Implementing a Standardized Radiograph and MRI Reporting System for Suspected Pedal Osteomyelitis

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Our project utilized the Institute for Healthcare Improvement methodology

IHI.org
What are we trying to accomplish?

Improve underlying issues with the appropriate imaging and reporting of pedal osteomyelitis

- Ambiguous reports
- Confusion among ordering clinicians
- Poorly defined extent of disease
- Inconsistent and non evidence-based recommendations

How will we know if a change is an improvement?

- Intradepartmental compliancy
- Survey feedback from ordering clinicians
What changes can we make that will result in an improvement?

• Map recommendations to the clinical treatment algorithm
• Standardize report impressions, terminology, and protocols.
• Eliminate ambiguous terminology
• Provide definitive, actionable recommendations

PLAN – Research

<table>
<thead>
<tr>
<th>ACR Appropriateness Criteria</th>
<th>Meeting with other Stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012 Infectious Diseases Society of America Clinical Practice Guideline for the Diagnosis and Treatment of Diabetic Foot Infections</td>
<td>Interdepartmental Research and Planning</td>
</tr>
</tbody>
</table>
**PLAN – Research**

ACR Appropriateness Criteria

<table>
<thead>
<tr>
<th>Clinical Condition</th>
<th>Suspected Osteomyelitis of the Foot in Patients with Diabetes Mellitus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variant 2:</td>
<td>Soft-tissue swelling without neuropathic arthropathy with ulcer.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-ray foot</td>
<td>9</td>
<td>Initial study. Radiographs and MRI are complementary, and both are indicated. The results of initial x-ray examination do not preclude the necessity for additional studies.</td>
</tr>
<tr>
<td>MRI foot without and with contrast</td>
<td>9</td>
<td>Radiographs and MRI are complementary, and both are indicated. MRI is useful preoperatively to identify the extent of involvement and to map devitalized areas. See statement regarding contrast in text under “Anticipated Exceptions.”</td>
</tr>
<tr>
<td>MRI foot without contrast</td>
<td>9</td>
<td>Radiographs and MRI are complementary, and both are indicated.</td>
</tr>
<tr>
<td>Labeled leukocyte scan foot (Tc-99m or Tl-199m)</td>
<td>3</td>
<td>May be appropriate in certain circumstances such as if MRI is contraindicated or unavailable.</td>
</tr>
<tr>
<td>Tc-99m 3-phase bone scan and labeled leukocyte scan (Tl-199m or Tc-99m) foot</td>
<td>1</td>
<td>***</td>
</tr>
<tr>
<td>Tc-99m 3-phase bone scan foot</td>
<td>1</td>
<td>***</td>
</tr>
</tbody>
</table>

**PLAN - Stakeholders**

- **Radiology**
- **Medical Management**
- **Surgical Management**
- **Orthopedics**
- **Internal Medicine**
- **Infectious Disease**
- **Podiatry**
- **Wound Center**
- **Patients**
PLAN – Design

Radiography
Standardize radiograph impressions to improve treatment and ordering patterns.

Hard recommendations implemented into every impression

MRI
MRI impression construct includes four categories based upon the suspicion for osteomyelitis.
- Normal
- Low Suspicion
- High Suspicion
- Compatible with Osteomyelitis

PLAN - Previous Treatment Algorithm

Diagnosis of Osteomyelitis in the Diabetic Foot
DO – Implement changes
Standardized Radiograph Impressions and Recommendations

**Negative Radiograph**

“No radiographic evidence of osteomyelitis. If clinical signs of osteomyelitis persist with routine care, recommend repeat radiographs in 6 weeks.”

**Positive**

“Radiographic findings compatible with osteomyelitis. A MRI of the (forefoot/midfoot/hindfoot/foot) WITH and WITHOUT contrast would provide additional information regarding the extent of the osteomyelitis.”

**Follow-up Negative**

“No radiographic evidence of osteomyelitis. In the setting of poor wound healing, recommend MRI of the (forefoot/midfoot/hindfoot/foot) WITH and WITHOUT contrast for a more sensitive evaluation.”

DO – Implement changes
Revised MRI Classification of Suspected Pedal Osteomyelitis

<table>
<thead>
<tr>
<th>Classification</th>
<th>T1 Signal</th>
<th>Secondary Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Normal</td>
<td>Absent</td>
</tr>
<tr>
<td>Low Suspicion</td>
<td>Reticular</td>
<td>Absent</td>
</tr>
<tr>
<td></td>
<td>Nonconfluent</td>
<td></td>
</tr>
<tr>
<td>High Suspicion</td>
<td>Reticular</td>
<td>Present (ulcer, abscess, sinus track)</td>
</tr>
<tr>
<td></td>
<td>Nonconfluent</td>
<td></td>
</tr>
<tr>
<td>Compatible with Osteomyelitis</td>
<td>Reticular</td>
<td>Present (ulcer, abscess, sinus track)</td>
</tr>
<tr>
<td></td>
<td>Confluent</td>
<td></td>
</tr>
</tbody>
</table>
Low suspicion

