**Definition:** A clinically important cervical spine injury is any fracture, dislocation, or ligamentous instability demonstrated on diagnostic imaging. A clinically unimportant injury is an isolated avulsion fracture of an osteophyte, an isolated fracture of a transverse process not involving a facet joint, an isolated fracture of a spinous process not involving the lamina, or a simple compression fracture involving less than 25% of the vertebral body height. (1)

**Epidemiology:** Cervical spine injury causes an estimated 6,000 deaths and 5,000 new cases of quadriplegia in the United States each year. Males are affected 4 times as frequently as females. Two to three percent of blunt trauma patients who undergo cervical spine imaging are diagnosed with a fracture. The second vertebra is most commonly injured, accounting for 24% of fractures; the sixth and seventh vertebrae in combination account for 39% of fractures. Head-injured patients are almost four times as likely to have a cervical spine injury as those without head injuries. Those at highest risk have an initial Glasgow Coma Scale (GCS) score of 8 or lower and are likely to sustain unstable injuries in the high cervical spine. (1)

**Etiology:** The most common factors and causes associated with cervical spine injury are:
- Altered mental status
- Loss of consciousness
- Nonambulatory
- Focal neurological findings
- Complaint of neck pain
- Posterior midline neck tenderness
- Any neck tenderness
- Torticollis
- Substantial injury to the extremities, face, head, or torso
- Predisposing conditions such as Down’s syndrome, Klippel-Feil syndrome, achondroplasia, mucopolysaccharidosis, Ehlers-Danlos syndrome, Marfan syndrome, osteogenesis imperfecta, Larsen syndrome, juvenile rheumatoid arthritis, juvenile ankylosing spondylitis, renal osteodystrophy, rickets, or a history of cervical spine injury or surgery
- High risk mechanisms of injury such as diving, falling, hanging, pedestrian, bicyclist, or nonmotorized vehicle being hit by a motor vehicle, motor vehicle collision including motorcycles, axial load to any region of the head, or clothes-lining (2)

**Inclusion Criteria**
- All pediatric patients with blunt trauma mechanisms of injury to the cervical spine (3)

**Exclusion Criteria**
- Pediatric patients with penetrating trauma mechanisms of injury (3)

**Differential Diagnosis**
- Spinal fracture
- Cervical disc herniation
- Subarachnoid hemorrhage
- Meningitis
- Cervical spondylosis
- Tumor growth
- Rotator cuff pathology
- Nerve compression in the shoulder area
- Brachial neuritis

**Diagnostic Evaluation**

**History: Assess for**
- Predisposing conditions
- History of non-accidental trauma

**Physical Examination**
- Height, weight, and head circumference
- Vital signs
- Detailed physical exam (plus assess for trauma, upper airway obstruction, or facial dysmorphism)
  - Altered mental status
  - Loss of consciousness
  - Nonambulatory
  - Focal neurological findings
  - Complaint of neck pain
  - Posterior midline neck tenderness
  - Any neck tenderness
  - Torticollis
  - Developmental assessment
**Evidence Supports**
- Utilization of cervical spine clearance process for patients with high risk blunt mechanisms of cervical spine injury (4-17)
- Use of the long spine board with a vacuum mattress immobilization device or padding as an adjunct during patient transport (18-50)
- Transporting patient who does not require spinal immobilization or lying flat in an age-appropriate car seat secured to the stretcher (18-50)
- Heightened clinical suspicion of a cervical spine injury if the patient presents with high risk mechanism of injury (2)
- Clearance of the cervical spine and removal of the cervical collar by an emergency center, trauma, or Neurosurgery attending physician, fellow, or senior resident; Orthopedic attending or fellow; or a trauma advanced practice provider. If unable to clear the cervical spine when using the clinical clearance criteria (absence of midline neck tenderness, evidence of intoxication, altered level of consciousness, focal neurological deficit, painful or distracting injury, torticollis, communication barriers, and agitation), consult Neurosurgery. (58-60)
- Imaging of the cervical spine despite the risks of radiation exposure. If the patient needs a CT scan of the head as part of the initial trauma assessment, scan down through the cervical spine before admitting to PICU. (61-72)
- Imaging with CT if the patient presents with a high risk mechanism injury and if he/she does not meet the clinical clearance criteria (absence of midline neck tenderness, evidence of intoxication, altered level of consciousness, focal neurological deficit, painful or distracting injury, torticollis, communication barriers, and agitation). Clinically clear the cervical spine if there is no presence of neck tenderness; if there is neck tenderness, keep the collar in place for two weeks. If the CT is normal but the GCS score is <15, keep the cervical collar on and clinically clear when GCS = 15. If unable to do so, consult Neurosurgery and obtain MRI within 72 hours to evaluate for a ligamentous injury. (73-84)
- Utilization of imaging despite the risk of intra-facility transportation in the unconscious, intubated, but medically stable patient (95)

