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

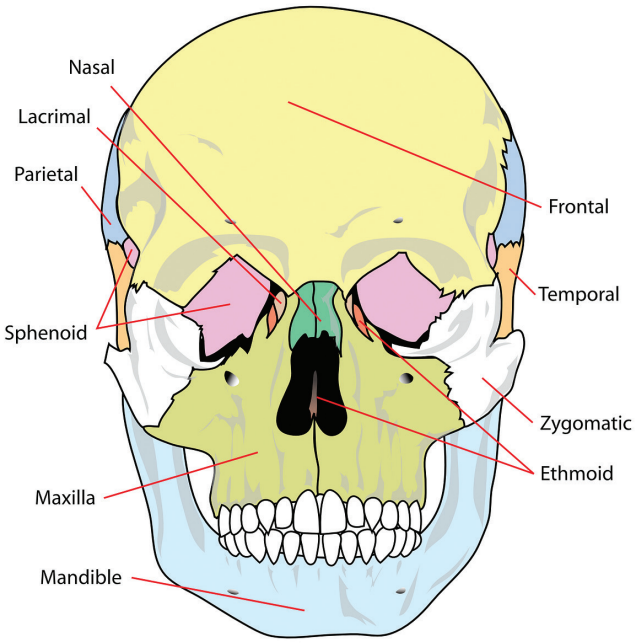


Figure 22-1. The bones of the skull. Reproduced from pixabay.com. https://pixabay.com/vectors/skull-diagram-labelled-human-41552/

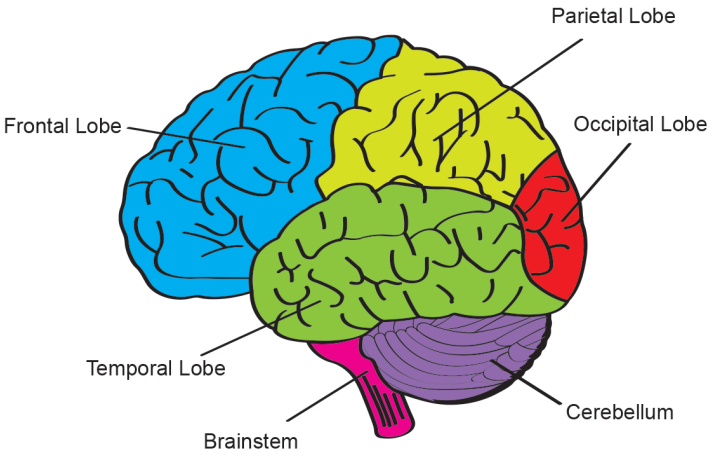


Figure 22-2. Basic brain anatomy.

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).

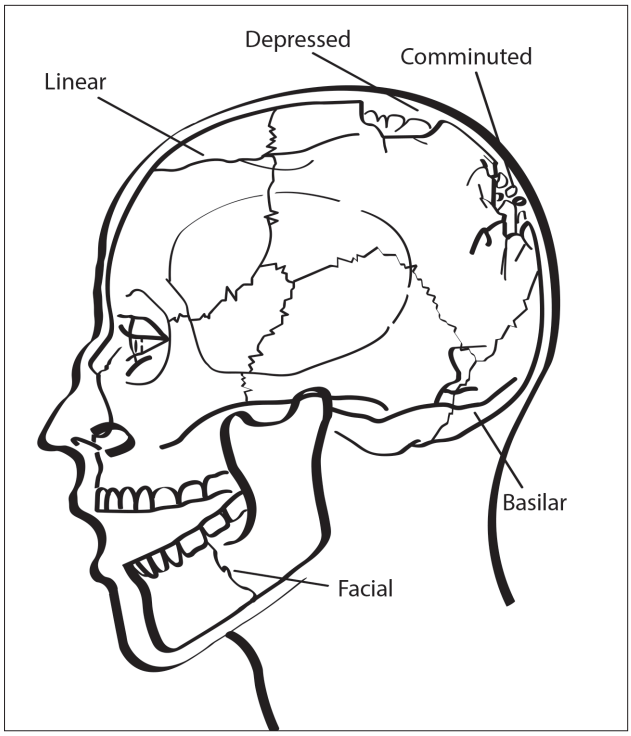


Figure 22-3. Types of skull fractures.

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.

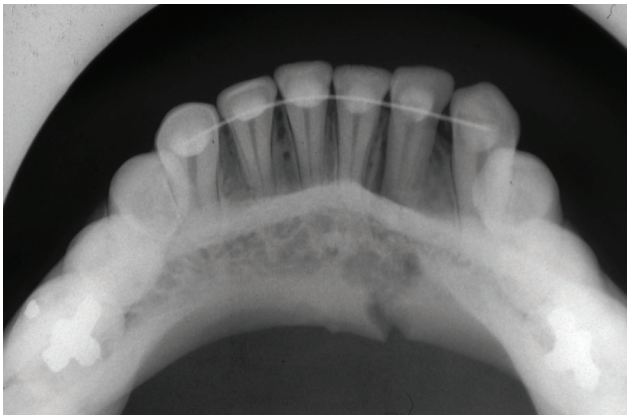


Figure 22-4. Mandible fracture. Occlusal radiograph of a mandibular parasymphysis fracture. Image by Coronation Dental Specialty Group. Reproduced from Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Occlusal_view_symphsis_fracture.jpg

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.