- Nonconfluent, reticular, hypointense T1 signal
- No secondary signs (ulcer, abscess, sinus tract)

High suspicion

- Nonconfluent, reticular, hypointense T1 signal
- Secondary sign present (ulcer, abscess, sinus tract)
**Compatible with Osteomyelitis**

- Abnormal, low signal which is CONFLUENT
- Secondary sign present (ulcer, abscess, sinus tract)

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**DO – Appropriateness of Recommendations**

- Before implementation nuclear medicine scans were frequently recommended (15% of initial radiographs)
- The literature and appropriateness criteria only supports these studies in very limited circumstances.
- Evidence-based changes were made to the clinical treatment algorithm.
- Imaging recommendations were mapped to the revised algorithm
DO – Revised Treatment Algorithm

![Algorithm Diagram]

DO – Implement changes

- An oral presentation of changes was given to the radiology residents
- Hard copies of this information and templates were posted by each ER and MSK workstation
- Electronic copies were placed in PACS and on the residency website (blackboard.org)
STUDY – Measure Results

• For both MRI and radiography studies were compared before and after changes were implemented
• Studies were first filtered within PACS using the search term: “osteomyelitis”
• Forty studies from before and after implementation were chosen at random within a 3 month time interval

STUDY – Measure Results

• Internal
  – Template Compliancy
  – Appropriateness of recommendations
• External
  – Ordering clinician satisfaction survey
STUDY – MRI Compliancy Results

• For a report to be considered compliant:
  – Utilizes one of the department MRI templates
  – Impression includes probability of disease based on our construct.
  – Clearly defines extent of disease

• Compliancy – 90%
  - Only staffed by MSK section attendings

STUDY – Radiograph Compliancy Results

• For a report to be considered compliant:
  – Utilizes one of the department templates
  – Impression includes appropriate recommendation

• Total Compliancy – 36%
• MSK section compliancy – 73%
• Non-MSK section compliancy – 27%
STUDY – Survey Results

- Surveys were distributed to ordering attending physicians.
- Sample size – 10.
  - Response rate greater than 50%
- Survey consisted of 4 multiple choice questions and an additional comment field
- Each question used a five-level Likert scale

STUDY – Survey Results
Questions standardized into a five-level Likert scale

1. Clarity of radiograph and MRI reports:
   - Anchors: Always unclear to Always clear
   - Before: 2.8
   - After: 3.6

2. Confidence in the Diagnosis based on the imaging impression:
   - Anchors: Not confident at all to Always confident
   - Before: 3.1
   - After: 3.9

3. How often is there a need to clarify an impression?
   - Anchors: Never to Always
   - Before: 3.0
   - Always: 3.8

4. Overall satisfaction with pedal osteomyelitis improvement project:
   - Anchors: Very unsatisfied to Very satisfied
   - Before: 3
   - After: 3.9
STUDY – Survey Results

Examples of specific comments:

“The standardization has vastly improved my confidence in the radiograph reports. The issue was never about the MRI reports, but about when to order an MRI.”

“Since implementation the need for MRI’s ordering has gone down and the confidence that an MRI does or does not need to be ordered has gone up.”

“This has reduced the cost of healthcare treatment”

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STUDY - Radiograph Compliancy

<table>
<thead>
<tr>
<th></th>
<th>Pre-implementation</th>
<th>Post-implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambiguous reports</td>
<td>27.5%</td>
<td>10%</td>
</tr>
<tr>
<td>Hard recommendations</td>
<td>5%</td>
<td>25%</td>
</tr>
<tr>
<td>Soft recommendations</td>
<td>37.5%</td>
<td>15%</td>
</tr>
<tr>
<td>MSK staff compliancy</td>
<td>na</td>
<td>73%</td>
</tr>
<tr>
<td>Non-MSK staff compliancy</td>
<td>na</td>
<td>27%</td>
</tr>
<tr>
<td>Total staff compliancy</td>
<td>na</td>
<td>36%</td>
</tr>
</tbody>
</table>
STUDY - Assess Internal Results

MRI compliancy likely superior to xrays due to a smaller cohort reading those studies.

– MSK section – 3 members in section
  • (73% compliancy)
– Other staff – 14 members in cohort
  • (27% compliancy)

Prioritize compliancy in the next improvement cycle, especially among non-MSK staff.

ACT – Next Cycle, CQI

• Discussion for a system-wide implementation is already underway
• Increase compliancy of standardized impressions, especially among non-MSK staff
• Add recommendations for the setting of potential osteomyelitis with coexisting neuropathic arthropathy.
• Improve ordering within the electronic medical record.
  – The chief of infectious disease recommends the addition of discrete fields for diabetes, presence of skin defect, peripheral vascular disease, etc
Summary

This project demonstrates that when standardized impressions and recommendations are mapped to a clinical treatment algorithm, radiologists have the opportunity to lead quality improvement at the interdepartmental and system-wide levels.

References


