to commit suicide. In fact, confronting these feelings may deter the person from attempting suicide by demonstrating that someone cares. Express concerns about the impact of the person's decision on their significant others.

Individuals who attempt suicide most often feel alone, worthless, and unloved. You or any soldier can help a suicidal person by letting them know they are not alone and you are there to talk. By assuring them help is available, you are offering hope and throwing them a lifeline. Remember, although individuals may think they want to die, most have an innate will to live and are more than likely hoping to be rescued.

Get help and help the suicidal individual understand you are seeking help because you are concerned about them. The most useful thing that can be done for a suicidal person is to get them professional help. The battalion aid station, emergency department of any medical treatment facility, community mental health service, social work services, chaplain, Army Community Service, and the chain of command are some possible agencies and places that can assist with a suicidal individual. Getting help for someone involves respect for their welfare and dignity. Be compassionate toward the needs of others. Accompany the person to a behavioral health expert or assign them an escort.

Always keep a suicidal individual safe; do not leave the person alone if you believe the risk for suicide is imminent. Have a capable soldier stay with the individual at all times. Do not assume a person is not the suicidal "type." Take every threat and suspicion seriously and refrain from making moral judgments, acting shocked, or making light of the situation. This only adds to the guilt, humiliation, shame, and isolation the individual may feel. Offering advice such as "be grateful for what you have" or "you're so much better off than most people" may only deepen a sense of guilt the person may already feel. Don't keep your suspicions secret (deadly secret); tell a commander, mental health provider, or other members of the military support system what you suspect.

Check on Learning

5. Which of the following is not an imminent sign of possible suicide attempt?
   a. Initiating a personal life insurance policy.
   b. Obsession with death, sad music, or sad poetry; themes of death in letters or artwork.
   c. Talking about one's own death or hinting at suicide.
   d. Giving away important possessions or making a will in connection with the disposal of personal property.

PROTECTIVE FACTORS

In addition to suicide risk reduction strategies, there are numerous protective factors that may be enhanced by DOD efforts. Protective factors function like insulators, and they are an important component in the complex interplay of suicide risk factors. You should be familiar with factors that fortify at-risk individuals. They include the following[10]:

- effective clinical care for mental health and substance abuse issues;
- easy access to support for those seeking help;
- strong bonds with family, social groups, and community;
- effective problem solving and conflict resolution skills; and
- embrace of cultural or religious beliefs that support self-preservation.

SUMMARY

The Army Suicide Prevention Program is based on prevention, intervention, and integration of installation and community resources. Preventing suicide is always the goal of the program.

Intervention attempts to prevent a life crisis or behavioral disorder from leading to suicidal behavior, and it includes managing suicidal thoughts that may arise. At its most basic level, intervention may simply include listening, showing empathy, and escorting a person to a helping agency. This is something that can be done at the unit level by any soldier, civilian, or family member with minimal training. Army-approved training for this level includes suicide prevention training programs for soldiers, leaders, DOD civilians, and families.

CHECK ON LEARNING ANSWERS

1. In the DOD, who has the duty of suicide prevention?

   Everyone, including leaders, supervisors, soldiers, and civilian employees.

2. Select the statement about suicide in the Army that is NOT correct.
   a. In 2018, the Army suicide rate dropped significantly due to effective prevention.
   b. The suicide rate in the Army has increased over the past several years.
   c. Adverse events in childhood may increase a soldier's suicide attempt risk.
   d. Suicide prevention efforts are complicated by complex suicidal motivations and underlying causes.

   a. In 2018, the Army suicide rate dropped significantly due to effective prevention.

3. What is one genetic vulnerability that could increase suicide risk in an individual?

   Alcoholism or psychiatric illness.

4. Myth or fact? December is the most common month for suicide due to the holiday season.

   Myth—spring and fall have the highest incidences of suicide.

5. Which of the following is not an imminent sign of possible suicide attempt?
   a. Initiating a personal life insurance policy.
   b. Obsession with death, sad music, or sad poetry; themes of death in letters or artwork.
   c. Talking about one's own death or hinting at suicide.
   d. Giving away important possessions or making a will in connection with disposal of personal property.

   a. Initiating a personal life insurance policy.

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29 HUMANITARIAN and LEGAL STANDARDS IN WAR

CORE CONCEPTS

- Restate the history of the International Humanitarian Law.
- Identify protected personnel, medical facilities, and transports.
- Explain protected persons' limits of self-defense and defense of patients and detainees.
- Recall medical care requirements of the prisoner of war and detainee.
- Describe initial actions upon capture.
- Summarize the medical care requirements for confined individuals.

INTRODUCTION

Customary international law and treaties, such as the Geneva and Hague Conventions, regulate the conduct of hostilities. The rights and duties set forth in the conventions are part of the supreme law of the land. The United States is obligated to adhere to these laws even when an opponent does not. Department of Defense (DOD) and Army policies require that operations be conducted in a manner consistent with these obligations.

During all military operations, members of the US armed forces must be prepared to detain personnel who are no longer willing or able to continue fighting, as well as others who fall under specific detention criteria (eg, those who pose a threat to US forces). This means the medical community must be prepared to take into custody, protect, and medically care for potential detainees in any category. It is imperative that all individuals detained by US forces be treated in accordance with DOD policies and domestic and international law. Combat medics are responsible for adhering to and maintaining DOD and Army policies in a manner consistent with these obligations.

INTERNATIONAL HUMANITARIAN LAW

International humanitarian law is the body of wartime rules that protect people who are not participating in the hostilities. Its central purpose is to limit and prevent human suffering in times of armed conflict. The rules are to be observed by governments, their armed forces, armed opposition groups, and any other parties to a conflict.

History of International Humanitarian Law

The Geneva Conventions are a series of treaties signed by most countries. The first treaty was signed in 1864 (Figure 29-1). It established rules to protect

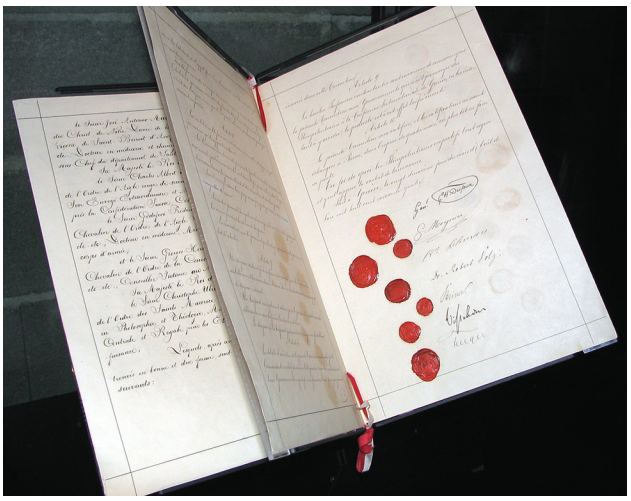


Figure 29-1. The first document of the first Geneva Convention from 1864, on loan to the International Red Cross and Red Crescent Museum in Geneva, Switzerland. Photograph by Kevin Quinn. Reproduced with permission from Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Original_Geneva_Conventions.jpg



Figure 29-2. The headquarters of the International Committee of the Red Cross (ICRC) in Geneva, Switzerland. Photograph by Alexander Umbricht. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/wiki/File:IKRK_Hauptquartier.jpg

soldiers who are wounded to the extent that they can no longer serve as combatants. The original rules, or conventions, were expanded over the years. The four Geneva Conventions of 1949 establish the humanitarian protections that are currently applied during armed conflict. The conventions and their protocols specifically protect people who do not take part in the fighting or who can no longer fight.

Nations that signed the Geneva Conventions are required to educate their citizens (civilian and military) about these laws. The International Committee of the Red Cross (**ICRC**) (Figure 29-2) is the official protector of victims of war. However, the ICRC does not have enforcement power. The nations that signed the conventions are required to enforce the rules themselves and publicize the most serious violations, known as breaches or war crimes. Just as the majority of people do not commit serious criminal offenses, such as murder or rape, neither do most people involved in armed conflicts commit war crimes. Nations are often anxious to show that what they do is lawful, according to the standards adopted by the international community.

Requirements for United States Soldiers

Soldiers must not engage in acts that violate the Geneva Conventions or the law of war. An example of an unlawful order is a commander ordering a soldier to "shoot every man, woman, and child in sight." Soldiers should disregard an illegal order and try to get it rescinded, based on the fact that it violates the law of war. This takes courage, but following a criminal order is committing the crime, which can result in trial and punishment. No one can force you to commit a crime, and soldiers cannot be court-martialed or punished for refusing to obey an unlawful order. The lack of courage to disregard a criminal order, or the mistaken fear of being court-martialed or punished for disobeying a criminal order is not a valid excuse for committing a war crime. The US Fighting Force Code of Conduct says, "I am an American, fighting for freedom, responsible for my actions, and dedicated to the principles which made my country free."[1] Soldiers who follow the code should have no problem identifying and disobeying unlawful orders.

If a criminal order results in a violation of the law of war, it must be reported to appropriate authorities. Any known or suspected violations must also be reported. Your first and best option is to report through your chain of command; your commander has established regulations governing reporting procedures. If you fail to follow these procedures, you could be prosecuted under the Uniform Code of Military Justice (UCMJ). You can report a known or suspected violation by someone in your chain of command to the local Office of the Inspector General, the Office of the Provost Marshal (military police), a judge advocate (military lawyer), or a chaplain, who can help you report through official channels.

Regardless of how you decide to report a violation of the law of war, you should do it at once. Evidence and witnesses may disappear quickly, and a prompt investigation is more likely to dispel mistaken charges. Even the perception of impropriety can be detrimental to the mission and US interests.

Check on Learning

1. Describe the ways a soldier may report a suspected war crime.
2. To whom could you report a suspected war crime?

PROTECTED PEOPLE, MEDICAL FACILITIES, AND TRANSPORTS

Protected People

Under the law of war, certain individuals are protected as noncombatants (Figure 29-3). Civilians, those wounded in the field or at sea, prisoners of war (POWs), chaplains, and medical personnel are all protected.

Civilians are people who are not members of the enemy's armed forces and do not take part in hostilities. Civilians (and their property) cannot be the subjects of a military attack. Journalists and members of the ICRC are also given protection as civilians. The



Figure 29-3. Executions of Jews by German army mobile killing units (Eisatzgruppen) near Ivangorod, Ukraine. Originally published in Zwiazek Bojowników o Wolnosc i Demokracje / League of Fighters for Freedom and Democracy / Union des Combattants pour la Liberté et la Démocratie / Verband der Kämpfer für Freiheit und Demokratie (1959) *1939-1945. We have not forgotten / Nous n'avons pas oublié / Wir haben es nicht vergessen.* Warsaw, Poland: 267. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Einsatzgruppen_murder_Jews_in_Ivanhorod,_Ukraine,_1942.jpg

Geneva Conventions contain specific rules to protect civilians, including the following:

- Pillage, reprisals, indiscriminate destruction of property, and the taking of hostages are prohibited.[2,3]
- Civilians are not to be subjected to collective punishment or deportation.[2,4]
- The safety, honor, family rights, religious practices, manners, and customs of civilians are to be respected.[5]
- Civilians are to be protected from murder, torture, or brutality, as well as discrimination on the basis of race, nationality, religion, or political opinions.[6,7]
- Children who are orphaned or separated from their families must be cared for.[8]
- If security allows, civilians must be permitted to lead normal lives.[9,10]

Soldiers who can no longer fight due to sickness or wounds are to be respected and protected, as are POWs. Surrender may be made by any means that communicates the intent to give up. There is no clear rule about what constitutes surrender; however, most agree that surrender constitutes the cessation of resistance and placement of one's self at the direction of the captor. Captors must respect (not attack) and protect (care for) those who surrender.

Chaplains and medical personnel are specifically identified in the first Geneva Convention as follows: "Medical personnel exclusively engaged in the search for, or the collection, transport, or treatment of the wounded and the sick, or in the prevention of disease, staff exclusively engaged in the administration of medical units and establishments, as well as chaplains attached to the armed forces, shall be respected and protected in all circumstances."[11] This includes permanent medical personnel (eg, doctors, nurses, physician assistants, and medics) and medical support personnel. Those who look after the administration of medical units and establishments are protected because they are an integral part of the medical service of the military.

Medical personnel receive two forms of protection under the Geneva Conventions[12,13]:

1. Protection from attack. Note that medical personnel who perform nonmedical duties harmful to the enemy lose their protective status.
2. Protection upon capture. If captured, medical personnel are considered as "retained personnel," not POWs. Retained personnel can only be required to perform medical duties. They must receive at least all the benefits conferred on POWs and must obey the POW camp rules. They may be retained only as long as needed to tend to prisoners of war who are sick and wounded and must be returned when their retention is no longer essential.

Defense of Self, Patients, and Detainees

In combat operations, medical personnel are entitled to defend themselves and their patients from unlawful attacks; however, the conventions permit only use of small, defensive arms against unlawful enemy attacks. Any use of a weapon by protected personnel in an offensive manner (eg, a medic firing on enemy soldiers during an offensive attack) may result in forfeiture of protected status and exposure to penalties for violation of the law of war. The use or mounting of offensive weapons (eg, machine guns, grenade launchers, hand grenades, and antitank weapons) on dedicated medical evacuation vehicles and aircraft jeopardizes the protections afforded by the Geneva Conventions.

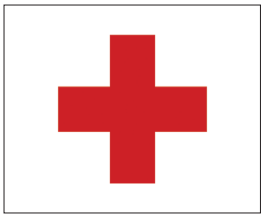


Figure 29-4. Flag of the Red Cross. Photograph by Jon Harald Søby. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Flag_of_the_Red_Cross.svg

Check on Learning

3. What happens if medical personnel use defensive weapons to fire at enemy soldiers?
4. Why should medical personnel avoid carrying grenades or machine guns?

Protected Medical Facilities and Transports

All US medical facilities and transports display the distinctive emblem of the Geneva Conventions. It is displayed over the unit or facility and in other places as necessary to adequately identify the unit or transport as medical. The Geneva Conventions authorize the use of the following distinctive emblems on a white background[14]:

- red cross (Figure 29-4); the reverse of the Swiss flag, in honor of the origin of this initiative (not a Christian symbol),
- red crescent (Figure 29-5), and
- red crystal (Figure 29-6).

