Background

- Blunt trauma with potential cervical spine injury (CSI) is a frequent reason for presentation to emergency departments in the US.
  - More than 1 million patients treated annually.
- Delay or failure to diagnose injuries has disastrous consequences.
- As a result, emergency physicians often have a low threshold for ordering cervical spine imaging, which leads to high numbers of negative C-spine CT scans.
- Potential to both improve cost-effectiveness and decrease radiation exposure through the use of strict clinical criteria.
Background

- In 2000, the National Emergency X-Radiography Utilization Study (NEXUS) Low-Risk Criteria (NLC) were established to identify patients with a low probability of cervical spine injury.
- One of the standard practices for determining the need for cervical spine imaging in trauma patients.
- Used as part of the ACR Appropriateness Criteria (along with Canadian Cervical Spine Rule CCR).
- Despite the presence of screening tools for cervical spine imaging, many patients continue to be imaged without meeting these criteria.

<table>
<thead>
<tr>
<th>NEXUS Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>- No tenderness at the posterior midline of the cervical spine.</td>
</tr>
<tr>
<td>- No focal neurologic deficit.</td>
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<tr>
<td>- Normal level of alertness.</td>
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<tr>
<td>- No evidence of intoxication.</td>
</tr>
<tr>
<td>- No clinically apparent, painful injury that might distract the patient from the pain of a cervical spine injury.</td>
</tr>
</tbody>
</table>

Purpose

- The purpose of this multi-phase study was to:
  - Analyze the use of screening cervical spine CT performed following blunt trauma in order to establish the number of potentially avoidable studies when strict criteria (NEXUS criteria) are applied.
  - Determine the indications for ordering studies in the absence of guideline criteria.
  - Assess whether introduction of a clinical education program could improve utilization rates.
Project Design

- Project broken into **3 phases**:

  **Phase 1:** Retrospective Evaluation of Utilization
  **Phase 2:** Prospective Evaluation of Utilization
  **Phase 3:** Post-Intervention Evaluation of Utilization

- Phase 1:
  Retrospectively assess use of **screening cervical spine CT** for blunt trauma and whether **strict application of NEXUS criteria** could have reduced the number of unnecessary studies.

  Clinical Education Program

  Survey Introduction
Project Design

- Prospectively establish the number of potentially avoidable cervical spine CT studies based on proper application of established clinical guidelines.
- Determine indications used for ordering studies in the absence of guideline criteria.
- Establish a baseline to assess improvement following intervention.

Phase 1: Retrospective Evaluation of Utilization

Phase 2: Prospective Evaluation of Utilization

Phase 3: Post-Intervention Evaluation of Utilization

Project Design

- Institute a clinical education program for clinicians in the Emergency Department regarding appropriate use of CT in the setting of blunt trauma.
- Assess improvement in utilization of cervical spine CT studies based on proper application of established clinical guidelines.
Phase 1: Retrospective Evaluation of Utilization

Retrospectively assess use of screening cervical spine CT for blunt trauma and whether strict application of NEXUS criteria could have reduced the number of unnecessary studies.
Phase 1: Materials and Methods

- All cervical spine CT studies performed within the Henry Ford Health System on patients over 18 years of age were assessed for:
  - Presence of cervical spine fracture, dislocation or subluxation.
  - Presence of the 5 NEXUS criteria.

**Phase 1: Materials and Methods**

- Total Studies: 2224
- Performed at Satellite Facility: 419
- Level I Trauma Center Studies: 1805
- Included Studies: 1589
- Excluded due to:
  - No documented trauma
  - Presented as outpatient or inpatient
  - Remote trauma (> 48 hours)
  - Penetrating injuries
  - Follow-up of known fracture.
### Phase 1: Results