**Evidence Against**
- Utilization of cervical spine clearance process for patients with a penetrating neck injury (4-17)
- Use of the long spine board without additional padding during patient transport (18-50)
- Heightened clinical suspicion of a cervical spine injury if the patient presents with a non-accidental trauma (51-57)

**Evidence Lacking/Inconclusive**
- Removal of a rigid cervical collar for a patient with a suspected cervical spine injury who cannot be examined and does not have imaging to confirm or rule out an injury
- Removal of a rigid cervical collar for patients who are unable to be examined and who have a negative CT scan until either a normal neurological exam can be obtained (i.e., patient wakes up), or an MRI is obtained within 72 hours

*NOTE: The references cited represent the entire body of evidence reviewed to make each recommendation.

**Practice Recommendations**

**Imaging**
Non-accidental trauma should not be considered a high risk mechanism of injury. For the most severely ill patients (i.e., altered mental status, intubated, or injuries on head imaging), a cervical collar should be applied initially. For patients who have findings on imaging but have a reassuring clinical exam, a cervical collar should not be applied. For children with a non-accidental trauma, the low incidence of fractures reported should preclude the routine use of CT of the cervical spine. Only if there is clinical concern based on positive physical symptoms and signs should MRI of the cervical spine be considered. (51-57) – Strong recommendation, low quality evidence

The risk of radiation exposure does not outweigh the benefit of imaging the cervical spine. If the patient needs a CT scan of the head as part of the initial trauma assessment, scan down through the cervical spine before admitting to PICU. (61-72) – Strong recommendation, low quality evidence

If the patient presents with a high risk mechanism of injury and if they do not meet the clinical clearance criteria (absence of midline neck tenderness, evidence of intoxication, altered level of consciousness, focal neurological deficit, painful or distracting injury, torticollis, communication barriers, and agitation), it is recommended to image with CT. If the CT is normal but the GCS score is <15, keep the cervical collar on and clinically clear when GCS = 15. If unable to do so, consult Neurosurgery and obtain MRI within 72 hours to evaluate for a ligamentous injury. Clinically clear the cervical spine if there is no presence of neck tenderness; if there is neck tenderness, keep the collar in place for two weeks. (73-84) – Strong recommendation, low quality evidence

In an unconscious, intubated, but stable pediatric patient, the risk of transport to MRI does not outweigh the benefit of cervical spine injury detection. If the patient is not medically stable, wait to image until the patient has stabilized. (95) – Strong recommendation, very low quality evidence

**Clearance**
Clearance of the cervical spine and removal of the cervical collar by an emergency center, trauma, or neurosurgery attending physician, fellow, or senior resident; orthopedic attending or fellow; or a trauma advanced practice provider. If unable to clear the cervical spine when using the NEXUS criteria, consult Neurosurgery. (58-60) – Strong recommendation, low quality evidence

A child with a suspected cervical spine injury who cannot be examined and does not have imaging to confirm or rule out injury should remain in a rigid cervical collar. – Strong consensus recommendation
Pediatric patients who are unable to be examined and who have a negative CT scan should remain with the cervical collar in place until either a normal neurological exam can be obtained (i.e., patient wakes up), or an MRI is obtained within 72 hours. An MRI should be obtained if the patient does not become alert within 72 hours. – Strong consensus recommendation

Increased Risk of Injury or Negative Outcome

Children who have suffered a penetrating neck injury should not receive cervical spinal immobilization, regardless of whether they are exhibiting neurological symptoms. (4-17) – Strong recommendation with very low quality evidence

High risk blunt mechanisms of cervical spine injury include high risk motor vehicle collisions, recreational vehicles (all-terrain vehicles and snowmobiles), axial loading, substantial torso injuries, and falls greater than 10 feet. (4-17) – Strong recommendation, moderate quality evidence

Do not use long spine boards for transport of patients. If a patient is being transported with a long spine board, consider the use of a vacuum mattress immobilization device or padding as an adjunct.

