Guideline Summary NGC-7777

Guideline Title
ACR Appropriateness Criteria® suspected spine trauma.

Bibliographic Source(s)

Guideline Status
This is the current release of the guideline.


The appropriateness criteria are reviewed annually and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

FDA Warning/Regulatory Alert

Note from the National Guideline Clearinghouse: This guideline references a drug(s) for which important revised regulatory and/or warning information has been released.

- September 9, 2010 – Gadolinium-based Contrast Agents: The U.S. Food and Drug Administration (FDA) is requiring changes in the professional labeling for gadolinium-based contrast agents (GBCAs) to minimize the risk of nephrogenic systemic fibrosis (NSF), a rare, but serious, condition associated with the use of GBCAs in certain patients with kidney dysfunction.

Scope
Disease/Condition(s)
Suspected spine trauma

Guideline Category
Diagnosis
Evaluation

Clinical Specialty
Critical Care
Emergency Medicine
Neurological Surgery
Neurology
Orthopedic Surgery
Pediatrics
Radiology

Intended Users
Health Plans
Hospitals
 Managed Care Organizations
Physicians
Utilization Management

Guideline Objective(s)
To evaluate the appropriateness of radiologic procedures in the differential diagnosis and evaluation of spine trauma

Target Population
Patients with suspected spine trauma

**Interventions and Practices Considered**

1. X-ray cervical spine
   - Lateral
   - Anteroposterior (AP) lateral open mouth
   - AP lateral open mouth obliques
   - AP lateral open mouth obliques flexion/extension
2. X-ray thoracic or lumbar spine
3. Computed tomography (CT) cervical spine without contrast
   - With sagittal and coronal reformat
   - Myelography
4. CT thoracic or lumbar spine without contrast
   - Dedicated images with sagittal and coronal reformat or derived from thorax-abdomen-pelvis (TAP) scan
   - Myelography
5. Computed tomography angiography (CTA) of the head and neck
6. Magnetic resonance imaging (MRI) without contrast
   - Cervical spine
   - Thoracic or lumbar spine
7. Magnetic resonance angiography (MRA) neck with contrast
8. Cervicocerebral arteriography

**Major Outcomes Considered**
Utility of radiologic procedures in diagnosis and evaluation of suspected spine trauma

**Methodology**

**Methods Used to Collect/Select the Evidence**
Searches of Electronic Databases

**Description of Methods Used to Collect/Select the Evidence**

**Literature Search Procedure**

The Medline literature search is based on keywords provided by the topic author. The two general classes of keywords are those related to the condition (e.g., ankle pain, fever) and those that describe the diagnostic or therapeutic intervention of interest (e.g., mammography, MRI).

The search terms and parameters are manipulated to produce the most relevant, current evidence to address the American College of Radiology Appropriateness Criteria (ACR AC) topic being reviewed or developed. Combining the clinical conditions and diagnostic modalities or therapeutic procedures narrows the search to be relevant to the topic. Exploding the term "diagnostic imaging" captures relevant results for diagnostic topics.

The following criteria/limits are used in the searches.

1. Articles that have abstracts available and are concerned with humans.
2. Restrict the search to the year prior to the last topic update or in some cases the author of the topic may specify which year range to use in the search. For new topics, the year range is restricted to the last 5 years unless the topic author provides other instructions.
3. May restrict the search to Adults only or Pediatrics only.
4. Articles consisting of only summaries or case reports are often excluded from final results.

The search strategy may be revised to improve the output as needed.

**Number of Source Documents**
The total number of source documents identified as the result of the literature search is not known.

**Methods Used to Assess the Quality and Strength of the Evidence**
Weighting According to a Rating Scheme (Scheme Given)

**Rating Scheme for the Strength of the Evidence**

**Strength of Evidence Key**

Category 1 - The conclusions of the study are valid and strongly supported by study design, analysis, and results.
Category 2 - The conclusions of the study are likely valid, but study design does not permit certainty.
Category 3 - The conclusions of the study may be valid, but the evidence supporting the conclusions is inconclusive or equivocal.

Category 4 - The conclusions of the study may not be valid because the evidence may not be reliable given the study design or analysis.

Methods Used to Analyze the Evidence
Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence
The topic author drafts or revises the narrative text summarizing the evidence found in the literature. American College of Radiology (ACR) staff draft an evidence table based on the analysis of the selected literature. These tables rate the strength of the evidence for all articles included in the narrative text.

The expert panel reviews the narrative text, evidence table, and the supporting literature for each of the topic-variant combinations and assigns an appropriateness rating for each procedure listed in the table. Each individual panel member forms his/her own opinion based on his/her interpretation of the available evidence.

More information about the evidence table development process can be found in the ACR Appropriateness Criteria® Evidence Table Development document (see “Availability of Companion Documents” field).

Methods Used to Formulate the Recommendations
Expert Consensus (Delphi)

Description of Methods Used to Formulate the Recommendations
Modified Delphi Technique
When the data available from existing scientific studies are insufficient, the American College of Radiology Appropriateness Criteria (ACR AC) employs systematic consensus techniques to determine appropriateness. The ACR AC panels use a modified Delphi technique to determine the rating for a specific procedure. A series of surveys are conducted to elicit each individual panelist’s expert opinion of the appropriateness of an imaging or therapeutic procedure for a specific clinical scenario based on the available data. ACR staff distributes surveys to the panelists along with the evidence table and narrative. Each panelist interprets the available evidence and rates each procedure. Voting surveys are completed by panelists without consulting other panelists. The ratings are integers on a scale between 1 and 9, where 1 means the panel member feels the procedure is "least appropriate" and 9 means the panel member feels the procedure is "most appropriate." Each panel member has one vote per round to assign a rating. The surveys are collected and de-identified and the results are tabulated and redistributed after each round. A maximum of three rounds are conducted. The modified Delphi technique enables each panelist to express individual interpretations of the evidence and his or her expert opinion without excessive bias from fellow panelists in a simple, standardized, and economical process.

