A Clinician’s Guide to the Appropriate Utilization of Diagnostic Imaging Studies

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This educational activity is jointly sponsored by UPSTATE Medical University and Atlantic Medical Imaging

6.0 credits
REMINDER

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Low Back Pain

Disc Disease: semantics and ongoing debates about cause/effect

RM Glassberg, M.D.
Low Back Pain

• When should you order an imaging study
• Which imaging study should be requested
• Unknown cases
Differential Diagnosis of Low Back Pain

- Back Strain
- Acute disc herniation
- Osteoarthritis
- Spinal Stenosis
- Spondylolysis/Spondylolisthesis
- Ankylosing Spondylitis
- Infection
- Malignancy
- Compression fracture
When should you order an imaging study
Unknown Case #1

• 34 year old male with acute onset low back pain following a lifting injury at work.

• What study should be ordered?
Which study should you order for 34 year old with acute onset back pain?

• MRI L-spine
• CT L-spine
• L spine x-ray
• Bone scan
Do not image uncomplicated acute low back pain

- Acute low back pain (LBP) with or without radiculopathy is one of the most common health problems in the United States and is the leading cause of disability for persons younger than age 45. The cost of evaluating and treating acute LBP runs into billions of dollars annually, not including time lost from work.

- It is now clear that uncomplicated acute LBP or radiculopathy is a benign, self-limited condition that does not warrant any imaging studies.

ACR Guidelines
Consider imaging for those with no improvement after 6 weeks or the following red flags

Indications of a more complicated status include back pain/radiculopathy in the following settings:

- Trauma, cumulative trauma
- Unexplained weight loss, insidious onset
- Age >50 years, especially women, and males with osteoporosis or compression fracture
- Unexplained fever, history of urinary or other infection
- Immunosuppression, diabetes mellitus
- History of cancer
- Intravenous (IV) drug use
- Prolonged use of corticosteroids, osteoporosis
- Age >70
- Focal neurologic deficit(s) with progressive or disabling symptoms, cauda equina syndrome
- Duration longer than 6 weeks
- Prior surgery
Patient with low back pain

Idiopathic back pain (No red flag)

Self care ± pharmacotherapy ± other noninvasive therapies based on severity of pain and level of disability, consider multidisciplinary approach for patients not responsive to usual care, follow-up in 6 weeks

Improvement in patient pain

Patient education and self-care, follow-up in 6 weeks, if needed

Radiculopathy or spinal stenosis

< 6 Weeks

No improvement, signs and symptoms of severe radiculopathy or spinal stenosis (back or leg pain relieved by sitting)

Consider imaging (if not done yet) and referral for potentially invasive procedures, if needed

Red flags exist (Suspicion for serious spine problems)

Complete workup (e.g., imaging, blood test, etc.)

Any primary spine lesion found?

No

Yes

Treat accordingly

> 6 Weeks

No improvement, no signs or symptoms of radiculopathy or spinal stenosis

Reassess for red flags, consider required workup including imaging, and reassess psychosocial characteristics of the patient
American College of Radiology (ACR)

• ACR has established **appropriateness criteria** for many clinical situations.

• On the ACR website, you can find these criteria


• These criteria are a great reference for deciding the best imaging study to order.

• AMI Radiologists
The Profession of Radiology

I am a Radiologist
To save time,
Let's just assume
That I am never wrong
Appropriateness Criteria (ACR)

Low Back Pain

• Variant 1: Uncomplicated acute low back pain and/or radiculopathy, nonsurgical presentation. No red flags.

• Variant 2: Patient with one or more of the following: low velocity trauma, osteoporosis, focal and/or progressive deficit, prolonged symptom duration, age >70.

• Variant 3: Patient with one or more of the following: Suspicion of cancer, infection, and/or immunosuppression.
Appropriateness Criteria (ACR)  
Low Back Pain

• Variant 4: Low back pain and/or radiculopathy. Surgery or interventional candidate.

• Variant 5: Prior lumbar surgery.

• Variant 6: Cauda equina syndrome, multifocal deficits or progressive deficit.
**Clinical Condition:** Low Back Pain

**Variant 1:** Uncomplicated acute low back pain and/or radiculopathy, nonsurgical presentation. No red flags. (Red flags defined in the text below.)

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI lumbar spine without contrast</td>
<td>2</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>X-ray lumbar spine</td>
<td>2</td>
<td></td>
<td>📏</td>
</tr>
<tr>
<td>Myelography and postmyelography CT lumbar spine</td>
<td>2</td>
<td>In some cases postinjection CT imaging may be done without plain-film myelography.</td>
<td>📏</td>
</tr>
<tr>
<td>X-ray myelography lumbar spine</td>
<td>2</td>
<td></td>
<td>📏</td>
</tr>
<tr>
<td>Tc-99m bone scan with SPECT spine</td>
<td>2</td>
<td></td>
<td>📏</td>
</tr>
<tr>
<td>CT lumbar spine without contrast</td>
<td>2</td>
<td></td>
<td>📏</td>
</tr>
<tr>
<td>CT lumbar spine with contrast</td>
<td>2</td>
<td></td>
<td>📏</td>
</tr>
<tr>
<td>MRI lumbar spine without and with contrast</td>
<td>2</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>CT lumbar spine without and with contrast</td>
<td>1</td>
<td></td>
<td>📏</td>
</tr>
</tbody>
</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level*
### Relative Radiation Level Designations

<table>
<thead>
<tr>
<th>Relative Radiation Level*</th>
<th>Adult Effective Dose Estimate Range</th>
<th>Pediatric Effective Dose Estimate Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0 mSv</td>
<td>0 mSv</td>
</tr>
<tr>
<td>★</td>
<td>&lt;0.1 mSv</td>
<td>&lt;0.03 mSv</td>
</tr>
<tr>
<td>★★</td>
<td>0.1-1 mSv</td>
<td>0.03-0.3 mSv</td>
</tr>
<tr>
<td>★★★</td>
<td>1-10 mSv</td>
<td>0.3-3 mSv</td>
</tr>
<tr>
<td>★★★★</td>
<td>10-30 mSv</td>
<td>3-10 mSv</td>
</tr>
<tr>
<td>★★★★★</td>
<td>30-100 mSv</td>
<td>10-30 mSv</td>
</tr>
</tbody>
</table>

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as NS (not specified).*
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhalation of air</td>
<td>1.26</td>
<td>2.28</td>
<td>0.40</td>
<td>mainly from radon, depends on indoor accumulation</td>
</tr>
<tr>
<td>Ingestion of food &amp; water</td>
<td>0.29</td>
<td>0.28</td>
<td>0.40</td>
<td>(K-40, C-14, etc.)</td>
</tr>
<tr>
<td>Terrestrial radiation from ground</td>
<td>0.48</td>
<td>0.21</td>
<td>0.40</td>
<td>depends on soil and building material</td>
</tr>
<tr>
<td>Cosmic radiation from space</td>
<td>0.39</td>
<td>0.33</td>
<td>0.30</td>
<td>depends on altitude</td>
</tr>
<tr>
<td><strong>sub total (natural)</strong></td>
<td><strong>2.40</strong></td>
<td><strong>3.10</strong></td>
<td><strong>1.50</strong></td>
<td>sizeable population groups receive 10-20 mSv</td>
</tr>
<tr>
<td>Medical</td>
<td>0.60</td>
<td>3.00</td>
<td>2.30</td>
<td>world-wide figure excludes radiotherapy; US figure is mostly CT scans and nuclear medicine.</td>
</tr>
<tr>
<td>Consumer items</td>
<td>-</td>
<td>0.13</td>
<td></td>
<td>cigarettes, air travel, building materials, etc.</td>
</tr>
<tr>
<td>Atmospheric nuclear testing</td>
<td>0.005</td>
<td>-</td>
<td>0.01</td>
<td>peak of 0.11 mSv in 1963 and declining since; higher near sites</td>
</tr>
<tr>
<td>Occupational exposure</td>
<td>0.005</td>
<td>0.005</td>
<td>0.01</td>
<td>world-wide average to all workers is 0.7 mSv, mostly due to radon in mines;[1] US is mostly due to medical and aviation workers.[2]</td>
</tr>
<tr>
<td>Chernobyl accident</td>
<td>0.002</td>
<td>-</td>
<td>0.01</td>
<td>peak of 0.04 mSv in 1986 and declining since; higher near site</td>
</tr>
<tr>
<td>Nuclear fuel cycle</td>
<td>0.0002</td>
<td>0.001</td>
<td></td>
<td>up to 0.02 mSv near sites; excludes occupational exposure</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
<td>0.003</td>
<td></td>
<td>Industrial, security, medical, educational, and research</td>
</tr>
<tr>
<td><strong>sub total (artificial)</strong></td>
<td><strong>0.61</strong></td>
<td><strong>3.14</strong></td>
<td><strong>2.33</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3.01</strong></td>
<td><strong>6.24</strong></td>
<td><strong>3.83</strong></td>
<td>millisievert per year</td>
</tr>
</tbody>
</table>
**Variant 2:** Patient with one or more of the following: low velocity trauma, osteoporosis, focal and/or progressive deficit, prolonged symptom duration, age >70 years.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI lumbar spine without contrast</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT lumbar spine without contrast</td>
<td>6</td>
<td>MRI preferred. CT useful if MRI is contraindicated or unavailable, and/or for problem solving.</td>
<td></td>
</tr>
<tr>
<td>X-ray lumbar spine</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tc-99m bone scan with SPECT spine</td>
<td>4</td>
<td>SPECT/CT may be useful for anatomic localization and problem solving.</td>
<td></td>
</tr>
<tr>
<td>MRI lumbar spine without and with contrast</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT lumbar spine with contrast</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT lumbar spine without and with contrast</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myelography and postmyelography CT lumbar spine</td>
<td>1</td>
<td>In some cases postinjection CT imaging may be done without plain-film myelography.</td>
<td></td>
</tr>
<tr>
<td>X-ray myelography lumbar spine</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-ray discography lumbar spine</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-ray discography and post-discography CT lumbar spine</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level*
**Variant 3:** Patient with one or more of the following: suspicion of cancer, infection, and/or immunosuppression.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI lumbar spine without and with contrast</td>
<td>8</td>
<td>Contrast useful for neoplasia subjects suspected of epidural or intraspinal disease. See statement regarding contrast in text under &quot;Anticipated Exceptions.&quot;</td>
<td>☢️ 0</td>
</tr>
<tr>
<td>MRI lumbar spine without contrast</td>
<td>7</td>
<td>Noncontrast MRI may be sufficient if there is low risk of epidural and/or intraspinal disease.</td>
<td>☢️ 0</td>
</tr>
<tr>
<td>CT lumbar spine with contrast</td>
<td>6</td>
<td>MRI preferred. CT useful if MRI is contraindicated or unavailable, and/or for problem solving.</td>
<td>☢️ ☢️</td>
</tr>
<tr>
<td>CT lumbar spine without contrast</td>
<td>6</td>
<td>MRI preferred. CT useful if MRI is contraindicated or unavailable, and/or for problem solving.</td>
<td>☢️ ☢️</td>
</tr>
<tr>
<td>X-ray lumbar spine</td>
<td>5</td>
<td></td>
<td>☢️ ☢️</td>
</tr>
<tr>
<td>Tc-99m bone scan whole body with SPECT spine</td>
<td>5</td>
<td>SPECT/CT may be useful for anatomic localization and problem solving.</td>
<td>☢️ ☢️</td>
</tr>
<tr>
<td>CT lumbar spine without and with contrast</td>
<td>3</td>
<td></td>
<td>☢️ ☢️ ☢️</td>
</tr>
<tr>
<td>X-ray myelography lumbar spine</td>
<td>2</td>
<td></td>
<td>☢️ ☢️ ☢️</td>
</tr>
<tr>
<td>Myelography and postmyelography CT lumbar spine</td>
<td>2</td>
<td>In some cases postinjection CT imaging may be done without plain-film myelography.</td>
<td>☢️ ☢️ ☢️</td>
</tr>
</tbody>
</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level*
## Variant 4: Low back pain and/or radiculopathy. Surgery or intervention candidate.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI lumbar spine without contrast</td>
<td>8</td>
<td>MRI preferred. CT useful if MRI is contraindicated or unavailable, and/or for problem solving.</td>
<td>😤😤</td>
</tr>
<tr>
<td>CT lumbar spine with contrast</td>
<td>5</td>
<td>MRI preferred. CT useful if MRI contraindicated or unavailable, and/or for problem solving.</td>
<td>😤😤</td>
</tr>
<tr>
<td>CT lumbar spine without contrast</td>
<td>5</td>
<td>MRI preferred. CT useful if MRI contraindicated or unavailable, and/or for problem solving.</td>
<td>😤😤</td>
</tr>
<tr>
<td>MRI lumbar spine without and with contrast</td>
<td>5</td>
<td>Indicated if noncontrast MRI is nondiagnostic or indeterminate. See statement regarding contrast in text under &quot;Anticipated Exceptions.&quot;</td>
<td>😤😤</td>
</tr>
<tr>
<td>Myelography and postmyelography CT lumbar spine</td>
<td>5</td>
<td>MRI preferred. May be indicated if MRI is contraindicated or nondiagnostic. In some cases postinjection CT imaging may be done without plain-film myelography.</td>
<td>😤😤</td>
</tr>
<tr>
<td>X-ray discography and post-discography CT lumbar spine</td>
<td>5</td>
<td></td>
<td>😤😤</td>
</tr>
<tr>
<td>X-ray lumbar spine</td>
<td>4</td>
<td>Usually not sufficient for decision making without MR and/or CT imaging.</td>
<td>😤😤</td>
</tr>
<tr>
<td>Tc-99m bone scan with SPECT spine</td>
<td>4</td>
<td>May be particularly useful for facet arthropathy, stress fracture, and spondylolysis. SPECT/CT may be useful for anatomic localization and problem solving.</td>
<td>😤😤</td>
</tr>
<tr>
<td>X-ray discography lumbar spine</td>
<td>4</td>
<td></td>
<td>😤😤</td>
</tr>
<tr>
<td>CT lumbar spine without and with contrast</td>
<td>3</td>
<td></td>
<td>😤😤</td>
</tr>
<tr>
<td>X-ray myelography lumbar spine</td>
<td>2</td>
<td></td>
<td>😤😤</td>
</tr>
</tbody>
</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level*
## Variant 5: Prior lumbar surgery.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI lumbar spine without and with contrast</td>
<td>8</td>
<td>Can differentiate disc from scar. See statement regarding contrast in text under &quot;Anticipated Exceptions.&quot;</td>
<td>O</td>
</tr>
<tr>
<td>CT lumbar spine with contrast</td>
<td>6</td>
<td>Most useful in postfusion patients or when MRI is contraindicated or indeterminate.</td>
<td>☠☢☢</td>
</tr>
<tr>
<td>CT lumbar spine without contrast</td>
<td>6</td>
<td>Most useful in postfusion patients or when MRI is contraindicated or indeterminate.</td>
<td>☠☢☢</td>
</tr>
<tr>
<td>MRI lumbar spine without contrast</td>
<td>6</td>
<td>Contrast often necessary.</td>
<td>O</td>
</tr>
<tr>
<td>Myelography and postmyelography CT lumbar spine</td>
<td>5</td>
<td>In some cases postinjection CT imaging may be done without plain-film myelography.</td>
<td>☠☢☢</td>
</tr>
<tr>
<td>X-ray lumbar spine</td>
<td>5</td>
<td>Flex/extension may be useful.</td>
<td>☠☢☢</td>
</tr>
<tr>
<td>Tc-99m bone scan with SPECT spine</td>
<td>5</td>
<td>Helps detect and localize painful pseudoarthrosis. SPECT/CT may be useful for anatomic localization and problem solving.</td>
<td>☠☢☢</td>
</tr>
<tr>
<td>X-ray discography and post-discography CT lumbar spine</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-ray discography lumbar spine</td>
<td>4</td>
<td></td>
<td>☠☢</td>
</tr>
<tr>
<td>CT lumbar spine without and with contrast</td>
<td>3</td>
<td></td>
<td>☠☠</td>
</tr>
<tr>
<td>X-ray myelography lumbar spine</td>
<td>2</td>
<td></td>
<td>☠</td>
</tr>
</tbody>
</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level*
### Variant 6: Cauda equina syndrome, multifocal deficits or progressive deficit.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI lumbar spine without contrast</td>
<td>9</td>
<td>Use of contrast depends on clinical circumstances.</td>
<td>O</td>
</tr>
<tr>
<td>MRI lumbar spine without and with contrast</td>
<td>8</td>
<td>Use of contrast depends on clinical circumstances. See statement regarding contrast in text under &quot;Anticipated Exceptions.&quot;</td>
<td>O</td>
</tr>
<tr>
<td>Myelography and postmyelography CT lumbar spine</td>
<td>6</td>
<td>Useful if MRI is nondiagnostic or contraindicated. In some cases postinjection CT imaging may be done without plain-film myelography.</td>
<td>☠️ ☠️ ☠️</td>
</tr>
<tr>
<td>CT lumbar spine with contrast</td>
<td>5</td>
<td></td>
<td>☠️ ☠️ ☠️</td>
</tr>
<tr>
<td>CT lumbar spine without contrast</td>
<td>5</td>
<td></td>
<td>☠️ ☠️ ☠️</td>
</tr>
<tr>
<td>X-ray lumbar spine</td>
<td>4</td>
<td></td>
<td>☠️ ☠️ ☠️</td>
</tr>
<tr>
<td>CT lumbar spine without and with contrast</td>
<td>3</td>
<td></td>
<td>☠️ ☠️ ☠️</td>
</tr>
<tr>
<td>Tc-99m bone scan with SPECT spine</td>
<td>2</td>
<td></td>
<td>☠️ ☠️ ☠️</td>
</tr>
<tr>
<td>X-ray myelography lumbar spine</td>
<td>2</td>
<td></td>
<td>☠️ ☠️ ☠️</td>
</tr>
</tbody>
</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level*
Unknown Case