Griffith et al. *AJR* 2011; 197(2):463-7

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>No Acute Cervical Spine Injury</th>
<th>Positive Cervical Spine Injury</th>
<th>Indeterminate initial study (negative on follow-up)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All studies</strong></td>
<td>1589</td>
<td>1524 (95.9%)</td>
<td>41 (2.6%)</td>
<td>24 (1.5%)</td>
</tr>
<tr>
<td><strong>Positive NEXUS</strong></td>
<td>1217</td>
<td>1160 (95.3%)</td>
<td><strong>37 (3.0%)</strong></td>
<td>20 (1.6%)</td>
</tr>
<tr>
<td>Positive Liberalized NEXUS</td>
<td>1273</td>
<td>1216 (95.5%)</td>
<td>37 (2.9%)</td>
<td>20 (1.6%)</td>
</tr>
<tr>
<td>No NEXUS Documented</td>
<td>372</td>
<td>364 (97.8%)</td>
<td>4 (1.1%)</td>
<td>4 (1.1%)</td>
</tr>
<tr>
<td>No Liberalized NEXUS</td>
<td>316</td>
<td>308 (97.5%)</td>
<td>4 (1.3%)</td>
<td>4 (1.3%)</td>
</tr>
</tbody>
</table>
Phase 1: Conclusions

- **Strict application of NEXUS criteria** prior to cervical spine imaging would have decreased the number of negative studies by **23.9%** (364 fewer studies).
- In this study, 4 patients with cervical spine injury had no documented NEXUS or “liberalized” NEXUS criteria in their charts. However, no potentially missed fractures were unstable or required surgical intervention.
- Despite its retrospective nature, the evidence suggests that despite the presence of clinical screening tools, **many patients continue to be imaged despite having no NEXUS criteria.**

Phase 2: Prospective Evaluation of Utilization

Phase 1: Retrospective Evaluation of Utilization  Phase 2: Prospective Evaluation of Utilization  Phase 3: Post-Intervention Evaluation of Utilization
Phase 2: Purpose

- Given the limitations of a retrospective study, a collaborative prospective study between the departments of radiology and emergency medicine was undertaken.
- The purpose of this study was to:
  - Prospectively establish the number of potentially avoidable cervical spine CT studies based on proper application of established clinical guidelines.
  - Determine indications used for ordering studies in the absence of guideline criteria.
  - Establish a baseline to assess improvement following intervention.

Phase 2: Material and Methods

- All patients presenting in the setting of blunt trauma who underwent screening CT of the cervical spine were eligible for the study.
- Exclusion criteria included: <18 yrs of age; penetrating trauma; transfer patient; remote injury (>48 hours); known cervical spine fracture/dislocation/subluxation.
Phase 2: Material and Methods

- Ordering clinicians completed survey documenting:
  - Mechanism of Injury
  - Indication for ordering study
  - Clinical suspicion for cervical spine injury
- CT interpreted by board-certified radiologist blinded to survey information.

Phase 2: Results
Phase 2: Results

Study Indications (NEXUS criteria present)

Indication for Study (in absence of NEXUS) | 81 total patients
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Dangerous mechanism - Canadian CSR | 24 (29.6%)  
Dangerous mechanism - other | 15 (18.5%)  
Age >65 yrs | 11 (13.6%)  
Paresthesias in extremities | 5 (6.2%)  
Inability to actively rotate neck | 5 (6.2%)  
Paravertebral tenderness | 8 (9.9%)  
Suspicious radiographs | 0  
Intracranial injury on Head CT | 1 (1.2%)  
Complains of neck pain | 33 (40.7%)  
Consulting service requested | 7 (8.6%)  
Other | 4 (4.9%)
**Phase 2: Results**

<table>
<thead>
<tr>
<th>Evaluator</th>
<th>All</th>
<th>Studies Indicated by NEXUS (426)</th>
<th>Studies Not Indicated by NEXUS (81 total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff</td>
<td>115 (22.7%)</td>
<td>104 (90.4%)</td>
<td>11 (9.6%)</td>
</tr>
<tr>
<td>Resident</td>
<td>301 (59.4%)</td>
<td>250 (83.1%)</td>
<td>51 (16.9%)</td>
</tr>
<tr>
<td>PA</td>
<td>45 (8.9%)</td>
<td>36 (80%)</td>
<td>9 (20%)</td>
</tr>
<tr>
<td>NA</td>
<td>46 (9.1%)</td>
<td>36 (78.3%)</td>
<td>10 (21.7%)</td>
</tr>
</tbody>
</table>