Consensus among the panel members must be achieved to determine the final rating for each procedure. If eighty percent (80%) of the panel members agree on a single rating or one of two consecutive ratings, the final rating is determined by the rating that is closest to the median of all the ratings. Up to three voting rounds are conducted to achieve consensus.

If consensus is not reached through the modified Delphi technique, the panel is convened by conference call. The strengths and weaknesses of each imaging examination or procedure are discussed and a final rating is proposed. If the panelists on the call agree, the rating is accepted as the panel’s consensus. The document is circulated to all the panelists to make the final determination. If consensus cannot be reached, "No consensus" appears in the rating column and the reasons for this decision are added to the comment sections.

Rating Scheme for the Strength of the Recommendations
Not applicable

Cost Analysis
Published cost analyses were reviewed.

Method of Guideline Validation
Internal Peer Review

Description of Method of Guideline Validation
Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

Recommendations

Major Recommendations

Note from the American College of Radiology (ACR) and the National Guideline Clearinghouse (NGC): ACR has updated its Relative Radiation Level categories and Rating Scale. The Rating Scale now includes categories (1, 2, 3 = Usually not appropriate; 4, 5, 6 = May be appropriate; 7, 8, 9 = Usually appropriate). See the original guideline document for details.

ACR Appropriateness Criteria®
Clinical Condition: Suspected Spine Trauma

**Variant 1:** Cervical spine imaging not indicated by NEXUS or CCR clinical criteria. Patient meets low-risk criteria.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-ray cervical spine</td>
<td>1</td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>CT cervical spine without contrast</td>
<td>1</td>
<td>With sagittal and coronal reformat.</td>
<td>Med</td>
</tr>
<tr>
<td>Myelography and post myelography CT cervical spine</td>
<td>1</td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>CTA head and neck</td>
<td>1</td>
<td></td>
<td>Med</td>
</tr>
<tr>
<td>MRI cervical spine without contrast</td>
<td>1</td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>MRA neck with contrast</td>
<td>1</td>
<td>May be performed without contrast if gadolinium-based agents are contraindicated.</td>
<td>None</td>
</tr>
<tr>
<td>Arteriography cervicalcerebral</td>
<td>1</td>
<td></td>
<td>Med</td>
</tr>
</tbody>
</table>

**Rating Scale:** 1=Least appropriate, 9=Most appropriate

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

**Variant 2:** Suspected acute cervical spine trauma. Imaging indicated by clinical criteria (NEXUS or CCR). Not otherwise specified.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT cervical spine without contrast</td>
<td>9</td>
<td>With sagittal and coronal reformat.</td>
<td>Med</td>
</tr>
<tr>
<td>X-ray cervical spine</td>
<td>6</td>
<td>Lateral view only. Useful if CT reconstructions are not optimal.</td>
<td>Low</td>
</tr>
<tr>
<td>Myelography and post myelography CT cervical spine</td>
<td>1</td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>CTA head and neck</td>
<td>1</td>
<td>See variant 6.</td>
<td>Med</td>
</tr>
<tr>
<td>MRI cervical spine without contrast</td>
<td>1</td>
<td>See variant 3.</td>
<td>None</td>
</tr>
<tr>
<td>MRA neck with contrast</td>
<td>1</td>
<td>See variant 6. May be performed without contrast if gadolinium-based agents are contraindicated.</td>
<td>None</td>
</tr>
<tr>
<td>Arteriography cervicocerebral</td>
<td>1</td>
<td>See variant 6.</td>
<td>Med</td>
</tr>
</tbody>
</table>

**Rating Scale:** 1=Least appropriate, 9=Most appropriate

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

**Variant 3:** Suspected acute cervical spine trauma. Imaging indicated by clinical criteria (NEXUS or CCR). Myelopathy.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT cervical spine without contrast</td>
<td>9</td>
<td>With sagittal and coronal reformat. MRI and CT provide complementary information. It is appropriate to perform both exams.</td>
<td>Med</td>
</tr>
<tr>
<td>MRI cervical spine without contrast</td>
<td>9</td>
<td>MRI and CT provide complementary information. It is appropriate to perform both exams.</td>
<td>None</td>
</tr>
<tr>
<td>X-ray cervical spine</td>
<td>6</td>
<td>Lateral view only. Useful if CT reconstructions are not optimal.</td>
<td>Low</td>
</tr>
<tr>
<td>Myelography and post myelography CT cervical spine</td>
<td>5</td>
<td>If MRI is contraindicated or inconclusive.</td>
<td>High</td>
</tr>
<tr>
<td>CTA head and neck</td>
<td>1</td>
<td>See variant 6.</td>
<td>Med</td>
</tr>
<tr>
<td>MRA neck with contrast</td>
<td>1</td>
<td>See variant 6. May be performed without contrast if gadolinium-based agents are contraindicated.</td>
<td>None</td>
</tr>
<tr>
<td>Arteriography cervicocerebral</td>
<td>1</td>
<td>See variant 6.</td>
<td>Med</td>
</tr>
</tbody>
</table>

**Rating Scale:** 1=Least appropriate, 9=Most appropriate

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

**Variant 4:** Acute cervical spine trauma. Imaging indicated by clinical criteria (NEXUS or CCR). Treatment planning for mechanically unstable spine.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT cervical spine without contrast</td>
<td>9</td>
<td>With sagittal and coronal reformat.</td>
<td>Med</td>
</tr>
<tr>
<td>MRI cervical spine without contrast</td>
<td>8</td>
<td>Useful for thorough evaluation of ligamentous injury.</td>
<td>None</td>
</tr>
<tr>
<td>X-ray cervical spine</td>
<td>6</td>
<td>Lateral view only, or AP, lateral, open mouth, and obliques may be appropriate. Individualized in consultation with ordering physician for surgical planning.</td>
<td>Low</td>
</tr>
<tr>
<td>Myelography and post myelography CT cervical spine</td>
<td>4</td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>CTA head and neck</td>
<td>1</td>
<td>See variant 6.</td>
<td>Med</td>
</tr>
<tr>
<td>MRA neck with contrast</td>
<td>1</td>
<td>See variant 6. May be performed without contrast if gadolinium-based agents are contraindicated.</td>
<td>None</td>
</tr>
<tr>
<td>Arteriography cervicocerebral</td>
<td>1</td>
<td>See variant 6.</td>
<td>Med</td>
</tr>
</tbody>
</table>