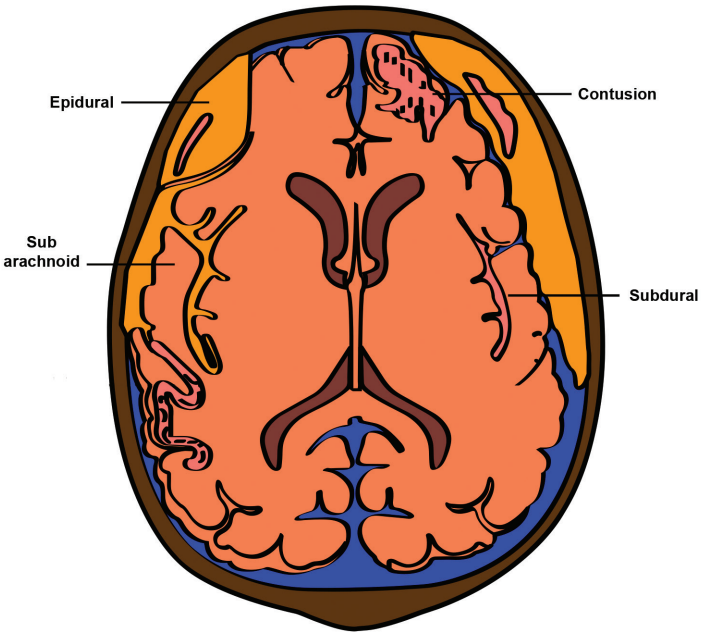


Figure 22-5. Types of severe TBI: intracranial hemorrhage and cerebral contusion.

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.

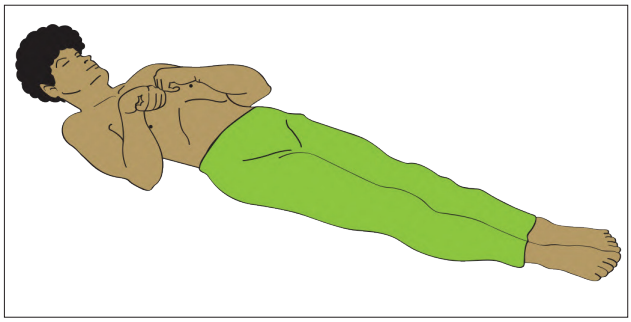


Figure 22-7. Decorticate posturing.

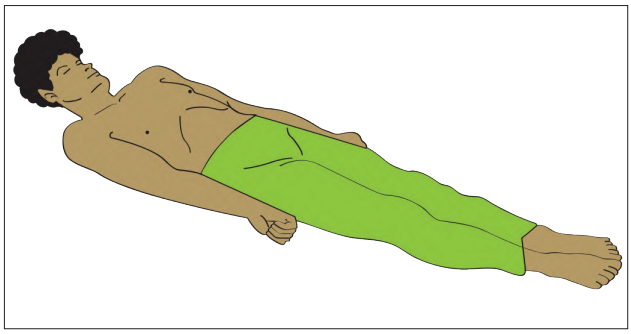


Figure 22-8. Decerebrate posturing.

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

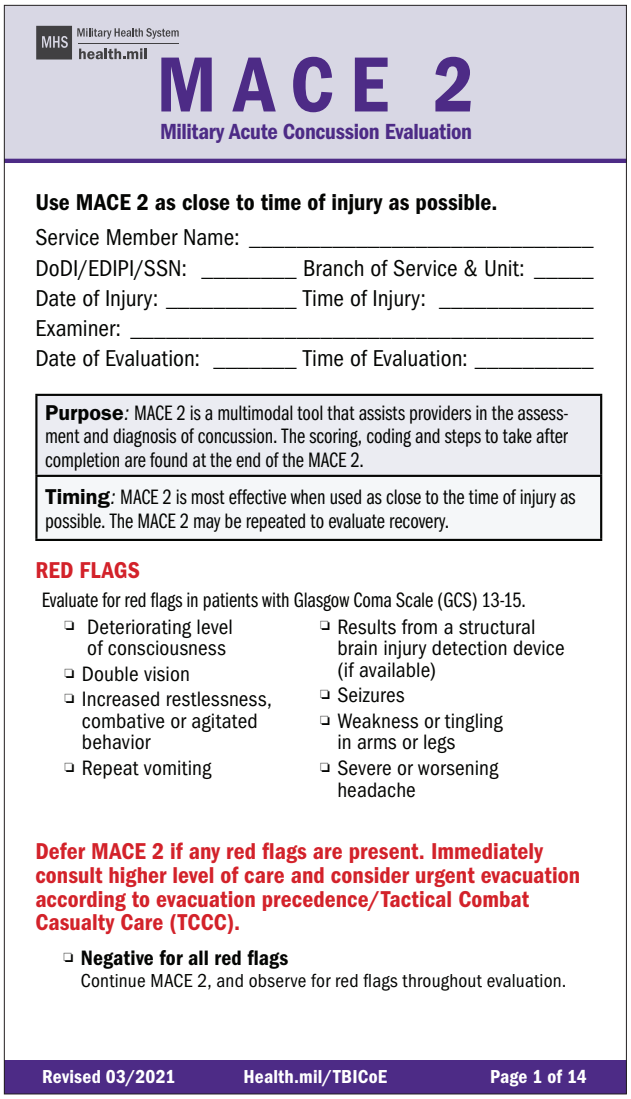
The card starts with a short administrative data portion and some usage information, followed by the RED FLAGS section (Figure 22-9). RED FLAGS will be the first critical evaluation in patients with a GCS score of 13 to 15. Use the checklist on the card to determine presence or absence of RED FLAGS.

