Washington State Department of Health Office of Community Health Systems
Emergency Medical Services and Trauma Section

Trauma Clinical Guideline
Initial Management of Traumatic Brain Injury

The Trauma Medical Directors and Program Managers Workgroup is an open forum for designated trauma services in Washington state to share ideas and concerns about providing trauma care. The workgroup meets regularly to encourage communication among services, and to share best practices and information to improve quality of care. On occasion, at the request of the Emergency Medical Services and Trauma Care Steering Committee, the group discusses the value of specific clinical management guidelines for trauma care.

The Washington State Department of Health distributes this guideline on behalf of the Emergency Medical Services and Trauma Care Steering Committee to assist trauma care services with developing their trauma patient care guidelines. Toward this goal the workgroup has categorized the type of guideline, the sponsoring organization, how it was developed, and whether it has been tested or validated. The intent of this information is to assist physicians in evaluating the content of this guideline and its potential benefits for their practice or any particular patient.

The Department of Health does not mandate the use of this guideline. The department recognizes the varying resources of different services, and approaches that work for one trauma service may not be suitable for others. The decision to use this guideline depends on the independent medical judgment of the physician. We recommend trauma services and physicians who choose to use this guideline consult with the department regularly for any updates to its content. The department appreciates receiving any information regarding practitioners' experience with this guideline. Please direct comments to 360-236-2874.

This is a trauma assessment and management guideline. It was adapted from professional literature. The workgroup reviewed the guideline, sought input from trauma care physicians throughout Washington state, and used that input to make changes. Both the Emergency Medical Services and Trauma Care Steering Committee and the Department of Health Office of Community Health Systems endorsed the guideline. This guideline has not been tested or validated.

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The problem
Traumatic brain injury (TBI) is a frequent event and occurs in more than 1.7 million people annually, resulting in more than 1 million emergency room visits. TBI has significant public health and socioeconomic effects, resulting in more than 50,000 deaths per year and billions in healthcare costs. In children, TBI is the leading cause of death in patients less than 18 years of age and results in more than 60,000 admissions. The majority of TBIs occur from blunt injuries sustained in falls, motor vehicle crashes (MVC), sports and recreational injuries.

Assessment
The assessment of any trauma patient should follow a systematic approach (primary and secondary survey) such as that discussed in the Advanced Trauma Life Support (ATLS) course. This process will ensure immediate life-threatening injuries are discovered and treated first, and will help limit the potential for missed injuries.

The initial or early signs of TBI may be subtle and relate to small increases in intracranial pressure. They include:

- headache
- nausea
- altered level of consciousness (LOC)
- Glasgow coma scale (GCS) < 15

If left untreated, intracranial pressure may increase and result in herniation of the brain. Assessment findings with brain herniation may include:

- unilateral or bilateral pupil dilatation
- GCS < 8
- Cushing's triad (widened pulse pressure, bradycardia, irregular respirations)
- absence of deep tendon and plantar responses
- Abnormal posturing (decorticate and decerebrate)

Initial documentation of the GCS is a vital step in the assessment process. The initial GCS will serve as a baseline on which future neurological assessments will be based. The brief neurological assessment in the primary survey should include not only the GCS but also the LOC, pupillary size and response to light, posturing, and vital signs review. The neurological assessment in the secondary and tertiary surveys should be in more detail.

Early consideration should be given to the patient's medical history. Patients prescribed any type of anticoagulant are at increased risk for intracerebral bleeding. In these cases, providers should immediately consider reversal of anticoagulation. The Head Injury in the Anticoagulated Patient guideline should be referenced.

Diagnostics
The patient with TBI should be closely monitored with trending of vital signs to include GCS and LOC. Assessing the vital signs over time will help identify the initial onset of increased ICP developing as Cushing's triad (widened pulse pressure, bradycardia, and irregular respirations).

If the patient has been prescribed anticoagulant medications, an immediate coagulation study and computed tomography (CT) should be performed. Prediction rules have been developed to help determine

if a TBI may exist and also to help assist in the decision-making to obtain a CT. If the patient meets one of the followed prediction criteria, a TBI may exist for which a CT is warranted for definitive diagnosis. If hemodynamically unstable, patients should be resuscitated before receiving a CT.