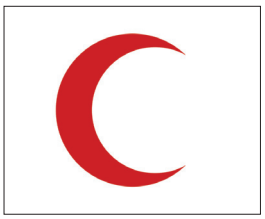


Figure 29-5. Flag of the Red Crescent. Photograph by Jon Harald Søby. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Flag_of_the_Red_Crescent.svg

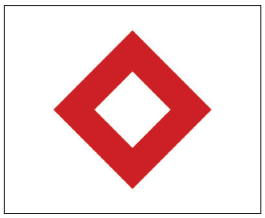


Figure 29-6. A new symbol, adopted by the Red Cross and Red Crescent Societies of the world in 2005, will give a country that doesn't want to utilize the internationally recognized ICRC red cross or red crescent symbols (eg, Israel) protections provided by the law of war. This symbol is not intended to replace any existing symbols approved by the ICRC. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/w/index.php?title=File:Flag_of_the_Red_Crystal.svg&aldid=295462258

The red Star of David emblem has not been officially authorized by the conventions but is recognized in practice (Figures 29-7 and 29-8).

Occasionally other countries have applied to the ICRC to use a particular symbol instead of the Red Cross (eg, red flame, red lion with sun [Figure 29-9], elephant, or Star of David on a white background), but these applications have been refused in an attempt to limit the number of symbols used.

A competent military leader with legal authority to make this decision may display, obscure, or remove the distinctive emblem during military operations. The removal of the distinctive emblem alone does not remove the protected status of the facility or vehicle. The military authority may decide to obscure or remove the emblem for purposes such as camouflage, or if it is assessed that enemy forces will fail to respect the emblem and will seek to attack medical personnel. The purpose of the distinct emblem is to facilitate the identification of protected status. If it is removed or obscured, enemy forces may not recognize the protected status and attack the medical facility or vehicle in error.

A unit will never display the distinctive emblem while engaging in attacks in order to shield, favor, or protect one's own military operations, or to impede enemy military operations. An example of this is using an ambulance displaying a distinct emblem, to mount a surprise attack against enemy forces. If a commander wants to use a ground medical transport for nonmedical use, such as transporting able-bodied combatants or ammunition, the distinctive emblem must be covered or removed, its protected status is forfeited, and the transport and its occupants are subject to attack.

The conventions also say that fixed or mobile medical facilities "shall at all times be respected and protected."[13] This means they may not be attacked intentionally. Although the enemy may not deliberately target a hospital, legitimate military facilities are acceptable targets. If such military objectives are located adjacent to a hospital, the hospital may be inadvertently hit. Therefore, it is prudent to situate hospitals away from potential military targets. A hospital will remain protected unless it is used to commit "acts harmful to the enemy."[15] Similarly, medical supplies, equipment, and transports (eg, ambulances, medical ships, medical aircraft) used exclusively to remove the sick and wounded and to transport medical personnel and equipment are also protected by the conventions. However, a convoy carrying both wounded and able-bodied soldiers, or

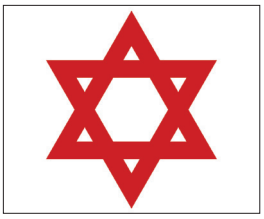


Figure 29-7. Although not recognized internationally by the ICRC, the Red Star of David is used by Israel within its borders. Authored by user: Denelson83. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/w/index.php?title=File:Red_Star_of_David.svg&aldid=29546225

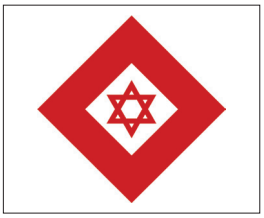


Figure 29-8. Because the Red Star of David is not an internationally recognized symbol to provide protections by the law of war, the Star of David is placed in the middle of the internationally recognized Red Crystal. Additional protocol III (added in 2005) to the 1949 Geneva Convention provides protection for countries that use the Red Crystal only, and once another symbol is placed into the center of the Red Crystal, it no longer becomes an internationally recognized symbol. The Star of David in the center of the Red Crystal is the symbol of the Magen David Adom, which is the national aid society of the state of Israel when performing missions outside of the Israeli border. It requires permission from the host country. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/w/index.php?title=File:Red_Crystal_with_Star.svg&aldid=1805970

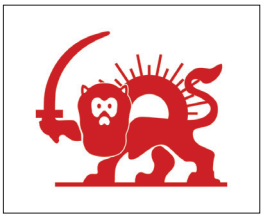


Figure 29-9. An example of a symbol used by other countries, but it is not internationally recognized by the ICRC and the laws of war and provides no internationally recognized protections. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Red_Lion_with_Sun.svg

wounded personnel and offensive weapons would lose this protection.

Medical aircraft must be marked with a distinctive medical emblem and must fly at heights, at times, and on routes specifically agreed upon between the parties concerned (Figure 29-10).[16,17] Medical aircraft shall be clearly marked with the emblem, together with their national colors, on their lower, upper, and lateral surfaces.[16] Unless agreed to otherwise, flights over enemy or enemy-occupied territory are prohibited. Medical aircraft shall obey every summons to land but may continue its flight after examination.[16,17] In the event of an involuntary landing in enemy or enemy-occupied territory, the wounded and sick as well as the crew of the aircraft may become POWs; medical personnel should be treated as designated in the Geneva Conventions.



Figure 29-10. A UH60 MEDEVAC Black Hawk Helicopter of the C Co 2/149th Alamo Dustoff displaying the ICRC red cross. Photograph by Michael Davis.

Check on Learning

5. Could a commander order the removal of the ICRC emblem and still use the vehicle for a medical purpose?
6. To enhance operational security, can the emblem be camouflaged (eg, a dark brown cross with a light brown background)?
7. Can a commander legally use an ambulance for a nonmedical purpose (eg, to transport combat troops)?
8. Could a commander take a combat vehicle and put a red cross on it to avoid attack while it is performing a nonmedical function?

POW AND DETAINEE CARE AND TREATMENT

A detainee is any person captured or under control of DOD personnel.[18] As a matter of policy, all detainees will be treated in accordance with the principles applicable to enemy POWs unless and until a more precise legal status is determined. An enemy prisoner of war (**EPW**) is one who, while engaged in combat under government orders, is captured by enemy armed forces. A civilian internee is an individual interned during an international armed conflict for security reasons,

for protection, or because he or she has committed an offense (insurgent, criminal) against the detaining power. A retained person is an enemy individual serving in medical, religious support, or voluntary aid society (eg, ICRC) roles. Other detainees are people in the custody of US armed forces who have not yet been classified.

Following the declaration of a Global War on Terror, an additional detainee classification was created: enemy combatant. These are individuals who, through their own conduct and actions, are not entitled to the privileges and protection of the Geneva Conventions, but they are still entitled to humane treatment.

Note: A comprehensive list of terrorists and terrorist groups is identified under Executive Order 13224, at http://www.treas.gov/ofac/. Any detainee affiliated with these organizations will be classified as an enemy combatant.

The Geneva Conventions specify that detainees must be cared for "without any adverse distinction based on sex, race, nationality, religion, political opinions, or any other similar criteria."[19] US law also requires that certain rights be afforded to individuals captured on the battlefield. Every soldier should be aware of these basic rights. Granting these protections is also valuable militarily; ultimately, these rules benefit US soldiers on the battlefield because enemies are more likely to surrender when they know they will be treated by their captors with dignity and respect. It is also hoped that these rights will be afforded to US soldiers should they be captured.

Detainees must be protected against all acts of violence, including murder, mutilation, torture, rape, forced prostitution, assault, corporal punishment, and theft[20] (Figures 29-11 through 29-13). All detainees will be protected against any other cruel, inhuman, or degrading treatment not listed above. For example, detainees may not be paraded publicly in an attempt to expose them to ridicule, humiliation, or attacks by civilians. They will not be subjected to medical or scientific experiments.[21] Inhumane treatment of detainees is never justified by the stress of combat or extreme provocation.

Initial Actions upon Capture

Always initially treat a captured person as an EPW. Infantry detainee teams process the individual according to the "5 Ss and T" technique[22]:

1. **Search** the person immediately for weapons, ammunition, equipment, and documents with intelligence value. EPWs and retained persons will be allowed to retain personal effects of sentimental or religious value. Female detainees should be searched by female personnel.
2. **Segregate** them into groups of enlisted, noncommissioned officers, and officers. Individuals presumed to have intelligence value should be separated immediately from other EPWs. Segregation rules may differ depending on the situation.
3. **Silence** the individual. Segregation should prevent prisoners from communicating with each other by voice or visual means, including singing or praying out loud.
4. **Safeguard** the individual. You are responsible for the individual's safety and humane treatment.
5. **Speed** the individual to the rear. Wounded EPW patients should be evacuated to the rear as soon as their medical conditions permit.
6. **Tag** using DD Form 2745. The tag should include date and time of capture, location of capture, capturing unit, and circumstances.

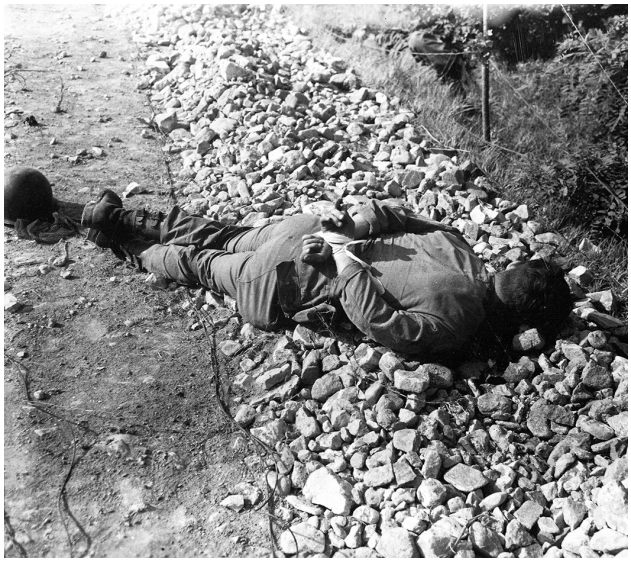


Figure 29-11. One of four American soldiers from the 21st Infantry Regiment found between the forward observation post and the front line, who were captured by the enemy on the night of July 9, 1950 and executed. Photograph by Corporal Robert Dangel, National Archives ID 531361. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Americanexecuted1950korea.jpg

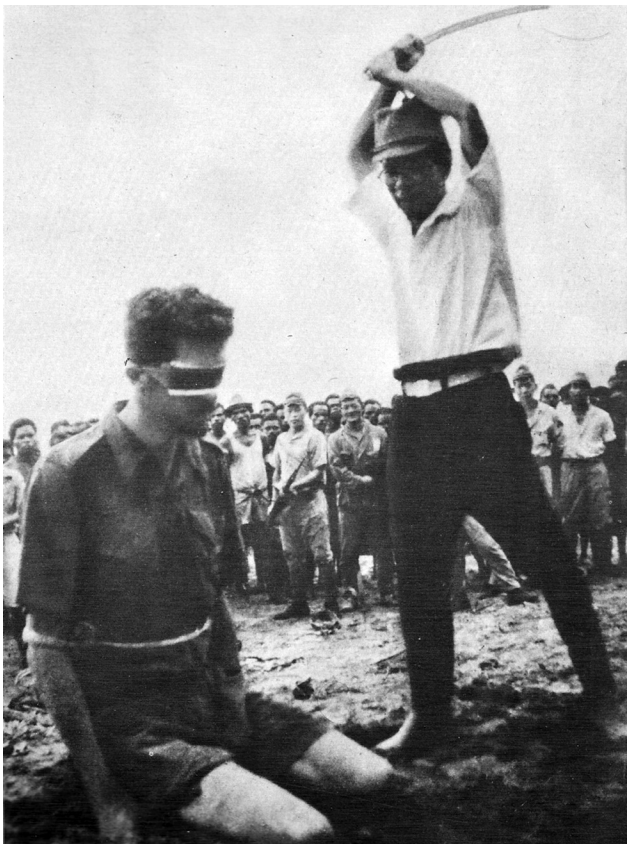


Figure 29-12. Moments before the execution of SGT Leonard G. Siffleet of "M" Special Unit of the Australian Netherlands East Indies Forces by Japanese Naval Force member Yasuno Chikao. It was confirmed that Yasuno Chikao was killed before the end of WWII, and the photograph was found on the body of a dead Japanese soldier. Australian War Memorial ID Number 101099. Reproduced from Wikimedia Commons. https://en.wikipedia.org/w/index.php?title=File:LeonardGSiffleet.jpg



Figure 29-13. Eighty-four American POWs of the 285th Field Artillery Observation Battalion, massacred by the members of Kampfgruppe Peiper (Part of the 1st SS Panzer Division) during the battle of the Bulge, at the Baugnez crossroads near Malmedy, Belgium, during WWII. Courtesy of the National Oceanic and Atmospheric Administration/Department of Commerce. Reproduced from NOAA Photo Library. https://photolib.noaa.gov/Collections/Coast-Geodetic-Survey/War-Service/emodule/956/eitem/46916

Detainee Medical Care

The medical standard of care for detainees is the same as for US forces. According to the Geneva Conventions, "All the wounded, sick and shipwrecked, whether or not they have taken part in the armed conflict, shall be respected and protected. In all circumstances they shall be treated humanely and shall receive, to the fullest extent practicable and with the least possible delay, the medical care and attention required by their condition."[23] Priority for medical treatment is based on the severity of the wound or injury; the most urgent cases will be treated first, regardless of whether the individual is a friend or an enemy. Medical support will include first aid, all sanitary aspects of food service, preventive medicine, professional medical services, medical supply, and coordinating the use of medically trained EPWs, civilian internees, retained personnel, and medical materiele.[24] The conventions further require that detainees never be left without medical assistance or care.

