Meeting Agenda

• Welcome- Fisher
• Logo-Fisher
• Case Study- Implementing MRI
  • Afif Kulaylat-Penn State Children’s
  • Q&A
• Next Webinar-Fisher
  • Implementation Guide Results
Welcome!

<table>
<thead>
<tr>
<th>California</th>
<th>New York</th>
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<tbody>
<tr>
<td>Kaiser Foundation Oakland,</td>
<td>Upstate Golisano, Jennifer Stanger</td>
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<td>Kaiser Foundation Santa Clara,</td>
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<tr>
<th>Massachusetts</th>
<th>Oregon</th>
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<tr>
<td>Baystate Children’s, Kevin Moriarty</td>
<td>Doernbacher Children’s, Sanjay Krishnaswami</td>
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<tr>
<th>Michigan</th>
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<td>Helen DeVos Children’s, Emily Durkin</td>
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PSQC Member Hospitals
Proposed PSQC Logos
PSQC Brief Update

Kevin Lally, MD, MS, FACS
PSQC Executive Director
Surgeon-in-Chief, Children’s Memorial Hermann Hospital
Houston, TX
Case Studies in MRI

Afif N. Kulaylat, M.D., M.Sc.
Assistant Professor of Surgery and Pediatrics
Penn State Children’s
Reducing CT use through implementation of an MRI program for pediatric appendicitis

Afif Kulaylat MD MSc
Division of Pediatric Surgery, Penn State Children’s Hospital
Penn State Children’s Hospital

- 150 Bed Children’s Hospital within a General Health System
  - Level 1 ACS Verified Children’s Surgery Center
- Immediately adjacent/connected to Penn State Milton S. Hershey Medical Center (600 bed)
Resources

• 3 MRI Magnets (1.5T, 3Tx2)
• 6 pediatric radiologists (board certified)
• Senior radiology residents overnight with pediatric radiologist available for consultation with remote PACS capability
• Limited sonographers/coverage
Motivation for change ~2009/2010

- Increasing data negative effects radiation
- Limited U/S coverage + less than optimal diagnostic results
- New data suggesting MRI as an alternative to CT
- Right people, right time
Champions

- Robert Cilley – Chief of Pediatric Surgery
- Peter Dillon – Chair of Surgery
- Kathy Eggli - Chair of Radiology
- Danielle Boal – Chief of Pediatric Radiology
- Michael Moore – Pediatric Radiologist
- Glenn Geeting – Emergency Physician
MRI Protocol

- 4 Sequences
- No IV or oral contrast
- No sedation
- Pts 5 -17 years
- Consider ages 3-4 if they could tolerate exam without sedation
Initial Experience

- March 2010 – March 2011
- MRI replaced CT scan without overlap period
- Diagnostic outcomes
  - Sensitivity: 97.6%
  - Specificity: 97.0%
  - PPV: 88.9%
  - NPV: 99.4%
Initial Experience

• Time parameters
  – Median acquisition time 12 minutes
  – Median request to first sequence: 65 minutes
  – Last sequence to report 46 minutes
  – Request to prelim report 133 minutes
  – Request to final report 164 minutes
Follow-up experience

An implemented MRI program to eliminate radiation from the evaluation of pediatric appendicitis

Afif N. Klaylat a, Michael M. Moore b, Brett W. Engbrecht a, James M. Brian b, Aliasgher Khaku c, Christopher S. Hollenbeak d, Dorothy V. Rocourt a, Michael A. Hulse b, Robert P. Olympia e, Mary C. Santos a, Sosamma T. Methratta b, Peter W. Dillon a, Robert E. Cilley a

- 30 consecutive months, July 2011 – Dec 2013
- 510 patients
- Diagnostic Outcomes
  - Sensitivity 96.8%
  - Specificity 97.4%
  - PPV 92.4%
  - NPV 98.9%
Follow-up Experience

- Clinical Outcomes
  - 10 false positives (6 ruled out clinically)
  - Negative appendectomy 3.1% → 1.5%
  - 4 false negatives, two admitted + OR, two sent home & came back w/evidence of perforation
  - Admitted observation 49 (10% of cohort)
  - Alternative diagnosis documented in 20%
Alternative Diagnoses