Prediction Rules (recommend CT)

- GCS < 15
- Altered mental status
- Skull fracture
- Loss of consciousness
- Vomiting
- Severe mechanism of injury (patient ejected from vehicle, death of another vehicle passenger, vehicle rollover, or fall greater than twice the height of the patient)
- Severe headache

Interventions

The goals of treatment for the patient with a TBI should be directed toward preventing a secondary injury. Secondary injury results from hypotension, hypoxemia, hypercarbia, cerebral edema, increased intracranial pressure (ICP), decreased cerebral perfusion pressure (CPP), and cerebral ischemia. All of these can cause further injury to the brain, compounding the initial injury. Interventions should be directed to prevent secondary injury.

The patient's airway and oxygenation should be assessed immediately upon arrival. Oxygen therapy should be started and the need for intubation should be anticipated. Appropriate ventilation can be guided by monitoring the expiratory carbon dioxide (CO_2) levels via capnography (35-45 mm Hg). Capnography values should be used with caution and correlated with blood gas results in hypovolemic/shock patients.

The systolic blood pressure (SBP) should be monitored closely to avoid hypotension. The patient should receive controlled crystalloid intravenous (IV) solutions with caution to prevent circulatory overload. Patients with simultaneous hemorrhage should receive blood products.

The patient's core temperature should also be monitored closely to prevent hypothermia. It may be necessary to implement warming measures such as warm blankets, increasing ambient air temperature, or applying an external warming device.

To help facilitate the flow of blood out of the head and to prevent any increase in ICP, the head of bed should be elevated to 30 degrees (low semi-fowlers position). If there is a suspected spine injury, use caution and consider the reverse Trendelenburg position.

In some cases any agitation to the patient or pain can increase ICP. Consideration should be made to administering sedative and/or pain medications.

Patients suspected of having a TBI with significant neurological injury should be consulted to neurosurgery immediately. If neurosurgical services are unavailable the patient should be transferred to a higher level designated trauma service with neurosurgical capabilities.

Advanced interventions

If impending brain herniation is occurring based on the signs and symptoms above, it may be necessary to administer hypertonic saline (23.4 percent) or an osmotic diuretic such as Mannitol. These medications

will help reduce interstitial fluid, thus limiting the effect of increasing ICP. These medications should not be used in patients with hypotension or hemorrhage. Hypertonic saline should be given via central line. These interventions should be considered with neurosurgical consultation and preparation for transport to definitive care.

Pediatrics

Traumatic brain injury is a leading cause of death and disability in children, resulting in about 7,400 deaths, more than 60,000 hospital admissions, and more than 600,000 emergency department visits every year. Over the past decade the use of CT has become the standard diagnostic tool when evaluating children with TBI. In recent years it has been discovered the overuse of CT has placed young patients at risk for malignancies. As a result, current clinical recommendations suggest limiting the use of CT when clinical prediction rules are available. Evidence–based guidelines used to identify children at very low risk of clinically significant TBI were developed and validated by the Pediatric Emergency Care Applied Research Network (PECARN) and adopted by the Choosing Wisely campaign. These clinical prediction rules risk-stratify TBI according to age and clinical symptoms. When followed, these prediction rules result in a greater than 99 percent accuracy rate for identifying children with low-risk TBI, who do not require CT. CT is recommended in high-risk patients. Intermediate-risk patients are either observed or a CT is obtained, depending on associated clinical factors. Of note, patients with concern for child physical abuse or non-accidental trauma (NAT) are excluded from the PECARN decision tool.