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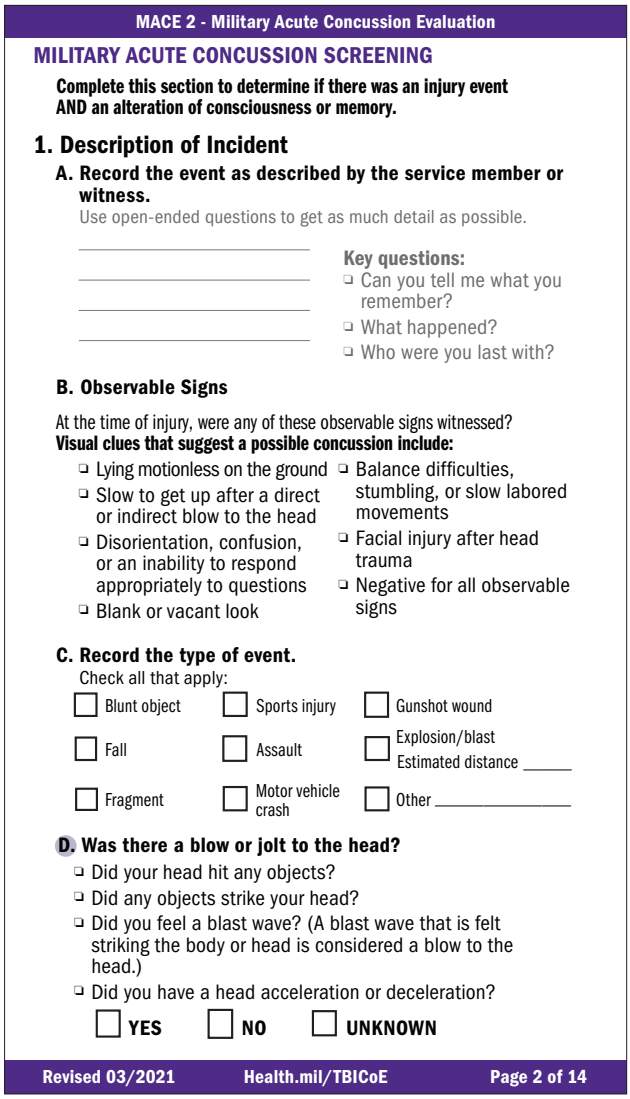
Figure 22-9. Military Acute Concussion Evaluation II, page 1.

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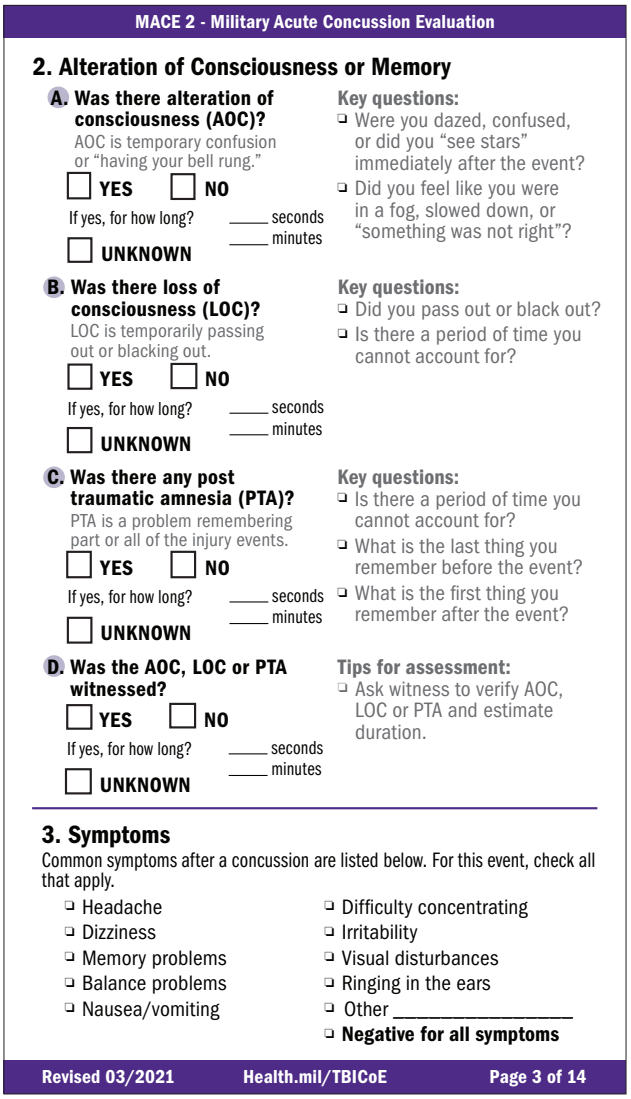
Figure 22-10. Military Acute Concussion Evaluation II, page 2.



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.