Children who do not require spinal immobilization or lying flat may be safely transported when restrained in an age-appropriate car seat secured to the stretcher. Children who do require spinal immobilization or lying flat should be directly secured to the stretcher. (18-50) – Strong recommendation, low quality evidence

The historical, clinical findings and predisposing conditions below should heighten the clinician’s suspicion for cervical spine injury following blunt trauma in children. (2) – Weak recommendation, very low quality evidence

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Definition for Chart Abstraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altered mental status</td>
<td>Glasgow Coma Scale score &lt;15, AVPU scale (Alert, Voice, Pain, Unresponsive) &lt;A, evidence of intoxication, or mental status descriptions deemed by consensus panel to represent altered level of consciousness</td>
</tr>
<tr>
<td>Loss of consciousness</td>
<td>History of loss of consciousness post-injury</td>
</tr>
<tr>
<td>Nonambulatory</td>
<td>Child &gt;2 y reported as unable to ambulate post-injury</td>
</tr>
<tr>
<td>Focal neurologic findings</td>
<td>Paresthesias, loss of sensation, motor weakness, or other neurologic finding deemed consistent with spine injury by consensus panel (e.g., priapism)</td>
</tr>
<tr>
<td>Complaint of neck pain</td>
<td>History states that the child (if &gt;2 y) complained of neck pain</td>
</tr>
<tr>
<td>Posterior midline neck tenderness</td>
<td>Physical examination notes neck tenderness as posterior, midline, or at a designated cervical level; or a descriptor that consensus panel deemed consistent with posterior midline neck tenderness</td>
</tr>
<tr>
<td>Any neck tenderness</td>
<td>Any documented tenderness on physical examination of the neck</td>
</tr>
<tr>
<td>Torticollis</td>
<td>Torticollis, limited range of motion, or difficulty moving the neck noted in history or physical examination</td>
</tr>
<tr>
<td>Substantial injury</td>
<td>Observable injuries that are life threatening, warrant surgical intervention, or warrant inpatient observation</td>
</tr>
<tr>
<td>Extremity</td>
<td>Considered legs to hip and arms to clavicle (e.g., long bone fractures, degloving injuries)</td>
</tr>
<tr>
<td>Face</td>
<td>Considered noncranial region of the head (e.g., orbital, maxilla, or mandible fractures)</td>
</tr>
<tr>
<td>Head</td>
<td>Considered cranial region of the head (e.g., skull fracture, intracranial hemorrhage)</td>
</tr>
<tr>
<td>Torso</td>
<td>Thorax including clavicles, abdomen, flanks, back including the spine and the pelvis (e.g., rib fractures, visceral or solid organ injury, pelvic fracture)</td>
</tr>
<tr>
<td>Predisposing condition*</td>
<td>Conditions known to predispose to CSI (Down syndrome, Klippel-Feil syndrome, achondroplasia, mucopolysaccharidosis, Ehlers-Danlos syndrome, Marfan syndrome, osteogenesis imperfecta, Larsen syndrome, juvenile rheumatoid arthritis, juvenile ankylosing spondylitis, renal osteodystrophy, rickets, history of CSI or cervical spine surgery)</td>
</tr>
<tr>
<td>High-risk mechanism</td>
<td>Diving</td>
</tr>
<tr>
<td>Diving</td>
<td>Diving</td>
</tr>
<tr>
<td>Fall</td>
<td>Fall from a height &gt;10 ft</td>
</tr>
<tr>
<td>Hanging</td>
<td>Hanging</td>
</tr>
<tr>
<td>Hit by car</td>
<td>Pedestrian, bicycle rider, or nonmotorized vehicle struck by a motor vehicle</td>
</tr>
<tr>
<td>MVC</td>
<td>Head-on collision, rollover, ejected from the vehicle, death in the same crash, or speed &gt;55 miles/h</td>
</tr>
<tr>
<td>Other MV</td>
<td>Nonautomobile, MVC (e.g., motorcycle)</td>
</tr>
<tr>
<td>Axial load to any region of the head</td>
<td>The impact was noted in history to be head first, any region of the head</td>
</tr>
<tr>
<td>Axial load to top of the head</td>
<td>The impact was noted in history to be head first, region noted to be top of head</td>
</tr>
</tbody>
</table>
| Clothes-lining | Injury the result of a rope, cable, or similar item exerting traction on the neck while the child is in motion