Pediatric Head Trauma CT Decision Algorithm for Children Younger than two Years

High Risk → CT

- GCS less than 15
- Signs of palpable skull fracture
- Altered mental status (agitation, somnolence, repetitive questioning, or slow response to verbal communication)

Intermediate Risk → Observation vs. CT using shared decision-making*

- Occipital or parietal or temporal scalp hematoma (excluding frontal)
- History of LOC ≥ 5 seconds
- Severe mechanism of injury
    - motor vehicle crash with patient ejection, death of another passenger, or rollover
    - pedestrian or bicyclist without helmet struck by a motorized vehicle
    - falls of more than 0.9 m (3 feet)
    - head struck by a high-impact object
- Not acting normally per parent

Low Risk → no CT

Pediatric Head Trauma CT Decision Algorithm for Children 2 Years or Older

High Risk → CT

- GCS less than 15
- Signs of basilar skull fracture
- Altered mental status (agitation, somnolence, repetitive questioning, or slow response to verbal communication)

Intermediate Risk → Observation vs. CT using shared decision-making*

- History of vomiting
- History of LOC
- Severe mechanism of injury
  - motor vehicle crash with patient ejection, death of another passenger, or rollover
  - pedestrian or bicyclist without helmet struck by a motorized vehicle
  - falls of more than 1.5 m (5 feet)
  - head struck by a high-impact object
- Severe headache

Low Risk → no CT

*Clinical Factors used to guide decision-making:

- Physician experience
- Multiple versus isolated findings
- Patients with certain isolated findings (i.e., with no other findings suggestive of traumatic brain injury) have a risk of clinically-important TBI substantially lower than 1 percent:
  - isolated LOC
  - isolated headache
  - isolated vomiting
  - certain types of isolated scalp hematomas in infants older than 3 months.
- Worsening symptoms or signs after emergency department observation (AMS, headache, vomiting)
- Age <3 months
- Parental preference

Patients at low risk for TBI with no other injuries can be safely discharged home to the care of a responsible family member or guardian. In cases when patients do not meet the prediction rules for TBI or the need for CT, but the provider feels uncomfortable not having definitive diagnostic imaging, or there is a concern for NAT, social issues, difficulty assessing mental status, or isolated skull fractures, expert consultation with a designated pediatric trauma hospital should be sought.

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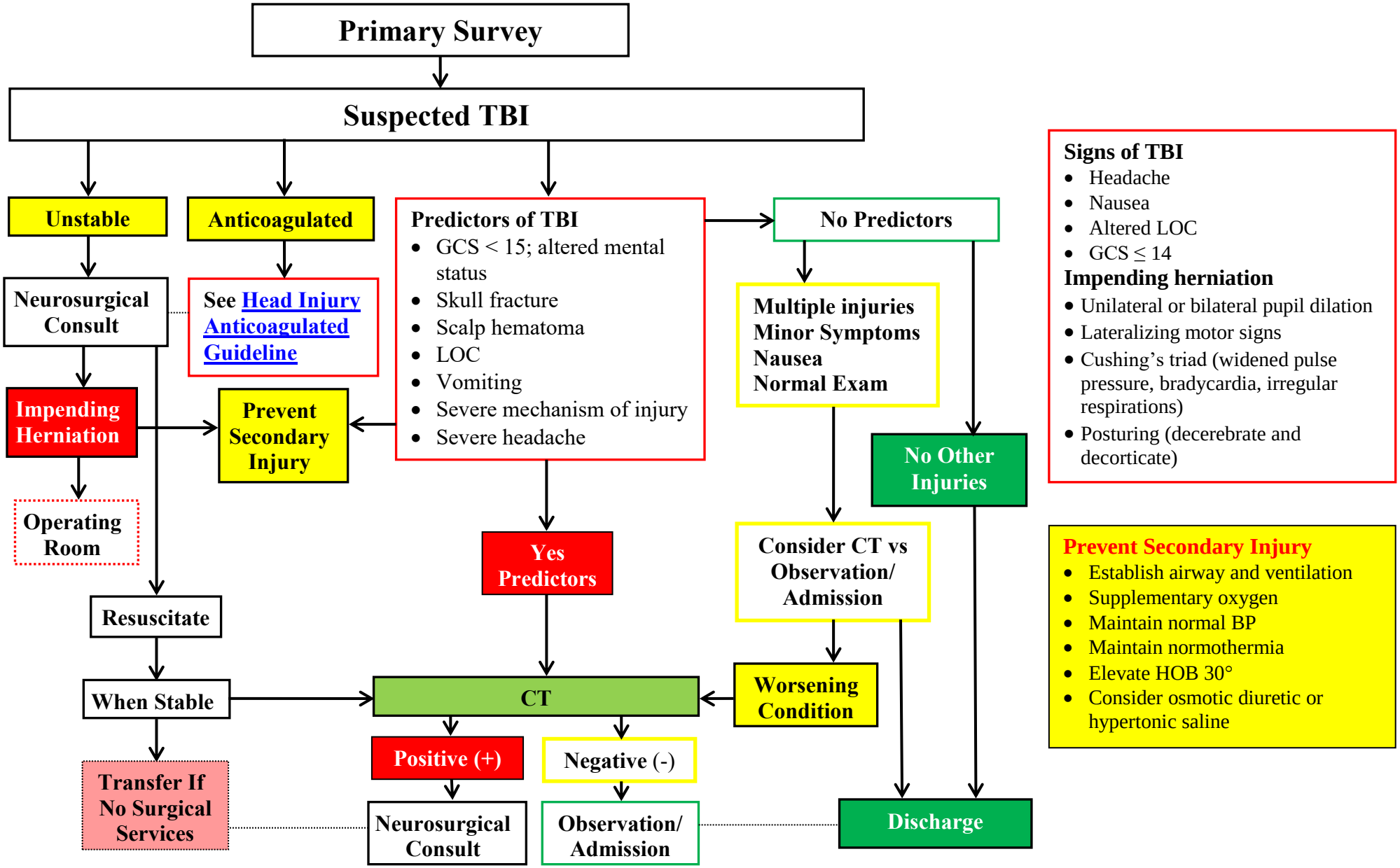
Adult Initial Management of Traumatic Brain Injury