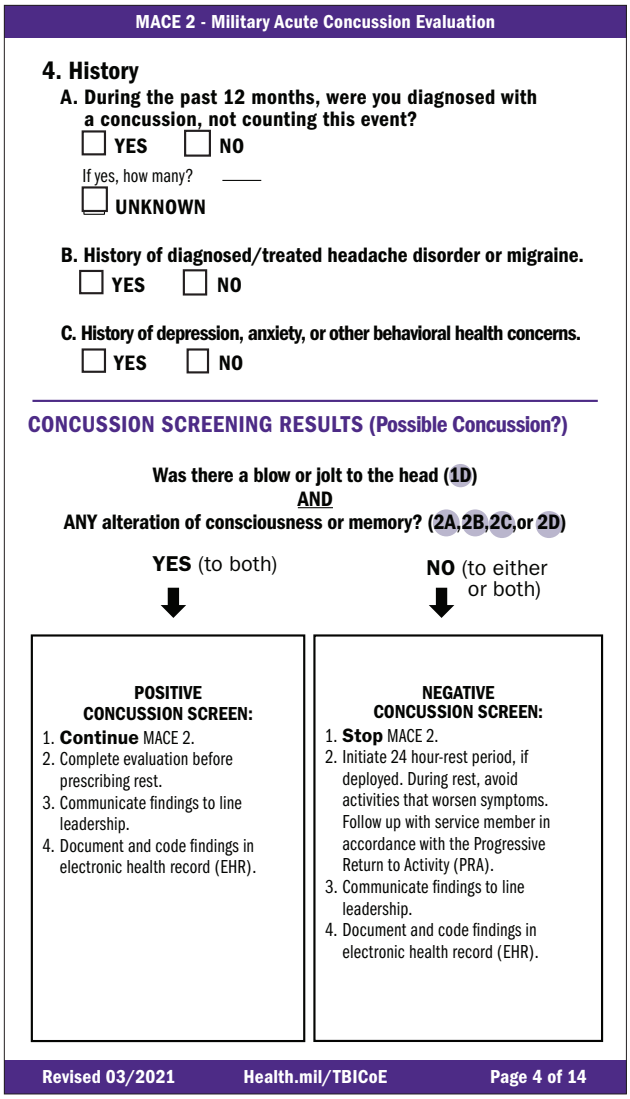
another type of event that is not listed, check the "other" box and write it in on the line. Part 1, section D, should be answered by the casualty. Ask if there was a blow or jolt to the casualty's head. If yes, use the checklist to gather more details about the blow. If the casualty does not know, mark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

NO (to either or 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).

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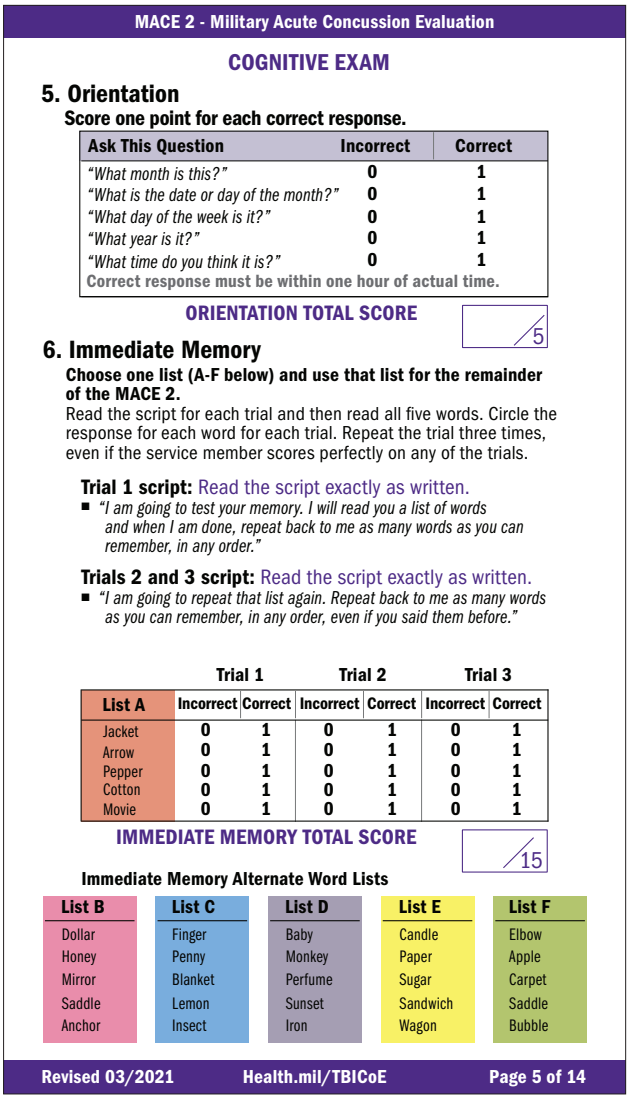
Figure 22-12. Military Acute Concussion Evaluation II, page 4.



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.