**Phase 2: Conclusions**

- **Strict application of NEXUS criteria** prior to imaging would have decreased the number of negative studies by **16.3% (81 fewer studies)**. This is decreased from the **23.9%** observed in the retrospective study.
- In addition, further analysis found that strict application of either the NEXUS criteria or an abbreviated Canadian Cervical Spine Rule (CCR)*, would have still decreased the number of negative studies by **7.6%**.
- **All patients (5) with injury were detected by application of the NEXUS criteria.**

*Abbreviated CCR: Dangerous mechanism, Age > 65 yrs, Paresthesias in extremities, Inability to actively rotate neck*
Phase 2: Conclusions

- While Phase 2 confirmed frequent imaging of patients meeting the NEXUS criteria for non-imaging, the findings suggest potential decrease in over-utilization (23.9% to 16.3%) by institution of a simple survey, perhaps acting as a “reminder” for ordering clinicians.
- Staff physicians demonstrate stricter application of clinical criteria (9.6% overutilization vs. 16.9% for residents and 20% for PAs)
  - Further education, especially of residents and mid-level providers, may decrease over-utilization.

Phase 3: Post-Intervention Evaluation of Utilization
Phase 3: Purpose

- The purpose of the final phase was to assess improvement in cervical spine CT utilization in the setting of blunt trauma following implementation of a clinical education program.

Phase 3: Material and Methods

- A clinical education program was used to educate clinicians responsible for ordering studies in the emergency department regarding:
  - Findings of the prior retrospective and prospective studies.
  - Current clinical guidelines for ordering cervical spine imaging in the setting of blunt trauma with specific emphasis on the ACR appropriateness criteria (CCR and NEXUS).
Phase 3: Results

Strict application of NEXUS criteria would have decreased the number of negative studies by 13.9%. This is decreased from the 16.1% observed in Phase 2 and 23.9% in Phase 1.

Phase 3: Conclusions

- Strict application of NEXUS criteria would have decreased the number of negative studies by 13.9%. This is decreased from the 16.1% observed in Phase 2 and 23.9% in Phase 1.
Phase 3: Conclusions

- When allowing for application of either the NEXUS or abbreviated CCR criteria, the number of negative studies would have decreased by only **4.9%**. This is improved from the **7.6%** in Phase 2 (p = 0.128).

![Over-Utilization by NEXUS or CCR Criteria](image)

Phase 3: Conclusions

- By applying criteria more strictly, the cervical spine injury rate amongst imaged patients increased from **1%** to **2.8%** (p = 0.045).

![Fracture Rate](image)
Even with wide acceptance of clinical screening tools for cervical spine injury, many patients continue to be imaged despite failing to meet appropriate criteria. Following initiation of a clinical education program, the rate of over-utilization decreased from 7.6% to 4.9%. By applying criteria more strictly, the cervical spine injury rate amongst imaged patients increased from 1% to 2.8%. No patients imaged in the absence of appropriate clinical criteria in Phase 2 or Phase 3 were found to have injury of the cervical spine.

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Educating clinicians with regards to ACR appropriateness criteria was effective in improving patient care in the setting of blunt trauma by decreasing the number of unnecessary studies performed. Applying a similar approach to other imaging studies has the potential to decrease imaging “over-utilization” and significantly improve patient care.
Teaching Points

- Recent shifts towards quality-based reimbursement, as well as changes to the maintenance of certification (MOC) process have placed increased emphasis on practice quality improvement (PQI).
- Documenting impact on quality of care is essential to maintaining radiology’s integral role in healthcare delivery.
- Through projects such as this, radiologists can work to improve imaging utilization through practice quality improvement – thereby satisfying an MOC requirement while ensuring patients continue to receive appropriate and effective imaging.

For additional information, please see Exhibit LL-HPE4578 “A Guide to Improving Imaging (Over-)Utilization Through Practice Quality Improvement”

THANK YOU!

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