A Standardized Protocol for the Evaluation of Cervical Spine Injuries Reduces Radiation Exposure and Imaging Costs

Christopher Pennell, Jayesh Gupta, Michael March, L. Grier Arthur, Erika Lindholm, Martin Herman, Harsh Grewal
Disclosures

• None
Background and Hypothesis

• Pediatric C-spine injuries (CSI) are rare (1-2%)
  – High morbidity and mortality

• NEXUS not well-validated in children
  – Variable practice nationally

• A Standardized Protocol for evaluating CSIs would:
  – Reduce radiation exposure
  – Reduce imaging costs
  – Accurately identify children with CSIs
Methods

• Protocol implemented November 2017, emphasizing:
  – Initial imaging with plain X-ray
  – Wait-and-reevaluate approach

• Retrospective cohort study
  – Pre-SP (July 2015 – May 2016)
  – Post-SP (November 2017 – June 2018)

• Trauma activations <18 years with possible CSI
  • Exclusions: Abuse, penetrating injury, CT/MRI at outside hospital
GCS = 14 or 15

History*
- Child or parent reports persistent neck pain, abnormal head posture, or difficulty with neck movement
- History of focal sensory abnormality or motor deficit

Physical Exam
- Torticollis/abnormal head position
- Posterior midline neck tenderness
- Limited cervical range of motion
- Not able to maintain focus due to other injuries
- Visible known substantial injury to chest, abdomen, or pelvis**

Answer “No” to all of the above

Clear c-spine

Answer “Yes” to any of the above

Plain radiograph*
(lateral view minimum)

Normal

Options:
1) Clear c-spine if physical exam findings resolve
2) Obtain Flexion / Extension radiographs#
3) Maintain collar and re-evaluate in 2 weeks
4) Spine Consult

Abnormal

Spine consult
## Results

<table>
<thead>
<tr>
<th>Condition</th>
<th>Pre-SP (n=248)</th>
<th>Post-SP (n=111)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleared Clinically</td>
<td>15.3%</td>
<td>43.2%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>X-Ray</td>
<td>70.2%</td>
<td>55.0%</td>
<td>0.005</td>
</tr>
<tr>
<td>Computed Tomography</td>
<td>14.5%</td>
<td>5.4%</td>
<td>0.013</td>
</tr>
<tr>
<td>Magnetic Resonance Image</td>
<td>6.9%</td>
<td>7.2%</td>
<td>0.904</td>
</tr>
<tr>
<td>Cervical Spine Injury</td>
<td>2.8%</td>
<td>1.8%</td>
<td>0.567</td>
</tr>
</tbody>
</table>

*No difference in baseline age, ISS, GCS, and mechanism of injury*
Summary

• A standardized protocol can be successfully implemented with good compliance (87.4%)
  – Reduced radiation exposure
  – Accurate injury identification

<table>
<thead>
<tr>
<th></th>
<th>Annual Studies Spared</th>
<th>Cost Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-Ray</td>
<td>98</td>
<td>$4,341.40</td>
</tr>
<tr>
<td>CT Scan</td>
<td>30</td>
<td>$5,604.39</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>$9,945.79</strong></td>
</tr>
</tbody>
</table>

• C-Spine clearance is not an emergency
  – “Wait and re-evaluate”
Cervical Spine Clearance Protocol

GCS = 14 or 15

- History*
  - Child or parent reports persistent neck pain, abnormal head posture, or difficulty with neck movement
  - History of focal sensory abnormality or motor deficit
  - Physical Exam
  - Torticollis/abnormal head position
  - Posterior midline neck tenderness
  - Limited cervical range of motion
  - Not able to maintain focus due to other significant injuries
  - Visible known substantial injury to chest, abdomen, or pelvis***

*Answer "No" to all of the above
**Answer "Yes" to any of the above

Options:
1) Clear c-spine if physical exam findings resolve
2) Obtain Flexion / Extension radiographs**
3) Maintain collar and re-evaluate in 2 weeks
4) Spine Consult

GCS = 9 - 13

- Potential to improve mental status to a GCS of 14 or 15?
  - Yes
  - Plain radiograph# (lateral view minimum)

- No
  - Repeat clinical examination within 12 hours

GCS ≤ 8

- And reasonable suspicion for cervical spine injury

  - CT**

    - Abnormal
      - Patient has achieved GCS 14 - 15 and no longer presents with abnormal head posture, persistent neck pain, or difficulty in neck movement
      - Yes
      - Spine consult
    - Normal
      - Patient improves to GCS 14 / 15 within 72 hours
      - No
        - Repeat clinical examination

# All imaging should be read by an attending physician
**Adequate Flexion / Extension is defined as ≥ 30 degrees of flexion and ≥ 30 degrees of extension
***Patient has achieved GCS 14 - 15 and no longer presents with abnormal head posture, persistent neck pain, or difficulty in neck movement

*Stronger consideration for imaging should be given towards patients with the following mechanisms of injury (MOI): diving, axial load, close-lining and high-risk MVC (HR-MVC), however the literature findings are controversial. HR-MVC is defined as a head-on collision, rollover, ejected from the vehicle, death in the same crash, or speed > 55mph

Clinical pathways are designed to assist clinicians by providing an analytical framework for the diagnosis and treatment of specific clinical problems. They are not intended to replace a physician's judgment or to establish a protocol for all patients with particular conditions. The ultimate decision regarding the care of any patient should be made in regard to the individual's circumstances presented by the patient.

St. Christopher's Hospital for Children
A Voice for the Injured Child

Drexel University
Pediatric Trauma Society
## Results

<table>
<thead>
<tr>
<th></th>
<th>Pre-SP (n=248)</th>
<th>Post-SP (n=111)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>9.0</td>
<td>10.0</td>
<td>0.615</td>
</tr>
<tr>
<td><strong>Injury Severity Score (ISS)</strong></td>
<td>4</td>
<td>2</td>
<td>0.268</td>
</tr>
<tr>
<td><strong>Glasgow Coma Score (GCS)</strong></td>
<td>15</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>• 3-8</td>
<td>5.2%</td>
<td>0.9%</td>
<td>0.086</td>
</tr>
<tr>
<td>• 9-13</td>
<td>3.6%</td>
<td>2.7%</td>
<td></td>
</tr>
<tr>
<td>• 14-15</td>
<td>89.9%</td>
<td>96.4%</td>
<td></td>
</tr>
<tr>
<td><strong>Male Sex (%)</strong></td>
<td>59.3%</td>
<td>70.3%</td>
<td>0.047</td>
</tr>
<tr>
<td><strong>Mechanism (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Pedestrian/Cyclist Struck</td>
<td>33.9%</td>
<td>38.7%</td>
<td>0.107</td>
</tr>
<tr>
<td>• Fall</td>
<td>31.0%</td>
<td>36.0%</td>
<td></td>
</tr>
<tr>
<td>• Motor Vehicle Collision</td>
<td>11.7%</td>
<td>12.6%</td>
<td></td>
</tr>
<tr>
<td>• Assault</td>
<td>10.9%</td>
<td>9.9%</td>
<td></td>
</tr>
<tr>
<td>• Other</td>
<td>12.5%</td>
<td>2.7%</td>
<td></td>
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<td><strong>Cervical Spine Injury (%)</strong></td>
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