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Condition-Specific Elements of Clinical Management

In addition to routine care, consider:

- Mechanism of injury and severity before imaging
- The location and type of trauma experienced (i.e., blunt, penetrating, non-accidental) when evaluating and clearing a cervical spine
- Clearance of the cervical spine and collar removal only by appropriate providers
- Utilization of appropriate transportation precautions with the long spine board and car seat
- Use of imaging (CT and MRI) if unable to clinically clear a cervical spine
- Use of imaging and cervical collar for a patient who is unconscious or intubated

Measures

- Imaging utilization
  - MRI
  - CT
  - X-ray
- Percentage of injuries detected using imaging vs. Imaging studies performed
  - MRI/CT/X-ray
  - Osseous or ligamentous
- Missed injuries vs. clearance method used
  - Clinical clearance
  - Imaging
TCH Evidence-Based Outcomes Center
Clinical Algorithm for In-Hospital Cervical Spine Trauma Clearance

Arrive at Emergency Department

Penetrating trauma to the neck?

No

Stabilize neck without the use of a collar

Yes

High Risk Mechanism of Injury?

No

Consult Neurosurgery

Yes

Obtain CT imaging of cervical spine

Presence of any of the following:

- Midline neck tenderness
- Evidence of intoxication
- Altered level of consciousness
- Focal neurological deficit
- Painful, distracting injury
- Torticollis
- Agitation
- Communication barriers

*Communication Barriers:

- <3 years old
- Significant developmental delay that impairs their ability to comprehend and/or communicate
- Speaks a language that the provider does not speak proficiently, when an interpreter is not available

Consult Neurosurgery

Is the CT image normal?

Yes

Able to clinically clear the cervical spine?

Yes

Remove collar

OFF algorithm

No

Consult Neurosurgery

Is Glasgow Coma Scale score = 15?

Yes

Able to clinically clear cervical spine?

Yes

Keep collar on and clinically clear when GCS = 15. If unable to do so, obtain MRI within 72 hours to evaluate for ligamentous injury

No

Clear cervical spine if no neck tenderness; if there is neck tenderness, keep collar in place for 2 weeks

Consult Neurosurgery

No

Able to clinically clear cervical spine?

Yes

Replace collar and consider X-ray imaging of the cervical spine

No

Able to clinically clear the cervical spine?

Yes

Remove collar

OFF algorithm

No

Consult Neurosurgery

Glasgow Coma Scale

<table>
<thead>
<tr>
<th>Eye Opening (E)</th>
<th>Verbal Response (V)</th>
<th>Motor Response (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4= Spontaneous</td>
<td>5= Oriented</td>
<td>6= Obey commands</td>
</tr>
<tr>
<td>3= To sound</td>
<td>4= Confused</td>
<td>5= Localizing</td>
</tr>
<tr>
<td>2= To pressure</td>
<td>3= Words but not coherent</td>
<td>4= Normal flexion</td>
</tr>
<tr>
<td>1= None</td>
<td>2= No words; only sounds</td>
<td>3= Abnormal flexion</td>
</tr>
<tr>
<td></td>
<td>1= None</td>
<td>2= Extension</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1= None</td>
</tr>
</tbody>
</table>

Total Score = E + V + M
References


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**Guideline Preparation**

This clinical standard was prepared by the Evidence-Based Outcomes Center (EBOC) team in collaboration with content experts at Texas Children's Hospital. Development of this clinical standard supports the TCH Quality and Patient Safety Program initiative to promote clinical standards and outcomes that build a culture of quality and safety within the organization.