**Rating Scale:** 1=Least appropriate, 9=Most appropriate

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.
Variant 5: Suspected acute cervical spine trauma. Imaging indicated by clinical criteria (NEXUS or CCR). Patient persistently clinically unevaluable for >48 hours.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT cervical spine without contrast</td>
<td>9</td>
<td>With sagittal and coronal reformat. Another CT is not needed if already done on initial evaluation.</td>
<td>Med</td>
</tr>
<tr>
<td>MRI cervical spine without contrast</td>
<td>9</td>
<td>To look for ligamentous injury, cord pathology, and edema.</td>
<td>None</td>
</tr>
<tr>
<td>Myelography and post myelography CT cervical spine</td>
<td>2</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>X-ray cervical spine</td>
<td>1</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>CTA head and neck</td>
<td>1</td>
<td>See variant 6.</td>
<td>Med</td>
</tr>
<tr>
<td>MRA neck with contrast</td>
<td>1</td>
<td>See variant 6. May be performed without contrast if gadolinium-based agents are contraindicated.</td>
<td>None</td>
</tr>
<tr>
<td>Arteriography cervicocerebral</td>
<td>1</td>
<td>See variant 6.</td>
<td>Med</td>
</tr>
</tbody>
</table>

**Rating Scale:** 1=Least appropriate, 9=Most appropriate

*Relative Radiation Level*

Variant 6: Suspected acute cervical spine trauma. Imaging indicated by clinical criteria (NEXUS or CCR). Clinical or imaging findings suggest arterial injury.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT cervical spine without contrast</td>
<td>9</td>
<td>With sagittal and coronal reformat. Another CT is not needed if already done on initial evaluation.</td>
<td>Med</td>
</tr>
<tr>
<td>CTA head and neck</td>
<td>9</td>
<td>Either CTA or MRA can be performed depending on institutional preference.</td>
<td>Med</td>
</tr>
<tr>
<td>MRA neck with contrast</td>
<td>9</td>
<td>Either CTA or MRA can be performed depending on institutional preference. May be performed without contrast if gadolinium-based agents are contraindicated. See statement regarding contrast in the text below under &quot;Anticipated Exceptions.&quot;</td>
<td>None</td>
</tr>
<tr>
<td>MRI cervical spine without contrast</td>
<td>8</td>
<td>If neurological deficit present.</td>
<td>None</td>
</tr>
<tr>
<td>Arteriography cervicocerebral</td>
<td>5</td>
<td>For treatment planning or problem solving.</td>
<td>Med</td>
</tr>
<tr>
<td>X-ray cervical spine</td>
<td>1</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Myelography and post myelography CT cervical spine</td>
<td>1</td>
<td>High</td>
<td></td>
</tr>
</tbody>
</table>

**Rating Scale:** 1=Least appropriate, 9=Most appropriate

*Relative Radiation Level*

Variant 7: Suspected acute cervical spine trauma. Imaging indicated by clinical criteria (NEXUS or CCR). Clinical or imaging findings suggest ligamentous injury.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT cervical spine without contrast</td>
<td>9</td>
<td>With sagittal and coronal reformat. Often need both CT and MRI to evaluate soft-tissue and ligamentous damage.</td>
<td>Med</td>
</tr>
<tr>
<td>MRI cervical spine without contrast</td>
<td>8</td>
<td>Often need both CT and MRI to evaluate soft-tissue and ligamentous damage.</td>
<td>None</td>
</tr>
<tr>
<td>X-ray cervical spine</td>
<td>1</td>
<td>If needed for surgical planning. See variant 4.</td>
<td>Low</td>
</tr>
<tr>
<td>Myelography and post myelography CT cervical spine</td>
<td>1</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>CTA head and neck</td>
<td>1</td>
<td>See variant 6.</td>
<td>Med</td>
</tr>
<tr>
<td>MRA neck with contrast</td>
<td>1</td>
<td>See variant 6. May be performed without contrast if gadolinium-based agents are contraindicated.</td>
<td>None</td>
</tr>
<tr>
<td>Arteriography cervicocerebral</td>
<td>1</td>
<td>See variant 6.</td>
<td>Med</td>
</tr>
</tbody>
</table>

**Rating Scale:** 1=Least appropriate, 9=Most appropriate

*Relative Radiation Level*

Variant 8: Suspected cervical spine trauma. Imaging indicated by clinical criteria (NEXUS or CCR). Follow-up imaging on patient with no unstable injury demonstrated initially, but kept in collar for neck pain. Returns for evaluation.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-ray cervical spine</td>
<td>7</td>
<td>AP, lateral, open mouth, obliques, and flexion/extension views.</td>
<td>Low</td>
</tr>
<tr>
<td>CT cervical spine without contrast</td>
<td>1</td>
<td>With sagittal and coronal reformat. May need repeat CT if radiographs suggest a further problem. Not indicated unless follow-up radiographs or clinical examination suggest an abnormality.</td>
<td>Med</td>
</tr>
<tr>
<td>Myelography and post myelography CT cervical spine</td>
<td>1</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>CTA head and neck</td>
<td>1</td>
<td>Med</td>
<td></td>
</tr>
<tr>
<td>MRI cervical spine without contrast</td>
<td>1</td>
<td>May be appropriate if radiographs suggest a further problem. Not</td>
<td>None</td>
</tr>
</tbody>
</table>
Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

**Variant 9: Blunt trauma meeting criteria for thoracic or lumbar imaging. With or without localizing signs.**

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT thoracic or lumbar spine without contrast</td>
<td>9</td>
<td>Dedicated images with sagittal and coronal reformat or derived from TAP scan.</td>
<td>Med</td>
</tr>
<tr>
<td>MRI thoracic or lumbar spine without contrast</td>
<td>9</td>
<td>For cord abnormalities.</td>
<td>None</td>
</tr>
<tr>
<td>Myelography and post myelography CT thoracic or lumbar spine</td>
<td>7</td>
<td>If MRI contraindicated.</td>
<td>High</td>
</tr>
<tr>
<td>X-ray thoracic or lumbar spine</td>
<td>3</td>
<td>Useful for localizing signs.</td>
<td>Med</td>
</tr>
</tbody>
</table>