- 81 year old woman with history of osteoporosis presents with acute onset back pain.

- Does she require imaging?
Consider imaging for those with no improvement after 6 weeks or the following red flags:

Indications of a more complicated status include back pain/radiculopathy in the following settings:

- Trauma, cumulative trauma
- Unexplained weight loss, insidious onset
- Age ≥50 years, especially women, and males with osteoporosis or compression fracture
- Unexplained fever, history of urinary or other infection
- Immunosuppression, diabetes mellitus
- History of cancer
- Intravenous (IV) drug use
- Prolonged use of corticosteroids, osteoporosis
- Age >70
- Focal neurologic deficit(s) with progressive or disabling symptoms, cauda equina syndrome
- Duration longer than 6 weeks
- Prior surgery
• For the 81 year old osteoporotic, which imaging study should be ordered?
Low Back Pain

Indications for Radiographs

- Radiographs may be useful in any of the **red flag** categories. Lumbar radiographs may be sufficient for the initial evaluation of the following red flags, with further imaging indicated for treatment planning if findings are abnormal or inconclusive:
  - Recent significant trauma (at any age)
  - Osteoporosis
  - Age >70 years
- The initial evaluation of the LBP patient may also require further imaging if other red flags such as suspicion of cancer or infection are present.
Differentiating Acute vs. Chronic Compression Fractures on MRI

- Acute/Subacute (marrow edema)
- Chronic (normal marrow signal)
Acute vs Chronic Fracture L2?
Bone Scan to differentiate acute/subacute vs. chronic fractures

- Total body bone scan using Tc 99m MDP
Unknown case

- Trauma (mva) with leg weakness, saddle anesthesia, bladder dysfunction and decreased rectal tone.
Diagnosis?
Cauda Equina Syndrome

• Results from any lesion that compresses the cauda equina.

• Symptoms include low back pain, sciatica (unilateral or, usually, bilateral), saddle sensory disturbances, bladder and bowel dysfunction, and variable lower extremity motor and sensory loss.

• The prognosis for cauda equina syndrome (CES) improves if a definitive cause is identified and management is instituted early.
Unknown case

• 58 year old male with 5 week history of worsening low back pain and fever
Subtle plain film findings
Mission, Vision and Core Values

**Mission:**
Atlantic Medical Imaging is a quality-driven medical imaging practice committed to clinical excellence by providing innovative service and compassionate care that exceeds expectations.

**Vision:**
Atlantic Medical Imaging is recognized as the region’s premier medical imaging provider of choice - where unparalleled service and care are the top priorities.
Terminology of Spine Imaging

- DDD
- DJD
- Spondylosis
- Spondylolysis/Spondylolisthesis
- Foraminal and central stenosis
- Disc Herniation/Protrusion/Bulge
Disc Pathology

Traumatic vs Degenerative

New vs Old
Anatomy of a Disc

Nucleus Pulposus
Annulus Fibrosis
Anatomy of a Disc

Anterior/Posterior Longitudinal Ligaments

End-plate Periosteum

Ring apohysis
Patho-physiology of a Degenerative Disc

• Loss of H2O (water) from nucleus = desiccation
  • Less shock absorption
  • Decreased Height

• Decreased height........laxity of ligaments/ST’s............(micro)-motion instability.............(osteo)arthritis

• Reparation: ligament/capsular, etc. hypertrophy & osteophyte production
More Pathophysiology

*Just as the Nucleus desiccates, so too does the annulus
*Fissures/cracks develop
*Resultant disc Bulge and/or Herniation

*A degenerated Disc is at increased susceptibility of Herniation *

*Degenerative findings co-exist with HNP *
Traumatic Herniation

- Mechanical Force (trauma) causes fissures/cracks which result in disc Bulge and/or Herniation

- Loss of H2O..............loss of height........

- Same degenerative cascade

- Degenerative findings co-exist with HNP
Traumatic vs Degenerative HNP
“chicken & the egg”

• Did the degenerative findings precede or come after the HNP?

• Without pre-/post- can be impossible to tell

• How long after a traumatic HNP do degenerative findings appear?

• Degenerative Findings DO NOT exclude Traumatic Etiology
Might all HNP’s be Traumatic?

- Degenerative Disc: increased susceptibility for HNP i.e.; less mechanical force (trauma) required

- Why do some HNP’s result from simple flexion/extension?

- Why do some MVA’s result in HNP and others not?
Standardized/Structured Reporting

• An offshoot of the Healthcare IT revolution

• Digital, voice-recognition dictation

• Radiologist productivity and efficiency

• Referrer preference; efficiency of garnering results

• Patient engagement
Standardized Lexicon

2001:

NASS: North American Spine Society

ASNR: American Society of NeuroRadiology

AANS: American Association of Neurologic Surgeons

AAOS: American Academy of Orthopedic Surgeons
How’s Your Disc? Illustrative Glossary of Degenerative Disc Lesions using Standardized Lexicon

Boo, S., MD and Hogg, JP., MD
WVU Health Sciences Center, Dept. of Radiology
May/June 2010
Lumbar Disc Nomenclature: version 2.0
Recommendations of the combined task forces of the NASS, the ASNRS and the ASSR

Fardon, D., MD et al
Yale, USC, Wisconsin, Rush, etc.
The Spine Journal, 2014
Descriptive

NOT Pathologic

NOT Anatomic

NOT Etiologic/Causality

NOT Clinical
Disc Bulge
HNP: Focal or Broad

Focal/Local

Broad – (Based)
HNP: Protrusion or Extrusion

Protrusion

Extrusion
ALL Herniations

Focal/Localized Protrusion

Broad - (based) Protrusion

Focal/Localized Extrusion

Broad – (Based) Extrusion
Disc Herniation
Unknown case
Unremarkable MRI Lumbar Spine
MRI L2-L3 level
What is your diagnosis?
27-year-old man with vertebral hemangioma
Benign hemangioma?
## Comparison of Imaging Modalities for the Diagnosis of Vertebral Osteomyelitis

<table>
<thead>
<tr>
<th>Modality</th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain film x-ray</td>
<td>Sensitive when infection well established</td>
<td>Signs do not develop until 10-21 days after start of infection</td>
</tr>
<tr>
<td></td>
<td>Readily accessible</td>
<td></td>
</tr>
<tr>
<td>MRI</td>
<td>Most sensitive for early detection (edema)</td>
<td>Moderate specificity</td>
</tr>
<tr>
<td></td>
<td>No radiation exposure</td>
<td>Contraindications to MR, e.g. claustrophobia, pacer, etc.</td>
</tr>
<tr>
<td>CT</td>
<td>More sensitive than plain film for detecting bone and disc erosions</td>
<td>Less sensitive than MR to soft tissue lesions and abscesses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Iodinated contrast administered</td>
</tr>
<tr>
<td>Gallium-Bone Scan</td>
<td>May be useful if CT and/or MRI equivocal</td>
<td>Low spatial resolution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Requires 2 days</td>
</tr>
</tbody>
</table>
Back pain with fever
Diagnosis?
Diagnosis?