**Evaluation and Clearance of the Pediatric Cervical Spine**

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No relevant financial or intellectual conflicts to report.

**Development Process**

This guideline was developed using the process outlined in the EBOC Manual (2013). The evidence summary documents the following steps:

1. Review Preparation  
   - PICO questions established  
   - Evidence search confirmed with content experts
2. Review of Existing Internal and External Guidelines  
   - N/A
3. Literature Review of Relevant Evidence  
   - Searched: EBSCO, PubMed, CINAHL
4. Critically Analyze the Evidence  
   - 15 nonrandomized studies
5. Summarize the Evidence  
   - Materials used in the development of the guideline, evidence summary, and order sets are maintained in an Evaluation and Clearance of the Pediatric Cervical Spine evidence-based review manual within EBOC.

**Evaluating the Quality of the Evidence**

Published clinical guidelines were evaluated for this review using the AGREE II criteria. The summary of these guidelines are included in the literature appraisal. AGREE II criteria evaluate

Guideline Scope and Purpose, Stakeholder Involvement, Rigor of Development, Clarity and Presentation, Applicability, and Editorial Independence using a 4-point Likert scale. The higher the score, the more comprehensive the guideline is. This clinical standard specifically summarizes the evidence in support of or against specific interventions and identifies where evidence is lacking/inconclusive. The following categories describe how research findings provide support for treatment interventions. “Evidence Supports” provides evidence to support an intervention “Evidence Against” provides evidence against an intervention. "Evidence Lacking/Inconclusive" indicates there is insufficient evidence to support or refute an intervention and no conclusion can be drawn from the evidence. The GRADE criteria were utilized to evaluate the body of evidence used to make practice recommendations. The table below defines how the quality of the evidence is rated and how a strong versus weak recommendation is established. The literature appraisal reflects the critical points of evidence.

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Type of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>STRONG</td>
<td>Evidence supports</td>
</tr>
<tr>
<td>WEAK</td>
<td>Evidence closely balanced with undesirable effects</td>
</tr>
<tr>
<td>Quality</td>
<td>Type of Evidence</td>
</tr>
<tr>
<td>High</td>
<td>Evidence from well-performed RCTs or exceptionally strong evidence from unbiased observational studies</td>
</tr>
<tr>
<td>Moderate</td>
<td>Evidence from RCTs with important limitations (e.g., insufficient results, methodological flaws, indirect evidence, or imprecise results) or unusually strong evidence from unbiased observational studies</td>
</tr>
<tr>
<td>Low</td>
<td>Evidence for at least 1 critical outcome from observational studies, RCTs with serious flaws or indirect evidence</td>
</tr>
<tr>
<td>Very Low</td>
<td>Evidence for at least 1 critical outcome from unsystematic clinical observations or very indirect evidence</td>
</tr>
</tbody>
</table>

**Recommendations**

Practice recommendations were directed by the existing evidence and consensus amongst the content experts. Patient and family preferences were included when possible. The Content Expert Team and EBOC team remain aware of the controversies in the evaluation and clearance of the pediatric cervical spine. When evidence is lacking, options in care are provided in the clinical standard and the accompanying order sets (if applicable).

**Approval Process**

Clinical standards are reviewed and approved by hospital committees as deemed appropriate for its intended use. Clinical standards are reviewed as necessary within EBOC at Texas Children’s Hospital. Content Expert Teams are involved with every review and update.

**Disclaimer**

Practice recommendations are based upon the evidence available at the time the clinical standard was developed. Clinical standards (guidelines, summaries, or pathways) do not set out the standard of care and are not intended to be used to dictate a course of care. Each physician/practitioner must use his or her independent judgment in the management of any specific patient and is responsible, in consultation with the patient and/or the patient’s family, to make the ultimate judgment regarding care.

**Version History**

<table>
<thead>
<tr>
<th>Date</th>
<th>Action</th>
<th>Comments</th>
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</thead>
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<tr>
<td>Jun 2015</td>
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