Detainees must be provided with adequate food, drinking water, and clothing. Detainees' food rations shall be sufficient in quantity, quality, and variety to keep them in a good state of health.[25] When providing food to a detainee, their cultural and religious requirements must be considered to ensure an appropriate diet.[26] Withholding food and medical treatment to interrogate a detainee is not allowed.[27]

Detainee Hold and Evacuation

Noninjured detainees are to be humanely evacuated from the combat zone as quickly as possible.[28] Sick and wounded detainees should be evacuated separately and as warranted by their medical condition but in the same manner as US and allied forces.[29]

Body cavity examinations may be performed for valid medical reasons with the verbal consent of the patient. Body cavity searches not conducted for medical reasons may be performed only when there is a reasonable belief that the detainee is concealing an item that could present a security risk and must be authorized by the first general officer in the chain of command. Body cavity searches, if warranted, will be conducted by trained personnel of the same gender and with the utmost respect for the detainee's dignity and privacy.[29] Performing a body cavity examination is **not** in the 68W's scope of practice.

Units designated to hold and evacuate detainees will triage detainees and categorize the sick and wounded in their custody as walking or nonwalking (litter). These detainees will be delivered to the nearest medical treatment facility and evacuated to another treatment facility (if medically stable) through medical channels.[30] During transport, detainees will have sufficient food and drinking water to keep them in good health and will be provided adequate clothing, shelter, and medical attention. Medical personnel do not guard detainee patients.

Check on Learning

9. What types of medical support do US soldiers offer detainees?
10. Suppose wounded and hungry enemy soldiers are under your medical care. You think they know the locations of enemy units in the area. Can you deny them medical treatment or food until they tell interrogators what they want?

Medical Care for Enemy Prisoners of War

Inprocessing Medical Requirements

All detainees must receive a screening medical examination during inprocessing. Medical requirements include the following[24]:

- medical history;
- physical examination to detect lice and communicable diseases (eg, sexually transmitted diseases);
- overall health, nutrition, and hygiene assessment;
- screening chest radiograph for tuberculosis;
- dental screening;
- mental health screening;
- height and weight measurement;
- immunizations against diseases (as recommended by the theater surgeon); and
- creation of a medical record containing all this information.

Documentation of medical care will occur at every level, and the records must accompany detainees throughout the medical system, including through transport. Copies should be provided to detainees upon their release, if requested. Each facility shall provide copies of the applicable Geneva Conventions for detainees in the detainees' own language. The detaining authority will ensure medical personnel complete the appropriate medical records. The detaining authorities shall, upon request, issue an official certificate indicating the nature of the injury or illness and the duration and type of treatment to every detainee who has undergone treatment. A duplicate certificate will be sent to the ICRC. Per DOD policy, the ICRC is the only organization with authorized access to detainees.

Sick Call and Medical Support

EPWs, retained persons, and civilian internees may not be denied medical care, and every camp will have an infirmary.[31] Sick call for detainees requiring medical attention should be held daily.[32] To the extent possible, detainees will be cared for separately from coalition forces and civilians, and every effort should be made to have female health care providers screen and care for female detainees.[29] Special facilities should be made available for the care and rehabilitation of those with disabilities.[31]

Any detainee with a contagious disease, mental condition, or other illness as determined by the physician or physician assistant will be isolated from the other patients. Any detainee found to be suffering from a medical condition that requires specialized treatment or who has a life-threatening illness must be treated in a military or civilian medical treatment facility.[31]

Other Medical Concerns

Medical inspections for general health, nutrition, and cleanliness should be held at least once a month.[33] Detainees should be provided with sanitary supplies, service, and facilities necessary for their personal cleanliness and sanitation.[34] The detaining power is responsible for the hygiene and sanitation of the camp or detainment facility and should periodically inspect and remedy unhealthful conditions.

Sick or wounded detainees may be questioned by human intelligence collectors, provided they have permission from an appropriate medical provider.[29] At no time should detainee medical information be available for interrogation purposes. However, if a detainee has a medical condition that may be exacerbated during an interrogation session, the health care provider should inform the interrogation team of the existing medical limitations. Detainees should not be handcuffed or tied, except to ensure safety and security,[35] or when prescribed by a responsible physician as needed to control a medical case requiring restraint.[29,36] Medical personnel are obligated to report any information obtained during the course of medical care that could affect the safety and security of other detainees or coalition forces.[36]

Check on Learning

11. Under what medical conditions are detainees isolated?
12. How often are medical inspections performed in detainee centers?

HUMAN REMAINS AND PORTIONS

During combat operations, medical personnel will take care of the wounded as well as the deceased. Battlefield transportation and recovery of the deceased are directed in Army regulations to be the responsibility of the Quartermaster Corps (more commonly known as logistic operations); however, medics are often asked to recover human remains. Treat human remains with dignity, reverence, and respect. Human remains recovery is important; family members should get a full accounting (security classification permitting) of the circumstances in which their loved ones were killed.

Human remains recovery operations should begin after the area is secure. When recovering the remains of a deceased casualty, prepare Department of Defense Form 1380 Tactical Combat Casualty Care (TCCC) card as deceased, and attach the document to the remains. Do not remove clothing, organizational clothing and individual equipment, or personal effects. When a casualty has died during medical treatment, do not remove intravenous lines; monitor patches, cut intravenous tubes, and leave catheters in place. Prepare Department of Defense Form 1380 TCCC card as deceased, and attach the document to the remains. List all lifesaving procedures that were attempted.

Place the remains and any clothing that was removed during medical aid in a human remains pouch. Place individual body armor in a separate bag marked with the casualty's name and the date. Evacuate to the nearest Mortuary Affairs Collection Point (**MACP**).

When recovering portions of remains, do not remove any personal effects from portions. Place each portion in an individual plastic bag; individually bagged portions may be placed in one human remains pouch to facilitate transport. Evacuate to the nearest MACP.

At times, you may recover disassociated personal effects (effects that were separated from the casualty during the fatal event). Individually bag each of these items. Individually bagged, disassociated effects may be placed in one plastic bag or human remains pouch to facilitate transport. Evacuate these to the nearest MACP.

SUMMARY

The guiding principle in the Geneva Conventions, International Humanitarian Law, and the recovery of human remains is humanity. Although nations still engage in war, many nations have set rules to make warfare more humane and to lessen its sufferings. The rules recognize that everyone involved in war is human and should be afforded rights and dignity accordingly. The humanitarian provisions of the law of war protect everyone caught up in a conflict: friend, foe, and bystander alike.

US soldiers are duty bound to avoid causing unnecessary suffering or destruction. Therefore, all prisoners of war, captured or detained individuals, civilians, and even human remains must be treated humanely.

Soldiers must refuse to obey any order that requires them to violate the law of war and report violations to the appropriate authorities. Above all, soldiers must remember that they are personally responsible for any unlawful act they commit.

Remember that respect for others does not disappear if a casualty perishes. Treat human remains with dignity and respect; fallen individuals have friends watching how you treat their remains. If the deceased is a local national, the local population is watching how you treat their loved one and will judge not only you, but your entire country, accordingly.

By knowing our rights and responsibilities, as humans and as American soldiers, reporting all suspected war crimes to the proper authorities, and knowing the rights of our enemies and of the civilian population, we play an important part in mission success and return to peace.

KEY TERMS AND ACRONYMS

ICRC. International Committee of the Red Cross.
EPW. Enemy prisoner of war.
MACP. Mortuary Affairs Collection Point.

CHECK ON LEARNING ANSWERS

1. Describe the ways a soldier may report a suspected war crime.

   The first and best option is to report through your chain of command. Your commander has established regulations governing reporting procedures. If you must report a known or suspected violation by someone in your command, there are other reporting options.

2. To whom could you report a suspected war crime?

   Chain of command, Office of the local Inspector General, Office of the Provost Marshall (military police), judge advocate (military lawyer), and a chaplain (who can help you report through official channels).

3. What happens if medical personnel use defensive weapons to fire at enemy soldiers?

   Medical personnel may always fire in defense of themselves or their patients. However, if medical personnel start acting as combatants, the enemy will respond accordingly. Any use of a weapon by protected personnel in an offensive manner (eg, a medic firing on enemy soldiers during an offensive attack) may result in forfeiture of protected status and exposure to penalties for violation of the law of war.

4. Why should medical personnel avoid carrying grenades or machine guns?

   They are offensive weapons and could jeopardize the protection of the medical establishment.

5. Could a commander order the removal of the ICRC emblem and still use the vehicle for a medical purpose?

   Yes, there is no requirement to affix a Red Cross to anything. However, it may jeopardize the protection it would be entitled to; it may not be recognized as being used to provide medical care.

6. To enhance operational security, can the emblem be camouflaged (eg, a dark brown cross with a light brown background)?

   To be protected under the Geneva Conventions, the emblem must be red upon a white background.

7. Can a commander legally use an ambulance for a nonmedical purpose (eg, to transport combat troops)?

   Yes, but he must cover up the Red Cross or other protective emblem; however, this will result in the ambulance being a legitimate target.

8. Could a commander take a combat vehicle and put a red cross on it to avoid attack while it is performing a nonmedical function?

   No. Misuse of the medical emblem in this manner is a war crime.

9. What types of medical support do US soldiers offer detainees?

   First aid; all sanitary aspects of food service; preventive medicine; professional medical services; medical supply; and coordinating the use of medically trained EPWs, civilian internees, retained personnel and medical materiel.

10. Suppose wounded and hungry enemy soldiers are under your medical care. You think they know the locations of enemy units in the area. Can you deny them medical treatment or food until they tell interrogators what they want?

    No. The Geneva Convention that protects EPWs prohibits forcing a prisoner into giving information of any kind.

11. Under what medical conditions are detainees isolated?

    If they suffer from a contagious disease, mental condition, or other illness as determined by the medical officer.

12. How often are medical inspections performed in detainee centers?

    Monthly medical inspections will be held for general health, nutrition, and cleanliness.

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30 ENVIRONMENTAL THREATS

CORE CONCEPTS

- Explain how disease is spread.
- Identify mosquito-borne diseases and how to reduce transmission.
- Recite the illnesses that can be spread by filth flies, cockroaches, fleas, ticks, chiggers, and lice and learn how to reduce a soldier's risk of contracting such illnesses.
- Identify weather-related injuries and their associated risk reduction measures.
- Recognize the different types of spiders and scorpions that pose a threat to soldiers training in the United States.
- Identify dangerous snakes that inhabit training areas and how to treat a casualty if bitten.
- List the different altitude injuries and their treatments.

INTRODUCTION

High-tech weapons systems are not the only things that can decimate an army. History is full of examples of armies that were significantly affected by disease, as well as environmental extremes (cold or heat). During the Korean War (July 1950–July 1953), for every 1,000 US Army soldiers deployed to the Korean peninsula, 30 were killed in action, 121 were wounded, and 570 were admitted to the medical treatment facilities due to disease and nonbattle injury (**DNBI**).[1] During Napoleon's 1812 Russia campaign, French forces initially totaled about 490,000; but during his retreat, they totaled at most 100,000—approximately 41,000 had been killed in combat, but the vast majority were killed by **typhus**, hunger, and cold weather injuries.[2] Even today, soldiers are impacted by disease and injury, despite improved prevention and mitigation strategies.

Due to the seriousness of DNBIs and their effects on combat strength, combat medics must teach soldiers about environmental threats and train them to use personal protective measures. This chapter provides an overview of diseases transmitted by **vectors**, threatening **arthropods**, snakes, heat and cold weather injuries, and altitude disorders.

HOW DISEASES SPREAD

Arthropods are invertebrate animals with exoskeletons, such as ticks, spiders, mites, and crustaceans (eg, shrimp and crabs). An arthropod that transports a **pathogen** from one host to another is called a vector. For example, **plague** is caused by *Yersinia pestis* (the pathogen), which is transmitted by fleas (the vector). There are several mechanisms of vector-borne disease transmission.

Mechanical Transmission

Mechanical transmission is also called passive transmission. It occurs when an arthropod carries a pathogen among hosts or contaminated surfaces. During the transfer, the pathogen remains the same and does not undergo any change in structure or number. For example, filth flies carry bacteria and other disease-causing organisms on their mouthparts and feet from infected human feces. If soldiers eat food that has been contaminated by a fly landing on it and depositing pathogens, **dysentery** or other diarrheal disease may occur. Similarly, cockroaches carry disease organisms on their appendages and mouthparts. These pathogens can cause diarrheal diseases, such as **cholera**.

Biological Transmission

Biological transmission is also called active transmission. It occurs when a pathogen changes in number or form while being carried in the body of a vector, before being transmitted to another host. There are four ways a pathogen can be passed to humans via biological transmission:

- **Inoculation** occurs when a vector injects a pathogen into the host with its saliva while it feeds on the host (eg, mosquitoes transmit **malaria** by inoculation).
- **Regurgitation** occurs when the vector vomits the pathogen into the host while it feeds on the host. (eg, fleas transmit bubonic plague by regurgitation).

Note: The bacteria that causes bubonic plague multiplies rapidly in the flea's gut and blocks it (like stopping up a drain). When the flea attempts to eat, it cannot ingest the host's blood due to the blockage. The flea ends up regurgitating the bacteria into the host.

- Fecal contamination occurs when the vector defecates into a wound on the host. The feces deposited in the wound causes irritation and itching. Scratching at the wound facilitates pathogen entry into the host body (eg, Chagas disease, also known as American trypanosomiasis, is transmitted in this way by the kissing bug).
- Crushing occurs when a vector is smashed onto the skin of a host. When the host attempts to remove the dead bug, by brushing it off with their hand, the pathogen is rubbed into the skin. (eg, epidemic typhus can be transmitted by crushing body lice and rubbing bacteria into broken skin).

Note: Many diseases transmitted by different vectors cause illnesses that are beyond the treatment capability of most combat medics. Identification of illnesses, based on signs and symptoms, necessitates a referral by the combat medic to the unit medical officer (MO) for evaluation and treatment.

Note: Many diseases (such as plague, **yellow fever**, **typhoid**, and cholera) have vaccines available that provide prophylaxis for soldiers prior to deployment to endemic areas of the world.

MOSQUITOES

Of all of the arthropods that can affect the military, mosquitoes (Figure 30-1) are the most important. They are found nearly everywhere in high numbers and are capable of transmitting many diseases, some of which impacted the outcomes of wars. During the Civil War, "fully one quarter of all illness reported in the Union Army was malarial in character,"[3] spread by mosquitoes.