T2WI

Post contrast
Two different patients with similar findings but two different diagnoses.
Diagnosis?
Intradural lymphoma
Unknown case

• 36 year old male with low back and buttock pain
36 year old with low back and buttock pain
What is the diagnosis?
Ankylosing Spondylitis
Ankylosing Spondylitis
Unilateral Sacroiliitis
Lumbar Spinal Stenosis
Unknown case

42 year old woman with back pain and bilateral radiculopathy
Spondylolisthesis

- Grade I is a slip of up to 25%,
- grade II is between 26%-50%,
- grade III is between 51%-75%,
- grade IV is between 76% and 100%, and
- Grade V, or spondyloptosis occurs when the vertebra has completely fallen off the next vertebra.
Spondylolysis / Spondylolisthesis

Vertebra L5
the pars
Spondylolisthesis
Common distribution of tumors of the spine

- **Multiple?**
  - metastasis
  - myeloma
  - lymphoma
  - enostosis
  - hemangioma
  - eosinophilic granuloma

- **Involvement of adjacent vertebral levels?**
  - osteosarcoma
  - chondrosarcoma
  - myeloma
  - plasmacytoma
  - lymphoma
  - Ewing sarcoma
  - chordoma
  - ABC
  - giant cell tumor

  † may extend through the intervertebral disk

- **Location in vertebrae?**

  - **Malignant**
    - metastasis
    - myeloma
    - plasmacytoma
    - lymphoma
    - chordoma
  
  - **Exceptions**
    - hemangioma
    - eosinophilic granuloma
    - giant cell tumor

  - **Benign**
    - osteoid osteoma
    - osteoblastoma
    - osteochondroma
    - ABC

  - **Exceptions (sarcomas)**
    - chondrosarcoma
    - osteosarcoma
    - Ewing sarcoma

  ≡ common extension in the neural arch
  # common extension in the vertebral body
Thank You.
Overview

- Claudication & PAD
- Risk Factors and Staging Systems
- Critical Limb Ischemia
- Noninvasive Testing
- Treatment methods
- Case Examples
Claudication

• Three types
  – Vascular Claudication
    • Typically due to PAD
  – Venous Claudication
    • Typically due to venous insufficiency
  – Neurogenic Claudication
    • Typically due to Lumbar Spinal Stenosis
### Differentiating between types

<table>
<thead>
<tr>
<th></th>
<th>Vascular Claudication</th>
<th>Venous Claudication</th>
<th>Neurogenic Claudication</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quality of pain</strong></td>
<td>Cramping</td>
<td>&quot;Bursting&quot;</td>
<td>Electric shock-like</td>
</tr>
<tr>
<td><strong>Onset</strong></td>
<td>Gradual, consistent</td>
<td>Gradual, can be immediate</td>
<td>Can be immediate, inconsistent</td>
</tr>
<tr>
<td><strong>Relieved by</strong></td>
<td>Standing still</td>
<td>Elevation of leg</td>
<td>Sitting down, bending forward</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td>Buttock, thigh, calf</td>
<td>Whole leg</td>
<td>Poorly localized, can affect whole leg</td>
</tr>
<tr>
<td><strong>Legs affected</strong></td>
<td>Usually one</td>
<td>One or both</td>
<td>Often Bilateral</td>
</tr>
</tbody>
</table>

Unfortunately, History alone can miss up to 90% of cases!
Peripheral Arterial Disease

• PAD occurs in approximately 1/3 of all patients
  - Risk increases over age 70
  - Higher risk at age 50 in smokers or DM
• Increased risk of stroke, MI, and cardiovascular death
• Progressive disease in 25% with worsening claudication or limb threatening ischemia
• Results in impaired quality of Life, Limb Loss, and early mortality
Need for Screening

Progressive Disease ~25%
Lose a Leg, Lose a Life

PAD + LE amputation = 48.3% mortality at 1 year
PAD without LE amputation = 24.2% at 1 year

2013 Study from Duke University reviewed Medicare data 2000-2008

Double the mortality at 1 year in those patients with PAD + Amputation

Independent of cardiovascular risk factors – Lower rates of stroke and MI
Risk Factors

<table>
<thead>
<tr>
<th>Reduced</th>
<th>Increased</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking</td>
<td>Diabetes</td>
</tr>
<tr>
<td>Hypertension</td>
<td>Hypercholesterolemia</td>
</tr>
<tr>
<td>Hyperhomocysteinemia</td>
<td>Fibrinogen</td>
</tr>
<tr>
<td>C-Reactive Protein</td>
<td>Alcohol</td>
</tr>
</tbody>
</table>

Data from the Framingham Heart showing the odds ratio for developing intermittent claudication
Who should undergo testing?

• Symptomatic Patients
  – Vascular claudication, ischemic rest pain, tissue loss, ulceration, trophic changes

• High Risk Patients
  – Age <50 years, with diabetes plus additional RF (smoking, dyslipidemia, hypertension, or hyperhomocysteinemia)
  – Age 50-69 and history of smoking or diabetes
  – Age 70 or older
  – Known atherosclerotic coronary, carotid, or renal disease
<table>
<thead>
<tr>
<th>Fontaine</th>
<th>Clinical</th>
<th>Rutherford</th>
<th></th>
<th>Category</th>
<th>Clinical</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Asymptomatic</td>
<td>0</td>
<td>0</td>
<td></td>
<td>Asymptomatic</td>
</tr>
<tr>
<td>IIa</td>
<td>Mild claudication</td>
<td>I</td>
<td>1</td>
<td></td>
<td>Mild claudication</td>
</tr>
<tr>
<td>IIb</td>
<td>Moderate to severe claudication</td>
<td>I</td>
<td>2</td>
<td></td>
<td>Moderate claudication</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>3</td>
<td></td>
<td>Severe claudication</td>
</tr>
<tr>
<td>III</td>
<td>Ischemic rest pain</td>
<td>II</td>
<td>4</td>
<td></td>
<td>Ischemic rest pain</td>
</tr>
<tr>
<td>IV</td>
<td>Ulceration or gangrene</td>
<td>III</td>
<td>5</td>
<td></td>
<td>Minor tissue loss</td>
</tr>
<tr>
<td></td>
<td></td>
<td>III</td>
<td>6</td>
<td></td>
<td>Major tissue loss</td>
</tr>
</tbody>
</table>
Critical Limb Ischemia (CLI)

- Critical limb ischemia refers to a condition characterized by chronic ischemic at-rest pain, ulcers, or gangrene in one or both legs attributable to objectively proven arterial occlusive disease.
- Prevalence is 1.5% of all patients over 50
- Will develop in approximately 10% of patients with known PAD over lifetime

Diabetic Foot Ulcers (DFU) & PAD

- 65% of DFU have ischemic or neuroischemic component

<table>
<thead>
<tr>
<th>Feature</th>
<th>Neuropathic</th>
<th>Ischaemic</th>
<th>Neuroischaemic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensation</td>
<td>Sensory loss</td>
<td>Painful</td>
<td>Degree of sensory loss</td>
</tr>
<tr>
<td>Callus/necrosis</td>
<td>Callus present and often thick</td>
<td>Necrosis common</td>
<td>Minimal callus Prone to necrosis</td>
</tr>
<tr>
<td>Wound bed</td>
<td>Pink and granulating, surrounded by callus</td>
<td>Pale and sloughy with poor granulation</td>
<td>Poor granulation</td>
</tr>
<tr>
<td>Foot temperature and pulses</td>
<td>Warm with bounding pulses</td>
<td>Cool with absent pulses</td>
<td>Cool with absent pulses</td>
</tr>
<tr>
<td>Other</td>
<td>Dry skin and fissuring</td>
<td>Delayed healing</td>
<td>High risk of infection</td>
</tr>
<tr>
<td>Typical location</td>
<td>Weight-bearing areas of the foot, such as metatarsal heads, the heel and over the dorsum of clawed toes</td>
<td>Tips of toes, nail edges and between the toes and lateral borders of the foot</td>
<td>Margins of the foot and toes</td>
</tr>
<tr>
<td>Prevalence (based on 35)</td>
<td>35%</td>
<td>15%</td>
<td>50%</td>
</tr>
</tbody>
</table>

Noninvasive Vascular Testing
Ankle Brachial Index

• Workhorse of the lower extremity vascular evaluation
• Easy to perform
  – Blood pressure cuffs, Doppler
  – DP/PT to brachial artery pressure
  – Sensitivity ~ 75%, Specificity ~ 90%
    Depending on cutoff value (0.90 - 0.95)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Index Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&gt;0.96</td>
</tr>
<tr>
<td>Claudication</td>
<td>0.50-0.95</td>
</tr>
<tr>
<td>Rest Pain</td>
<td>0.30-0.49</td>
</tr>
<tr>
<td>Tissue loss</td>
<td>&lt;0.30</td>
</tr>
<tr>
<td>Significant change</td>
<td>0.15 or more</td>
</tr>
</tbody>
</table>
If claudication symptoms but normal rest ABI, exercise ABI should be performed

False negatives
  - Non-compressible vessels
    - Typically diabetics or renal patients
    - May lead to higher than normal ABI (>1.3)
    - Toe pressures may help (>0.7 TBI normal)
  - Concomitant subclavian or brachiocephalic disease
Pulse Volume Recordings

- Combines segmental pressures with waveforms

- Technique:
  - Pneumatic Cuff inflated at multiple Levels
  - Inflated to 65 mm Hg
Pulse Volume Recordings

• Advantages:
  – Not Impacted by Calcification
  – More sensitive than ABI
  – Allows for waveform analysis

• Disadvantages:
  – Lacks very specific anatomic information
  – More time consuming than ABI
Duplex Doppler

- More specific in location of stenosis
- Also screen for AAA
- Great for surveillance of bypass grafts
- Can semi-quantify degree of stenosis
- Overall about 80% sensitivity and 90% specific
Advanced Testing - CTA

• Advantages
  – Provides good anatomic localization
  – Can give temporal information on delayed imaging
  – Good evaluation of aorto-iliac vessels
  – Speed
  – Ability to evaluate stented arteries
  – Pacer safe
  – Helps determine approach for intervention
Advanced Testing - CTA

• Disadvantages
  – Dense calcification difficult to assess patency or degree of stenosis
  – Radiation
  – Distal vessel limited (less of an issue now)
  – Renal failure/contrast allergy
Advanced Testing CTA

- Axial imaging
- Maximal Intensity Projection
- Shaded Surface Display
Advanced Testing - MRA

• Advantages
  – Renal Impairment
    • Gad vs. Time of Flight
  – Good anatomic Localization
  – Also gives temporal information
  – No radiation

• Disadvantages
  – Uncooperative patient
  – Claustrophobia
  – Metal artifact
  – Pacemakers/ICDs
  – Lack of visualization of calcium
No Contrast!
Treatment

• All Patients with PAD
  – Immediate Smoking Cessation
    (Most beneficial modifiable risk factor)
  – Antiplatelet Agents
  – Diabetes Control
  – Blood Pressure Reduction
  – Lipid Control
Management of Symptomatic Pts.

• Intermittent Claudication pts. without lifestyle limitation should undergo a trial of risk factor modification and exercise program

• Claudication pts. with inflow disease or lifestyle limitation should be considered for revascularization

• Critical Limb Ischemia (rest pain or tissue loss) should undergo revascularization as soon as possible

– AHA Level IA Recommendations
Detecting PAD in Clinical Practice

• Consider performing ABI testing for at risk population in office
  – Reimbursable if waveform recorded

• Consider questionnaire:
  – Slow healing wound or ulcers
  – Missing pulses or poor circulation
  – Exertional cramping or fatigue relieved by rest
  – Resting pain in extremity that may disturb sleep
  – Gangrenous or black skin tissue
  – Toes or feet that have become pale or discolored
Multidisciplinary Approach

- Multidisciplinary foot care teams for non-healing wounds have been shown to reduce amputation rates from 36-86%.
- The care provided by the disciplines should coordinate diagnosis, offloading, preventative care, and revascularization.
- PCP, Vascular specialist, Podiatrist, wound care, infectious disease, endocrinologist, general surgeon.

Revascularization
Endovascular First

- BASIL trial published in 2005 finalized 2010
  - Prospective RCT of Angioplasty vs. bypass
  - No difference in 5 year amputation free survival
    - This was also using technology from 10 years ago. (First gen stents, no atherectomy, no DES, etc.)
  - Other studies have shown nearly double mortality rates for bypass over endovascular treatment (PREVENT III)
Amputation rates decrease as Revascularization rates increase

Single Center 12 Year Review

N = 1615 lower extremity vascular procedures

Open Surgical Role

• Endarterectomy of common femoral artery
  – Can combine for hybrid revasc in fem-pop disease
• Bypass if endovascular treatment fails or is felt to have limited patency
  – Autologous vein bypass preferable
  – Unfortunately low availability in this patient population (30-50% unavailable or poor quality)
  – PTFE comparable patency rates to endovascular (BASIL trial)
Below the Knee Interventions

- No surgical option in below knee disease
- Part of a successful limb salvage program must include the ability to perform complex BTK interventions
- Calcium is disproportionately deposited infrainguinal and below the knee
  - Nearly all diabetics and renal patients
Calcium / Plaque distribution

- Intra-arterial calcium is disproportionately distributed below the waist (10% above and 90% below).
- Below the waist, the majority (75%) of intra-arterial calcium resides in the infrapopliteal vessels.