**Variant 10: Blunt trauma meeting criteria for thoracic or lumbar imaging. Neurologic abnormalities.**

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT thoracic or lumbar spine without contrast</td>
<td>9</td>
<td>Dedicated images with sagittal and coronal reformat or derived from TAP scan.</td>
<td>Med</td>
</tr>
<tr>
<td>MRI thoracic or lumbar spine without contrast</td>
<td>9</td>
<td>For cord abnormalities.</td>
<td>None</td>
</tr>
<tr>
<td>Myelography and post myelography CT thoracic or lumbar spine</td>
<td>7</td>
<td>If MRI contraindicated.</td>
<td>High</td>
</tr>
</tbody>
</table>

**Variant 11: Child, alert, no neck or back pain, neck supple, no distracting injury.**

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-ray cervical spine</td>
<td>5</td>
<td>AP, lateral, and open mouth views. Distracting injury alone is not an indication for thoracolumbar imaging.</td>
<td>Low</td>
</tr>
<tr>
<td>CT cervical spine without contrast</td>
<td>5</td>
<td>With sagittal and coronal reformat. Should not be first-line evaluation.</td>
<td>High</td>
</tr>
<tr>
<td>CT thoracic and lumbar spine without contrast</td>
<td>5</td>
<td>Dedicated images with sagittal and coronal reformat or derived from TAP scan. If TAP CT performed for other reasons, then look at the spine.</td>
<td>High</td>
</tr>
</tbody>
</table>

**Variant 12: Child, alert, no neck or back pain, neck supple, fractured femur.**

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-ray cervical spine</td>
<td>5</td>
<td>AP, lateral, and open mouth views. Distracting injury alone is not an indication for thoracolumbar imaging.</td>
<td>Low</td>
</tr>
<tr>
<td>CT cervical spine without contrast</td>
<td>3</td>
<td>With sagittal and coronal reformat. Should not be first-line evaluation.</td>
<td>High</td>
</tr>
<tr>
<td>CT thoracic and lumbar spine without contrast</td>
<td>3</td>
<td>Dedicated images with sagittal and coronal reformat or derived from TAP scan. If TAP CT performed for other reasons, then look at the spine.</td>
<td>High</td>
</tr>
</tbody>
</table>

**Variant 13: Child with known cervical fracture.**

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT thoracic and lumbar spine without contrast</td>
<td>9</td>
<td>Dedicated images with sagittal and coronal reformat or derived from TAP scan.</td>
<td>High</td>
</tr>
<tr>
<td>X-ray thoracic and lumbar spine</td>
<td>5</td>
<td>Not needed if visualized on TAP scan. Preferred modality.</td>
<td>Med</td>
</tr>
</tbody>
</table>

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.
Variant 14: Child with known thoracic or lumbar fracture.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-ray cervical spine</td>
<td>No consensus</td>
<td>Panel members agreed that further imaging of the spine is indicated but could not agree on the modality. Limited data available.</td>
<td>Low</td>
</tr>
<tr>
<td>CT cervical spine without contrast</td>
<td>No consensus</td>
<td>With sagittal and coronal reformat. Panel members agreed that further imaging of the spine is indicated but could not agree on the modality. Limited data available.</td>
<td>High</td>
</tr>
</tbody>
</table>

Rating Scale: 1=Least appropriate, 9=Most appropriate

*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

**Summary of Literature Review**

**Cervical Spine Imaging**

Evaluation of patients with suspected spine trauma is a controversial topic that involves several specialties, including emergency medicine, trauma surgery, orthopedics, and neurosurgery, as well as radiology. Several questions remain controversial: 1) which patients need imaging, 2) how much imaging is necessary, and 3) exactly what sort of imaging is to be performed. Conservative estimates in the literature indicate that more than one million blunt trauma patients who have the potential for sustaining a cervical spine injury are seen in emergency departments in the United States each year.

The original literature reviewed for the cervical portion of this ACR Appropriateness Criteria® topic included the initial investigations of 5,719 patients with cervical trauma. The literature review for this revision includes data on over 55,000 patients, as well as findings of the National Emergency X-Radiography Utilization Study (NEXUS) on 34,069 patients and from the Canadian C-Spine Rule (CCR) group on 8,924 patients.

Use of multi-detector-row computed tomography (MDCT) instead of radiography has been advocated. Radiography is reserved for evaluating patients suspected of cervical spine injury and those with injuries of the thoracic and lumbar areas where suspicion of injury is low. Investigators have shown that screening computed tomography (CT) of the cervical spine, if performed with MDCT equipment, is faster than radiography. Three-view radiography appeared to offer high sensitivity for spinal injuries with rapid imaging times and at limited cost. With more sensitive imaging techniques now available, CT and magnetic resonance imaging (MRI) have revealed a significant number of fractures and other injuries that are missed on radiography. Using data from the NEXUS study of 34,069 patients evaluated for possible cervical spine injury, the negative predictive value for unstable injuries of a technically adequate 3-view radiograph series accurately interpreted as normal was 99.99% (95% confidence interval 99.9% to 100%). Unfortunately, many patients did not receive technically adequate studies, and some of those that were adequate were inaccurately interpreted as normal.

Other examinations were nonspecifically abnormal and failed to identify the lesion. Overall, there were 1,496 cervical spine injuries identified in this study. Of these, only 932, or 62%, were identified with the radiographs. Five-hundred sixty four injuries were missed on radiographs. Even by a more generous standard—the ability to detect any abnormality, not necessarily all abnormalities—technically adequate radiography recorded a sensitivity of only 89.4%. Radiographs were indeterminate or inadequate in one third of patients with injuries. Note that, since many patients underwent radiography but not CT, some injuries may have been missed in this incomplete evaluation. Therefore, these estimates of the sensitivity of the older technique represent maximums and may overstate the reliability of radiography.