Habitat

Mosquito larvae (Figure 30-2) inhabit areas with standing water, such as ponds, puddles, small containers, and ditches. Anything that can hold water provides a habitat for mosquito larvae (Figure 30-3). Adult mosquitoes may stay close to larval habitats or move for many miles, depending on the species.



Figure 30-1. An *Anopheles merus* mosquito obtaining a blood meal from a human hand. Photograph by James Gathany. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=18762



Figure 30-2. Mosquito larvae collecting at the surface of a water sample. Content provided by CDC. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=4914



Figure 30-3. A member of the Malaysian Field Epidemiology Training Program team examining a prime breeding ground (discarded tires) for mosquitoes during a dengue fever outbreak in the area. Photograph by Suhaiza Sulaiman, Malaysia. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=19726

Diseases Transmitted by Mosquitoes

Note: Only female mosquitoes feed on blood; therefore, only females transmit diseases.

Malaria

Malaria is a tremendous problem in tropical, developing countries, causing 300 to 500 million cases each year. Malaria is an ancient disease and is one of the most important preventable diseases in humans. Malaria is transmitted to humans from the bite of an infected *Anopheles* mosquito. Mosquitoes feed on the blood of an infected person and transmit the disease to a healthy person during a subsequent feeding. When a person is suspected of contracting malaria, place them under mosquito netting (also known as an insect bar) to prevent transmission of the disease to healthy individuals operating in the mosquito-infested area. The time between an infective bite and the appearance of symptoms usually ranges from 7 to 30 days, depending on the type of malaria parasite.

Malaria must always be considered in soldiers presenting with unexplained febrile illness if they are deployed to, or spent time in, a location where malaria is present. The signs and symptoms of malaria include:

- fever alternating with chills,
- headache,
- muscle aches,
- sweats, and
- abdominal pain with diarrhea.

Note: During World War II, malaria caused more casualties than combat wounds in the South Pacific. Over 60% of all American soldiers were infected at least once, and the success of the military campaign was jeopardized.[4] The soldiers who did not practice effective preventive measures contracted malaria.

Note: Blackwater fever is an acute and potentially fatal complication of malaria. It causes **hemolysis** of red blood cells, and often leads to kidney failure.

Medications for treatment of malaria are available, but management plans must be tailored for the affected individual. Factors that affect the treatment regimen include the severity of disease, the specific type of infecting parasite, parasite susceptibility to drugs, and patient factors. Supportive care is provided as well.

Dengue Fever

Aedes mosquitoes transmit the viral disease, dengue fever. A slang name for dengue fever is "breakbone fever" because of the severe joint point that infected people suffer. It is widely endemic in the tropics around the world. It is significant to the military because of its explosive nature, resulting in high numbers of casualties in a short time, coupled with a prolonged convalescent period.

Signs and symptoms of dengue fever are high fever of approximately 104 °F plus two following:

- severe headache,
- nausea and vomiting,
- pain in the muscles and joints,
- severe pain behind the eyes,
- swollen lymph nodes,
- cough, and
- sore throat.

There is no specific therapy for dengue fever; treatment is supportive. Vaccines are currently under development.

Yellow Fever

Yellow fever is a potentially fatal viral disease that is transmitted by *Aedes* mosquitoes. Yellow fever mostly occurs in urban and forest or jungle environments in Africa and Central or South America. While yellow fever affects the liver, kidney, and heart, it gets its name from the yellowing of skin (jaundice) due to the virus attacking the liver.

Signs and symptoms of yellow fever are:

- fever,
- headache,
- body aches,
- nausea and vomiting, and
- fatigue.

Soldiers are immunized with yellow fever vaccine prior to deployment in endemic areas. Booster doses are recommended every 10 years. Although uncommon among soldiers because of the effective vaccine, yellow fever can be fatal (Figure 30-4).

Place yellow fever patients under mosquito netting (or where mosquitoes cannot enter) to prevent non-infected mosquitoes from contracting and spreading the virus.



Figure 30-4. The tombstone of Henry Warren, RN, who died of yellow fever in 1855. Content provided by CDC. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=691

Encephalitis

Aedes and *Culex* mosquitoes (Figure 30-5) carry several viral **encephalitides**. They include West Nile virus (**WNV**) (Figure 30-6), St Louis encephalitis, Japanese B encephalitis, and California encephalitis.

WNV was first identified in 1937 in Africa. Epidemics have occurred in the Middle East and Europe. It was first identified in the United States in 1999, but it is not known how it arrived in New York. WNV is spread when mosquitoes bite birds and infect them with the virus. The bird becomes ill and then the virus is spread to new mosquitoes when they bite the bird. The virus may spread to other species, such as humans or horses.



Figure 30-5. This mosquito species is one of many that are West Nile virus vectors. Photograph by James Gathany. Content provided by CDC/James Gathany. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=4734

According to the Centers for Disease Control and Prevention, WNV has a range of symptoms and severity.[5] Most people who are infected with WNV do not have symptoms. Approximately 20% of people infected with WNV will develop fever, headache, and body aches. About 1 in 150 people infected will develop more severe disease. The symptoms of severe infection (West Nile encephalitis or meningitis) include high fever, neck stiffness, coma, seizures, and paralysis. Mortality is most likely to occur among elderly individuals. Treatment for WNV is supportive. A vaccine is currently under development.

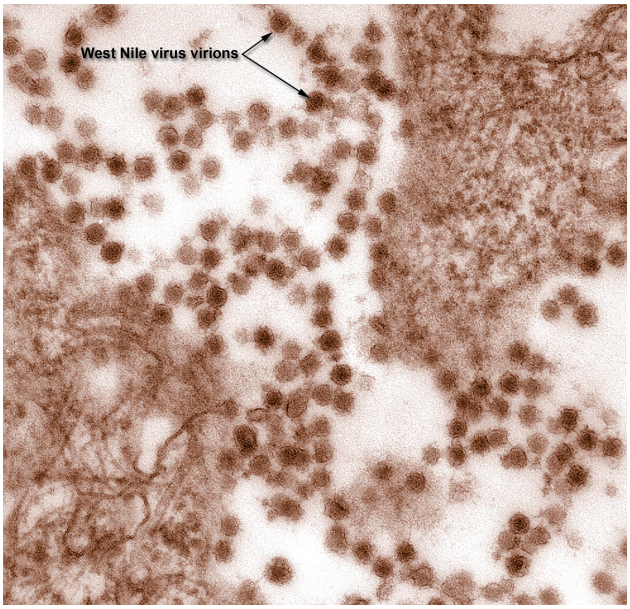


Figure 30-6. A digitally colorized transmission electron microscope image of West Nile virus in a cell culture. Photograph by Cynthia Goldsmith. Content provided by CDC/P.E. Rollin. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=10700

Prevention and Personal Protective Measures

Use mosquito control and personal protective measures for prevention of all mosquito-borne diseases. The most effective method of control is avoiding mosquito bites. Mosquito netting (insect bars) is commonly used in the military to prevent mosquitoes from biting soldiers while they sleep (Figure 30-7). Soldiers can use aerosol sprays on the inside of the net to kill any mosquitoes that may get through. Wearing long-sleeved, loose-fitting clothing is another good preventive measure. Mosquitoes can bite through clothing only when it is worn tightly against the skin.

Chemical repellents such as **DEET** (N,N-diethyl-m-toluamide) should be applied to all exposed skin surfaces and repeated every 4 to 6 hours (Figure 30-8). Use **permethrin** to impregnate fabrics (eg, uniforms, bed nets, tent screens, sleeping bags). Prevention also includes education on eliminating or destroying mosquito larval habitats (eg, standing water, runoffs, any water-holding containers near or within human habitations).

Caution: Do not apply permethrin to inner clothing or hats.



Figure 30-7. A Peruvian woman sitting next to her child who is lying in bed surrounded by mosquito netting. Photograph by Alison Paredes Torrez, Peru. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=19890



Figure 30-8. A man applying DEET (N, N-Diethyl-meta-toluamide) insect repellent. Photograph by James Gathany. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=4429

Malaria is one of the few vector-borne diseases that can be largely prevented through scrupulous use of prescribed antimalarial medications. **Chemoprophylaxis** does not provide protection against other mosquito-borne diseases. **Chloroquine** is one standard medication that prevents the parasite from surviving and causing disease in humans. In many countries, though, the malaria parasites are resistant to chloroquine, making it ineffective. In this case, other

antimalarial drugs must be used (eg, mefloquine, atovaquone-proguanil, doxycycline). Soldiers with an acute febrile illness and a history of travel to a malaria risk area must be evaluated by an MO.

Note: Due to drug resistance, malaria chemoprophylaxis may not be 100% effective.

FILTH FLIES AND COCKROACHES

The behaviors of flies (Figure 30-9) and cockroaches (Figure 30-10) make them potential vectors for disease. Cholera, dysentery, typhoid, and food-borne gastroenteritis outbreaks are associated with filth flies and cockroaches. They pick up organisms from sewage, garbage, manure, and decaying animal bodies. The organisms are then passed on to humans and animals through the feces and vomit of the fly and the "taxi ride" of the cockroach.



Figure 30-9. A dorsal view of a house fly. Content provided by CDC. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=5452

Habitat

Filth flies and cockroaches live in or near animal or human waste, garbage, decomposing plants and animals, or in mud with high organic content. A large population of flies or cockroaches is usually a good indicator of unsanitary conditions.

Diseases Spread by Filth Flies and Cockroaches

Filth flies and cockroaches are implicated in transmission of the following diseases, but they are not necessary components of the chain of infection.



Figure 30-10. A dorsal view of a cockroach, *Periplaneta americana*, which is a mechanical vector for many pathogens. Content provided by CDC. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=6319

Cholera

Cholera is a serious diarrheal disease of the small intestine, caused by *Vibrio cholerae* bacteria. If untreated, the diarrhea will result in severe dehydration and may cause death within hours. Cholera infection can occur after ingesting contaminated food or water.

Signs and symptoms of cholera are:

- severe, acute, watery diarrhea (that resembles rice water), and
- severe dehydration.

Dysentery

Dysentery is a condition in which the patient experiences severe, watery (and often bloody) diarrhea. Dysentery is most often caused by species of *Shigella* or *Entamoeba* bacteria. Contaminated food or water is usually the source of this condition. A patient with dysentery must receive aggressive rehydration.

Typhoid

Typhoid is a bacterial infection caused by food or water that is contaminated with *Salmonella typhi*. Typhoid infection presents as an acute fever. Signs and symptoms are nonspecific and difficult to distinguish from other infections that manifest as fever. They include:

- acute, long-lasting fever (differing from patient to patient in severity),
- headache,
- loss of appetite,
- gastrointestinal signs and symptoms (ranging from constipation to diarrhea), and
- nausea.

Disease management includes aggressive rehydration, antibiotic therapies when possible, and additional supportive care.

Prevention and Personal Protective Measures

Locating and removing the food sources of filth flies and cockroaches are the key to eliminating them from any environment. Field latrines and soakage pits should be constructed, used, maintained, and closed to minimize breeding grounds for flies. Sprays, fogs, and sticky traps are useful tools but are successful only when used with pest elimination measures.

SAND FLIES

Phlebotomine sand flies are small, blood-sucking gnats (Figure 30-11). Sand flies attack humans at the wrists, ankles, or any exposed part of the body.

Habitat

Phlebotomine sand flies are widely distributed throughout temperate, tropical, and subtropical areas of Europe, Africa, the Americas, and Asia. Phlebotomine sand flies thrive in areas with high humidity and temperatures above 60 °F.



Figure 30-11. This photograph depicts a *Phlebotomus papatasi* sand fly obtaining a blood meal. Photograph by James Gathany. Content provided by CDC/Frank Collins. Reproduced from Public Health Image Library. https://phil.cdc.gov/details.aspx?pid=10277

Diseases Spread by Sand Flies

Phlebotomus Fever

Sand fly bites can result in sand fly fever, which is an acute, self-limiting, sometimes recurrent viral disease. Epidemics occur among non-native persons such as US troops entering endemic areas. "During the North African campaign of World War II, large numbers of American forces were incapacitated from 7 to 14 days or longer after contracting phlebotomus fever (sand fly fever)."[6]

Signs and symptoms of sand fly fever are:

- sudden onset of fever and chills,
- headache,
- pain behind the eyes (retro-orbital),
- **photophobia**,
- **malaise**, and
- nausea and vomiting.

Leishmaniasis

Leishmaniasis is a disease found in most developing countries. Leishmaniasis is caused by the protozoan parasite *Leishmania* and is transmitted by the bite of an infected sand fly. There is no vaccine available. Leishmaniasis can present in three forms[7]:

1. Visceral leishmaniasis (kala-azar) is the most severe form of the disease. It results in death up to 95% of the time if untreated.
2. Cutaneous leishmaniasis (Figure 30-12) is the most common form of the disease. It presents with skin lesions that can scar and cause permanent disability.
3. Mucocutaneous leishmaniasis can partially or completely destroy mucous membranes of the mouth, pharynx, and nose.

Signs and symptoms of leishmaniasis include:

- irregular occurrences of fever (visceral),
- weight loss (visceral),
- **splenomegaly** (visceral),
- **hepatomegaly** (visceral),
- skin lesions (cutaneous), and
- severe lesions of the nose or mouth (mucocutaneous).



Figure 30-12. The face of a person with cutaneous leishmaniasis on his left nares. Content provided by CDC/Dr. Mae Melvin. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=15333

Prevention and Personal Protective Measures

Proper wear of the uniform and application of repellents will prevent most infections. Apply permethrin to your uniforms and DEET to your skin. Avoid dogs (and other domesticated animals), especially in areas with sand fly infestation, because dogs are considered to be the primary reservoir for leishmaniasis.

FLEAS

Adult fleas (Figure 30-13) are persistent and painful biters. They are efficient vectors of plague, typhus, and **tularemia**. Fleas become infected by feeding on rodents (eg, chipmunks, rats, and squirrels) and other mammals infected with the disease. Fleas transmit the bacteria to humans when they feed (bite). Plague and typhus have been identified as potential biowarfare agents.

Habitat

Large populations of fleas can usually be found around animal beds, burrows, and nests. Outdoors, fleas are abundant during rainy summers and in high humidity areas.