Maximizing BTK Outcomes

• Requires advanced wire & microcatheter techniques

• Comfort with retrograde pedal access
  – Antegrade failure in 10-15%

• Variety of adjunctive devices on the market to improve patency
  – Most currently used adjunct is atherectomy
AMI PAD Algorithm

Vascular Consultation & Evaluation

- Rutherford 1-3
  - Risk Factor Modification, Exercise Regimen, follow-up
  - Good endovascular option?
  - Hybrid Tx

- Rutherford 4-6
  - Arteriogram & Runoff
  - Poor endovascular option or CFA occlusion?
  - Hybrid Tx
  - Surgical Tx

Hybrid Tx

Clinic Follow-up 1, 3, 6, 12 month
Preserving options is key
Orbital Atherectomy

- Used for severely calcified lesions to debulk plaque prior to PTA, especially helpful BTK
- Utilizes diamond coated crown to “sand” away particulate into particles small enough to pass through capillary beds
- Changes vessel compliance, resulting in lower pressures for PTA
- Differential sanding – lower rates of dissection compared to PTA alone
Orbital Atherectomy

• Compliance 360 study
  – Above knee lesions, 70% lower rate of stent placement

• Calcium 360 study
  – Below the knee, significantly lower restenosis rates & adverse outcomes

Importance of Providing Successful & Durable Interventions

Day of Case
- Increased lab time to manage adverse event
- Increased bail-out stent rate: $1,070-$2,660/each\(^1\)

Durability
- Increased re-intervention rate at $15,000 – 27,000 each\(^2\)

Wound Healing
- Average cost to heal chronic wound = $17,096\(^3\)

Amputation
- Amputation cost = $20,000 - $60,000\(^4\)
- Annual cost of follow-up care = $49,000\(^5\)
- Annual cost of nursing home: $70,000 – 100,000\(^5\)

---

Angiosome Concept

Angiosomes of the lower extremity

- Anterior tibial angiosome
- Posterior tibial angiosome
- Peroneal angiosome

Key structures:
- Anterior tibial artery
- Posterior tibial artery
- Calcaneal branch
- Medial plantar branch
- Lateral plantar branch
- Peroneal artery

Atlantic Medical Imaging
Case Examples
Case

- 69 yo F, diabetes, ESRD on HD, non-healing wound left great toe suspected osteomyelitis
- Poor granulation tissue at margins
- Foot cold, no dopplerable pulses
- Poor wound healing anticipated
- Vascular consultation requested
Arteriogram

BEFORE

AFTER
Follow-up

• Foot warm, healing of ulceration
• Patient underwent partial amputation distal phalanx of left hallux with good wound healing
• No evidence of residual infection at 3 months
Case

- 54 yo M with very severe right lower extremity rest pain
- Known long segment occlusion of right SFA
- Monophasic faint doppler pulses below
- Very hard calcific plaque could not be crossed from above
- Transpedal approach employed (SAFARI)
Follow up

• 3 month course plavix was completed
• 2 + pulses RLE at 6 month follow up
• Complete resolution of Rest Pain
Case

- 66 yo F smoker with severe claudication and rest pain (Rutherford 4)
- ABI 0.54 with abnormal PVR tracings
- Developing ischemic changes on heal
Follow up

• Atherectomy, PTA, required stenting
• Near immediate improvement of rest pain, ischemic changes and claudication
• 3 month plavix regimen
• Patient quit smoking, began exercising!
Case

• 78 yo F with non-healing wound on medial ankle and heal (Rutherford 6)
• Hospitalized for planned BKA
• Denied bypass given lack of BTK target vessel
Follow up

- Performed below the Knee atherectomy + PTA
- Gradual but continued healing of ulceration
- Successful limb salvage
Case

• 66 yo male, significant past smoking history, presented to podiatrist with forefoot rest pain
• Podiatrist noted absent DP pulses on both feet.
• At vascular consultation, ABIs only mildly diminished but no doppler-able DP on either foot.
No Anterior Tibial Art.
Follow up

• BTK atherectomy and PTA
• Resolved rest pain in left forefoot at 2 week follow-up. 2+ DP noted on exam.
• Returned for right foot arteriogram and revascularization with similar results.
Follow up

• 6 month follow-up – 2+ DP b/l on exam
  – both AT remain patent
• Denies any rest pain
• Plavix regimen discontinued
Case

- 68 yo F with prior left lower ext femoro-post tibial bypass, p/w severe claudication and rest pain
- Pre-procedure CTA ordered to evaluation bypass
Follow-up

- Patient began 3 month plavix regimen
- Near immediate relief of rest pain and claudication
Case

• 79 yo male, DM2, referred for non-healing wound right great toe, non-palpable pulses on exam
• Bilateral diminished ABIs on exam
Follow up

- BTK atherectomy and PTA
- Newly palpable pulses DP and PT
- 3 month Plavix regimen
- Near complete resolution of DFU at 6 weeks
Take Home Points

• History alone can miss up to 90% of peripheral arterial disease cases - need for screening!

• PAD is a progressive disease in 25%, including asymptomatic presentations

• Early detection can reduce cardiovascular related morbidity/mortality
Take Home Points

• ABI/PVRs are screening study of choice but consider advanced modalities or specialist referral in high suspicion cases.

• Patients with critical limb ischemia (rest pain, tissue loss, neuro-ischemic ulcers) should be offered revascularization.

• Endovascular approach first is now widely considered standard of care.

• Maximizing outcomes requires experience with BTK interventions & advanced techniques.
Take Home Points

Combined multispecialty care maximizes chances of limb salvage in CLI

CLI Team:
- Primary Care Physician
- Infectious Disease
- Nephrology
- General Surgeon
- Orthopedist
- Vascular Specialist
- Wound Care
- Nursing / Assistants
- Podiatry
References


References


The AMI IR Vascular Clinic

• Our Primary Goal = Limb Salvage!
• Complete clinical evaluation and management of suspected PVD
  – Arterial and Venous comprehensive treatment
  – Both Hospital and outpatient settings
• Cutting edge endovascular techniques
• Multidisciplinary involvement
  – Surgical, Podiatric, Infectious Disease, etc.
• Complete noninvasive vascular testing/imaging
• Free ABI screening studies
Patients and Providers can schedule testing or consultation online at AMI-IR.com
Thank You
IS YOUR PRACTICE ICD-10 READY?

Presented by:
Ginny Ruane, RN, MSN, CPC
Precision Healthcare Management, LLC
Readiness Assessment Components

- **Internal Staff**
  - ICD-10 Training & familiarity to recognize ICD-10 code sets & documentation needs
  - Pre-Certification of services such as high tech radiology. ICD-9 codes up to 9/30/2015 and ICD-10 for 10/1/2015 services and forward.

- **Payers**
  - Payer readiness & claim testing, review updated Local Coverage Determinations (LCDs) from Medicare to determine ICD-10 guidelines for medical necessity

- **Vendors/Systems**
  - All software enhancements completed?
  - Has billing system been updated to include ICD-10 codes?
  - Has a cross walk been built between the most common ICD-9 codes to ICD-10?

- **Physician Education & Training**
Prepare for “Revenue Disruption”

- Insufficient documentation will require review by front office staff and physicians.
- Coder productivity is expected to drop by 10 to 25% which will mean a slower through-put of gross billings out the door.
- Payer Denials are expected to increase especially when documentation is lacking from a medical necessity perspective.
- Despite third party payers saying that they are ready to accept ICD-10 codes, problems will likely occur which will impact cash flow similar to when the 5010 Claim change occurred back in 2011 & 2012.
ICD-10 Example- Injury/Trauma

- ICD-10 has expanded categories for “injuries”
- A 7th character extension defines the encounter type:
  - “A” for initial encounter
  - “D” for subsequent encounter (active follow-up treatment)
  - “S” for Sequelae (treating complications of injury or late effects)

- Documentation of injuries should include:
  - Specific Location of injury or trauma
  - Mechanism of injury (i.e. how & where it occurred, external causes)
  - Size
  - Depth of Injury
Injury Examples- ICD-10

Appropriate Physician Documentation

- “Left ankle sprain. Patient slipped on wet leaves on their driveway getting out of their car. Initial encounter for this problem.”
- “Right knee injury. Patient was playing basketball and landed wrong and felt their knee twist. Initial encounter.”

Documentation not ideal for ICD-10

- “Knee swelling and pain.”
- “Shoulder pain. Patient fell.”

In the above examples, the laterality is missing and the mechanism of the injury is missing.

- In the first example, which knee and where did the fall occur and is this the initial encounter?
- In the second example, which shoulder is injured and where did the fall occur? Was it work related? Is this the initial visit or subsequent encounter or late effect of a fall from the past?
Neoplasm Coding in ICD-10

- ICD-9 classified neoplasm by site & behavior
- ICD-10 classifies neoplasms by site, behavior & morphology
  - Need to document:
    - Site/laterality
    - Behavior (benign, carcinoma in-situ, malignant, uncertain behavior, unspec)
    - Primary or secondary
    - Cell type or subtype
    - Acuity
- ICD-10 appropriate example- “female patient with two malignant neoplasms of the left breast; one in the upper-outer quadrant and one in the lower-inner quadrant; primary”
Fracture Coding in ICD-10

- Initial
  - Open vs. closed (if not specified then closed is assumed)
  - Displaced vs. non-displaced (if not specified then displaced is assumed)
  - Traumatic vs. pathological
  - Specify Site of fracture

- Subsequent
  - Routine healing vs. delayed healing
Subsequent encounter

Patient returns for x-rays one month after the date of injury

Radiologist’s impression is routine healing of right subtrochanteric femur fracture. There is no indication of delayed healing, malunion or non-union.

ICD-10 Code is S72.21XD- displaced subtrochanteric fracture of right femur, subsequent encounter for closed fracture with routine healing
What Last Minutes Steps Should I Take?

- Practice ICD-10 documentation and coding prior to October 1, 2015. That way your practice will know what your gaps will be from a documentation & physician education perspective.

- Cross-walk your top 30 to 50 ICD-9 codes so that you can expedite workflow starting 10/1/2015 for those indications that are more straight-forward.

- Track your rejected claims after 10/1/2015 and pay attention to payer problems. Try to correct as soon as possible to minimize revenue disruption.

- Review pre-authorizations that were issued prior to 10/1/2015 but that were not yet scheduled for the service. These authorizations may need to be re-done and updated to ICD-10 coding requirements.
QUESTIONS?

Thank you!
PROSTATE MRI
Stephen McManus, MD
David Levi, MD
Prostate MRI - *Indications*

- **INITIAL DETECTION, STAGING, PRE-ACTIVE SURVEILLANCE, RECURRENT TUMOR LOCALIZATION, RADIATION THERAPY PLANNING**

- **INITIAL DETECTION**
  - Clinically suspected prostate cancer before or after TRUS negative biopsy

- **STAGING** in patients with biopsy proven prostate cancer
  - Low risk: confirm absence of more significant tumor to differentiate between active surveillance versus surgery
  - Intermediate risk: detect extra-capsular disease, assess neurovascular bundles
  - High risk: detect extra-capsular disease, nodes and bones

- **RADIATION THERAPY PLANNING**
  - Limit collateral damage

- **RECURRENT TUMOR LOCALIZATION**
  - PSA relapse after definitive therapy
Oncology

Dynamic Contrast-enhanced–magnetic Resonance Imaging Evaluation of Intraprostatic Prostate Cancer: Correlation with Radical Prostatectomy Specimens

Philippe Puech, Eric Potiron, Laurent Lemaitre, Xavier Leroy, Georges-Pascal Haber, Sebastien Crouzet, Kazumi Kamoi, and Arnauld Villers

OBJECTIVES
To determine the diagnostic performance of dynamic contrast-enhanced–magnetic resonance imaging (DCE-MRI) in the identification of intraprostatic cancer foci related to cancer volume at histopathology, in patients with clinically localized cancer treated by radical prostatectomy, with whole-mount histopathologic sections as the reference standard.

METHODS
Eighty-three consecutive radical prostatectomy specimens from patients referred for a prostate-specific antigen elevation were correlated with prebiopsy MRI. MRI results ranked on a 5-point scale were correlated with the findings of histopathology maps in 8 prostate sectors, including volume, largest surface area, and percentage of Gleason grade 4/5. The area under the receiver operating characteristic curve was used.

RESULTS
Median prostate-specific antigen was 8.15 ng/mL. DCE-MRI was suspicious in 55 (66%) out of 83 patients. A separate cancer foci (mean 2.55 per patient) was present in 212 (34%) of 664 octants and DCE-MRI was suspicious in 68 of 212. Sensitivity and specificity of DCE-MRI at score 3.4 or 5 for identification of cancer foci at any volume was 32% and 95%, respectively. For identification of cancer foci > 0.5 mL, the sensitivity and specificity were 86% and 94%, respectively, with the under the receiver operating characteristic curve of 0.874. Mean volume of DCE-MRI detected and missed cancers were 2.44 mL (0.02–14.5) and 0.16 mL (0.005–2.4), respectively. Sensitivity and specificity of DCE-MRI for identification of > 10% of Gleason grade 4/5 were 81% and 82%, respectively.

CONCLUSIONS
DCE-MRI can accurately identify intraprostatic cancer foci. Possible applications are guidance for biopsies, selection of patients for watchful waiting, and focal treatment planning.


The detection of a prostatic cancer relies on systematic biopsies in case of increased prostate-specific antigen (PSA) or abnormal digital rectal examination. Magnetic resonance imaging (MRI) is commonly used after a negative systematic transrectal ultrasound (TRUS)-guided biopsy and a high cancer suspicion, to find an abnormality and/or to detect extraprostatic or lymph node invasion. A better knowledge of preoperative cancer characteristics, that is, location, size, surface area, cancers than in benign prostate tissues. It was shown that prostate MRI using a high-resolution pelvic phased-array (PPA) coil either stand alone or combined with endorectal coil and of T1-weighted imaging (T1-WI) sequences may result in higher localization rates due to better signal homogeneity, especially in the anterior compartment. Current MRI protocols can combine other MRI sequences including proton spectroscopy or diffusion-weighted imaging. In a recent review of the
DETECTION

- 83 patients
  - Pre-biopsy MRI followed by radical prostatectomy
  - Specimens compared with pre-biopsy MRI results
- PPV of MRI was 76% (68/90)
- NPV of MRI was 75% (498/664)
- For cancer > 0.5 cc:
  - sensitivity of 86%
  - specificity of 94%

65 yo PSA=5.9
Negative TRUS biopsy
ADC map = restricted diffusion
Color Map = Rapid wash in & washout
Targeted re-biopsy: Gleason 6 cancer
Staging low risk patients prior to active surveillance

Percentage of men under active surveillance for insignificant prostate cancer reclassified as significant cancer at 2 years is:

20–30%
Preoperative nomograms incorporating magnetic resonance imaging and spectroscopy for prediction of insignificant prostate cancer

Amita Shukla-Dave, Hedvig Hricak, Oguz Akin, Changhong Yu, Kristen L. Zakian, Kazuma Udo, Peter T. Scardino, James Eastham and Michael W. Kattan

Departments of *Medical Physics, †Radiology and ‡Urology, Memorial Sloan-Kettering Cancer Center, New York, NY, ∗Department of Quantitative Health Sciences, Cleveland Clinic, Cleveland, OH, USA, and †Department of Urology and Department of Urology and Microbiology, Faculty of Medicine, Saga University, Saga, Japan

Accepted for publication 10 June 2011

Study Type – Prognosis (case series)
Level of Evidence 4

OBJECTIVES

- To validate previously published nomograms for predicting insignificant prostate cancer (PCa) that incorporate clinical data, percentage of biopsy cores positive (≥Bc+) and magnetic resonance imaging (MRI) or MRI/MRI spectroscopic imaging (MRSI) results.
- We also designed new nomogram models incorporating magnetic resonance results and clinical data without detailed biopsy data. Nomograms for predicting insignificant PCa can help physicians counsel patients with clinically low-risk disease who are choosing between active

What's known on the subject? and What does the study add?
Nomograms are available that combine clinical and biopsy findings to predict the probability of pathologically insignificant prostate cancer in patients with clinically low-risk disease. Based on data from patients with Gleason score 6, clinical stage ≤ T2a and PSA <20 ng/ml, our group developed the first nomogram models for predicting insignificant prostate cancer that incorporated clinical data, detailed biopsy data and findings from MRI or MRI/MRSI (BJU Int. 2007;99(4):786–93). When tested retrospectively, these MR models performed significantly better than standard clinical models with and without detailed biopsy data.

