Cost Effective Radiology: What Specialists Should Now Know

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Ramin Khorasani, MD, MPH

Professor of Radiology, Harvard Medical School

Director, Center for Evidence-Based Imaging
Vice Chair, Department of Radiology
Brigham and Women’s Hospital
Disclosure

• Consultant: Medicalis (health IT vendor)
Objective

All slides and answers can be found at:
Center for Evidence based Imaging web-site
(presentations page from left menu bar)

I. Discuss factors that may contribute to the inappropriate use of radiological studies
II. Discuss the imaging workup of some commonly encountered clinical problems
III. Recommend methods to reduce inappropriate use of imaging studies
Background

• Excessive number of tests with ? Impact on patients’ outcome
  – concern of radiation risk; Increasing concern of costs
  – Patient experience

• ‘Steady’ growth of imaging costs
  – Pre-authorization programs by payers
  – CMS program on Imaging CDS

• Proper selection of imaging tests
  – Clinical problem, test characteristics, local expertise
  – Increasing complexity of imaging technology
  – Use of contrast-e.g. gadolinium induced NSF

Impossible to present “all” guidelines
I. Main causes of inappropriate use of imaging studies

• Test results are unlikely to affect patient management
• “short” interval follow-up studies
• Repeating studies which have already been performed (including elsewhere)
• Patient demand
• Not requesting the best test
  – Access to technology
• Inadequate clinical information provided on the ‘requisition’
II. Imaging Guidelines

- American College of Radiology (ACR)

- The British royal College of Radiologists (BRCR):
  - “Making the best use of a department of clinical radiology: guidelines for doctors”; 1995
II. Imaging Guidelines

• 80-90% of recommendations based on consensus opinion
• Take a long time to develop
• These are *not* algorithms:
  – do not account of local expertise
  – do not account for patient to patient variations
• Role of a Radiology Consultation Service?
Radiology Consultation Service - Peer to peer consultation

• Designed like other consultation services in medicine
• Allows for on-the-ward, or outpatient clinic consultation
• Comprehensive imaging consultation
• Many advantages and disadvantages
• Expect expansion of concept with ‘value-based’ contracts
Imaging Modalities

- **Ultrasound:**
  - **adv:** ionizing radiation, relatively cheap and accessible. Exam of choice in OB, excellent in the female pelvis
  - **disadv:** operator dependent, interference from bone, air, fat, difficult in the very obese
Imaging Modalities

• Computed Tomography (CT):
  – adv: no interference from bone, air or fat, easy in the obese, non-operator dependent, rapid exam, easily accessible at most sites
  – disadv: more expensive than US, ionizing radiation, intravenous contrasts with associated costs and risks
Imaging Modalities

- Magnetic Resonance Imaging (MRI):
  - adv. No ionizing radiation, exquisite soft tissue contrast (similar spatial resolution to CT), multiplanar imaging
  - disadv: more expensive than CT, less accessible than US/CT, rapidly changing technology, length of exam longer than CT, patient contraindications
Clinical Problem: Imaging Strategy

- Neuroradiology:
  - acute and chronic headache, low back pain
- Thoracic Radiology:
  - pulmonary embolism
- Abdominal Radiology:
  - bowel obstruction, appendicitis, renal colic, hematuria, common incidental lesions
- Musculoskeletal radiology
  - hip fracture
Case 1

• 40 year old female with acute onset of severe headache and loss of consciousness

• Best study to do first:

• If the first study is normal, the next test:
Best study to do first: CT
Next imaging study: cerebral arteriogram
Order #: 1  Modified from #: 0  Requested Date: 
Order: HEAD - VGH ED - CT  Side: 
Special View(s): 

**Pertinent History/Reason for Exam:**
wrong place, wrong time

Contraindications:
Comments:
Physician Name/Pager: ed

**Diabetic:** Not Diabetic
**Latex Allergy:** None Known - No Latex Allergy
CREAT: 64 UMOL/L  2013-07-31
EGFR: >120 ML/MIN  2013-07-31
INR:
PTT:
PLT: 326 GIGA/L  2013-07-31

Transport: Stretcher  [   ]No Sling
[   ]O2  [   ]HiFlow O2  [   ]Vent
[   ]B AG  [   ]Multi Drugs  [   ]Monitor
Clinical Decision Support for *iterative* Data Collection - e.g. Head CT Minor Head Trauma

### Decision Support

**Does any of the following apply to your patient:**

1. **Decision Support**
   - Please select ALL of the following that apply to your patient.

   - Persistent anterograde amnesia (short-term memory deficit)
   - Posttraumatic amnesia of 2 to < 4 hours
   - Contusion of the skull
   - Neurologic deficit
   - Glasgow coma scale deterioration of 1 point (1 hour after presentation)
   - None of the above

This information is presented to assist you in providing care to your patients. It is your responsibility to exercise your independent medical knowledge and judgment in providing what you consider to be in the best interest of the patient.

---

Submit  
Cancel  

This information is presented to assist you in providing care to your patients. It is your responsibility to exercise your independent medical knowledge and judgment in providing what you consider to be in the best interest of the patient.
Clinical Decision Support Output for Imaging Study Requests Deviating from Evidence

In patients with minor head injury and based on the information you have provided, the chance of positive findings on Head CT is extremely small according to three published large prospective controlled trials.


