Neuroimaging Following Concussion/Mild Traumatic Brain Injury: Guidance for the Primary Care Manager

Introduction

This Clinical Recommendation (CR) is intended to guide primary care managers (PCMs) in the use of neuroimaging for concussion/mild traumatic brain injury (mTBI) care. The recommendations in this CR are consistent with the most recent American College of Radiology Appropriateness Criteria for imaging and the 2021 Veterans Affairs/Department of Defense Clinical Practice Guideline (VA/DOD CPG) on mTBI.[1,2]

In the acute timeframe (≤ 7 days post-injury), after a suspected concussion the primary focus of neuroimaging is to rule out a more severe brain injury, such as life-threatening, or potentially life-threatening, intracranial lesions (e.g., hematomas, contusions).

In the post-acute timeframe (> 7 days post-injury), the primary clinical objective is identifying more subtle brain lesions that may help explain specific symptoms and help predict recovery.

Specialized imaging modalities are primarily used for research purposes and are outside the scope of this CR. These include magnetic resonance imaging (MRI) techniques such as diffusion tensor imaging (DTI), neurite orientation and dispersion density imaging (NODDI), and resting state functional MRI (fMRI) in addition to positron emission tomography (PET) and single photon emission computerized tomography (SPECT).

This CR should never supersede a provider's clinical judgment when evaluating a patient with concussion/mTBI.

This is an interactive document. Please click the links in each box on the following page for detailed instructions and additional resources.

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Potentially Concussive Event

Military Acute Concussion Evaluation (MACE 2)

(-)

- Initiate 24-hour rest period, if deployed
- Communicate findings to line leadership
- Document and code findings in electronic health record (EHR)

(+)

Modified Canadian CT Head Rule*

Inclusion Criteria	Rule
• Blunt and blast-related head trauma causing loss of consciousness, amnesia, or disorientation • Glasgow Coma Scale (GCS) 13–15 • Age ≥ 16 • No coagulopathy nor on anti-coagulation	• GCS score < 15 at 2 hours after injury • Suspected open or depressed skull fracture • Any sign of basal skull fracture (hemotympanum, raccoon eyes, cerebrospinal fluid (CSF) otorrhea/ rhinorrhea, Battle's sign) • Vomiting ≥ 2 episodes • Age ≥ 65 years • Amnesia before impact ≥ 30 min • Dangerous mechanism (pedestrian struck by motor vehicle, occupant ejected from motor vehicle, fall from height >3 feet or 5 stairs)

(+) for 1 or more**

Urgent CT without contrast

(+)

Emergent referral based on findings

(-)

(-) for all

CT not necessary

Progressive Return to Activity (PRA)

Is the service member (SM) progressing through the PRA?

Yes

Continue through PRA Stage 6

No

Indications for neuroimaging

≤ 7 days post-injury:
Worsening headache or neurologic decline

Urgent CT without contrast

> 7 days post-injury:
New or worsening symptoms or persistent symptoms (based on clinical judgement)

MRI without contrast

* There are several validated recommendations for the use of Computed Tomography (CT) scan acutely after TBI. The Canadian CT Head Rule (CCHR) was selected for use in this CR due to its favorable sensitivity and specificity for identifying intracranial lesions after TBI.[3,4] The inclusion criteria were modified due to redundancies with the MACE 2 Red Flags.

** Deployed/Austere Environment: NIRS or Biomarkers may also be considered to determine the risk for intracranial lesions detectable on CT scan. Immediately consult higher level of care and consider urgent evacuation according to evacuation precedence/Tactical Combat Casualty Care (TCCC).

Modality	Description	Clinical Considerations	Availability
CT without contrast	CT is an imaging technique that uses small amounts of ionizing radiation to produce cross-sectional images. CT without contrast is the preferred imaging modality for initial evaluation of acute TBI, including mild TBI.[2,5]	• Sensitive for acute intracranial hemorrhages, including any that would require surgical evacuation. • Sensitive for acute skull and facial fractures.[5]	• In garrison: Available at most military treatment facilities (MTFs) • In theater: Role 3 or higher
MRI (T1, T2, T2 FLAIR, SWI or T2*GRE) without contrast	Conventional MRI uses a magnetic field and radio waves to create detailed images of the brain. The timing of the radiofrequency pulse sequences can be adjusted to create T1 and T2 images to highlight tissues of various signal intensities, and fluid attenuated inversion recovery (FLAIR) images that suppress the signal from free fluids, such as cerebrospinal fluid. Susceptibility-weighted imaging (SWI) is an MRI sequence that has high sensitivity for microhemorrhages in the brain that are a hallmark of traumatic or diffuse axonal injury.[5] However, the clinical relevance of microhemorrhages, as they relate to post-concussive symptoms, injury severity, and outcomes, is unclear.[5,6] If SWI is not available, T2*gradient-echo (GRE) can be substituted.	• MRI is more sensitive than CT in detection of intracranial pathology, particularly contusions and traumatic axonal injury. However, MRI is less sensitive than CT for skull fractures, takes more time to complete, is less available, and is more expensive than CT.[7] • When ordering MRI without contrast, the provider does not need to specify SWI or T2*GRE, as this is standard protocol for MRI brain scans at most institutions.	• In garrison: Available at most MTFs • In theater: Typically not available
NIRS	Food and Drug Administration (FDA) cleared handheld near-infrared spectroscopy (NIRS) devices allow for non-invasive detection of traumatic intracranial hematomas within 2.5 cm of the skull and greater than 3.5 ml in volume.[8]	• Can be used as an adjunct in clinical decision making to determine risk for intracranial hematoma.	• In garrison: May be available, but CT scan preferred • In theater: Available in some austere environments or with specialized military units
Biomarkers	Two plasma biomarkers, glial fibrillary acidic protein (GFAP) and ubiquitin carboxyl-terminal hydrolase L1 (UCH-L1), are FDA approved as highly sensitive for an abnormal CT scan following mTBI and can be measured with the i-STAT handheld Alinity System. Currently the assay cannot be performed with whole blood, only with plasma.[9] Refer to Use of Traumatic Brain Injury Plasma Biomarkers after Potentially Concussive Event Clinical Practice Guideline for more information.	• Can be used as an adjunct in clinical decision making to determine the risk for an abnormal CT scan. • Because these biomarker tests have a low specificity, many patients with false positive tests could be inappropriately referred for CT.[10]	• In garrison: May be available, but CT scan preferred • In theater: Role 3 or higher

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This product is reviewed annually and is current until superseded. 800-870-9244 | **Health.mil/TBICoE**

References

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