We prospectively validated the previously published MR-based nomogram models in a population of patients with Gleason score 6, clinical stage ≤ T2a and PSA <10 ng/ml. Based on data from this same population, we also developed two new models for predicting insignificant prostate cancer that combine MR findings and clinical data without detailed biopsy data. Upon initial testing, the new MR models performed significantly better than a clinical model lacking detailed biopsy data.

- There were four models incorporating MRI or MRI/MRSI and clinical data with and similarly to the more comprehensive clinical model.
Low risk patients

- 181 low risk prostate cancer patients
- All had MRI before prostatectomy
- At surgical pathology, Gleason score was upgraded in 56% of patients
- MRI performed better than regular clinical models in predicting likelihood of insignificant disease

Imaging for radiation therapy planning

- CT typically used for external beam therapy due to ability to acquire 3D data set
- CT however is limited by:
  - Poor organ delineation
  - Ability to acquire images only in axial plane
MRI for radiation therapy planning

- MRI offers three main benefits:
  - Better spatial resolution = detailed anatomy and less collateral damage
  - Multiplanar acquisition
  - Target lesions for boosting
Definition of the CTV Prostate in CT and MRI by Using CT–MRI Image Fusion in IMRT Planning for Prostate Cancer

Bettina Hentschel¹, Wolfgang Oehler¹, Dirk Strauß¹, Andreas Ulrich², Ansgar Malich², Bettina Hentschel³

**Purpose:** To determine the prostate volumes defined by using MRI and CT scans, as well as the difference between prostate delineation in MRI and CT in three dimensions (3D). A further goal was to use MRI to identify subgroups of patients in whom seminal vesicle irradiation can be avoided.

**Methods and Materials:** A total of 294 patients with biopsy-proven prostate cancer (MRI stages: T₁, 16 [5%]; T₂, 84 [29%]; T₃, 191 [65%]; T₄, 3 [1%]) underwent pelvic CT and MRI scans before intensity-modulated radiation therapy (IMRT) planning. 3D images were used to compare the prostate volumes defined by superimposed MR and CT images. Prostate volumes were calculated in cm³.

**Results:** The mean prostate volume defined by MRI (44.3 cm³ [range, 8.8–182.8 cm³]) was 35% smaller than that defined by CT (68.5 cm³ [range, 15.2–241.3 cm³]). The areas of non-agreement were observed predominantly in the most superior and inferior portions of the prostate. The incidence of seminal vesicle invasion (SVI) identified by MRI was 63% (n = 182 of 290). The median length of SVI was 2.6 cm (range, 1.1–4.7 cm; 62% of the median SV length). The low-risk patients (59%, n = 171 of 290) calculated by applying the Roach and Diaz formula had a SVI rate of 57% (n = 97 of 171), the high-risk patients (41%, n = 119 of 290) of 71% (n = 85 of 119).

**Conclusions:** Compared with MRI, CT scans overestimate prostate volume by 35%. CT–MRI image fusion-based treatment planning allows more accurate prediction of the correct staging and more precise target volume identification in prostate cancer patients.

**Key Words:** Prostate cancer · MRI · Definition of prostate CTV · IMRT
Defining CTV with MRI vs. CT

- 294 patients with prostate cancer underwent MRI and CT prior to IMRT
- 3D images were used to calculate volume on MRI and CT
- Mean prostate volume was 35% smaller than mean CT volume
- MRI also more correctly identified SV invasion when compared with Roach-Diaz model
  - Limiting SV radiation reduces irradiated rectal volumes
Recurrent tumor localization

- Evaluate patients with biochemical failure
- Biopsy proven recurrence rate after radical prostatectomy: 32-54%
- Digital rectal examination and TRUS are often inadequate in detecting recurrent disease
Endorectal and Dynamic Contrast-Enhanced MRI for Detection of Local Recurrence After Radical Prostatectomy

OBJECTIVE. The objective of our study was to evaluate the sensitivity and specificity of endorectal MRI combined with dynamic contrast-enhanced MRI to detect local recurrence after radical prostatectomy.

MATERIALS AND METHODS. A total of 51 patients who had undergone radical prostatectomy for prostatic adenocarcinoma 10 months to 6 years before underwent a combined endorectal coil MRI and dynamic gadolinium-enhanced MRI before endorectal sonographically guided biopsy of the prostatic fossa. The MRI combined with MR dynamic imaging results were correlated with the presence of recurrence defined as a positive biopsy result or reduction in prostate-specific antigen level after radiation therapy.

RESULTS. Overall data of 46 (25 recurred, 21 nonrecurred) out of 51 evaluated patients were analyzed. All recurrences showed signal enhancement after gadolinium administration and, in particular, 22 of 24 patients (91%) showed rapid and early signal enhancement. The overall sensitivity and specificity of MR dynamic imaging was higher compared with MRI alone (88%, 95% CI 69–98% and 100%, 84–100% compared with 48%, 28–69% and 52%, 30–74%). MRI combined with dynamic imaging allowed better identification of recurrences compared with MRI alone (McNemar test: chi-square = 16.67; p = < 0.0001).

CONCLUSION. MRI combined with dynamic contrast-enhanced MRI showed a higher sensitivity and specificity compared with MRI alone in detecting local recurrences after radical prostatectomy.

Keywords: contrast-enhanced MRI, MRI, prostate neoplasm, recurrence

In patients with prostate cancer, the site of disease recurrence after radical prostatectomy is a critical issue because it may greatly influence the subsequent therapeutic strategy and patient management. Local recurrence of prostate cancer after radical prostatectomy is a fundamental issue for therapy and follow-up of these patients.

Digital rectal examination (DRE) has been shown to be inadequate in detecting local recurrences [5]. Although endorectal sonography (transrectal ultrasonography, TRUS) is better than DRE for detecting local recur-
Recurrent tumor localization

- 46 patients with biochemical failure underwent MRI followed by TRUS biopsy
  - 25 patients: recurrent tumor
  - 21 patients: no tumor

- DCE MRI for detection of recurrent tumor
  - Sensitivity of 88% (22/25)
  - Specificity of 100% (21/21)

Recurrent tumor localization
Sample Report

The following is a report on the examinations performed on the above captioned patient at the GALLOWAY office.

MRI PROSTATE WITH AND WITHOUT INTRAVENOUS CONTRAST

HISTORY: Elevated PSA.

PSA: 6.

COMPARISON: None.

TECHNIQUE: Magnetic resonance imaging of the prostate was performed on a 3 Tesla magnet with a surface phased array coil utilizing multiplanar T1, T2 weighted, diffusion weighted, and dynamic post contrast sequences. Postprocessing was performed with iCAD VividLook software.

CONTRAST: 20 cc IV Optimark.

FINDINGS:

Prostate size: 5.5 x 4.8 x 3.5 cm.
Prostate volume: 46 cc.

Central gland: Heterogenous with no discrete nodule. There is prominence of the median lobe.

Peripheral zone: There are 2 lesions which are low suspicion for malignancy and requires targeted biopsy including:

Left mid PZ: 19 x 12 x 9 mm lesion series 9 image 17 and series 5 image 9. This lesion is located 14 mm anterior to the posterior capsule. The midportion of this lesion is 15 mm from the midline. This lesion fills segment 4A. The lesion is low signal on T2, has a type II enhancement and no restricted diffusion.

Left apex: 8 x 8 x 7 mm lesion series 9 image 21 and series 10 image 10. This lesion abuts on the posterior capsule. The center of the lesion is 7 mm from the midline. This lesion straddles segments 5p and 6p. This lesion is low signal on T2, has a type II enhancement and mild restricted diffusion.

Capsule: Intact and smooth without bulging.

Neurovascular bundle: Intact with no evidence of invasion.

Seminal vesicles: Symmetric and within normal limits.

Bladder: Within normal limits.

Pelvic soft tissues: Within normal limits.

Lymph nodes: No adenopathy.

Bones: No aggressive bone lesions.

IMPRESSION:
Sample Report

Twenty-seven Regions of Interest

Twelve posterior (p) and twelve anterior (a) glandular regions - mediolobar and lateral at base, mid and apex. Three anterior stroma (as) central regions.
PI-RADS reporting:

- 1: Benign features
- 2: Low suspicion
- 3: Intermediate suspicion
- 4: High suspicion
- 5: Consistent with cancer
Prostate MRI Summary

- MRI is the OPTIMAL modality for imaging the prostate
- Multi-parametric approach required to maximize sensitivity and specificity of exam
- Endorectal coil not required
- MRI before radiation therapy affords less collateral damage and better lesion targeting
Prostate MRI Summary

- TRUS negative biopsy: 50% will be recommended for targeted rebiopsy.

- Targeted rebiopsy: 30% positive.

- Active surveillance: MR outperforms standard nomograms for confirming insignificant disease.

- Pre-op ECE/NVB: 72% accuracy

- Suspected recurrent tumor: 88% sensitive.
First presentation (TRUS biopsy)

Biopsy positive
- Curative intent
  - Staging MRI (intermediate or high risk)

Biopsy negative and clinical suspicion PCa
- Active surveillance
  - Staging MRI (low risk)

Detection MRI and re-biopsy
Thank you
Current Applications & Prospects of Coronary CT Angiography

Armin A. Zadeh MD PhD MPH
Associate Professor of Medicine
Associate Director, Cardiac CT
Division of Cardiology
Johns Hopkins University
Baltimore, MD
Disclosures

No financial conflicts of interest
Objectives

1. Provide an overview of the current clinical applications of coronary CTA
2. Discuss scan preparation and risks from CTA
3. Discuss reimbursement issues
4. Provide an outlook on emerging applications
2010 Appropriate Use Criteria for Cardiac Computed Tomography

A Report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, the Society of Cardiovascular Computed Tomography, the American College of Radiology, the American Heart Association, the American Society of Echocardiography, the American Society of Nuclear Cardiology, the Society for Cardiovascular Angiography and Interventions, and the Society for Cardiovascular Magnetic Resonance
Rule out CAD in symptomatic patients of low-intermediate pretest probability
### Appropriateness Criteria – Use of CTA in Symptomatic Patients

<table>
<thead>
<tr>
<th>Pretest Probability of CAD</th>
<th>Low</th>
<th>Intermediate</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECG interpretable AND Able to exercise</td>
<td>U (5)</td>
<td>A (7)</td>
<td>I (3)</td>
</tr>
<tr>
<td>ECG uninterpretable OR Unable to exercise</td>
<td>A (7)</td>
<td>A (8)</td>
<td>U (4)</td>
</tr>
</tbody>
</table>

Taylor AJ et al, J Am Coll Cardiol. 2010 23;56:1864-94
Assessment of Pre-Test Probability of CAD

<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>Typical/Definite Angina Pectoris</th>
<th>Atypical/Probable Angina Pectoris</th>
<th>Nonanginal Chest Pain</th>
<th>Asymptomatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;39</td>
<td>Men</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Very low</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>40–49</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>50–59</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td>&gt;60</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>High</td>
<td>Intermediate</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

Women <50 are of low pretest probability unless they have typical angina

Only men <40 with nonanginal pain are of low pretest probability

Taylor AJ et al, J Am Coll Cardiol. 2010 23;56:1864-94
## Appropriateness Criteria – Use of CTA in Symptomatic Patients

<table>
<thead>
<tr>
<th>Test Result/Ischemia</th>
<th>Sequential Testing After Stress Imaging Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discordant ECG exercise and imaging results</td>
<td>Equivocal</td>
</tr>
<tr>
<td>Prior stress imaging procedure</td>
<td>A (8)</td>
</tr>
</tbody>
</table>

Taylor AJ et al, J Am Coll Cardiol. 2010 23;56:1864-94
**CT vs. SPECT for Diagnosis of CAD**