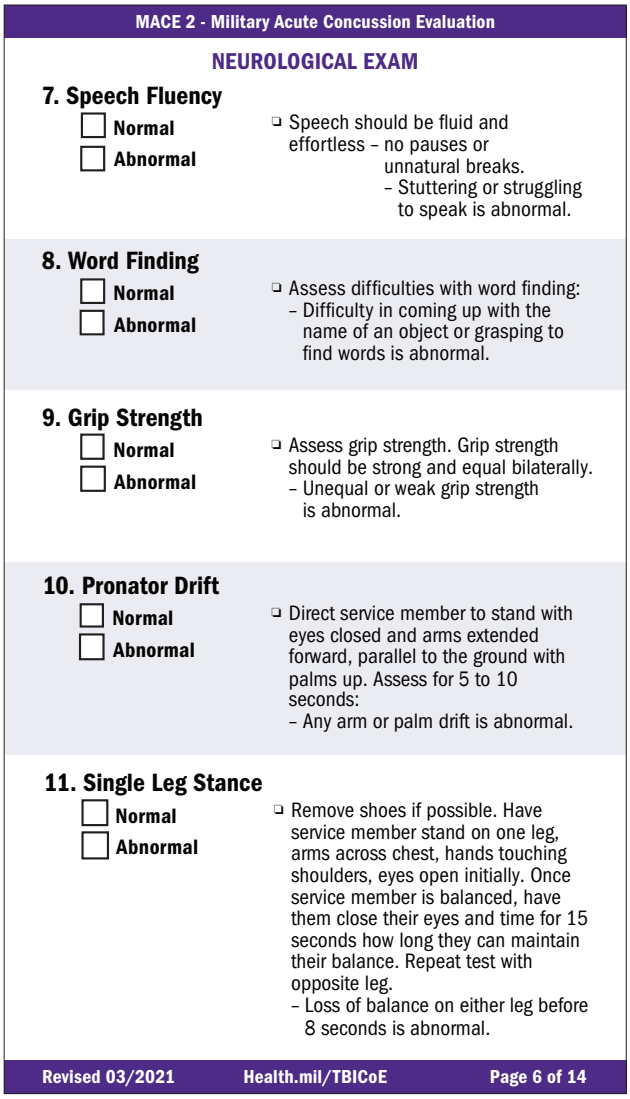
considered positive for concussion. Continue MACE 2 and follow the instructions in the left (positive) results box. If there was *neither* a blow or jolt to the head *nor* an alteration of consciousness, the concussion result is negative. If the casualty either has a blow or jolt to the head or alteration 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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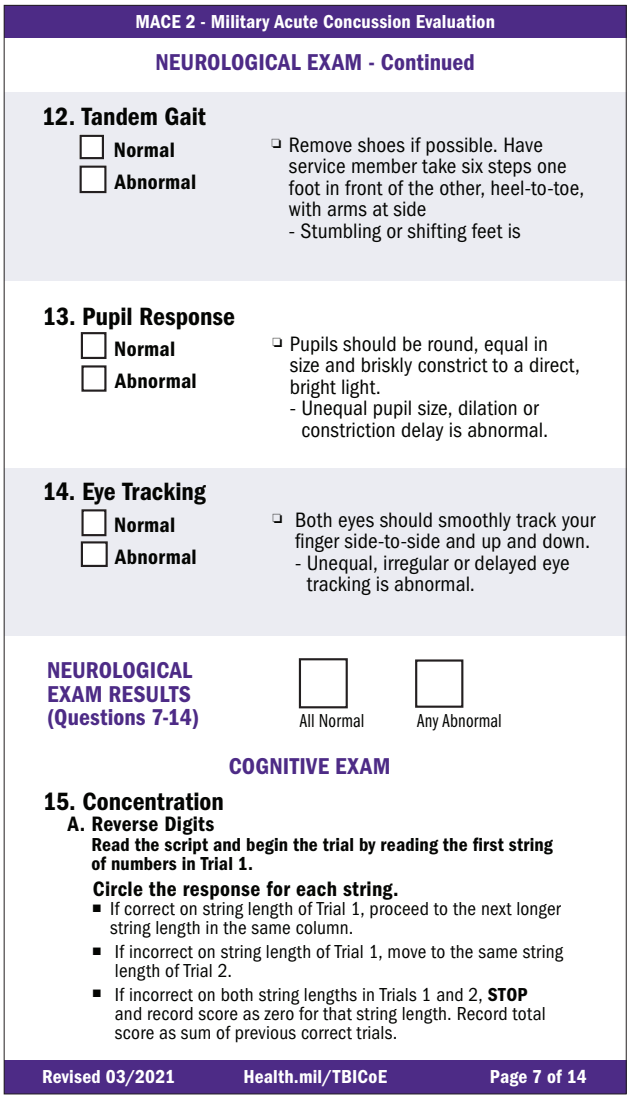
Figure 22-14. Military Acute Concussion Evaluation II, page 6.



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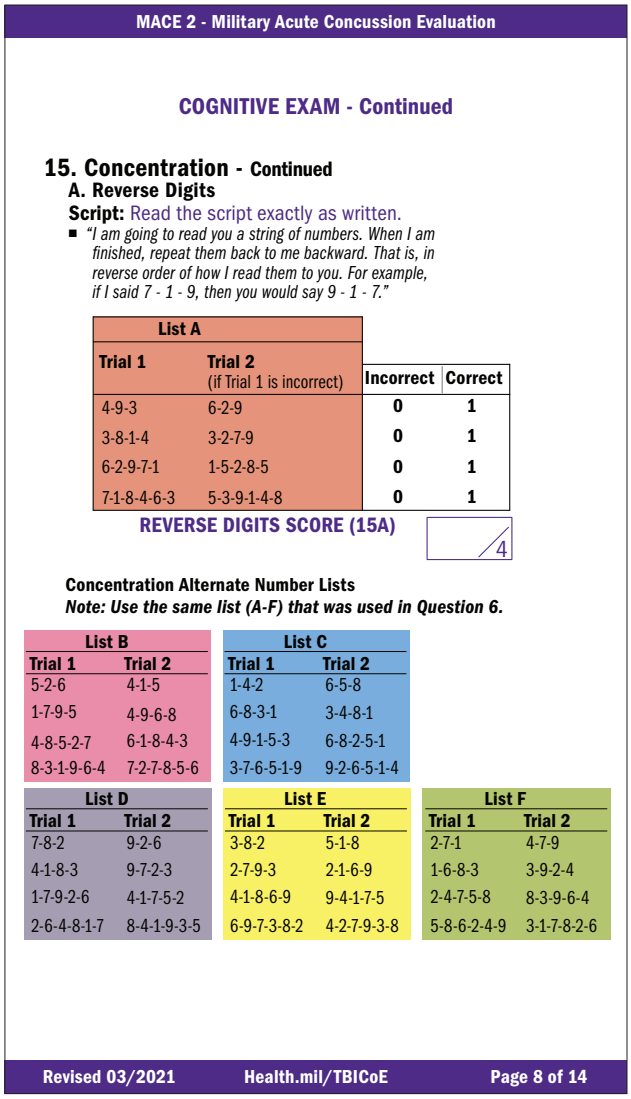
Figure 22-15. Military Acute Concussion Evaluation II, page 7.