In a study of unconscious intubated patients, one group of investigators reported a sensitivity for lateral radiographs of 39.3% for injuries overall and 51.7% for unstable injuries. CT had sensitivity, specificity, and negative predictive values of 98.1%, 98.8%, and 99.7%, respectively.

In a meta-analysis of seven studies that met strict inclusion criteria, the pooled sensitivity of radiography for detecting patients with cervical spine injury was 52%, while the combined sensitivity of CT was 98%. Screening the cervical spine with MDCT is faster than performing radiography, with far fewer technical failures. It has been suggested that thick-section CT may miss horizontally oriented fractures, and that a single lateral view of C2 should supplement CT. However, sufficiently thin CT sections and multiplanar reconstruction should alleviate this problem. If thin-section CT is available, there is no need for the lateral radiograph provided that the patient is reasonably cooperative in order to prevent motion artifact on the reformat ted images. Although there is no literature directly indicating the required section thickness, 1.25 mm should be thin enough to render the lateral radiograph unnecessary.

One study derived a set of risk prediction rules that endorsed the use of radiography for low-risk patients. In this study, they used an estimated sensitivity of radiography for detecting injuries of 94% by excluding all studies in which CT results were considered in determining the sensitivity of radiography. This group noted that their values for the sensitivity of radiography were probably overestimates. By excluding cases in which the fractures were found only on CT, but there were no clinical findings associated with the injury, they excluded cases in which CT revealed significant findings and for which prophylactic treatment was effective. They also excluded fractures of the transverse foramen with possible vertebral artery injury, which, if confirmed, may be treated with anticoagulation. The values for CT sensitivity likely were underestimates, being based on older technology and thick-section imaging. Given the far lower estimates of radiography sensitivity discussed above and the higher expected sensitivity of CT, their recommendations may be obsolete.

The panel concluded that thin-section CT, and not radiography, is the primary screening study for suspected cervical spine injury. The 3-view radiographic study should be performed only when CT is not readily available and should not be considered a substitute for CT. Furthermore, the panel recommended that sagittal and coronal multiplanar reconstruction from the axial CT images be performed for all studies to improve identification and characterization of fractures and subluxations.

Concerns about cost and radiation require careful selection of patients who truly are at risk and need imaging. The most significant studies in this respect evaluated the NEXUS and CCR criteria for cervical spine imaging. Both criteria, evaluated on one group of over 34,000 patients (NEXUS) or another of nearly 9,000 patients (CCR), produced similar high sensitivities for identifying patients at risk for significant spine injury. An attempt to compare the CCR to the
NEXUS criteria by applying both to the same patients indicated that CCR performed better, but it generated controversy about the accuracy of this conclusion. The ACR does not take a position on the relative merits of the two sets of criteria, but it recognizes that both are in widespread clinical practice, that they produce concordant predictions for most patients, and that these ACR Appropriateness Criteria® may be applied to either decision rule.

The guidelines proposed by each of these studies are listed in Appendix 1 of the original guideline document.

The NEXUS criteria have been evaluated in children and found to be reliable. However, there were few cervical spine injuries among the 3,065 children evaluated and fewer among those less than 9 years of age. Thus, the 95% confidence interval for the sensitivity of the NEXUS criteria for children was 87.8% to 100%. If the lower value is the correct figure, this would argue for a more aggressive imaging strategy. The authors did not discuss radiation doses involved, but it is notable that only 0.98% of children subjected to radiography were found to have spinal injuries. This implies that the level of radiography in this study may have been excessive.

A smaller, more recent study evaluated 1,692 pediatric patients with possible spinal injury. Retrospective application of the NEXUS criteria suggested that NEXUS should be reliable in children. However, the recommended protocol included radiography immediately followed by one or more clinical assessment findings. With CT imaging later or performed afterward if necessary. There was no discussion of radiation dose, but it was troubling to observe an increase in CT utilization from 9% to 21% of patients in two phases of the study without an apparent increase in sensitivity for detecting spinal lesions. The authors noted that the increase in CT utilization was due to practices at the initial admitting hospital rather than at the referral center where the protocol was implemented.

The high utilization of radiography raises concerns about radiation doses resulting from this approach. The findings did suggest that radiography, rather than CT, may be suitable in children. Another recent review recommended radiography rather than CT as the initial imaging study in suspected cervical spine injury in children. In none of these studies did the authors attempt to determine independently the reliability of radiography and CT. The panel concludes that there is adequate evidence to support applying the NEXUS criteria to older children, that the risk of missing fractures with radiography is low, and that CT imaging should be optimized to use appropriately reduced doses. There is not sufficient evidence to establish the reliability of the NEXUS criteria in younger children or to recommend whether radiography or CT should be the initial imaging study.

Injuries to Ligaments, Joint Capsules, and Other Soft Tissues

The vast majority of cervical spine injuries after severe trauma involve the ligaments, joint capsules, intervertebral disks, and cartilaginous endplates. In a review of autopsy material of patients with fatal craniofacial trauma, fine-detail specimen radiographs were correlated with inspection of cryosections of the excised spinal column. One-hundred-ninety-eight facet, ligament, and disk lesions were matched on the radiographs. These figures dwarf the relatively small number of fractures present, although every patient had at least one fracture. As might be expected, the radiographs missed nearly all of these lesions.

An autopsy study confined to cases in which radiographs were normal found 82 soft-tissue lesions in 16 spines. A similar study performed with radiography, MRI, and cryosections reported a total of 28 lesions. Only three of them were fractures, and only one fracture was identified on whole-specimen radiography. Blinded reading of the MRIs detected only 11 of 28 lesions. Thus, both MRI and radiography have distressingly low sensitivity for detecting soft-tissue injuries after trauma, with MRI the better of the two.

When the analysis is confined to those lesions that appear to be clinically significant, the situation brightens somewhat. Numerous reports have documented low rates of undiagnosed spine injuries that either required later repair or led to clinical deterioration.