CORE320, patients without history of CAD, n=232

<table>
<thead>
<tr>
<th></th>
<th>CTA</th>
<th>SPECT</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AUC</strong></td>
<td><strong>0.92</strong></td>
<td><strong>0.67</strong></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>(0.88-0.95)</td>
<td>(0.61-0.73)</td>
<td></td>
</tr>
<tr>
<td><strong>Sensitivity</strong></td>
<td><strong>0.91</strong></td>
<td><strong>0.56</strong></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>(0.84-0.96)</td>
<td>(0.46-0.65)</td>
<td></td>
</tr>
<tr>
<td><strong>Specificity</strong></td>
<td><strong>0.80</strong></td>
<td><strong>0.69</strong></td>
<td>0.08</td>
</tr>
<tr>
<td></td>
<td>(0.72-0.87)</td>
<td>(0.60-0.77)</td>
<td></td>
</tr>
<tr>
<td><strong>PPV</strong></td>
<td><strong>0.81</strong></td>
<td><strong>0.62</strong></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>(0.73-0.88)</td>
<td>(0.52-0.72)</td>
<td></td>
</tr>
<tr>
<td><strong>NPV</strong></td>
<td><strong>0.91</strong></td>
<td><strong>0.63</strong></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>(0.84-0.96)</td>
<td>(0.54-0.71)</td>
<td></td>
</tr>
</tbody>
</table>

### Outcome after CTA

Meta-Analysis from 32 studies, 41,960 patients

<table>
<thead>
<tr>
<th>Cardiac Death or MI</th>
<th>No CAD</th>
<th>Non-Obstructive CAD</th>
<th>Odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chow(^{36})</td>
<td>1 / 591</td>
<td>10 / 866</td>
<td>6.89 (0.88-53.99)</td>
</tr>
<tr>
<td>Øvrehus(^{33})</td>
<td>0 / 516</td>
<td>3 / 327</td>
<td>11.14 (0.57-216.37)</td>
</tr>
<tr>
<td>Gaemperli(^{10})</td>
<td>0 / 43</td>
<td>1 / 82</td>
<td>1.60 (0.06-40.14)</td>
</tr>
<tr>
<td>Min(^{11})</td>
<td>0 / 23</td>
<td>1 / 86</td>
<td>0.82 (0.03-20.91)</td>
</tr>
<tr>
<td>Dedic(^{57})</td>
<td>0 / 115</td>
<td>3 / 162</td>
<td>5.07 (0.26-99.09)</td>
</tr>
<tr>
<td>Cho(^{13})</td>
<td>1 / 1668</td>
<td>2 / 900</td>
<td>3.71 (0.34-41.00)</td>
</tr>
<tr>
<td>Aldrovandi(^{59})</td>
<td>0 / 219</td>
<td>4 / 282</td>
<td>7.09 (0.38-132.45)</td>
</tr>
<tr>
<td>Andreini(^{54})</td>
<td>0 / 503</td>
<td>23 / 241</td>
<td>108.30 (6.55-1791.09)</td>
</tr>
<tr>
<td>Pooled odds ratio</td>
<td>2 / 3678</td>
<td>47 / 2946</td>
<td>6.41 (2.44-16.84)</td>
</tr>
</tbody>
</table>

**Annualized Rate**

- <0.03%
- 0.80%

Habib PI et al. Int J Cardiol 2013
MI & Cardiac Death 5 years after CTA

N=1,234

Andreini et al, JACC IMG 2012
Current Reimbursement Policies

- Cardiac evaluation of a patient with chest pain syndrome as an alternative to cardiac catheterization (rule out CAD in new CHF)
- Assessment of coronary anatomy
- Uninterpretable or equivocal stress imaging test results
- In lieu of routine invasive coronary angiography prior to non-coronary cardiac or aortic surgery in patients at low risk of concomitant coronary disease
CTA For Stent Evaluation
### Appropriateness Criteria – Use of CTA Post Revascularization

<table>
<thead>
<tr>
<th>Symptomatic (Ischemic Equivalent)</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation of graft patency after CABG</td>
<td>A (8)</td>
</tr>
<tr>
<td>Prior coronary stent with stent diameter ≤ 3 mm or not known</td>
<td>I (3)</td>
</tr>
<tr>
<td>Prior coronary stent with stent diameter ≥ 3 mm</td>
<td>U (6)</td>
</tr>
</tbody>
</table>

Taylor AJ et al, J Am Coll Cardiol. 2010 23;56:1864-94
Patient Preparation – Heart Rate Control

- If HR > 65, oral beta blocker, e.g., metoprolol 25-150 mg
- If required, additional iv beta blocker, e.g., metoprolol 5-25 mg
- If required, additional ivabradine
Patient Preparation – HR Control

De Graaf FR, et al, Am J Cardiol 2010
Patient Preparation – Contrast

- Hold nephrotoxic drugs, e.g., NSAIDs
- Screening for CIN risk factors (DM, CRF, CHF, age >75*)
- Serum creatinine if indicated
- Hydration
- Premedication if indicated (e.g., prednisone, benadryl)
- NPO x 3 h
- No caffeine or nicotine x 12 h

Increased Cancer Risk by 1:500

Dose (mSv)

Radiation Doses From Cardiac Imaging

CT-FFR vs. FFR NXT Study

Norgaard et al. JACC 2014
CT-FFR vs. FFR NXT Study

![Graph showing sensitivity vs. 1-specificity with AUC values]

- $FFR_{CT}$ AUC: 0.90, 95% CI: 0.87, 0.94
- CT AUC: 0.81, 95% CI: 0.76, 0.87
- $\Delta AUC$: 0.09, 95% CI: 0.04, 0.14
- $P=0.0008$

Norgaard et al. JACC 2014
### Rate of non-obstructive disease

<table>
<thead>
<tr>
<th>Planned invasive test (n = 380)</th>
<th>Usual care strategy (n = 187)</th>
<th>FFR\textsubscript{CT}-guided strategy (n = 193)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>137 (73.3)</td>
<td>24 (12.4)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Douglas PM et al. Eur Heart J 2015
Combined CTA/CTP vs. QCA/SPECT – CORE320
CTA + CTP to predict flow limiting stenoses by QCA + SPECT

All Patients
CTA-CTP ROC Area = 0.87
95% CI [0.84-0.91]

No Prior MI
CTA-CTP ROC Area = 0.90
95% CI [0.87-0.94]

Without prior CAD
CTA-CTP ROC Area = 0.93
95% CI [0.89-0.97]

Rochitte et al, Eur Heart Journal 2014
Conclusions

- CTA is generally used to RULE OUT significant CAD in symptomatic patients of intermediate pretest probability, particularly, with equivocal stress test findings.

- A normal CTA is associated with an exceptionally low rate of adverse events for at least 5 years.

- Detecting non-obstructive CAD may help reducing events.

- Novel adjunct technology allows hemodynamic assessment of CAD, which will further increase attractiveness of coronary CTA.
Thank You
Imaging of Pedal Infection

David Levi, MD
Chief, Division of Musculoskeletal Radiology
Atlantic Medical Imaging
Overview

• Pedal Osteomyelitis and Soft Tissue Infection
  • Clinical background
  • Conventional Imaging Indications
  • Technique and Findings: Radiographs, CT, MRI, Nuclear Medicine
Pedal Osteomyelitis and Soft Tissue Infection

• Etiology- Contiguous spread and direct implantation are most common. Hematogenous spread is rare.

• Epidemiology- 200 mil diabetics. Most common cause of amputation. Lifetime risk of developing a pedal ulcer is 7-25% in diabetic. After amputation, 50% risk of serious complication in contralateral foot within 2 years.

• Immunopathy coupled with vascular disease, neuropathy and loss of plantar fat leads to wound infection eventually leading to osteomyelitis.
Foot Anatomy and Spread of Infection

- The foot has distinct myofascial compartments.

- However, in pedal osteomyelitis this anatomy is not reliable for predicting spread.

- Spread is most commonly in a centripetal pattern from the source (wound) but can spread along superficial fascial planes and tendon sheaths.

- Spread into deep fascial compartment is concerning as this can communicate to calf.
Foot anatomy and spread of infection

- Osteomyelitis almost always next to an ulcer
  - Exception is direct bone to bone spread of infection
- Most common locations
  - Forefoot: 1st and 5th met, distal 1st phalanx
  - Midfoot: uncommon
  - Hindfoot: calcaneus > lateral malleolus
Imaging Modalities

- Lack of uniform imaging algorithm based on many factors including access to imaging, reader expertise, access to white cell labeling, surgeon preference, imager preference and bias.

- Although not sensitive, initial imaging should always be radiographs of the foot, ankle or both. Radiographic evidence of osseous infection lags behind MRI/Nucs.

- MRI = gold standard

- All patients with contraindications to MRI should undergo nuclear imaging.
• Three Phase Bone Scan is sensitive for osseous involvement but has low specificity in complicated settings such as neuropathic disease, trauma and post-operative settings.

• Labeled WBC scan lacks anatomic detail but in conjunction with bone scan with or without marrow imaging increases overall sensitivity.

• In most studies, MRI has as good if not better sensitivity and specificity with the addition of better soft tissue evaluation and no radiation. Limitations also include the presence of neuropathic disease and presence of hardware.
## Sample MRI Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Sens</th>
<th>Spec</th>
<th>Accuracy</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ledermann 2002</td>
<td>90</td>
<td>79</td>
<td>90</td>
<td>158</td>
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<tr>
<td>Wang 1990</td>
<td>99</td>
<td>81</td>
<td>94</td>
<td>50</td>
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<tr>
<td>Nigro 1992</td>
<td>100</td>
<td>95</td>
<td>98</td>
<td>44</td>
</tr>
<tr>
<td>Weinstein 1993</td>
<td>100</td>
<td>81</td>
<td>95</td>
<td>47</td>
</tr>
</tbody>
</table>
ACR Recommendation

- Meta-analysis from 2007 shows MRI to be overall superior.

- American College of Radiology appropriateness criteria and recommendations suggest that MRI be performed preferentially to nuclear imaging in patients who can undergo MRI

- Key is that MRI shows more soft tissue findings and margins of unaffected bone providing useful surgical information and a road map for bone amputation and soft tissue debridement
Radiographs

- Findings of osteomyelitis include periosteal reaction, soft tissue swelling, soft tissue gas, osseous erosion and frank osseous destruction.

- Notoriously limited due to low sensitivity (usually don’t see findings for 2 weeks from initial infection).
Radiographs

• This patient population tends to have “ugly feet”

• Often see complex picture of degenerative changes, post surgical changes with and without hardware, amputations, dislocations and neuropathic changes. This limits the specificity and sensitivity.
Radiographs

3 weeks later
CT of Osteomyelitis
MRI for Pedal Osteomyelitis

• Contrast Administration
  • Pros: Better evaluation of soft tissues including ulcers, abscesses, devitalized soft tissue, differentiate cellulitis from soft tissue swelling
  • Cons: NSF in renal patients, Allergy, Scan time
• There is some disagreement in the literature as to whether contrast is necessary for diagnosis of pedal osteomyelitis
AMI MRI Protocol

- Long axis STIR
- Short axis T1
- Sagittal T1 and STIR
- Pre and post Gad- Ax T1 FS
- May need metal artifact reduction techniques
- Imaging tips of toes is most challenging
Foot MRI Soft Tissue Findings

- Callus, Ulcer and Adventitial Bursa
- Soft Tissue Edema and Cellulitis
- Muscle edema and infectious myositis
- Septic tenosynovitis
- Soft tissue abscess and devitalization
Soft Tissue Ulcer
Devitalized Soft Tissue
Diabetic Soft Tissue Edema
Infectious Cellulitis
Myositis and Abscess
Ulcer with Sinus Tract
Post Operative Osteomyelitis
Infections Tenosynovitis with wet gangrene

Donovan and Schweitzer, Radiographics, 2010
Foot MRI Bone Findings

- Osteomyelitis
  - Low signal on T1, High signal on T2/STIR, Enhancement
- Bone abscess
- Reactive osteitis vs early osteomyelitis

- If there is no signal abnormality on T1 weighted imaging but there is edema signal on T2 weighted imaging, the diagnosis is more likely reactive osteitis than osteomyelitis but must then use secondary signs to diagnosis possible early osteomyelitis.
Foot MRI Bone Findings

- If there is no signal abnormality on T1 weighted imaging but there is edema signal on T2 weighted imaging, the diagnosis is more likely reactive osteitis than osteomyelitis but must then use secondary signs to diagnosis possible early osteomyelitis.

  • Adjacent ulcer and soft tissue changes, ability to probe to bone
  
  • Does contrast help in these cases?