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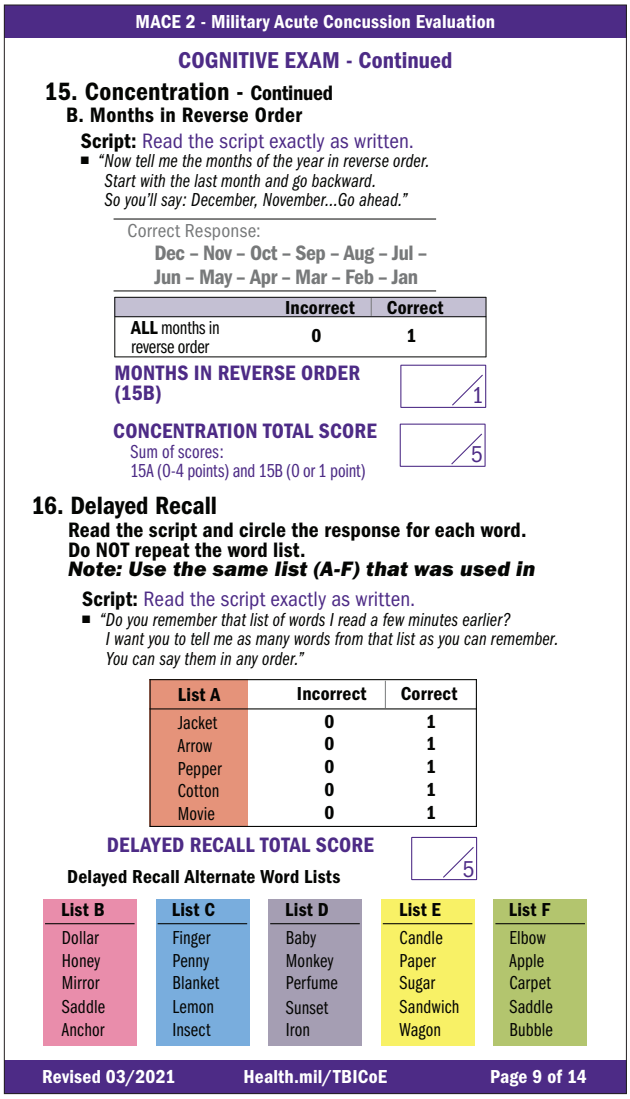
Figure 22-16. Military Acute Concussion Evaluation II, page 8.



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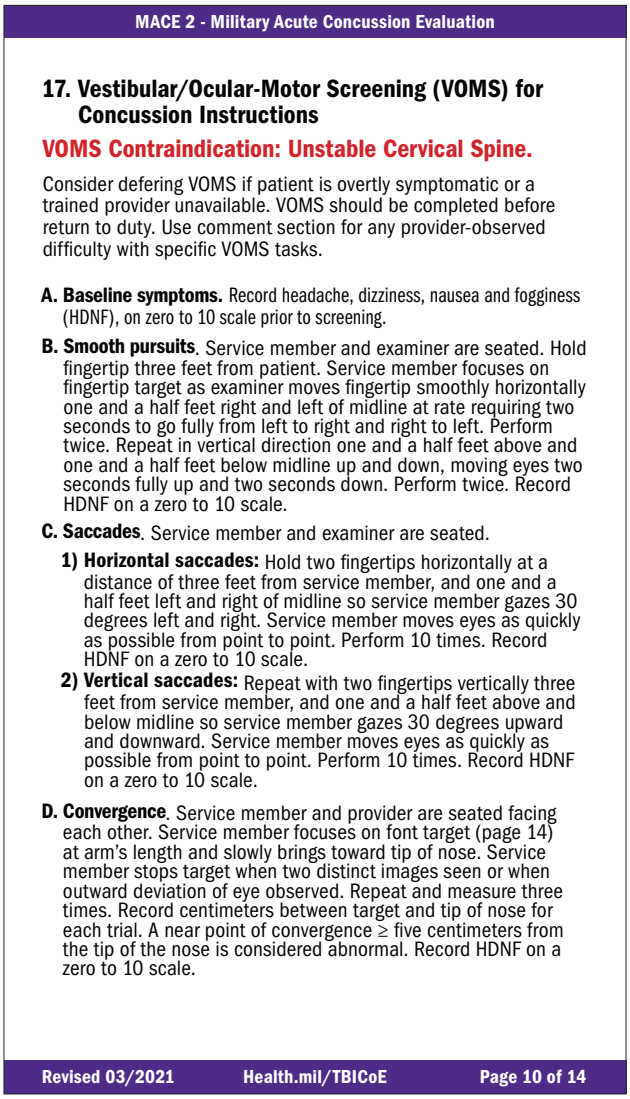
Figure 22-17. Military Acute Concussion Evaluation II, page 9.