Both MRI and flexion and extension (FE) radiography are used to diagnose ligamentous injury. Although MRI has a much higher rate of positive studies, it is not clear how many of those lesions identified on MRI but not with FE radiographs are clinically significant. The prevalence of unstable ligamentous injury in survivors of trauma has been estimated at 0.9% by FE radiography. MRI studies have estimated a prevalence of 23%, but since MRI did not directly assess stability, the implications for structural integrity of the spine remain unknown. In many instances, surgery was performed, but by routes that precluded assessing the apparently ruptured ligaments (for example, posterior fusion when the apparent lesion involved the anterior or posterior longitudinal ligaments).

Recent analyses have been uniformly negative in their assessment of the utility of static FE radiography or dynamic fluoroscopy (DF) for detecting cervical spine ligamentous injuries. One group of investigators reported only 4% of fluoroscopic studies visualizing the C7-T1 level. FE studies missed one case of severe instability and subluxation. Another group reported 837 FE series in trauma patients. Of these, 236 (28%) were technically inadequate. Of 33 positive studies, four potentially identified previously unknown instability, one was subsequently concluded to be false positive, and the other three were considered to be minor injuries, treated with collars. Another group reported 123 FE studies in trauma patients. The studies were false negative in four of seven patients with injuries. The authors concluded that the technique is too unreliable for use in trauma patients. Another group reported on 276 patients studied with DF. Of these, nine were inadequate, six were false positive, one was false negative, and there were no true positives. Another group reported findings of DF in 301 trauma patients. There were two true positive studies, both false negatives; one false positive; one false negative; and one false positive related to the DF examination. A more recent study concluded that DF offered no real advantage over helical CT. In summary, the low rate of technically adequate studies, low sensitivity, and high false positive rate leave little to recommend DF or FE in evaluation of trauma patients.

FE and DF may be useful in evaluating potential ligamentous injury in patients who have equivocal MRI examinations. These radiographic techniques would be most appropriate when the MRI has demonstrated abnormal signal in spinal ligaments without definite disruption. In this situation, where the level and nature of suspected lesion are known, FE or DF may aid in assessing the significance of the MRI findings.

The high sensitivity of MRI has led to a reputation for generating a large number of false positive examinations. In light of the postmortem data, it appears that MRI accurately demonstrates lesions in the ligaments, but that many of these are clinically insignificant. There are not, as yet, established criteria for distinguishing significant from inconsequential apparent abnormalities on MRI. In the absence of proven guidelines, many physicians use through-and-through tears of ligaments as indicating definite mechanical failure, with lesser evidence of injury, such as simple high signal on T2-weighted images, being considered ambiguous. These less specific findings tend to be incorporated with clinical findings, evidence of subluxation and other imaging findings, mechanism of injury, and likelihood of successful compliance with conservative treatment.
MRI reportedly has low sensitivity for detecting ligamentous injury if performed more than 48 hours after trauma. However, these assertions are based on inadequately documented anecdotes, with poor image quality and no evidence that delays between injury and imaging were responsible for false negative findings. The panel finds no evidence that MRI is more than 48 hours after injury is of lower sensitivity than acute MRI imaging. Instead, the recommendation to perform MRI within 48 hours is due to concerns about keeping patients in collars unnecessarily for prolonged periods of time. This guideline is also based on recognition that many patients with drug- or trauma-induced obtundation will recover to the point that a reliable neurologic examination may be performed within this time period.

The role of CT is still hotly debated, with evidence supporting its use for "clearing" the cervical spine in obtunded or unreliable patients countered by evidence favoring MRI. A group of authors found that CT with reconstructed sagittal and coronal images was just as effective as MRI for ruling out an unstable injury. Their findings were supported by the work of another group who found that while MRI identified microvascular fractures, intraspinal ligament injuries, cord signal abnormalities, and an epidural hematoma in neurologically intact patients, in none of the cases was management changed. Most recently, a study reported results on 690 patients and found that MRI identified acute traumatic findings in 38 of 180 patients who had normal CT and neurologic examinations. None of the patients had an unstable injury, or needed surgery, or developed delayed instabilities. They concluded that modern CT imaging protocols are adequate for clearing the spine in obtunded patients without neurologic deficits.

This most recent work supports the study of 366 patients who were assessed with MDCT and MRI for instability. The authors found that CT produced negative predictive values of 99% for ligamentous injury and 100% for unstable cervical spine injury, respectively.

They concluded that MRI may not be needed for detecting ligamentous injuries in obtunded patients. However, another study reported abnormal CT only in a small portion of patients who were found to have ligamentous injury on MRI.

Two additional recent studies concluded that CT alone was inadequate for "clearing" the spine in obtunded or unreliable patients. One of the studies went as far as saying that MRI should be considered the gold standard for this purpose. Finally, there are the recommendations of another group of authors who favored the combination of CT with MRI in obtunded patients. Thus, the recent literature adds more confusion than clarification.

The likelihood of abnormal CT in patients with ligamentous injury remains uncertain. Of course, there are other reasons for performing these MRI examinations, such as detecting cord contusions and compression. To that extent, the panel feels that both studies are appropriate in obtunded patients.

Overall, these results imply that soft-tissue injuries are quite common after significant trauma, and many of these lesions do not lead to mechanical instability. MRI detects many significant lesions, but misses others. It also detects many clinically insignificant lesions. DF and FE are less sensitive than MRI in identifying unstable injuries. The panel recommends that MRI be used to evaluate the cervical spine in patients whose neurologic status cannot be fully evaluated within 48 hours of injury, including those in whom the CT examination is normal. The panel recommends that FE radiography or DF be reserved for problem solving in patients in whom there remains a concern for ligamentous injury after a normal or equivocal MRI examination.

FE radiography does have a role for patients who have normal initial studies (CT and MRI), but who are treated with collars for persistent neck pain. After resolution of pain, these patients return for assessment of spinal stability before discontinuing the collar. At this time, FE radiographs can contribute to evaluation.