Diseases Spread by Fleas

Typhus

Typhus is a bacterial infection caused by *Rickettsia typhi* and is transmitted by infected fleas. Infected fleas defecate on a host and the host scratches or rubs the feces into a break in the skin, such as a cut or scrape.

Signs and symptoms of typhus infection usually manifest approximately 14 days after contact with an infected flea, and include:

- fever and chills,
- nausea and vomiting,
- rash (develops around the fifth day of illness), and
- body aches.

Plague

Plague has been a scourge on humanity throughout history. Since Roman times, plague has killed millions of people and greatly reshaped civilizations in its aftermath. In Europe, during the Middle Ages, flea-infested rats entered and inhabited human dwellings, which resulted in millions of people dying after they

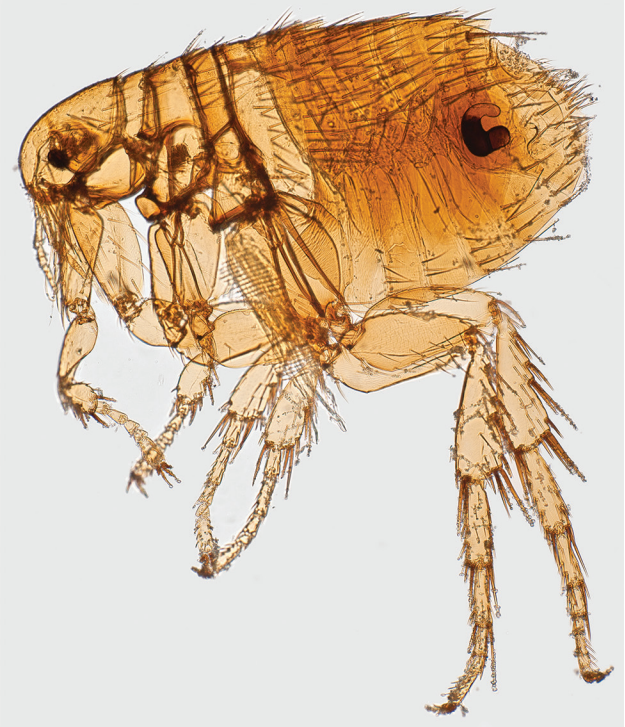


Figure 30-13. The left lateral view of a female Oriental rat flea. Photograph by James Gathany. Content provided by CDC/Ken Gage. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=22259

contracted plague from infected fleas. All mammals are susceptible to infection with the plague bacteria, and disease outbreaks still occur. Rural communities in developing countries are usually most affected by plague, but it is even found in the western United States, where people are occasionally infected.



Figure 30-14. A patient infected with bubonic plague shows symptoms that included a number of swollen inguinal lymph nodes or buboes. Bubonic plague is normally transmitted through the bite of an infected rat flea. Content provided by CDC. Reproduced from Public Health Image Library. https://phil.cdc.gov/details.aspx?pid=2047

When a flea feeds on an animal infected with *Yersinia pestis*, the plague bacteria, it ingests the bacteria along with the host's blood. After several days, the bacteria clumps together and blocks the junction where the flea's esophagus and stomach join. The blockage results in the flea no longer being able to digest the blood, so the flea begins to starve. As starvation sets in, the flea then bites hosts more frequently in an attempt to feed. However, due to the blockage, the blood backflows from the flea's esophagus into the host. This backflow carries the plague bacteria along with the blood and infects the host. Modern antibiotics are effective against plague; however, early treatment is essential.

There are three types of plague infections: bubonic, septicemic, and pneumonic. Signs and symptoms of plague infection are:

- sudden onset of fever and chills,
- headache,
- swollen lymph nodes (Figure 30-14),
- malaise,
- abdominal pain,
- bruising,
- black discoloration of tissues (especially digits or nose),
- pneumonia with difficulty breathing,
- chest pain,
- cough, and
- watery or bloody mucus (occasionally).

Isolate individuals suspected of having plague.

Prevention and Personal Protective Measures

Locating and removing the rodents are the key to eliminating the diseases they carry. Sprays, fogs, powders, poison baits, and traps are useful tools but are successful only when used with pest elimination measures.

Warning: Do not wear flea collars to repel insects. Flea collars are not labeled for human use. Contact with skin may cause severe chemical burns and absorption of toxic levels of insecticide through the skin.

TICKS

Ticks (Figure 30-15) are very efficient disease transmitters. This is because the female tick can pass the pathogen to the egg so that when the larva hatches it is already able to pass on the disease when it eats its first meal. Ticks are important disease vectors in many regions of the United States, Europe, Asia, and Australia.



Figure 30-15. Dorsal view of a tick climbing a blade of grass. Photograph by James Gathany. Content provided by CDC/ Dr. Christopher Paddock. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=10881

Habitat

Ticks and the illnesses they carry are found in all areas of the planet except the coldest regions (eg, Antarctica). Ticks inhabit wooded outdoor areas with tall grass, weeds, underbrush, and shrubs in close proximity to mammal resting places and watering holes. Although ticks are located in almost every region of the planet, they thrive in warm, humid climates.

Diseases Spread by Ticks

Lyme disease

Lyme disease is a bacterial infection that was named in 1977, when arthritis was noticed in a cluster of children in and around Lyme, Connecticut. It occurs in focal areas of North America, Asia, and Europe. Maintain a high index of suspicion when deployed in an area where Lyme disease is endemic.

Note: Lyme disease is the leading cause of vector-borne infectious disease in the United States, causing over 300,000 illnesses per year.[8]

Patients who are infected with Lyme disease often display a distinctive skin lesion in addition to experiencing **systemic** symptoms. The systemic symptoms may manifest in neurologic, orthopedic, and cardiac involvement that occur in combinations over months to years. The illness typically presents in summer and the first symptom most people notice is a red macule or papule that expands slowly in a circular manner, sometimes with a central clearing (Figure 30-16). This distinctive bull's-eye rash is called **erythema migrans**. The causative agent, *Borrelia burgdorferi,* is treated with antibiotics. If untreated, the patient may develop chronic arthritis or neurologic and cardiac problems. Signs and symptoms of Lyme disease include:



Figure 30-16. A patient suffering from Lyme disease. This patient exhibits erythema migrans, a rash that expands over a period of several days and can reach up to 12 inches across. Content provided by CDC. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=14476

- a red, slowly expanding bull's-eye rash, which starts at the bite site and gradually increases over several days up to 12 inches or more in diameter;
- tiredness;
- fever;
- headache;
- stiff neck;
- muscle and joint aches;
- facial palsy (drooping on one side of the face); and
- heart palpitations.

Rocky Mountain Spotted Fever



Figure 30-17. The characteristic spotted rash of Rocky Mountain spotted fever. Content provided by CDC. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=4476

Rocky Mountain spotted fever is one type of illness caused by rickettsial bacteria. This group of bacteria causes several spotted fever illnesses, all of which share similarities in signs and symptoms including:

- rash (a red, non-itchy rash that usually starts at the wrists or ankles and may move to the palms of the hands and the soles of the feet) (Figure 30-17),
- fever,
- headache,
- nausea and vomiting,
- abdominal pain, and
- musculoskeletal pain.

Tularemia

Tularemia is a disease caused by the bacteria *Francisella tularensis*. When there is an outbreak of tularemia in nature, large numbers of mammals such as rodents and rabbits die. Ticks and deer flies help spread this disease. Humans can contract tularemia through vectors such as ticks, by handling infected animals, or as a result of bioterrorism. Tularemia can be fatal if not treated promptly, but it does respond well to antibiotic therapy.

The signs and symptoms of tularemia depend on how the infection occurred. Ulceroglandular (Figure 30-18) or glandular infections are seen in patients



Figure 30-18. A tularemia lesion on the dorsal skin of the right hand, caused by the bacterium *Francisella tularensis*. Content provided by CDC/Dr. Brachman. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=2032

who were bitten by an infected tick or deer fly or who handled an infected animal. Ulcers appear at the site where the bacteria entered the body. Patients with glandular infections do not develop an ulcer. A conjunctival infection occurs when patients rub their eyes after touching an infected animal's body fluids. Patients who eat or drink contaminated food or water develop an oropharyngeal infection, and those who breathe dust or aerosols that contain the bacteria acquire a pneumonic infection. Pneumonic infections are the most life-threatening form of the disease and may result from a biological weapons attack that disperses the pathogen as an aerosol. Signs and symptoms of tularemia may include:

- ulcer (ulceroglandular infection),
- ocular inflammation (conjunctival or oculoglandular infection),
- swollen lymph nodes in front of the ear (ocularglandular infection),
- swollen lymph nodes in back of neck (oropharyngeal infection),
- sore throat (oropharyngeal infection),
- oral ulcers (oropharyngeal infection),
- tonsillitis (oropharyngeal infection),
- difficulty breathing (pneumonic infection),
- chest pain (pneumonic infection), and
- cough (pneumonic infection).

Tick Paralysis

Tick paralysis is a rare disorder caused by toxins in tick saliva. The signs and symptoms of this condition can be confused with other conditions such as **Guillain-Barre syndrome** and **botulism**.[9] The signs and symptoms subside about 24 hours after the tick is found and removed. Signs and symptoms of tick paralysis are:

- **ataxia,**
- difficulty standing,
- absent deep tendon reflexes,
- tachypnea,
- drooling,
- respiratory distress, and
- respiratory failure.

Prevention and Personal Protective Measures

Proper wear of the uniform and application of repellents will prevent most infections. Apply permethrin to your uniforms and DEET to your skin. Search your total body area for ticks daily. Promptly remove any that are found. With gloves on, remove attached ticks by using gentle, steady traction with forceps or tweezers applied close to the skin to avoid leaving mouthparts in the skin. Following tick removal, cleanse the skin site with soap and water. A Lyme disease vaccine is currently not available.

Note: Many diseases are transmitted to humans by tick vectors. The incidence of tick-borne diseases, especially Lyme disease, has been increasing as a result of reforestation and military deployments. Ticks can transmit viruses, bacteria, rickettsia, and parasites.

MITES

Itch Mites

Mites are tiny arthropods that are barely visible to the naked eye. Scabies, a highly contagious infestation in humans, is caused by the itch mite, *Sarcoptes scabiei* (Figure 30-19). Scabies may occur in all populations, but infestations are more common in developing countries. Scabies are most commonly found in skin folds, such as finger and toe webs, axilla, or genital areas and are easily transmitted from person to person through direct contact. They can be treated with ointments and clothes laundering.

Signs and symptoms of scabies are intense itching and a pimple-like skin rash. In rare cases, the skin may become thickly crusted.

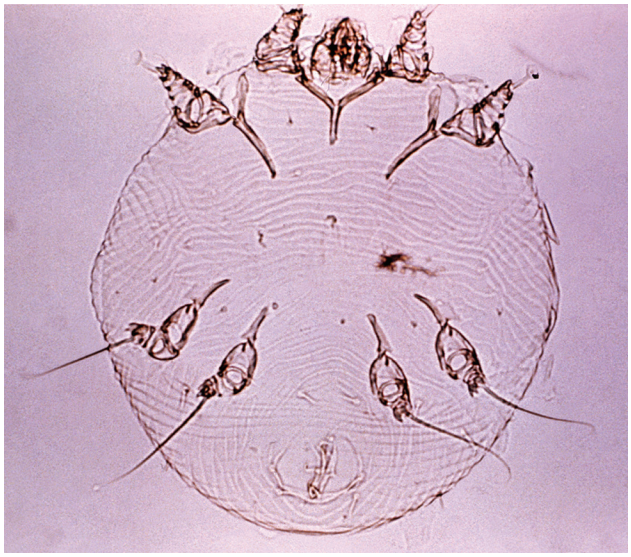


Figure 30-19. An enlarged view of a *Sarcoptes scabiei*, also known as the human itch mite. Photograph courtesy of the World Health Organization. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=6301

Chiggers

Chiggers, also known as redbugs, jiggers, or harvest mites, are the immature stages of a tiny, reddish-orange mite from the family Trombiculidae. They are found in most areas of the world and inhabit areas of tall grass associated with low, wet spots such as ponds and forest underbrush. They attach themselves to clothing and then move to an area of the body to feed. Chiggers do not embed themselves under skin; they inject saliva that helps them feed on host cell fluids (Figure 30-20).

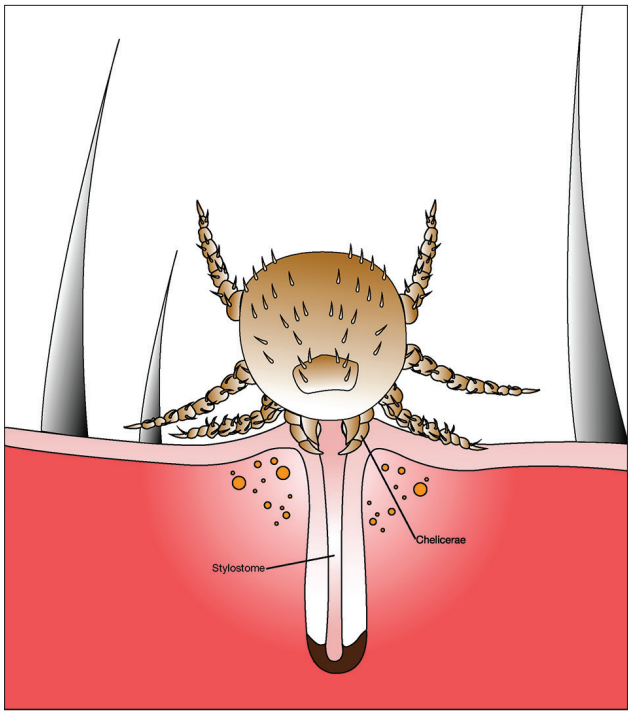


Figure 30-20. This illustration depicts how a chigger (Trombiculidae) feeds. The chigger is an extremely small, reddish-orange insect that uses digestive enzymes to break down skin cells and then feeds on the broken-down skin. Diagram by Bugboy52.40. Adapted from Wikimedia Commons. https://commons.wikimedia.org/wiki/File:File-Chigger_bite.svg

Signs and symptoms of chigger bites are intense itching with small welts over the bite area, caused by a host immune response to chigger saliva. Bites may itch for up to 2 weeks after the chigger has finished feeding and dislodged from the host.