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).

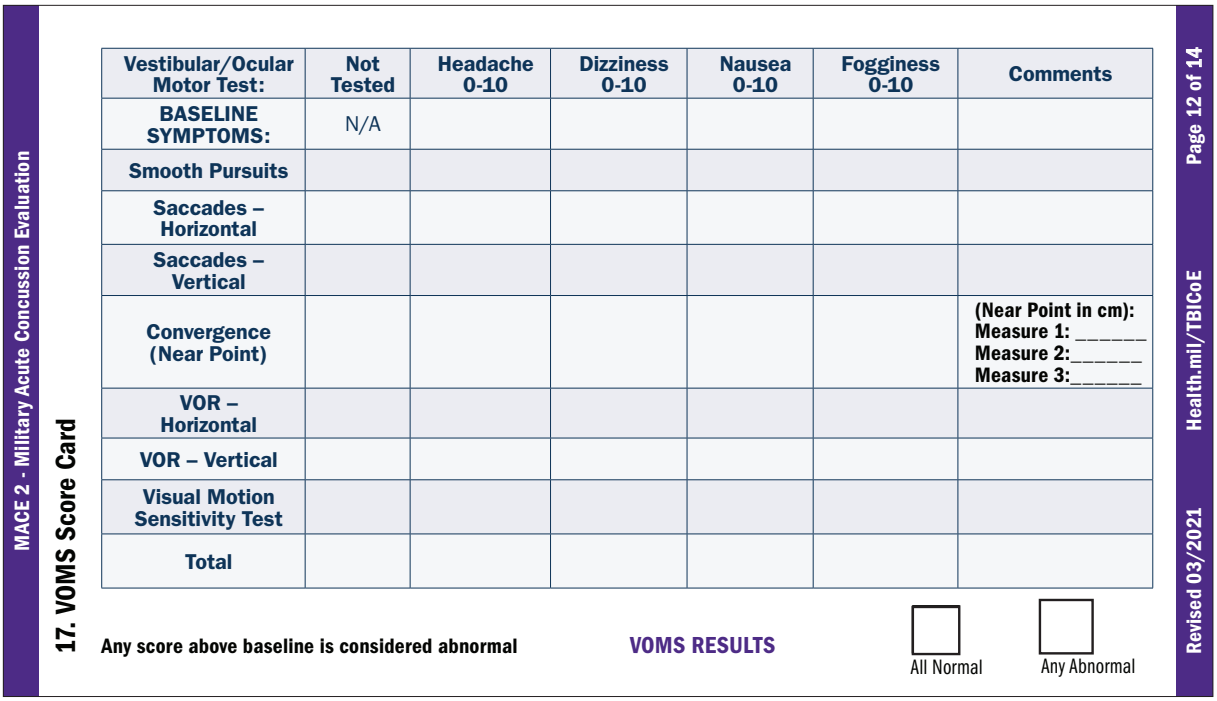
The remainder of the VOMS test will comprise assessment and recording of HDNF on the VOMS scorecard after the casualty performs specified tasks. The number of times the casualty is required to perform a test before HDNF assessment is completed varies, so be sure to follow the instructions carefully. 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

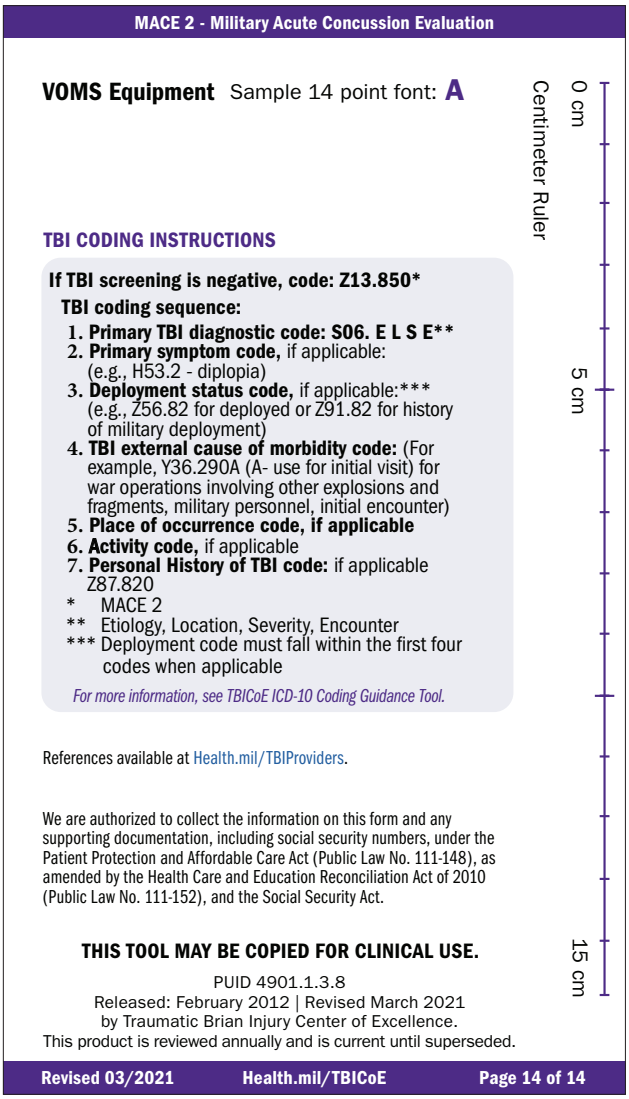
The concussion screening results can be used to determine whether further evaluation for TBI is indicated. Based on the casualty's signs and symptoms, the screening results will help medical providers determine if evacuation to a higher level of care is necessary.