**Spinal Cord Imaging**

MRI is valuable for characterizing the cause of myelopathy in patients with spinal cord injury. The severity of the injury—including extent of intramedullary hemorrhage, length of edema, and evidence of cord transaction—contributes to predicting outcome. Compression of the cord by disk herniations, bone fragments, and hematomas is best displayed on MRI, and MR images may be used to guide surgical intervention. For these reasons, the MRI examination should include T2-weighted images as well as gradient echo images. In the subacute and chronic stages after cord trauma, MRI can help define the extent of cord injury. This is particularly important in patients who suffer late deterioration, which is sometimes caused by treatable etiologies such as development or enlargement of intramedullary cavities.

Although numerous research studies have reported a potential value of diffusion MRI for characterizing spinal cord injury, technical problems have prevented widespread application of this technique to human studies. The current utility of diffusion MRI for cord trauma remains unknown.

**Associated Vascular Injury**

Arterial injury can be a concern in blunt and penetrating spinal injury. These injuries can include transection, pseudoaneurysm formation, and simple dissection. In cases of active bleeding, urgent intervention is indicated. Both CT and MRI have value in detecting hematoma accumulation. Acute traumatic pseudoaneurysms are not necessarily treated immediately, and may be followed with later surgery, stenting, or occlusion depending on the location of the lesion and which vessel is involved.

Dissections may or may not produce stenosis of the affected artery. If there is arterial narrowing, it may be detected with computed tomography angiography (CTA) or magnetic resonance angiography (MRA). The presence of dissection itself is generally taken to represent a risk for thrombus formation and subsequent embolization. For this reason, these patients will often be treated with anticoagulation or antiplatelet agents unless contraindicated by other conditions such as massive multisystem trauma. If there is concern of dissection, demonstration of an intramural hematoma may lead to treatment. For this purpose, MRI with fat suppression and T1-weighted and T2-weighted images perpendicular to the course of the vessel has been very useful, especially with the application of superior and inferior saturation pulses. Use of three-dimensional (3D) time of flight with intravenously administered gadolinium contrast may greatly improve depiction of the vessels. MRA has been a useful adjunct for demonstrating arterial narrowing and pseudoaneurysm formation. More recently, CTA has become a viable alternative to MRA, although the anterior and posterior uncinate processes forming the transverse foramina may partially obscure the vertebral arteries when the raw data are manipulated at a 3D workstation.

This tidy summary is confounded by the low risk of carotid artery injury in blunt trauma, disagreement over the utility of screening for blunt carotid injury, and disagreement about the necessity of treating dissections with heparin. Transverse foramen fractures and complex fractures with subluxation do indicate an increased risk of vertebral artery injury. The available evidence on the performance of CTA for detecting dissection has been discouraging, with low reported sensitivities in several studies. Note that the performance of MRA has been similarly uninspiring. These
studies apparently did not include transverse T1-weighted imaging. However, attempts to characterize CTA over the last few years have been compromised by rapidly changing technology, and more recent articles have been more encouraging. The ability of CT or CTA to detect intramural hematomas remains unknown.

**Thoracic and Lumbar Spine Imaging**

The literature review for thoracic and lumbar injuries included data on several thousand patients. There are far fewer data concerning the indications for imaging the thoracic and lumbar (TL) spine. In contrast to multiple prospective studies of several thousand patients in each for the cervical spine, the largest of these TL studies has 1,000 patients, and many are far smaller, with several hundred or fewer. Therefore the recommendations based on these reports are less definitive than those for cervical imaging.

The presence of distracting injuries has been postulated to be an indication for screening for thoracolumbar spine fractures. The authors of that study found that osseous fractures yielded a sufficiently high proportion of spinal fractures on screening CT to justify its use, but that laceration, contusions, and other soft-tissue injuries rarely implied spinal fractures. Thoracolumbar spine injuries are often multiple and frequently are missed in patients with multiple other injuries. The authors of this study concluded that high-energy injury mechanisms imply a substantial risk of TL spine fractures. A comprehensive review of the literature led to recommendations to image the TL spine if any of the following are present: 1) back pain or midline tenderness, 2) local signs of thoracolumbar injury, 3) abnormal neurological signs, 4) cervical spine fracture, 5) Glasgow Coma Score (GCS) <15, 6) major distracting injury, 7) alcohol or drug intoxication. Fractures found in one level of the spine indicate an increased risk of spinal fractures elsewhere. Thus, identification of a spinal fracture may imply a need to survey the remainder of the spine.

MDCT is now the imaging procedure of choice for evaluating trauma patients. A number of authors have recommended using reformatted images of the thoracic and lumbar spine from thorax-abdomen-pelvis body (TAP) scans. However, none of these reports directly assessed the value of acquired axial images, for detecting or characterizing TL spinal injuries. These authors firmly establish the superiority of the spine images obtained during torso CT over radiographs for detecting TL spinal injuries. The role of reformatted images is not addressed, nor are other technical considerations such as the importance of section thickness, reconstruction field of view, and reconstruction algorithm. Thus, the literature supports the appropriateness of using the spine images obtained as part of torso CT for evaluating the spine in trauma patients. These images are clearly superior to radiographs. There are no data directly assessing the need for reformatted images, but the committee agrees that it is appropriate to reformat the axial images, since this involves no additional cost or radiation and may improve characterization of alignment.

Regarding pediatric patients, the literature is even more deficient where suspected thoracic and/or lumbar injuries are concerned than it is for suspected injuries in the cervical region. The experience of the panelists has been that thoracic and lumbar injuries to the pediatric age group are not as subtle as those in adults, and that radiography is adequate in most instances to delineate those injuries. If the child undergoes a CT study of TAP, spine images, reconstructed at a thinner slice thickness, may be used, similar to studies in adults. Direct thoracic or lumbar CT carries a higher radiation dosage than radiography. Nonetheless, CT may be used selectively for problem solving as a supplement to thoracic and lumbar radiographs.

Since spine images are now effectively obtained in all patients who undergo torso CT, the indications for spine imaging assume less importance than the indications for obtaining torso CT. One group of investigators reported the results of liberal use of “pan scan” in blunt trauma patients and found a high rate of positive studies. They suggested that the following criteria should be used: “1) no visible evidence of chest or abdominal injury, 2) hemodynamically stable, 3) normal abdominal examination results in neurologically intact patients or uneventful abdominal examination results secondary to a depressed level of consciousness, and 4) significant mechanisms of injury as any of the following: 1) motor vehicle crash at greater than 35 mph, 2) falls of greater than 15 ft, 3) automobile hitting pedestrian with pedestrian present more than 10 ft away and 4) assaulted with a depressed level of consciousness.” Although the authors provided little information on the yield of spine injuries, they argued that the number of other injuries identified justified liberal use of CT scanning.