[Image of medical scans with arrows indicating areas of interest]
Follow-up Experience

• 30 consecutive months, July 2011 – Dec 2013
• 510 patients

<table>
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<tr>
<th>Variable</th>
<th>Total (n = 510)</th>
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<tbody>
<tr>
<td>Radiologic</td>
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<tr>
<td>Request to scan, minutes</td>
<td>71 (51–102)</td>
</tr>
<tr>
<td>Duration of imaging, minutes</td>
<td>11 (8–17)</td>
</tr>
<tr>
<td>Last sequence to interpretation, minutes</td>
<td>31 (20–47)</td>
</tr>
<tr>
<td>Request to interpretation, hours</td>
<td>2.0 (1.6–2.6)</td>
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<tr>
<td>Clinical</td>
<td></td>
</tr>
<tr>
<td>Arrival to initial assessment, minutes</td>
<td>22 (13–38)</td>
</tr>
<tr>
<td>Assessment to admit order, hours</td>
<td>4.1 (3.1–5.1)</td>
</tr>
<tr>
<td>Assessment to antibiotic administration, hours</td>
<td>4.7 (3.9–6.7)</td>
</tr>
<tr>
<td>Assessment to operating room, hours</td>
<td>9.1 (5.8–12.7)</td>
</tr>
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</table>

IQR — interquartile range.

a For non-transferred and non-outpatient clinic patients (n = 458)
Follow-up Experience

- CT used in an additional 88 patients
  - 31% due to age
  - 19% alternative concern on ddx
  - 15% neurologic/developmental d/o
  - 35% MRI unavailability/physician preference

- US used in an additional 57 patients
  - 28% due to age
  - 31% alternative concern on ddx
  - 40% MRI unavailability/physician preference
Follow-up Experience

• Costs
  – 2014 Dollars Medicare Fee Schedule Payments
  – Vs. CT scan: + $247.96
  – Vs. U/S Complete: $381.20
  – Vs. U/S Limited: $556.31
  – Direct Costs should be balanced against
    • Detection of alternative diagnosis
    • Maintaining sonography staffing/training
    • Facilitating discharge
    • Observation considerations
    • Time efficiencies single vs. two stage
    • Preventing future malignancy
Reflections - Stakeholders

- Surgeons
- Emergency Physicians
- Radiologists
- Technologists
- Sonographers
- Patients/families
Reflections - Keys to Success

• Shared MRI resources with 24/7 staffing
• Scheduling flexibility of MRI technologists
• Institutional alignment
• Champions
• Designed around our specific institutional structure/resources
Reflections - Barriers

- Improving scheduling flexibility
- Surgeon difficulty with interpretation
- No formal PEM division, adult providers ordering CT scans
- Learning curve
Pediatric patient (age <18 years) with suspected appendicitis

Nurse & provider evaluation
Nurse places LMX if desired
Reassess if unstable

Imaging already performed at outside facility?

If surgery awareness of patient, consult surgery
NPO
Send CBC, CRP, BMP, urine dip, hcg, if results not available
Med: Tylenol IV pm fever or mild pain
Morphine pm
Zofran pm
NS bolus if dehydrated

Image:
- Able to hold still: MRI abdomen & pelvis
- Symptoms 5+ days: w/o contrast
- Symptoms >5 days: w/ contrast
- Unable to hold still: US abdomen limited
  (most patients age <5 yrs, developmental delay, etc)

Imaging not completed within 1hr of order:
Consult surgery for recommendations

Review outside images:
Upload disc
Place order for radiology read

Imaging:
- MRI abdomen & pelvis
  - Symptoms 5+ days: w/o contrast
  - Symptoms >5 days: w/ contrast
- US abdomen limited
  (most patients age <5 yrs, developmental delay, etc)

Imaging read:

Negative for appendicitis
Inconclusive (appendix not visualized)
Positive for appendicitis

Give antibiotics:
Ceftriaxone
Flagyl
MIVFs (NS)

Pain control:
Meds:
Tylenol IV prn fever or mild pain
Morphine prn
Zofran prn
NS bolus if dehydrated

Pediatric Surgery Consult
Page surgery resident:
Weekdays: robotic surgery
Weekends: general surgery
Check x-ray & abdomen
- General surgery ED consult resident
- Med Dosing:
  Tylenol IV: 13mg/kg qhs prn
  Zofran IV: 0.1mg/kg max 4mg
  Morphine IV: 0.05-0.1mg/kg
  Ceftriaxone: 50mg/kg max 4g
  Flagyl: 10mg/kg max 1000mg

Clinical picture still concerning for appendicitis?