    • May indicate adequate vascularity to treat with IV Abx...
Osteomyelitis
Osteomyelitis with Gadolinium
Osteomyelitis with Bone Abscess and Septic Arthritis
Osteomyelitis with Bone Abscess and Septic Arthritis
Complicating Conditions

- Complicating because they have similar imaging findings and are seen in similar patient populations
  - Charcot/Neuropathic
  - Gout
  - Other Inflammatory Arthropathies
Gout
Gout
Gout
Neuropathic Joint
Charcot Arthropathy

No osteomyelitis

Osteomyelitis

Donovan and Schweitzer, Radiographics, 2010
Nuclear medicine

- 3-phase bone scan (Tc-99m) historically has been nuclear medicine test of choice
  - Readily available
  - Positive on all 3 phases = diagnostic of osteomyelitis?
  - Sensitive but not specific
    - Mimics of osteomyelitis include neuropathic joint and pedal ulcer
3 phase bone scan
Nuclear medicine

• WBC imaging is gold standard for nuclear medicine imaging of pedal osteomyelitis in diabetics

• In-111 WBC: sensitivity 72-100%; specificity 67-100%

• Tc-99m WBC: sensitivity 86-93%; specificity 80-98%

• Specificity increases with SPECT-CT
WBC imaging
WBC Imaging
Conclusion

• Radiographs = starting point, but often lags

• MRI = gold standard for diagnosis of pedal infection/osteomyelitis
  • ACR appropriateness criteria
  • Allows best evaluation of soft tissues, better resolution than Nucs
  • IV contrast preferred but not necessary
  • Nuclear medicine = if contra-indication to MRI
References


Thank You
Radiation: Separating Fact from Fantasy

David Levi, MD
Chief, Division of Musculoskeletal Imaging
Atlantic Medical Imaging
Goals

1) Clarify what we know and (don’t know) about radiation:
   - Dose
   - Linear no threshold model
   - Does radiation cause cancer?
2) Who is most at risk?
3) How do we minimize radiation?
Imaging benefits

- Imaging has become integral to the diagnostic algorithm
  - Decrease in false positive surgical diagnoses
    - 24-3% from 1996-2006 for appendicitis
  - Earlier cancer detection
  - Image-guided interventional diagnosis and therapies
Radiophobia

- CT use has increased 20x since early 1990s
- Some authors are predicting thousands of radiation induced cancers in the future

Reducing CT radiation is **top priority** among hospitals’ health technology initiatives
Dose

- **Effective dose**: mSv
  - Dose which if delivered uniformly to the whole body would produce same health consequences as those caused by a dose to one organ
  - What we use to “score” radiation dose
- Effective dose is what we calculate on every CT
The problem with effective dose

“Effective dose is intended for use as a protection quantity. The main uses of effective dose are the prospective dose assessment for planning and optimization in radiological protection....Effective dose is not recommended for epidemiological evaluations, nor should it be used for detailed specific retrospective investigations of individual exposure and risk.”
Average effective dose per capita to the U.S. population from major sources of exposure.

- Radon (37%)
- Computed tomography (24%)
- Nuclear medicine (12%)
- Other background (13%)
- Consumer/occupational/industrial (2%)
- Radiographic/fluoroscopic (5%)
- Interventional (7%)
Commonly cited number is fatal cancer risk of 1:2000 per 10 mSv.
- Projected, theorized number

No prospective epidemiologic studies demonstrating increased cancer risk for doses less than 100 mSv

Putting data in perspective
- Recent retrospective cohort study demonstrated EAR of 0.83 cases of leukemia per 10k children with multiple head CT
- UNSCEAR report invalidating this study
EPI-CT

- Epidemiological study to quantify risks for pediatric CT and to optimize doses
- 1 million patients in 18 countries
- Data from 1985-2002 until now
- Comparing cancer rates in these patients vs. expected cancer rates in average population
- Results expected this year
Quantifying risk: data sources

- Atomic bomb survivors
  - Hiroshima and Nagasaki
  - Greatest emphasis

- People exposed to medical radiation

- Workers in radiation and nuclear industries

- Survivors of environmental radiation exposure
  - Chernobyl
  - Three Mile Island
Radiation from atomic bombs was different than radiation in medical imaging
  - Whole body radiation and radiation fallout
  - Different radiation particles
  - Difficult to extrapolate relevance to medical imaging

- At doses greater than 100 mSv, increased incidence of cancer
- At doses less than 100 mSv, no increased incidence of cancer
Graph shows models for extrapolating radiation-induced cancer risk to low doses (dashed line and curves).

Benefit: Benefit

- Re-evaluation of atomic bomb survivor data shows radiation hormesis below 100 mSv
- Adaptive response to radiation
  - Mutation rate secondary to radiation vs background mutation rate
  - Multi-hit + evasion from immune detection and destruction
- Response to low dose radiation vs. response to high dose radiation
Other data sources

- Occupational exposure
  - 500k nuclear power plant workers = no increase in cancers
  - Most population studies have revealed no or small demonstrable health effects of radiation exposure

- Chernobyl
  - Increased risk of thyroid cancer in persons exposed to downwind radiation in utero
  - Compare this with 15 million people who exhibited psychosomatic disorders from the radiation exposure
  - Workers cleaning up Chernobyl: no increased incidence of cancer

- Fukushima
  - >1000 evacuation related deaths
“Risks of medical imaging at patient doses below 50 mSv for single procedures or 100 mSv for multiple procedures over short time periods are too low to be detectable and may be nonexistent. Predictions of hypothetical cancer incidence and deaths in patient populations exposed to such low doses are highly speculative and should be discouraged.”
Who is at risk?

- Study by Zondervan et al. compared risk of dying within 3 years after a CT in young (18-35 yo) patients vs. theoretical risk of dying from future cancer
  - CT abdomen: 35x more likely to die from condition than theoretical radiation induced cancer
  - CT chest: 70x more likely to die from condition than theoretical radiation induced cancer
Radiophobia

- Virtually all imaging procedures deliver doses way below 100 mSv
- Predictions of cancer incidence and death are at best controversial and at worst lack supportive evidence and are speculative
- Patients often delay or defer necessary imaging due to these fears
CAUTION:
TREES OBSCURING VIEW OF FOREST
NEXT 5 MILES.
What we do know

- Age matters
- Weight matters
- Location matters
Common doses

- Background radiation = 3 mSv
- CT head = 2 mSv
- CT abd/pelvis = 8 mSv
- Nuclear stress test = 5 mSv
- Coronary CTA = 1 mSv
- Barium enema = 10-15 mSv
What we do know: dose reduction

- 64-row and above MDCT: 10.0
- Automatic exposure control: 7.5
- X-ray source (spectra) optimization: 5.6
- Z axis collimation: 5.1
- Iterative reconstruction: 2.8
- Interior tomography: 1.7
- Photon count detector: 1.1
Radiation Exposure Reduction

B

Namasivayam S et al. AJNR Am J Neuroradiol
2006;27:2221-2225
Dose reduction software

198mAs, 100kV, 2.5 mm slice thickness
Unprocessed

198mAs, 100kV, 2.5 mm slice thickness
Post-processed by SafeCT
Dose reduction software

Full-dose CT at 200mA

Half-dose SafeCT-processed image of the same patient (104mA)
ACR dose registry

DIR Facilities
Jan-Jun 2015

[Map of the United States showing DIR Facilities from January to June 2015 with states color-coded and black dots indicating facility locations.]
AMI vs. other imaging centers
Your patients

- If you believe that your patient needs a CT, then you should not hesitate to order it.

- Counsel them on:
  - Theoretical risks
  - Why the CT is necessary

- Appropriateness of imaging tests

- Make sure your radiologists are doing everything possible to minimize your patient’s dose.
While risk is theoretical, we must minimize dose as much as possible (ALARA)
- Using best technology possible
- Using best protocols
- Considering if there is another test we can use
- Dose minimization most important in children, but try to minimize dose to everyone

We must focus on the benefits of imaging (AHARA), realizing that the theoretical risk is small
Thank you
Low Dose CT Lung Cancer Screening Update

David Kenny DO
Atlantic Medical Imaging
## Cancer survival

<table>
<thead>
<tr>
<th>Primary cancer</th>
<th>5 year % survival 1975-77</th>
<th>1999-2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Colorectal</td>
<td>52</td>
<td>64</td>
</tr>
<tr>
<td>Breast</td>
<td>75</td>
<td>90</td>
</tr>
<tr>
<td>Pancreas</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>
No significant improvement in mortality in the past 15 years

Sputum and serologic markers haven’t yet shown to be of any benefit
## Estimated Cancer Deaths by Sex and Age (Years), 2014

<table>
<thead>
<tr>
<th></th>
<th>All ages</th>
<th>Younger than 45</th>
<th>45 and Older</th>
<th>Younger than 65</th>
<th>65 and Older</th>
</tr>
</thead>
<tbody>
<tr>
<td>All sites, men</td>
<td>310,010</td>
<td>9,490</td>
<td>300,520</td>
<td>96,920</td>
<td>213,090</td>
</tr>
<tr>
<td>All sites, women</td>
<td>275,710</td>
<td>10,570</td>
<td>265,140</td>
<td>83,950</td>
<td>191,760</td>
</tr>
<tr>
<td>Colon &amp; rectum, men</td>
<td>26,270</td>
<td>890</td>
<td>25,380</td>
<td>8,620</td>
<td>17,650</td>
</tr>
<tr>
<td>Colon &amp; rectum, women</td>
<td>24,040</td>
<td>700</td>
<td>23,340</td>
<td>6,040</td>
<td>18,000</td>
</tr>
<tr>
<td>Lung &amp; bronchus, men</td>
<td>86,930</td>
<td>930</td>
<td>86,000</td>
<td>25,860</td>
<td>61,070</td>
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<tr>
<td>Lung &amp; bronchus, women</td>
<td>72,330</td>
<td>930</td>
<td>71,400</td>
<td>19,680</td>
<td>52,650</td>
</tr>
<tr>
<td>Breast, women</td>
<td>40,000</td>
<td>2,480</td>
<td>37,520</td>
<td>16,970</td>
<td>23,030</td>
</tr>
<tr>
<td>Prostate</td>
<td>29,480</td>
<td>*</td>
<td>29,450</td>
<td>2,940</td>
<td>26,540</td>
</tr>
</tbody>
</table>

* Estimate is fewer than 50 deaths.

Projected deaths are based on US mortality data from 1995-2010, National Center for Health Statistics, Centers for Disease Control and Prevention. Note: Estimates should not be compared with those from previous years because of ongoing changes in the method for estimating cancer deaths.

American Cancer Society, Surveillance Research, 2014
37% of US adults are current or former smokers.

Estimated Attributable Portion of Lung Cancer Cases by Cause:

- Active Smoking: 90%
- Occupational Carcinogen Exposure: 9-15%
- Radon: 10%
- Outdoor Air Pollution: 1-2%
Effects of stopping smoking at various ages on the cumulative risk (%) of death from lung cancer up to age 75, at death rates for men in UK in 1990. Nonsmoker rates were taken from US prospective study of mortality.

* Importance of smoking cessation
Lung Cancer Diagnosis and Survival By Stage, 2001-2007

Leading cancer killer in both men and women since 1987

27% of all cancer deaths
November 2010 initial findings from the NLST were released.

Published online New England journal of Medicine June 2011
print August 2011
National Lung Screening Trial (NLST)

Divided more than 53,000 high risk smokers ages 55-74 into two groups
- CT
- CXR

Patients were imaged yearly for a total of 3 years and then followed for another 4 years

CT group showed 20% fewer deaths due to lung cancer compared with CXR

320 people needed to be screened with CT in order to save 1 life
Benefits of CT lung screening

- Detect more cancers at smaller size
- Detect earlier stage cancers
- Improved survival
- Detect other cancers and diseases
- Coronary artery disease
- Improved smoking cessation rates
Detect earlier stage cancers
Do you see the cancer?

CT vs. X-ray

Screening trials demonstrate that 70-80% of lung cancers seen on CT are missed on X-ray.
Cause and Effect
Using actuarial models, this study estimated the costs and benefits of annual lung cancer screening offered as a commercial insurance benefit in the high-risk US population ages 50–64. Assuming current commercial reimbursement rates for treatment, we found that screening would cost about $1 per insured member per month in 2012 dollars. The cost per life-year saved would be below $19,000, an amount that compares favorably with screening for cervical, breast, and colorectal cancers.

<table>
<thead>
<tr>
<th>Type of cancer</th>
<th>Screen intervention</th>
<th>$/Year of life saved in 2012 dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cervix</td>
<td>Pap</td>
<td>50,162-75,181</td>
</tr>
<tr>
<td>Colorectal</td>
<td>Colonoscopy</td>
<td>18,705-28,958</td>
</tr>
<tr>
<td>Breast</td>
<td>Mammography</td>
<td>31,309-51,274</td>
</tr>
<tr>
<td>Lung</td>
<td>LDCT Baseline</td>
<td>18,862</td>
</tr>
<tr>
<td></td>
<td>Low estimate</td>
<td>11,708</td>
</tr>
<tr>
<td></td>
<td>High estimate</td>
<td>26,016</td>
</tr>
</tbody>
</table>

Pyenson B S et al. Health Aff 2012;31:770-779
USPSTF

- Official recommendation December 2013 (category B)
  - High certainty of moderate net benefit
- Asymptomatic
  - 55-80 high risk annual low dose CT screening
- 30 pack year (or quit within 15 years)
Can Imaging practices provide multidisciplinary lung cancer screening?

- Hybrid multidisciplinary model
  - Multiple Institutions, private groups

- How?
  - Lung cancer screening database
  - Nursing Coordinator
  - “Recognized by the Lung Cancer Alliance”
  - 1 of 75 practices
Medicare covering LCS

To qualify for the once-per-year benefit, patients must be 55 to 77 years old. Additionally, Medicare beneficiaries must:

- currently smoke tobacco products or have quit within the past 15 years,
- have smoked an average of one pack of cigarettes a day for 30 years, and
- have a physician or other health care professional's written order requesting the test.

Medicare coverage includes an office visit dedicated to patient counseling on tobacco-related issues and a conversation about the relative harms and benefits of lung cancer screening.