Prevention and Personal Protective Measures

Preventive measures for scabies mites include personal cleanliness (frequent hand washing and bathing) and avoidance of potentially infested persons.

For chiggers, proper uniform wear and application of repellents will prevent most bites and subsequent infections. Apply permethrin to your uniforms and DEET to your skin.

LOUSE-BORNE ILLNESS

Head, Body, and Pubic Lice

Throughout history, louse-borne diseases have been a threat to fighting forces.[2] Soldiers during Napoleon's



Figure 30-21. A body louse, *Pediculus humanus corporis*. Content provider CDC/Joe Miller. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=5461

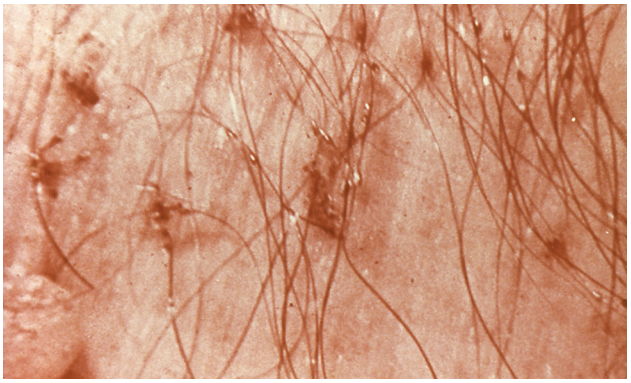


Figure 30-22. A close view of a patient's skin, infested with *Pthirus pubis* (crab lice). Content provided by CDC. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=4078

invasion of Russia were plagued so badly by body lice that it was common for them to strip and burn their uniforms just to watch the lice explode.[2] Three species of lice are of military importance: the body louse (*Pediculus humanus corporis*) (Figure 30-21), the head louse (*Pediculus humanus capitis*), and the crab louse (*Pthirus pubis*) (Figure 30-22). Anyone may become infested when exposed. Lice are easily transmitted from person to person through direct contact.

Head louse infestations are frequently found in schools and institutions. Crab lice are spread through sexual contact. Body louse infestations can be found among people living in crowded, unsanitary conditions where clothing changes and laundering are infrequent. Soldiers who do not practice good personal hygiene can become infested with lice and pass them on to other soldiers when they come in contact with their hair, clothing, sleeping bags, or linens.

Diseases Spread by Lice

Epidemic Louse-Borne Typhus

Epidemic louse-borne typhus is a bacterial disease that is transmitted from one person to another when human body lice feed on one person who is infected with typhus, and then transfer to another person. While feeding on the second person, transmission of the bacteria occurs when lice are crushed or when their feces are rubbed into the bite wound.

The signs and symptoms of epidemic louse-borne typhus are the same as for flea-borne typhus (Figure 30-23). Some people can have a relapse in disease months or years after the initial infection.



Figure 30-23. A patient exhibiting a torso rash caused by epidemic louse-borne typhus. Content provided by CDC/Dr. D.S. Martin. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=18838

Prevention and Personal Protective Measures

Prevention and personal protective measures include:

- good personal hygiene,
- regular changing of clothes,
- effective laundry procedures, and
- no sharing of clothing or bedding.

SCORPIONS AND SPIDERS

Scorpions

Scorpions are members of the class Arachnida (related to spiders, ticks, and mites). Scorpions have



Figure 30-24. The dorsal view of a highly toxic black scorpion. Content provided by CDC/World Health Organization. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=6295



Figure 30-25 A dorsal view of a brown recluse spider. Note the distinct characteristic violin-shaped mark on its dorsal cephalothorax. Content provided by CDC/Margaret Parsons. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=1125

eight legs and a small pair of claws (Figure 30-24). A scorpion's stinger is at the end of its long tail. Out of the nearly 650 species of scorpions in the world, stings of only about 25 can be fatal to humans. In the United States, only one can kill people and it is found in the Sonoran Desert. Most are relatively harmless, producing only localized sting reactions. The initial sting is very painful with little or no swelling or redness. Soldiers stung by scorpions must be evaluated by an MO to determine the risk of a potentially severe reaction to the sting. Ice application may relieve localized pain.

Brown Recluse Spiders

The brown recluse spider (Figure 30-25) is a highly venomous spider that is identified by the distinct violin-shaped area on its back. These spiders are found in midwestern and southern states of the United States, usually in woodpiles, garages, and other dark places. Brown recluse spiders have very small fangs and normally can bite only if the spider's body is pushed against a human's skin (eg, when the spider is trapped in clothing). The brown recluse spider bite may feel insignificant; however, the **venom** is hemotoxic and may cause a necrotizing ulcer (local tissue destruction) that requires medical treatment and may take over a month to heal. Pain at the site begins 1 to 4 hours after the bite and a pustule may grow and form a crater over 3 to 4 days. Healing is slow. The patient may have a low-grade fever, myalgia (muscle pain), nausea, and vomiting. Treatment is usually supportive but includes evaluation by an MO. Ice and elevation may help with localized pain. Verify tetanus vaccine status and update as needed. Provide antibiotics if a secondary infection occurs. Occasionally, surgical excision of the ulcerated area is needed.



Figure 30-26. A female black widow spider. Note the characteristic red hourglass located on the inferior abdominal surface. Content provided by CDC/James Gathany. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=20260

Black Widow Spiders

The female black widow is a highly venomous spider that is shiny black in color, with a distinct red hourglass marking on her abdomen (Figure 30-26). The bite is often unnoticed at first, but symptoms of **envenomation** occur within 10 to 60 minutes, including severe pain in the bite site and muscle spasms of the abdomen and trunk. Headache, nausea, and vom-

iting may occur. Symptoms may last 24 to 36 hours. Death is rare, but the populations at greatest risk are the very young and the very old. Treatment includes evaluation by an MO and analgesics. Evacuate to a treatment facility that can observe the casualty for 12 to 24 hours. Antivenom is rarely needed but may be ordered by an MO.

Snakes

Snake bites require special care but are usually not life threatening. Every person reacts differently, so consider all snake bites to be from a venomous snake. In the United States there are two groups of poisonous snakes—the pit vipers (including rattlesnakes, copperheads, and water moccasins) and coral snakes (Figures 30-27 to 30-30).

Signs and symptoms of a snakebite vary depending on the type of snake involved, and may include:

- noticeable bite or scratch on the skin (there may be only one fang mark);
- pain and progressive swelling in the bite area, sometimes requiring a surgical release of tissue pressure;
- rapid pulse and labored breathing;
- nausea and vomiting;
- progressive weakness to unconsciousness, and
- anaphylaxis.



Figure 30-28. A juvenile venomous copperhead snake. Photograph by James Gathany. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=22499



Figure 30-27. A timber rattlesnake, which is found throughout large portions of eastern and central North America. Photograph by Edward J. Wozniak, DVM, PhD. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=8162



Figure 30-29. A dorsal view of a water moccasin (cottonmouth). Photograph by Michael Smith. Content provided by CDC/Edward J. Wozniak DVM, PhD, Michael Smith. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=8124



Figure 30-30. A venomous coral snake. Note the color banding on the snake's body. Red on yellow banding is a distinguishing feature of a coral snake. Content provided by CDC/Edward J. Wozniak DVM, PhD. Reproduced from Public Health Image Library. https://phil.cdc.gov/Details.aspx?pid=8141

Caution: Surgical release of tissue pressure is NOT in the 68W's scope of practice.

Prevention of Snakebites

Every soldier should be aware of the venomous snakes in their area of operation and avoid their habitats when possible. When in snake habitat, always look before sitting or placing your hands on the ground, logs, rocks, or other surfaces. Always check tree branches as well, since many snakes are good climbers. Be cautious around natural bodies of water. Do not attempt to move or pick up snakes, even if they are dead or appear dead; this results in many unnecessary bites.

Field Treatment of Snakebites

The field treatment of snakebites includes the following:

- Conduct initial assessment and management of the airway, breathing, and circulation.
- Monitor for an allergic reaction or anaphylaxis.
- Provide oxygen, if available.
- Gain intravenous (IV) access in all snakebite victims (in an unaffected extremity).
- Remove watches and jewelry from the affected extremity.
- Keep the casualty as calm and inactive as possible to slow down the absorption of venom.
- Gently clean around the snakebite to remove any venom from the skin.
- Consider immobilizing and splinting the affected limb.
- Evacuate the casualty to the nearest treatment facility (tetanus prophylaxis status must be assessed).

Warning: When treating a snakebite, DO NOT delay treatment in an attempt to capture the snake. DO NOT cut into the bite site and attempt to suction the venom from the site. DO NOT place ice on the bite site. DO NOT touch the head of the dead snake, which may still contain venom and have a bite reflex. DO NOT transport a live snake with the casualty.

If possible, safely bring the dead snake to the treatment facility with the patient for identification.

Check on Learning

1. Malaria must always be considered in what group of individuals?
2. The most effective means of malaria control is avoiding mosquito bites. How is prevention implemented?
3. How is the impact of filth flies and cockroaches mitigated?
4. How is the impact of sandflies mitigated?
5. What should you do if you find a tick on yourself or a battle buddy?
6. Which arthropod could be used as a biological warfare agent?
7. What is the field treatment for a snakebite?

WEATHER-RELATED INJURIES

Risk Factors Influencing Weather-Related Injuries

Weather-related injuries are influenced by the following risk factors:

- Age—the very young and very old are more susceptible to environmental injuries.
- General health and fitness—poor health increases susceptibility.
- Fatigue—makes individuals more lax in taking proper precautions.

- Predisposing medical conditions—atherosclerosis, hypovolemia, diabetes, alcohol abuse, previous weather related injury, etc.
- Medications—peripheral vasodilator medications cause vessels to dilate and the body to lose more heat. **Diuretics** cause more fluid to be excreted, making dehydration more common. Nicotine causes peripheral vasoconstriction, which decreases circulation to the extremities. **Antihistamines** impair the body's ability to sweat and dissipate heat.
- Lack of acclimatization—individuals need about 2 weeks to become fully acclimatized to the heat. During periods of sudden temperature change, treat everyone as nonacclimatized.

Mechanisms of Heat Loss

Heat can be lost through the following mechanisms:

- Conduction—heat transfer between substances due to temperature differences.
- Convection—heat transfer through gas or liquid by circulated heat particles.
- Evaporation—heat loss at the surface from vaporization of liquid, eg, sweating (Figure 30-31).
- Radiation—energy in the form of heat radiates in waves through the air or other media (eg, water).
- Respiration—heat leaves the body through each breath.



Figure 30-31. Steam rising from Army Sergeant Jacob Cardenas after removing his body armor at the completion of a 10-mile road march. Photograph by Master Sergeant Michel Sauret. Reproduced from the Department of Defense Photo Gallery. https://media.defense.gov/2018/Apr/29/2001909901/-1/-1/0/180417-A-TI382-1069A.jpg

Environmental Factors Influencing Weather-Related Injuries

Climate, season, and weather are all factors that make you more susceptible to weather-related injuries. The cool, damp seasons of fall and winter cause more cold weather injuries than the warm seasons of spring or summer. High ambient temperature reduces your body's ability to lose heat by radiation. High relative humidity reduces your body's ability to lose heat through evaporation. Precipitation and wind chill also influence an individual's susceptibility to injury.

Atmospheric (barometric) pressure influences conditions that contribute to weather-related injuries. Atmospheric pressure is the pressure exerted by the weight of the air. The more dense the air pressure, the warmer the temperature. An increase in altitude decreases pressure, which also results in a decrease in temperature.

Mountain tops and high ridges have reduced atmospheric pressure due to their elevations and are subjected to higher wind velocities. Cooler temperatures and an increase in wind velocity results in colder weather and a possible increase in cold weather injuries. Other terrain features also affect risk of weather injuries. Valleys or depressions are lower in elevation, which results in higher atmospheric pressure and higher temperatures. There will also be less wind. Increased vegetation and higher land mass in the surrounding terrain partially obstructs wind currents. Desert areas (whether at high or low elevations) tend to have more wind and drastic temperature changes, which can result in an increase in weather-related injuries.

Heat Injuries

Types of Heat Injuries

There are three types of heat injury: heat cramps, heat exhaustion, and heatstroke. Heat cramps are muscle cramps or spasms of the voluntary muscles caused by depletion in the body's water and salt (dehydration). Heat exhaustion is a systemic reaction to prolonged heat exposure and is due to excessive fluid loss and electrolyte (sodium) depletion. Figure 30-32 shows soldiers performing common activities that may increase their risk of heat injury.

Caution: DO NOT ELIMINATE HEAT EXHAUSTION AS A POSSIBLE DIAGNOSIS. Heat cramps and heat exhaustion may coexist. Heat cramps usually occur in individuals with heat exhaustion who are not acclimatized to a hot environment.



Figure 30-32. Soldiers participating in the Bataan Memorial March in Iraq in 2009. Photograph by Sergeant Eric Jungels. Reproduced from the Department of Defense Photo Gallery. https://media.defense.gov/2009/May/11/2001096023/-1/-1/0/703252-C-XRW09-636.jpg

Heatstroke is caused by failure of the temperature-regulating system in the brain. Heatstroke usually involves excessive exposure to strenuous physical activity under hot conditions; however, elderly or chronically ill patients may develop heatstroke without strenuous physical activity. An altered mental status is the defining sign of this condition.