Discharge home
Return instructions
Limitations

• Don’t have good pre-implementation data
  – Admission for observation rates
  – Time parameters for ED stay, time to U/S
  – CT prevalence prior to 2010
• Cost-effectiveness easy to ask, difficult to solve
Lessons Learned

- MRI is a very good diagnostic tool for appendicitis/abdominal pain
- Clinical exam still very relevant
- Depending on system, may improve ED/hospital throughput
- Build to your strengths/resources
“MRI as a first-line diagnostic examination may result in lower overall health care costs by obviating multiple studies, reducing delays caused by the need for bladder filling for US, and expediting patient disposition”
Next directions

- Should we reconsider U/S in our algorithms
- Reassess outcomes, ED throughput, cost proposition
- Use of MRI in post-operative appy abscess
- Working with regional hospitals to decrease CT use
MRI Sequences
**PEDS APPENDICITIS**

**AGES:** 5 years old to 17 years 364 days/younger children (4-3 years old) if able to hold still without sedation

**SEDATION:** None/Exam not done on sedated patients

**CONTRAST:** No IV contrast. No Oral Contrast

**NOTE:** Haste sequences should be run free-breathing, no breath holds or triggering

<table>
<thead>
<tr>
<th>Plane/Sequence</th>
<th>Area of Coverage</th>
<th>FOV</th>
<th>Slice Thickness</th>
<th>GAP</th>
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<tbody>
<tr>
<td>1. CORONAL T2 HASTE</td>
<td>Lung Bases to Pubic Symphysis</td>
<td>Varies depending on size of pt.</td>
<td>4mm</td>
<td>10%</td>
</tr>
<tr>
<td>2. CORONAL T2 HASTE WITH FATSAT</td>
<td>Lung Bases to Pubic Symphysis</td>
<td>Varies depending on size of pt.</td>
<td>4mm</td>
<td>10%</td>
</tr>
<tr>
<td>3. AXIAL T2 HASTE</td>
<td>Lung Bases to Pubic Symphysis</td>
<td>Varies depending on size of pt.</td>
<td>4mm</td>
<td>10%</td>
</tr>
<tr>
<td>4. AXIAL T2 HASTE WITH FATSAT</td>
<td>Lung Bases to Pubic Symphysis</td>
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Magnetic resonance imaging in pediatric appendicitis: a systematic review

Michael M Moore¹, Afif N Kulaylat², Christopher S Hollenbeck²³, Brett W Engbrecht², Jonathan R Dillman⁴, Sosamma T Methratta⁵

Resources - Resident MRI Read

- High concordance demonstrated btw residents and pediatric radiologists
- Did not differ by residents PG year
- Overall concordance 97.1%
- Concordance for verified cases of appendicitis 93.4%
MRI for clinically suspected pediatric appendicitis: case interpretation

Michael M Moore, James M Brian, Sosamma T Methratta, Michael A Hulse, Arabinda K Choudhary, Kathleen D Eggli, Danielle K B Boal
Limitations of U/S

• 218/790 equivocal
• 41/790 technically inadequate
• 17 false positives
• 6 false negatives
Limitations of U/S

- Appendix only identified in 24.5% of cases
- Accuracy 85-91%
- 35 false positives, 54 false negatives
- Dedicated pediatric sonographers better than non-pediatric trained

A critical evaluation of US for the diagnosis of pediatric acute appendicitis in a real-life setting: how can we improve the diagnostic value of sonography?

Andrew T Trout 1, Ramon Sanchez, Maria F Ladino-Torres, Deepa R Pai, Peter J Strouse
Questions

Terry Cell: 832-441-6314
Next Webinar

Terry Fisher, MPH, PMP
Sr. Program Manager
Pediatric Surgery Quality Collaborative
UT McGovern Medical School