Signs of TBI

- Headache
- Nausea
- Altered LOC
- GCS ≤ 14

Impending herniation

- Unilateral or bilateral pupil dilation
- Lateralizing motor signs
- Cushing's triad (widened pulse pressure, bradycardia, irregular respirations)
- Posturing (decerebrate and decorticate)

Prevent Secondary Injury

- Establish airway and ventilation
- Supplementary oxygen
- Maintain normal BP
- Maintain normothermia
- Elevate HOB 30°
- Consider osmotic diuretic or hypertonic saline

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*** Severe mechanism of injury - patient ejected from vehicle, death of another vehicle passenger, vehicle rollover, or fall greater than three feet.**

Pediatric Head Trauma CT Decision Guide
Children younger than 2 years

GCS < 15
Palpable skull fracture
Altered mental status (agitation, somnolence, slow response, repetitive questioning)

Yes To Any → **CT (high risk)**

No →

Scalp hematoma (excluding frontal)
LOC > 5 seconds
Not acting normally per parent
Severe mechanism of injury
- -Fall > 3 feet
- -MVA w/ejection, rollover, or fatality
- -Bike/ped vs vehicle without helmet
- -Struck by high-impact object

Yes To Any → Observation vs CT using shared decision-making

No → CT not indicated **Observe**

Clinical factors used to guide decision-making:
- -Multiple vs isolated factors
- -Worsening findings during observation (AMS, headache, vomiting)
- -Physician experience
- -Parental preference
- -< 3 months old

Pediatric Head Trauma CT Decision Guide
Children 2 years and older

GCS < 15
Signs of basilar skull fracture
Altered mental status (agitation, somnolence, slow response, repetitive questioning)

Yes To Any → **CT (high risk)**

No →

Vomiting
LOC
Severe headache
Severe mechanism of injury
- -Fall > 5 feet
- -MVA w/ejection, rollover, or fatality
- -Bike/ped vs vehicle without helmet
- -Struck by high-impact object

Yes To Any → Observation vs CT using shared decision-making

No → CT not indicated **Observe**

Clinical factors used to guide decision-making:
- -Multiple vs isolated factors
- -Worsening findings during observation (AMS, headache, vomiting)
- -Physician experience
- -Parental preference

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