Warning: HEATSTROKE IS A MEDICAL EMERGENCY. If treatment is delayed, mortality rates may be as high as 70%.[10]

Signs and Symptoms of Heat Injuries

Signs and symptoms of a heat injury include the following:

- Painful spasms of skeletal muscles, including muscles of the extremities (arms and legs) and the abdomen. The muscles involved are generally the larger muscle groups. The muscles feel tight and hard when palpated.
- Dehydration. The body loses too much fluid, salt, and minerals. When individuals engage in any strenuous exercises or activities, an excessive amount of fluid and salt is lost through sweat. Dehydration is as prevalent in cold regions as in hot regions.
- Skin that is moist, pale to normal, and cool indicates a less serious condition. Skin that is hot, red, and dry or moist indicates a serious condition.
- Core temperature (the body's central temperature) is normal or elevated. To measure core temperature accurately, you must obtain rectal temperature readings.
- Headache, often with weakness, fatigue, thirst, dizziness, and confusion. The casualty may feel better when lying down but may become lightheaded when attempting to stand or sit (orthostatic hypotension).
- Loss of appetite, nausea, and sometimes vomiting.
- Respirations and pulse rate may be rapid, and the pulse may feel "thready" at the radial artery. Systolic blood pressure may be normal or slightly decreased.
- Dark urine.
- Altered mental status—a sign of heatstroke.
- Seizure activity may be present.

Warning: Remember—heatstroke is a medical emergency that often results in death if treatment is delayed. Suspect heatstroke in any casualty who is warm to the touch and with an altered level of consciousness and treat immediately.

Treatment for Heat Injuries

The first step in treating a heat injury is to remove the casualty from the environment. The longer a casualty remains with an elevated temperature, the more destructive and deadly the condition becomes. Provide rapid, active cooling by removing the individual's clothing, misting the casualty with water and fanning them (to promote evaporation), applying moist wraps, and immersing the individual in cool water, if available. Apply ice packs or sheets to the neck, groin, and axilla. Gently stretch the casualty's cramped muscles.

Caution: Do not lower core temperature below 102 °F. Temperature will continue to drop after removal from water. Prompt evaporative cooling is preferred; however, be aware of potential complications such as shivering (which will increase the core temperature).



Figure 30-33. Initial Entry Training soldier Private Second Class Hannah Murray drinking water during 68W10 Field Craft Training at the Department of Combat Medic Training.

A casualty who is alert and able to swallow, has a present radial pulse, and is not nauseated may be allowed to drink fluids by mouth (Figure 30-33). Withholding fluids from combat casualties that meet the above criteria is not recommended. Even if the casualty requires surgery (including penetrating torso trauma), the factors of transport delays and preexisting dehydration present during combat operations greatly exacerbate dehydration and reduce the chance of survival. Risk of emesis and aspiration in these combat casualties is low. If you have a casualty with an altered mental status, administer a 500 mL bolus of lactated Ringer solution by IV. If IV attempts fail, do not attempt intraosseous (IO) access. Immediately evacuate the casualty to be evaluated by an MO.

Note: Salt use is discouraged because the osmotic fluid shift can cause vomiting and damage to the stomach lining.

COLD WEATHER INJURIES

Nonfreezing Injuries

Nonfreezing injuries are commonly encountered when soldiers are operating in cold, wet, and windy environments. The following are types of nonfreezing injuries that can be encountered:

- hypothermia,
- chilblains,
- immersion syndrome (paddy foot),
- snow blindness, and
- dehydration.

Hypothermia

Hypothermia is a systemic cold injury. It generally occurs from prolonged exposure to low temperatures, often above freezing, or from immersion in cold water. Wet, cold, and windy conditions represent the greatest threats. There are three degrees of hypothermia:

- mild hypothermia—core body temperature ranges between 94 and 97 °F,
- moderate hypothermia—core body temperature ranges between 86 and 93 °F, and
- severe hypothermia—core body temperature of 85 °F or lower.

Note: During assessment, obtain an accurate core temperature through rectal measurement.

The signs and symptoms vary depending on the level of hypothermia and include:

- conscious (with no altered mental status) to unconscious;
- shivering, poor muscle coordination to rigid muscles;
- weak to absent pulse; and
- pale, cold to ice-cold skin.

Note: Unresponsive, hypothermic casualties require airway protection. At a minimum, insert an oropharyngeal airway or nasopharyngeal airway. If required, initiate ventilations with a bag valve mask. Intermediate airways (eg, i-gel [Intersurgical Ltd; East Syracuse, NY]) may be considered.

Treatment begins with preventing further heat loss. Move the casualty to a warm environment and remove wet clothing. Handle the casualty gently; a cold heart is more prone to ventricular fibrillation if the patient is handled roughly. If ventricular fibrillation occurs and the tactical environment allows, initiate cardiopulmonary resuscitation with an automated external defibrillator. Assess and manage the casualty's airway, breathing, and circulation.

Rewarm the body evenly with a heat source. Begin rewarming passively, in a dry sleeping bag. If possible, give heated and humidified air with any device available. Confine active rewarming to the trunk. Give warm liquids and do not further agitate or excessively handle the casualty. If the casualty's level of consciousness is altered, anticipate hypoglycemia. Provide warm, high-calorie, or glucose fluids orally. If necessary and available, provide a 500 to 1,000 mL bolus of D5W (5% dextrose in water IV solution) warmed to 109 °F. If D5W is not available, any crystalloid solution is satisfactory. Ensure the solution does not freeze during administration. Evacuate the casualty to the nearest medical treatment facility as soon as possible. Continuously monitor the casualty's vital signs and level of consciousness while in route.

Warning: Rewarming the extremities before the core can result in acidosis and/or hyperkalemia (excessive potassium) and actually LOWER the core temperature.

Chilblains

Chilblains (Figure 30-34) are caused by repeated or prolonged exposure of bare skin in damp, nonfreezing temperatures. Chilblains are most common in cold and damp climates. The signs and symptoms may include the following:

- redness or cyanosis of affected areas;
- blue-red patches on the lower extremities, face, hands, and feet;
- hot, tender, itching skin;
- subcutaneous nodules; and
- ulcerated or bleeding lesions (with chronic repeated episodes).

Caution: Do not rub, apply direct heat (heating pads, heaters), or ice to tissue suffering from chilblain.

Treatment begins by warming and drying the injured body part. Place the injured body part in contact with a warm object, such as a rescuer's hands or the casualty's body. Instruct the casualty to cross their arms and place their hands under their armpits. Elevate the affected body part. Protect the rewarmed injury from further cold exposure or trauma. Evacuate the casualty to the nearest medical treatment facility as soon as possible.



Figure 30-34. Chilblains caused by excessive icing of the feet. Photograph by James Heilman, MD. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Chilblains_from_excessively_icing_the_feet.jpg

Immersion Syndrome

Note: Trench foot occurred frequently during WWI. Soldiers stood in cold, wet, muddy trenches for extended periods of time awaiting movement orders. During the Vietnam War, soldiers were faced with similar environmental conditions. Paddy foot frequently occurred secondary to wet feet (service members walking through canals and rice paddies), even though the temperatures were higher.

Immersion syndrome (also called immersion foot, trench foot, or paddy foot) is an injury that results from prolonged exposure of the feet to cool or cold water or mud. Inactive feet in damp or wet socks and boots or in tightly laced boots that impair circulation are highly susceptible to injury (Figure 30-35).

The signs and symptoms include the following:

- Early stages (first phase). The affected area is cold, pale, numb, and tingling. Pulses are diminished or absent. This phase develops slowly over hours or days.
- Later stages (advanced phase). The casualty will complain of limbs feeling hot and burning, with shooting pains. The affected area is pale and there may be blisters, swelling, redness, and ulcerations. Anesthesia (numbness) may persist for weeks, along with hyperhidrosis (excessive sweating) and cold sensitivity. Infection and gangrene are complications of very severe cases.

Treatment for immersion syndrome is the same as the treatment for chilblains. To prevent immersion syndrome, soldiers should keep their feet warm and dry and change their socks several times each day. Ensure boots fit well and that soldiers never sleep in wet socks and boots.



Figure 30-35. A person displaying a mild case of immersion syndrome (trench foot). Photograph by Mehmet Karatay. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Trench_foot.jpg



Figure 30-36. This photograph is of an Inuit (tribe of indigenous people who inhabit the arctic regions of Alaska, Canada, and Greenland) man wearing snow goggles to prevent snow blindness. Photograph by Julian Idrobo, Winnipeg, Canada. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Inuit_snow_goggles.jpg

Snow Blindness

Snow blindness is a burn to the eye from ultraviolet radiation. The resulting cornea damage is similar to a welding flash burn. Snow blindness is more likely to occur in hazy or cloudy weather than in sunny weather. Signs and symptoms of developing snow blindness are:

- eye pain,
- scratchy feeling in the eyes as if irritated by sand or dirt,
- watery eyes,
- burning sensation in eyes, and
- photophobia**.**

Snow blindness can be avoided simply by wearing sunglasses or glasses with **photochromic** lenses that block 100% of ultraviolet rays. Figure 30-36 shows a type of snow goggles traditionally used by people who live in the arctic. Treatment for snow blindness includes a visual acuity test, covering the eyes with dark cloth, and evacuation. Consider the tactical environment before covering the eyes of the casualty.

Dehydration

In cold weather, it is extremely difficult to realize that dehydration is occurring. Sweat evaporates more quickly in cold environments than in warmer environments. Because evaporation is quicker, soldiers don't see a buildup of sweat on their skin or clothing and don't realize that they are becoming dehydrated.

Freezing Injuries

Frostbite

Frostbite is the freezing of body tissue, caused by exposure to very cold temperatures. Frostbite usually occurs when temperatures drop below 32 °F; however, other factors such as wind chill, duration of exposure, and inadequacy of protection can facilitate freezing even if the temperature is slightly higher than 32 °F. The body parts most easily frostbitten are the cheeks, nose, ears, chin, forehead, wrists, hands, and feet. Figures 30-37 to 30-39 show a frostbite injury over time. The signs and symptoms below are listed in the order in which they would appear with increased exposure and time:

- loss of sensation or numb feeling in any part of the body;
- sudden whitening of the skin in the affected area followed by a momentary tingling feeling;
- redness of skin in light-skinned soldiers, grayish coloring in dark-skinned soldiers;
- blisters with clear fluid (a less severe injury);
- hemorrhagic blisters (a deeper, more severe injury);
- swelling or tender areas;
- loss of previous feeling of pain in the affected area;
- pale, yellowish, waxy-looking skin; and
- frozen area feels solid or wooden to the touch.

Warning: DO NOT attempt to thaw the casualty's feet or other seriously frozen areas if the casualty will be required to walk or travel to receive further treatment. Thawing in the field increases the possibilities of infection, gangrene, or other injury. Avoid creating a "freeze-thaw-refreeze" situation.

Note: It usually takes 24 to 48 hours after warming to determine the extent of injury.



Figure 30-37. Frostbite of the toes on Mount Logan climber. Photograph by Dr S. Falz. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Frost_bite.jpg



Figure 30-38. Frostbitten foot of Mount Logan climber 12 days after freezing. Photograph by Dr S. Falz. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Human_toes,_12_days_post-frostbite.jpg



Figure 30-39. Frostbitten foot of Mount Logan climber 3 weeks after freezing. Photograph by Dr S. Falz. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Human_toes,_3_weeks_post-frostbite.jpg

Treatment for frostbite begins with warming the area by placing an affected appendage on a battle buddy's abdomen or under arms and applying firm, steady pressure. The battle buddy's body heat will start to thaw the frostbitten appendage. For frostbite of the face, ears, and nose, cover the area with the casualty's or battle buddy's hands until sensation and color return. Cover the casualty with a blanket or other dry material. Loosen or remove tight clothing, watches, and jewelry. Evacuate the casualty. Pain medication may be required.

Warning: DO NOT—

- soak the frostbitten part in water,
- rub the affected area with snow,
- expose the affected area to any extreme heat source,
- rub or move the part in any way to increase circulation,
- allow the casualty to smoke or drink alcohol, or
- expose the frozen part to an open fire.

Prevention of Heat and Cold Injuries

The wet bulb globe temperature (**WBGT**) index is used to determine the heat condition. Use of mission oriented protective posture (**MOPP)** (Figure 30-40) or body armor (Figure 30-41) increases the WBGT by about 10 °F. In an environment where ballistic protective gear (body armor) or MOPP gear is worn, heat stress is an important consideration. Even in environments with moderate and relatively comfortable temperatures, MOPP gear can increase temperatures to the most severe and debilitating level of heat stress. It is important that soldiers operating in MOPP gear maintain adequate water consumption and follow strictly monitored work-rest cycles. These actions reduce heat injuries and help maintain personnel effectiveness. When soldiers are working, regardless of the environment, leadership must implement guidance outlined in Training and Doctrine Command Regulation 350-29 for work-rest cycles and water consumption. When to drink is as important as how much. If a soldier waits until they are thirsty to consume water, they have waited too long. Avoid alcohol consumption prior to and during hot or cold weather missions.

Drinking fluids isn't the only way your body obtains water. Food contains water too, so soldiers should eat regular meals. Usually, eating field rations or liberally salting garrison food will provide enough salt to replace what is lost through sweating. Additionally, more calories are required in cold weather to continue to generate sufficient body heat.



Figure 30-40. Army National Guard soldier Private First Class Christopher Lopez decontaminating military vehicle in MOPP 4. Photograph by Specialist Cody Kilduff. Reproduced from Defense Visual Information Distribution Service. https://www.dvidshub.net/image/4471267/chemical-decontamination-site



Figure 30-41. Soldier trying on body armor at Fort Bliss, Texas. Photograph by Sergeant First Class Gary Witte. Reproduced from Defense Visual Information Distribution Service. https://www.dvidshub.net/image/2429066/checking-fit

Increase water consumption when wearing certain or additional clothing or equipment (eg, body armor and MOPP gear). Soldiers are more likely to drink if the fluid's temperature is opposite of the environment where they are working. Provide warm fluids in cold environments and cool fluids in hot environments. Field rations, such as Meals Ready to Eat (MREs), contain electrolyte replacement solutions to supplement the flavor of water and aid with hydration.

Note: The maximum recommended daily intake of water is 12 quarts (11.4 L).

Appropriate dress can help soldiers avoid hot and cold weather injury. The mnemonic **COLD.** may be helpful when selecting clothing: **C**lean, don't **O**verdress, **L**oose and in **L**ayers, **D**ry. Military units should allow 2 weeks for soldiers to become acclimatized to hot environments. During acclimation, progressively increase the workload during the second week. During periods of sudden temperature change, treat all soldiers as acclimatized. Heat effects build up during the day and over several days; this is known as a "cumulative effect." Recovery is slow, even after temperatures have decreased. Follow the highest heat category reached for the remainder of the day. Restrict or modify strenuous physical activities during high heat-stress conditions if the combat situation permits. Have soldiers take breaks in the shade and drink water. Provide rewarming tents. Consider carbon monoxide precautions when soldiers are sleeping in tents and vehicles. Plan for the weather. In hot environments, perform heavy work earlier in the day when the temperature is cooler. In cold weather, plan to be outside when the sun is up. Use the buddy system to look out for fellow soldiers.