The pros and cons of lung cancer screening for patients in this age group have been hot discussion topics among physicians and other stakeholders since at least the summer of 2013.
Potential Harms

- False positives
- Cascade of testing and treatment
  - Potential morbidity
- Unnecessary procedures
- 8 of 250 will have a negative biopsy or surgery
- After 3 years the number of false positives 390 per 1000
Radiologist interprets study same day
- Discuss the findings with patient
- Smoking cessation

AMI patient tracking
- program similar to BIRADS
How does we do LC screening?

At scheduling detailed questions are asked and insurance information obtained.

Specified criteria:

Low dose CT procedure (ASIR/SafeCT)

No oral or intravenous contrast needed

Patient is given information on lung smoking cessation programs and has the option of reviewing the scan with the radiologist.
What should screened patients know?

What is a positive screen?
Probability of false positive

What if I have a positive screen?
Most likely follow up studies

Abnormalities unrelated to lung cancer
Lung, esophageal, cardiac, mediastinal, renal, adrenal, lymphoid and vascular abnormalities

What if my screen is negative?
Screening is a process not a test
Radiation risk
Low dose CT at AMI

- Average radiation dose for protocol from NLST was approximately 2 mSv (natural background 3.1 mSv/year, chest x-ray 0.1 mSv)

- Using ASIR or Safe CT
  - even lower, approx 1 mSv (or less) at AMI
  - 2 recent representative cases 0.6 mSv
    - Additional cancer risk 0.0028%
    - Baseline cancer risk 44.9%
    - Comparable to 6 chest x-rays
AMI Lung Cancer Screening database

- November 2011 to present
- 2000 screenings
- Initial criteria for screening by NCCN and ACR
- Current criteria set forth USPTF
AMI LCS database

- 1.1 % lung cancer
- 0.2 % other cancers
- 33 % normal
- 66 % had nodules
AMI LCS database

- STAGE 1A 40 % (6 pts)
- STAGE 2A 20 % (3 pts)
- STAGE 4 33 % (5 pts)

- NLST estimated 1 life saved for every 350 screened
Thank You
Appropriate Outpatient Imaging

How do I know I’m ordering the right study?
Can/should I order that STAT?
ACR Appropriateness criteria

http://www.acr.org/Quality-Safety/Appropriateness-Criteria

- Evidence based guidelines
- Most appropriate decision: enhancing quality
- Developed by expert panels in 1994
- ACR Select. licensed software product used to be incorporated into EHR and computerized order entry.
Abdominal Pain

<table>
<thead>
<tr>
<th>Topic Name</th>
<th>Narrative</th>
<th>Evidence Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute (Nonlocalized) Abdominal Pain and Fever or Suspected Abdominal Abscess</td>
<td>🌐 Narrative</td>
<td>📖 Evidence Table</td>
</tr>
<tr>
<td>Acute Pancreatitis</td>
<td>🌐 Narrative</td>
<td>📖 Evidence Table</td>
</tr>
<tr>
<td>Blunt Abdominal Trauma</td>
<td>🌐 Narrative</td>
<td>📖 Evidence Table</td>
</tr>
<tr>
<td>Colorectal Cancer Screening</td>
<td>🌐 Narrative</td>
<td>📖 Evidence Table</td>
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<td>Crohn Disease</td>
<td>🌐 Narrative</td>
<td>📖 Evidence Table</td>
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<tr>
<td>Dysphagia</td>
<td>🌐 Narrative</td>
<td>📖 Evidence Table</td>
</tr>
<tr>
<td>Jaundice</td>
<td>🌐 Narrative</td>
<td>📖 Evidence Table</td>
</tr>
<tr>
<td>Left Lower Quadrant Pain — Suspected Diverticulitis</td>
<td>🌐 Narrative</td>
<td>📖 Evidence Table</td>
</tr>
<tr>
<td>Liver Lesion — Initial Characterization</td>
<td>🌐 Narrative</td>
<td>📖 Evidence Table</td>
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<tr>
<td>Palpable Abdominal Mass</td>
<td>🌐 Narrative</td>
<td>📖 Evidence Table</td>
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<tr>
<td>Pretreatment Staging of Colorectal Cancer</td>
<td>🌐 Narrative</td>
<td>📖 Evidence Table</td>
</tr>
<tr>
<td>Right Lower Quadrant Pain — Suspected Appendicitis</td>
<td>🌐 Narrative</td>
<td>📖 Evidence Table</td>
</tr>
<tr>
<td>Right Upper Quadrant Pain</td>
<td>🌐 Narrative</td>
<td>📖 Evidence Table</td>
</tr>
<tr>
<td>Suspected Liver Metastases</td>
<td>🌐 Narrative</td>
<td>📖 Evidence Table</td>
</tr>
<tr>
<td>Suspected Small-Bowel Obstruction</td>
<td>🌐 Narrative</td>
<td>📖 Evidence Table</td>
</tr>
</tbody>
</table>
Acute (non-localized) abdominal pain and fever, (possible or suspected abscess) no recent operation

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT abdomen and pelvis with contrast</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT abdomen and pelvis without contrast</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>US abdomen</td>
<td>6</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>X-ray abdomen</td>
<td>6</td>
<td>To evaluate for bowel perforation.</td>
<td></td>
</tr>
<tr>
<td>MRI abdomen and pelvis without contrast</td>
<td>5</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>MRI abdomen and pelvis without and with contrast</td>
<td>5</td>
<td>See statement regarding contrast in text under “Anticipated Exceptions.”</td>
<td>O</td>
</tr>
<tr>
<td>X-ray upper GI series with small bowel follow-through</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-ray contrast enema</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT abdomen and pelvis without and with contrast</td>
<td>3</td>
<td>May be helpful in select cases but should be used with caution because of increased radiation dose.</td>
<td></td>
</tr>
<tr>
<td>Ga-67 scan abdomen</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tc-99m WBC scan abdomen and pelvis</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-111 WBC scan abdomen and pelvis</td>
<td>3</td>
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**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level*
Clinical Decision Support Software

- Appropriate use, imaging and therapy
  - Declining reimbursement push for clinical decision support software
  - Telling you what to do? and how/when to do it.
    - Integrated workflow accepted by doctors
      - Meeting appropriateness guidelines, reducing unnecessary tests.....reducing HC cost
  - Cost.....MU-2
- Already in place in many hospital systems
Radiology Benefits Management Firms (EviCore, Medsolutions, AIM) and NCD/LCD (Medicare)

• Utilization management programs
  • Tools to appropriately manage radiology benefits
  • Use of evidence based criteria (based largely upon ACR appropriateness criteria)
  • Seen frequently as an obstacle but grew out of necessity to control cost and utilization
How do I order a study?

- In light of ICD-10 additional specific requirements
- Include brief but detailed clinical information, signs and symptoms
- Please DO NOT USE “Rule out” (unless signs and symptoms are included)
- If needed, specify a particular entity or condition that you would like us to comment on
Example:
STAT outpatient study

- Can I even do that? Should I? Should I send the patient to the ER?
- What’s the process?
- Is it even covered by insurance?
- Do I have to wait for pre-certification to be completed?
Reducing Emergency Department Overuse: A $38 Billion Opportunity

Opportunity

Emergency department overuse: $38 billion in wasteful health care spending.

Solutions

67 million, or more than half of the 120 million annual emergency visits, are potentially avoidable.

Drivers for Change

- Payment Reform for Providers
- Financial Incentives for Patients
- Improved Data on Emergency Department Utilization

An increasing number of people are using hospital emergency departments (ED) for non-urgent care and for conditions that could have been treated in a primary care setting. Nationally, 56 percent, or roughly 67 million visits, are potentially avoidable. Reducing this trend represents a significant opportunity to improve quality and lower costs in health care.

Significant Savings
- The average cost of an ED visit is $160 more than the cost of an office health care visit.

Who uses the ED for non-urgent care?
- All payer and age groups.
- Insured patients with eurer sources of primary care.

Increasing access to primary care services can reduce emergency department overuse by up to 56 percent. A number of tested measures already exist, including offering alternative approaches to primary care, specialized services for vulnerable populations, and effective chronic disease management.

Quality Improvements

- Improved Access to Primary Care Services
  - Patient-Centered Health Care Homes: Early data from health care homes, pilots have observed a 37 percent reduction in ED use.
  - Weekend Hours: Patients arriving from a primary care practice offering weekend hours use the ED 20 percent less than patients from practices that do not.
  - Telephone Consultation: 24-hour access to a physician teleconsult service reduced avoidable ED use from 6.1 percent of visits to 3.9 percent of visits.

Reducing the overuse of emergency department services requires policy actions that involve providers, payers, and patients.

Action Steps

- Payment Reform for Providers
  - Adopt payment approaches to ensure providers’ benefits in primary care improvements such as extended hours, increased contact with patients via telephone and e-mail, shared care information technologies, and additional staff and care resources.
  - Improvement performance-based payment systems that use patient ED utilization or appointment wait times as quality metrics to reward health care professionals who reduce ED volume.

Financial Incentives for Patients
- Reduce copayments for patients who use urgent care clinics.
- Increase patient copayments for non-urgent ED visits.

Improved Data on ED Utilization
- In order to report accurately and up-to-date information to providers on their patients’...
Need for improved access to primary care for emerging health problems.

- Cost for Emergency or even Urgent Care is astronomical

- For flank pain an ER visit can cost up to $5000

“I'm going to take your blood pressure, so try to relax and not think about what a high reading might mean for your chances of living a long, healthy life.”
- Horizon .... precertification through Evicore

- Amerihealth ..... Medsolutions

- What do I need?

- What are common pitfalls and denied indications?

- How can RADCON help?
Private Insurance  
Horizon, Amerihealth, Oxford, Aetna etc  
- Use Precertification process through third party  
  - Evicore, Medsolutions, AIM  

Determine a need for a STAT study and send the patient with an order or prescription for the STAT study  

Simultaneously the pre certification process is started with the above companies  
  - Either at your office or through a service such as RADCON the process must be initiated and will be finalized likely after the procedure has been done  

In the background the normal precertification process is taking place (this can take up to 3 days if all is well)
Complaints associated with abdominal or pelvic pain [One of the following]:

Abdominal pain persisting and one of the following:

Tenderness

Evidence of inflammatory reaction (such as aural temperature >38.3°C or >100.9°F or elevated WBC >11,500/cu.mm)  Muscular rigidity – guarding

Abdominal distention on exam

Obstructive uropathy or hydronephrosis (renal, ureteral, or bladder stone causing obstruction) [One of the following] :  
Pain in flank, radiating toward the groin

Hematuria
70450 CT of the Head or Brain without Contrast

Head trauma$^{1,2}$ [One of the following]

A. Minor or mild acute closed head trauma without neurologic deficit adult
   1. Glasgow Coma Scale $\geq 13$

Mild or moderate acute closed head injury under age 2

Minor or acute closed head injury with focal neurologic deficit

Moderate or severe closed head trauma

Subacute or chronic closed head trauma with cognitive and/or neurologic deficit (See F next slide) (MRI without contrast is preferred)

Suspected carotid or vertebral dissection (CTA head and neck is preferred)

Penetrating injury, stable neurologically intact (CT is preferred)

“You have a lot of boring health issues, so I’m prescribing medical marijuana for myself.”
Focal neurologic finding

I. Headache
   1. Vomiting
   2. Memory loss
   3. Seizure
   4. Ataxia
B. Drug or alcohol intoxication and evaluation is suboptimal or inadequate
C. Skull fracture

II. Abrupt onset of a neurologic deficit – including stroke and TIA [One of the following][3,4]
   A. Motor weakness affecting a limb, or one side of the face or body
   B. Decreased sensation affecting a limb, or one side of the face or body
   C. Acute ataxia (unsteady and clumsy motion of the limbs or trunk)
   D. Mental confusion including memory loss and disorientation
   E. Impaired vision, including amaurosis fugax, visual field loss and diplopia
   F. Aphasia (loss or impairment of the ability to produce or comprehend language due to brain damage)
   G. Dysarthria (speech disorder resulting from neurological injury)
   H. Dysphagia with no GI cause
   I. Vertigo with either headache or nystagmus
   J. Numbness, tingling, paresthesias
   K. Decreased level of consciousness
   L. Papilledema
   M. Stiff neck
RADCON provides a much needed service for your diagnostic imaging pre-authorization requests. This program covers pre-authorization requests for computed tomography (CT), computed tomography angiography (CTA), magnetic resonance imaging (MRI), magnetic resonance angiography (MRA) and nuclear medicine studies.

Our dedicated team of authorization specialists will work on the request, coordinate all requirements with the insurance companies, complete all follow-up and send results immediately back to you.

Our goal is to provide high-quality insurance authorization services, while reducing the time consuming administrative work involved in obtaining insurance authorizations for your patients.
TO GET STARTED

• You will need to register for the pre-authorization service by faxing the completed designation form and business associate agreement to RADCON at (855) RADCON2 (723-2662).

• If you have additional questions, please contact one of our authorization specialists at (855) RADCON1 (723-2661).
Helpful links

• EviCore
  https://www.carecorenational.com/content/pdf/44/4AE31EEFA155483CBBBE46B949999C5E.pdf

• Amerihealth

• RADCON Precert service
  http://radconinc.net/pre-cert-services/?lang=en

• ACR Appropriateness criteria
  https://acsearch.acr.org/list
Thank You