Therefore, it is appropriate to perform careful review of spine images obtained in the course of performing torso CT in trauma patients. The literature does not define minimum section thickness, maximum voxel dimensions, or other optimal technical factors for these images.

Isolated unstable ligamentous injury in the absence of fractures appears to be extremely rare in the TL spine, if it occurs at all. For this reason, screening the TL spine with MRI for detecting ligamentous disruption is not indicated when the CT is normal. As is the case for the cervical spine, a myelopathy indicates the need for imaging the symptomatic levels of the spine and spinal cord with MRI.

**Summary and Recommendations**

Adult patients who satisfy any of several “low-risk” criteria for cervical spine injury established in large multi-institutional studies need no imaging. Patients who do not fall into this category should undergo a thin-section CT examination that includes sagittal and coronal multiplanar reconstructed images. In most instances, the cervical CT examination will be performed immediately after the CT suite. This is both time-effective and cost-effective. For those patients who are unable to be examined by CT, a 3-view radiographic examination of the cervical vertebrae may be performed to provide a preliminary assessment of the likelihood of injury until a CT can be obtained.

MRI should be the primary modality for evaluating possible ligamentous injuries in acute cervical spine trauma. FE radiographs and dynamic fluoroscopy are of limited value in the acute trauma setting. MRI also provides crucial information about cord contusion and compression that cannot be obtained by any other means. FE radiography is best reserved for follow-up of symptomatic patients after neck pain has subsided.

The literature is sparse regarding pediatric patients. Children younger than age 14 do not suffer the same types of injuries that adults do. The majority of injuries in this age group are in the occiput-C1, C2 region. Typically, those injuries are readily identifiable on AP, lateral, and open mouth radiographs. Children 14 years of age and older should be treated as adults, since their spines have fully developed. Considerations regarding radiation exposure should be paramount in this age group. Initial evaluation of patients younger than age 14 should be with radiography (3-views) regardless of mental status. Evaluation of the thoracic and lumbar spine should be by radiography (AP, lateral) unless the patient has already had a CT examination of the chest, abdomen, and pelvis. In that case, reconstructed images of the spine from those studies can be done in a similar case to adults. CT should be used selectively in these patients for
problem solving as a supplement to radiographs.

The literature provides limited support for indications for thoracic and lumbar spine imaging (see Appendix 1 in the original guideline document). MDCT is the procedure of choice for this purpose. In patients who undergo torso CT, the images will be adequate to evaluate the spine. Because the incidence of multiple noncontiguous fractures is as high as 25%, the panel recommends imaging of the entire spine when there are known fractures in any segment.

MRI should be performed in patients who have possible spinal cord injury, in whom there is clinical concern for cord compression due to disk protrusion or hematoma, and in those suspected of ligamentous instability. Although there is encouraging evidence that MDCT is adequate for "clearing" the cervical spine, the subject is still controversial. The panel recommends that MRI be used to evaluate the cervical spine in patients whose neurologic status cannot be fully evaluated after 48 hours, including those in whom the CT examination is normal.

**Anticipated Exceptions**

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (i.e., <30 mL/min/1.73 m²), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73 m². For more information, please see the American College of Radiology (ACR) Manual on Contrast Media (see the “Availability of Companion Documents” field).

**Abbreviations**

- AP, anteroposterior
- CCR, Canadian C-Spine Rule
- CT, computed tomography
- CTA, computed tomography angiography
- Med, medium
- MR, magnetic resonance
- MRA, magnetic resonance angiography
- MRI, magnetic resonance imaging
- NEXUS, National Emergency X-Radiography Utilization Study
- TAP, thorax-abdomen-pelvis

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**Clinical Algorithm(s)**

None provided

**Evidence Supporting the Recommendations**

**Type of Evidence Supporting the Recommendations**

The recommendations are based on analysis of the current literature and expert panel consensus.

**Benefits/Harms of Implementing the Guideline Recommendations**

**Potential Benefits**

Selection of appropriate radiologic imaging procedures for suspected spine trauma

**Potential Harms**

Flexion and extension (FE) radiography and dynamic fluoroscopy (DF) may render false positive and false negative results and are of limited value in the acute trauma setting.

**Gadolinium-based Contrast Agents**

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (i.e., <30 mL/min/1.73 m²), and almost never in other patients. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73 m². For more information, please see the American College of Radiology (ACR) Manual on Contrast Media (see the
Relative Radiation Level (RRL)
Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, an RRL indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document (see "Availability of Companion Documents" field).

Qualifying Statements

The American College of Radiology (ACR) Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists, and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those exams generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

Implementation of the Guideline

Description of Implementation Strategy
An implementation strategy was not provided.

Implementation Tools
Personal Digital Assistant (PDA) Downloads
For information about availability, see the Availability of Companion Documents and Patient Resources fields below.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need
Getting Better

IOM Domain
Effectiveness

Identifying Information and Availability

Bibliographic Source(s)

Adaptation
Not applicable: The guideline was not adapted from another source.

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Guideline Committee
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Financial Disclosures/Conflicts of Interest

Not stated

Guideline Status

This is the current release of the guideline.

The appropriateness criteria are reviewed annually and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

Guideline Availability

Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site.


Print copies: Available from the American College of Radiology, 1891 Preston White Drive, Reston, VA 20191. Telephone: (703) 648-8900.

Availability of Companion Documents

The following are available:


Patient Resources

None available

NGC Status

This NGC summary was completed by ECRI Institute on December 20, 2007. This NGC summary was updated by ECRI Institute on May 21, 2010. This summary was updated by ECRI Institute on January 13, 2011 following the U.S. Food and Drug Administration (FDA) advisory on gadolinium-based contrast agents.

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