Altitude Injuries

Some syndromes can develop in unacclimatized persons shortly after ascent to high altitude (Figure 30-42). Altitude injuries usually begin around 10,000 feet, but may occur as low as 6,500 feet. There is no reliable way to identify soldiers who have difficulty with altitude acclimatization except by their previous experience with altitude exposure.

Types of Altitude Injuries

Acute Mountain Sickness

Acute mountain sickness is the most common altitude disorder. It is a syndrome in an unacclimatized person above 6,500 feet altitude who has a headache and one of the following:

- anorexia (decreased appetite),
- nausea and vomiting,
- lethargy,
- dizziness or lightheadedness, and
- altered mental status (the cause is unclear).



Figure 30-42. A UH-60 Black Hawk helicopter flying over the Bamyan river valley. This photograph shows the extreme altitude differences that US service members are operating in in Afghanistan. Photograph by Sergeant Ken Scar, 7th Mobile Public Affairs Detachment. Reproduced from Defense Visual Information Distribution Service. https://www.dvidshub.net/image/614493/bamyan-province-emerges-model-afghanistans-potential

Treatment for acute mountain sickness is administering oxygen by nasal cannula at 1 to 2 L per minute, descending 1,700 to 3,300 feet, and remaining at the descent altitude until symptoms resolve.

High Altitude Cerebral Edema

High altitude cerebral edema (**HACE**) is a potentially fatal condition in which a soldier experiences acute brain swelling after ascending too rapidly. Hypoxia increases vasodilation in blood vessels. This vasodilation causes an increase in blood flow to the brain. Simultaneously, there is an increase in the permeability of the cerebral capillary beds, resulting in more cerebral edema. This condition usually develops at altitudes above 8,000 feet. The signs and symptoms of HACE are:

- altered mental status for 24 hours or more,
- ataxic gait, and
- severe fatigue.

Treatment for HACE is immediate descent of 3,300 feet or more. Administer oxygen at 1 to 2 L per minute to achieve and maintain pulse oximetry readings of at least 90%.

High Altitude Pulmonary Edema

High altitude pulmonary edema (**HAPE**) is pulmonary edema (fluid in the alveoli) in an unacclimatized individual after a rapid ascent to high altitude. It can be rapidly fatal and is the most common cause of death due to altitude illness. After ascent to 10,000 to 12,000 feet (rarely as low as 8,000 feet) without proper acclimatization, the casualty's alveolar membranes become leaky and fluid starts filling the alveoli, decreasing alveolar surface area to conduct gas exchange. Signs and symptoms of HAPE are:

- dyspnea, even at rest;
- rales;
- tachypnea;
- tachycardia;
- cyanosis; and
- decreased oxygen saturation.

Treatment for HAPE is immediate evacuation and descent of 1,700 to 3,300 feet. Administer oxygen at 4 to 6 L per minute to achieve and maintain pulse oximetry readings of at least 90%.

Note: There does not seem to be any way to speed acclimatization; some soldiers acclimatize more rapidly than others, and a few soldiers may not acclimatize at all.

Management of Altitude Injuries

Prevent injury through acclimatization (the process whereby the body gradually adapts to the climate and environment). For acute mountain sickness, stop the ascent until symptoms resolve, then resume ascent following a stepped and staged plan. For HACE and HAPE, affected individuals require immediate descent with minimal casualty exertion, and evacuation. Provide oxygen, if available (high-flow oxygen therapy is not required). Refer to an MO for evaluation.

Acclimatization

Altitude disorders can be prevented by proper acclimatization. This allows soldiers to achieve the maximum physical work performance possible for the altitude at which they are employed. Once acquired, acclimatization is maintained as long as the soldier remains at that altitude but is lost upon return to lower elevations. The two types of acclimatization are staged ascent and graded ascent. The most effective acclimatization is a combination of the two.

Staged ascent requires soldiers to ascend to a moderate altitude and remain there for 3 days or more to acclimatize before ascending higher. When possible, soldiers should make several stops for staging during the ascent to allow a greater degree of acclimatization.

Graded ascent limits the daily altitude gain to allow partial acclimatization. The altitude at which soldiers sleep is the critical element. Having soldiers spend two nights at 9,000 feet and limiting the sleeping altitude to no more than 1,000 feet per day above the previous night's sleep altitude will reduce altitude illnesses.

Check on Learning

8. At what altitude should you begin assessing your fellow soldiers for altitude injuries?
9. You are in the mountains of Afghanistan on a patrol. A fellow soldier begins to show signs of an altitude injury. What should be done immediately?
10. What is the most effective type of acclimatization?

SUMMARY

As a combat medic, you will live and work in the same environment as the soldiers for whom you provide medical care. Your knowledge of how environmental factors can decimate combat effectiveness of a unit, and the actions that can preserve combat effectiveness are paramount during military operations. Many environmental threats ranging from disease vectors, venomous or nuisance arthropods and animals, heat and cold exposure, and high altitude can adversely affect an army's ability to fight and win. Prevention, mitigation, and treatment can have direct influence on victory on the battlefield.

KEY TERMS AND ACRONYMS

Antihistamines. An agent that opposes the action of histamine on H1 receptors.
Arthropod. One of a large group of invertebrate animals that includes ticks, spiders, mites, and other insects as well as crustaceans such as shrimp, lobster, and crabs.
Ataxia. Defective muscular coordination.
Botulism. A paralytic and occasionally fatal illness caused by exposure to toxins released from *Clostridium botulinum*, an anaerobic, gram-positive bacillus.
Chemoprophylaxis. The use of a drug or chemical to prevent a disease.
Chloroquine. A white, crystalline powder used to treat both malaria and amoebic dysentery.
Cholera. An acute bacterial infection, caused by *Vibrio cholera.* It involves the entire small intestine and is marked by profuse, watery, secretory diarrhea.
COLD. An acronym that helps soldiers remember how to appropriately dress in cold climates to prevent cold weather injuries. The acronym represents "clean, don't overdress, loose and in layers, dry."
DEET. N,N-diethyl-m-toluamide, a potent, broad spectrum insect repellent that is approved for use by the DOD.
Diuretics. An agent that increases urine output.
DNBI. Disease and nonbattle injury.
Dysentery. Diarrhea containing blood and mucus, resulting from inflammation of the walls of the gastrointestinal tract.
Encephalitis. An inflammation of the white and gray matter of the brain, mostly caused by a viral infection.
Encephalitides. Plural of encephalitis.
Envenomation. The poisonous effects of the bites or stings of arthropods or snakes.
Erythema migrans. A red, expanding lesion seen at the bite site of a tick infected with Lyme disease.
Guillain-Barre syndrome. A rare neurologic condition named after French neurologist Georges Guillain, which results in ascending paralysis.
HACE. High altitude cerebral edema. A potentially fatal condition in which the soldier experiences acute brain swelling due to too rapid ascent in altitude.
HAPE. High altitude pulmonary edema. Pulmonary edema (fluid in the alveoli) in an unacclimatized individual after a rapid ascent to high altitude.
Hemolysis. Destruction or disruption of red blood cells, resulting in the release of hemoglobin.
Hepatomegaly. Enlargement of the liver.
Inoculation. To spread a disease by inserting its etiologic agent.
Malaise. A feeling of discomfort, weakness, and fatigue due to an illness.
Malaria. A febrile hemolytic disease caused by protozoa of the genus *Plasmodium*.
MOPP. Mission oriented protective posture.
Pathogen. A microorganism capable of producing disease.
Permethrin. An insecticide and insect repellent.
Photochromic. Lenses that appear almost clear when indoors and darken when exposed to sunlight. Also known as light-adaptive lenses.
Photophobia. An extreme sensitivity to light.
Plague. Any widespread contagious disease associated with a high mortality rate. However, plague typically refers to the disease caused by the pathogen, *Yersinia pestis*.
Regurgitation. When the vector vomits the pathogen into the host while it feeds on the host.
Splenomegaly. Enlargement of the spleen.
Tularemia. A tick-borne infectious disease that is caused by *Francisella tularensis* bacteria.
Typhoid. Referring to typhus.
Typhus. A bacterial infection caused by *Rickettsia typhi*.
Vector. An arthropod that transports a disease-causing organism, or pathogen, from one host to another.
Venom. A toxin produced by some animals, such as scorpions, spiders, and snakes.
WBGT. Wet bulb globe temperature.
WNV. West Nile virus.
Yellow fever. A viral disease that is transmitted by mosquitoes in the genus *Aedes*.

CHECK ON LEARNING ANSWERS

1. Malaria must always be considered in what group of individuals?

   Any soldier with an unexplained febrile illness who had been recently deployed or is currently deployed in a malaria risk country.

2. The most effective means of malaria control is avoiding mosquito bites. How is prevention implemented?

   Insect bars (bed nets), properly fitted and worn clothing, chemical repellents, and eliminating mosquito larval habitats.

3. How is the impact of filth flies and cockroaches mitigated?

   Locating and removing the habitats and food sources; field latrines and soakage pits should be constructed, used, maintained, and closed to reduce fly breeding; sprays; fogs; and sticky traps.

4. How is the impact of sandflies mitigated?

   Proper wear of the uniform and application of repellents will prevent most infections. Avoid dogs and other domesticated animals.

5. What should you do if you find a tick on yourself or a battle buddy?

   With gloves on, remove any attached ticks by using gentle, steady traction with forceps or tweezers applied close to the skin to avoid leaving mouthparts in the skin. Following removal, cleanse the skin site with soap and water.

6. Which arthropods could be used as a biowarfare agent?

   Fleas.

7. What is the field treatment for a snake bite?

   Look for an allergic reaction. Provide oxygen, if available. Gain IV access in all snakebite victims (in the unaffected extremity). Remove watches and jewelry. Keep the casualty as calm and inactive as possible. Gently clean the bite site. Consider immobilization. Evacuate.

8. At what altitude should you begin assessing your fellow soldiers for altitude injuries?

   Altitude injuries usually begin around 10,000 feet, but may occur at 6,500 feet.

9. You are in the mountains of Afghanistan on a patrol. A fellow soldier begins to show signs of an altitude injury. What should be done immediately?

   Stop ascent.

10. What is the most effective type of acclimatization?

    A combination of staged ascent and graded ascent.

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Abbreviations and Acronyms

A
A&O×4. Alert and oriented to person, place, time, and event
ACE. Ask, care, and escort; ammunition, casualties, and equipment (report)
AED. Automatic external defibrillator
APEL. Authorized protective eyewear
AVPU. Alert, verbal, pain, unresponsive
AXP. Ambulance exchange point

B
BAS. Battalion aid station

C
CASEVAC. Casualty evacuation
CCP. Casualty collection point
CDC. Centers for Disease Control and Prevention
COLD. Clean, don't Overdress, Loose and Layers, Dry
CSF. Cerebrospinal fluid
CT. Computed tomography
CWMP. Combat wound medication pack

D
DA. Department of the Army
DCAP-BTLS. Deformities, contusions, abrasions, punctures/penetrations, burns, tenderness, lacerations, and swelling
DD. Department of Defense
DEET. N,N-diethyl-m-toluamide
DNBI. Disease and non-battle injury
DOB. Date of birth
DOD. Department of Defense

E
EPW. Enemy prisoner of war

G
GCS. Glasgow Coma Scale

H
HABC. Hemorrhage, airway, breathing, and circulation
HACE. High altitude cerebral edema
HAPE. High altitude pulmonary embolism
HDNF. Headache, dizziness, nausea, and fogginess
Hx. History

I
IAW. In accordance with
ICP. Intracranial pressure
ICRC. International Committee of the Red Cross
ID. Identification; intradermal
IED. Improvised explosive device
IO. Intraosseous
IV. Intravenous

L
LLQ. Left lower quadrant
LOC. Level of consciousness
LUQ. Left upper quadrant

M
MACE 2. Military Acute Concussion Evaluation 2
MACP. Mortuary affairs collection point
MARCH. Massive hemorrhage, airway, respirations, circulation, and hypothermia or head injury
MASCAL. Mass casualty
MEDEVAC. Medical evacuation
MO. Medical officer
MOI. Mechanism of injury
MOPP. Mission oriented protective posture
MRAP. Mine-resistant ambush protected
MREs. Meals Ready to Eat
MRI. Magnetic resonance imaging
MTF. Military Treatment Facility

N
NCO. Noncommissioned officer
NPA. Nasopharyngeal airway
NSAID. Nonsteroidal anti-inflammatory drug
NVGs. Night vision goggles

O
OD. Oculus dexter (right eye)
OEF. Operation Enduring Freedom
OIF. Operation Iraqi Freedom
OPA. Oropharyngeal airway
OPLAN. Operation plan
OPQRST. Onset, provoking or palliative factors, quality, radiation or region, severity, and timing; used to obtain patient history information
OPSEC. Operational security
OS. Oculus sinister (left eye)
OU. Oculus uterque (both eyes)

P
PMI. Patient movement items
PMS. Pulse, motor, and sensory
POI. Point of injury
POWs. Prisoners of war
PPE. Personal protective equipment
PRA. Progressive return to activity

R
RLQ. Right lower quadrant
RUQ. Right upper quadrant

S
SAM. Structural aluminum, malleable
START. Simple triage and rapid treatment

T
TBI. Traumatic brain injury
TBSA. Total body surface area
TCCC. Tactical combat casualty care
TIC. Tenderness, instability, and crepitus
TRADOC. Training and Doctrine Command
TSOP. Tactical standard operating procedures

U
UCMJ. Uniform Code of Military Justice

V
VMS. Visual motion sensitivity
VOMS. Vestibular/ocular-motor screening
VOR. Vestibular-ocular reflex

W
WBGT. Wet bulb globe thermometer
WNV. West Nile virus

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Amphastar Pharmaceuticals, Inc,
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