Application of National Emergency X-Radiography Utilization Study Criteria, the Canadian C-Spine Rule and an Institutional Hybrid Model Among Children Aged 8 to 17 years in the Emergency Department: A Retrospective Review

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Pediatric C-spine Clearance

- Pediatric c-spine injuries - rare but devastating if missed
- Validated clinical decision tools – NEXUS and CCR for adult use
- No pediatric c-spine clearance tools validated

**NEXUS**

- Focal deficits
- Midline tenderness
- Altered mental status
- Intoxication
- Distracting Injuries

  - No Imaging Indicated

**CCR**

- **High Risk Criteria**
  - Dangerous MOI
  - Parasthesias

  - No

- **Low Risk Criteria**
  - Simple rear-end collision
  - Found sitting in the ED
  - Ambulatory at anytime
  - No midline tenderness
  - Delayed onset of neck pain

  - Yes
  - Normal Neck ROM

  - Yes
  - No Imaging Indicated

- Yes

**References**

Pediatric C-spine Risk Factors

- Pediatric Emergency Care Applied Research Network (PECARN) retrospectively identified 8 factors highly associated with CSI in children 0-16 years.
  - Altered mental status
  - Focal neurologic deficits
  - Complaints of neck pain
  - Torticollis
  - Substantial injury to the torso
  - Predisposing condition for c-spine injury
  - High risk MVC
  - Diving

CCMC Pediatric C-spine Protocol Development

PECARN → NEXUS → CCR

Cohen Children’s Medical Center C-spine Protocol
CCMC C-spine Protocol:
NEXUS components

1. All high risk criteria absent
   • MOI: hanging, axial loading mechanism
   • MOI: high risk MVC, diving
     • Altered mental status (GCS <15, intoxication)
     • Focal neurologic deficit or paresthesias in upper extremity
   • Complaint of neck pain
   • Substantial torso injury
   • Condition predisposing for CSI
     • Distracting injury

2. Absence of midline tenderness

3. Normal neck range of motion
CCMC C-spine Protocol: CCR components

1. All high risk criteria absent
   - MOI: hanging, axial loading mechanism
   - MOI: high risk MVC, diving
   - Altered mental status (GCS < 15, intoxication)
   - Focal neurologic deficit or paresthesias in upper extremity
   - Complaint of neck pain
   - Substantial torso injury
   - Condition predisposing for CSI
   - Distracting injury

2. Absence of midline tenderness
3. Normal neck range of motion
CCMC C-spine Protocol: PECARN components

1. All high risk criteria absent
   - MOI: hanging, axial loading mechanism
   - MOI: high risk MVC, diving
   - Altered mental status (GCS < 15, intoxication)
   - Focal neurologic deficit or paresthesias in upper extremity
   - Complaint of neck pain
   - Substantial torso injury
   - Condition predisposing for CSI
   - Distracting injury

2. Absence of midline tenderness
3. Normal neck range of motion
CCMC C-spine Protocol

MOI: Diving, hanging, football ‘spearing’ tackle, other axial loading mechanism, or high risk MVC
Altered Mental Status or signs of intoxication
Distracting injury
Focal neurologic deficit or paresthesias
Complaints of neck pain
Substantial torso injury
Condition predisposing for CSI

Confrontational Exam
Midline tenderness
Decreased Neck ROM

Imaging Indicated

Yes

No

No Imaging Indicated

No
Hypothesis

CCMC C-Spine protocol will identify all cervical spine injuries in children and reduce unnecessary cervical spine CT evaluation.
Initial Objective

To determine the number of cervical spine CT scans that could have been avoided in injured children aged 3 to 17 with application of the NEXUS, CCR and CCMC c-spine protocols.
Methods

• **Design**: Retrospective chart review
  • IRB exempt

• **Inclusion criteria**: Patients 3-17 years who received a cervical spine CT scan for blunt trauma in the ED from 1/2010 to 11/2013