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.

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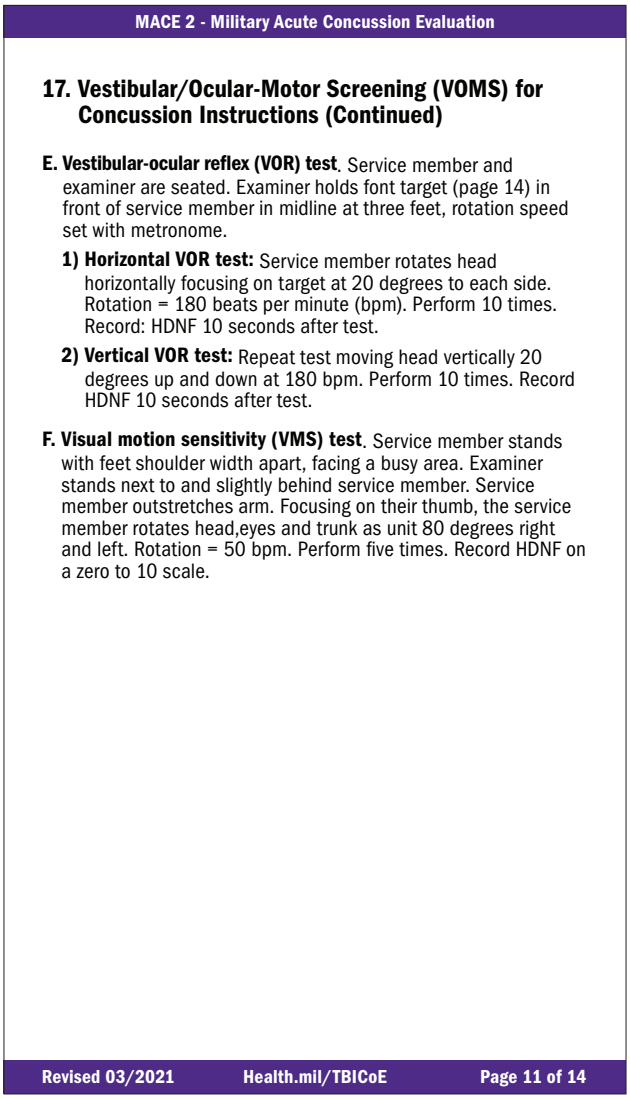
Figure 22-20. Military Acute Concussion Evaluation II, page 14.



MACE 2 - Military Acute Concussion Evaluation

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.

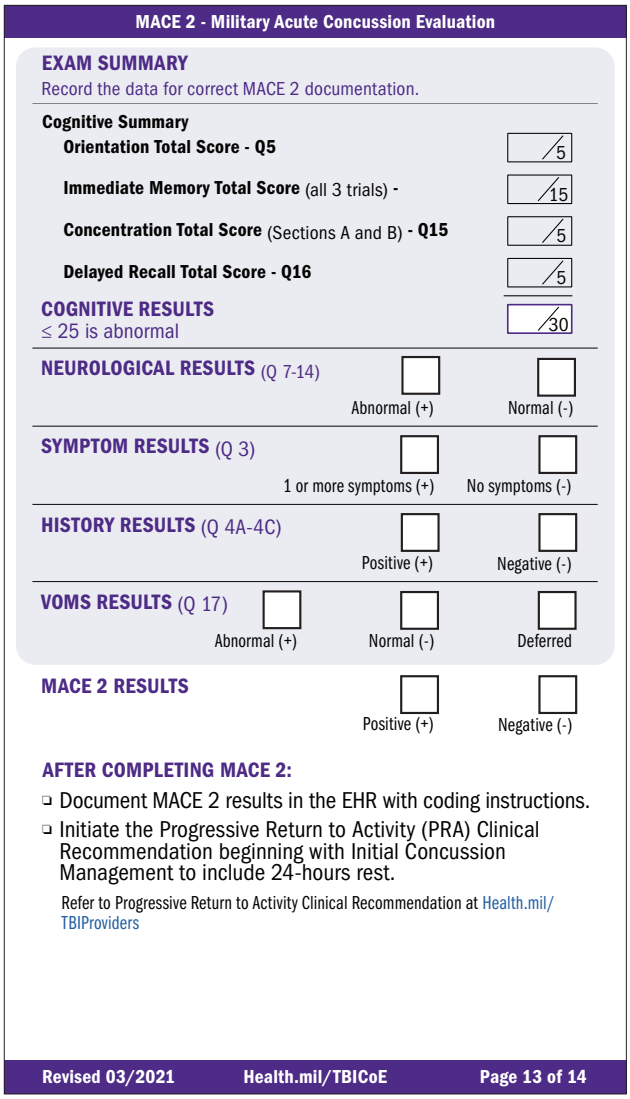
Special Considerations

- 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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