• **North Shore- LIJ Trauma**
  • ACS level I adult trauma center
  • NY state level I pediatric trauma center
<table>
<thead>
<tr>
<th>Demographics</th>
<th>Total (n=486)</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 to &lt;8 yo</td>
<td>54</td>
<td>11%</td>
</tr>
<tr>
<td>8 to &lt;18 yo</td>
<td>432</td>
<td>89%</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>306</td>
<td>63%</td>
</tr>
<tr>
<td>Female</td>
<td>180</td>
<td>37%</td>
</tr>
<tr>
<td><strong>Race</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>211</td>
<td>43%</td>
</tr>
<tr>
<td>Black</td>
<td>126</td>
<td>26%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>29</td>
<td>6%</td>
</tr>
<tr>
<td>Asian</td>
<td>55</td>
<td>11%</td>
</tr>
<tr>
<td>Other</td>
<td>65</td>
<td>13%</td>
</tr>
</tbody>
</table>
## Mechanism of Injury

<table>
<thead>
<tr>
<th>Mechanism of Injury</th>
<th>% of sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Vehicle Collision</td>
<td>18%</td>
</tr>
<tr>
<td>Pedestrian Struck</td>
<td>15%</td>
</tr>
<tr>
<td>Sports Injury</td>
<td>13%</td>
</tr>
<tr>
<td>Fall &gt; 3ft or &gt;5 stairs</td>
<td>12%</td>
</tr>
<tr>
<td>Other*</td>
<td>42%</td>
</tr>
</tbody>
</table>

*Includes: assault, axial load injury, bicycle accident, other motorized vehicle collision, or unknown mechanism*
## Clinically significant CSI in 1%

<table>
<thead>
<tr>
<th>Age</th>
<th>MOI</th>
<th>Diagnosis</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Pedestrian Struck</td>
<td>C3 wedge deformity fracture</td>
<td>Patient deceased due to head trauma</td>
</tr>
<tr>
<td>10</td>
<td>Diving</td>
<td>C7 Fracture</td>
<td>Miami J collar</td>
</tr>
<tr>
<td>12</td>
<td>Diving</td>
<td>C4,C5 compression fracture</td>
<td>Surgical intervention</td>
</tr>
<tr>
<td>13</td>
<td>Bike accident</td>
<td>Rotary subluxation at C1 and C2</td>
<td>Aspen collar</td>
</tr>
<tr>
<td>16</td>
<td>Sports injury</td>
<td>C5 and C6 avulsion fracture</td>
<td>Miami J collar</td>
</tr>
</tbody>
</table>
All CSIs captured 3-7 yo

<table>
<thead>
<tr>
<th>CT SCAN USE</th>
<th>NEXUS</th>
<th>CCR</th>
<th>CCMC C-spine Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicated</td>
<td>61% (33)</td>
<td>70% (38)</td>
<td>83% (45)</td>
</tr>
<tr>
<td>Not Indicated</td>
<td>30% (16)</td>
<td>9% (5)</td>
<td>2% (1)</td>
</tr>
<tr>
<td>Unable to Determine</td>
<td>9% (5)</td>
<td>20% (11)</td>
<td>15% (8)</td>
</tr>
<tr>
<td>CT SCAN USE</td>
<td>NEXUS</td>
<td>CCR</td>
<td>CCMC C-spine Protocol</td>
</tr>
<tr>
<td>---------------</td>
<td>--------</td>
<td>-------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Indicated</td>
<td>70% (303)</td>
<td>58% (250)</td>
<td>89% (384)</td>
</tr>
<tr>
<td>Not Indicated</td>
<td>24% (102)</td>
<td>16% (68)</td>
<td>3% (14)</td>
</tr>
<tr>
<td>Unable to Determine</td>
<td>6% (27)</td>
<td>26% (114)</td>
<td>8% (34)</td>
</tr>
</tbody>
</table>
Summary

- NEXUS and CCR would have reduced imaging utilization
- CCMC c-spine protocol would have identified all injuries, without lowering CT utilization
- **Future Work:** Prospective application of CCMC c-spine protocol
Thank You

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