This information is presented to assist you in providing care to your patients. It is your responsibility to exercise your independent medical knowledge and judgment in providing what you consider to be in the best interest of the patient.
Head and Neck
Clinical Problem: headache

• Acute, severe:
  – CT excellent for intracranial hemorrhage,

• Chronic
  – imaging not routinely indicated in the absence of focal signs or symptoms, unless evidence of raised intracranial pressure, posterior fossa signs

• MRI is superior to CT in the posterior fossa, sellar and juxta-sellar regions
Case 6

- 24 year old male with 6 wk history of low back pain not improving despite conservative treatment, right S-I radiculopathy

- Best study to do first:

- If first study is normal, the next test:
Best study to do first: MRI
Spine - Clinical Problem: low back pain

- 4-6 weeks of conservative treatment if no ‘red flag’
  - E.g. Malignancy, infection, bladder/bowel symptoms
- Remember that normal patients can have abnormal MRIs
- Need to continue to develop better decision rules and guidelines-
  - ACP October 2007, ACR
  - Embed as decision support in order entry systems
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<thead>
<tr>
<th>Pain severity (Specify)</th>
<th>Leg weakness left (Specify)</th>
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<tr>
<td>Specify</td>
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<tr>
<td>mild</td>
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<tr>
<td>moderate</td>
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<td>severe</td>
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<table>
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<th>Leg weakness right (Specify)</th>
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<td>Specify</td>
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<tr>
<td>Acute (&lt;4 weeks)</td>
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<td>Subacute (&gt;4 weeks - &lt;3 months)</td>
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<td>Chronic (&gt;3 months)</td>
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<th>Leg weakness bilateral (Specify)</th>
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<table>
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<th>Radicular pain right (Specify)</th>
<th>Bladder/Bowel dysfunction (Specify)</th>
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<th>Back Pain</th>
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<td>Asymptomatic</td>
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<table>
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<tr>
<th>Other:</th>
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### Relevant History: (Select one or more)

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<tr>
<th>Course of conservative treatment during this episode (Specify)</th>
<th>Differential Diagnosis: (Select one or more)</th>
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<td>Specify</td>
<td>Disc herniation</td>
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<td>None</td>
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<td>Pharmacological therapy</td>
<td>Spinal stenosis</td>
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<td>Physical Therapy</td>
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<table>
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<tr>
<th>Trauma severity (Specify)</th>
<th>Fracture</th>
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<table>
<thead>
<tr>
<th>Trauma: chronicity (Specify)</th>
<th>Demyelinating disease</th>
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<tr>
<td>IV conscious sedation/anesthesia required</td>
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| |
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|                            |                            |

### Relevant History: (Select one or more)

| |
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|                            |                            |

### Differential Diagnosis: (Select one or more)

| |
|-----------------------------|-----------------------------|
|                            |                            |

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<th>Decision Support</th>
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<tr>
<td><strong>Patient Name:</strong> Oatea, Carol</td>
<td>PERCIPIO MRN M8652089</td>
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<td>Birth Date: February 2, 1974</td>
<td>Age: 34 years</td>
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<td>Ordering Provider: Khorasani, Ramin, M.D.</td>
<td>Payor: Fallon</td>
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<td><strong>Exam:</strong> MRI L-Spine</td>
<td>Order ID: 12408446</td>
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<td><strong>Signs and Symptoms:</strong> Pain severity (Specify: mild), Pain duration (Specify: Acute &lt; 4 weeks)</td>
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<td><strong>Relevant History:</strong> Course of conservative treatment during this episode (Specify: None)</td>
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</tr>
<tr>
<td>Created By: N/A</td>
<td>Ordering Site: Primary Care Assoc of Norwood</td>
</tr>
</tbody>
</table>

**Decision Support**

Based on published evidence, MRI is not recommended in the absence of clinical "red flags." If symptoms are disabling, consider consultation with the comprehensive spine center at 617-732-8800.

**Clinical guidelines from the American College of Physicians and American Pain Society:** Clinicians should perform diagnostic imaging and testing for patients with low back pain when severe or progressive neurologic deficits are present or when serious underlying conditions are suspected on the basis of history and physical examination (strong recommendation, moderate-quality evidence).

Please note that the information is presented to assist you in providing care to your patients. We do not provide advice regarding the appropriateness of coding, billing, or claims processing. We make no representations regarding the payment or reimbursement for services rendered.

[Add Indications] [Ignore] [Cancel]
Advise,

**Source 1:** Diagnosis and Treatment of Low Back Pain: A Joint Clinical Practice Guideline from the American College of Physicians and the American Pain Society

- **Recommendation 3:** Clinicians should perform diagnostic imaging and testing for patients with low back pain when severe or progressive neurologic deficits are present or when serious underlying conditions are suspected on the basis of history and physical examination (strong recommendation, moderate-quality evidence).

- **Recommendation 5:** Clinicians should provide patients with evidence-based information on low back pain with regard to their expected course, advise patients to remain active, and provide information about effective self-care options (strong recommendation, moderate-quality evidence).

- **Recommendation 6:** For patients with low back pain, clinicians should consider the use of medications with proven benefits in conjunction with back care information and self-care. Clinicians should assess severity of baseline pain and functional deficits, potential benefits, risks, and relative lack of long-term efficacy and safety data before initiating therapy (strong recommendation, moderate-quality evidence). For most patients, first-line medication options are acetaminophen or nonsteroidal anti-inflammatory drugs.


**Source 2:** American College of Radiology

**ACR Appropriateness Criteria** [American College of Radiology Appropriateness Criteria.pdf](http://www.annals.org)

**Indications of a more complicated status, often termed**

"red flags," include the following:

- Recent significant trauma, or milder trauma, age > 50
A peer-to-peer consultation is required in order to submit an order.

Peer-to-peer consultation is available Monday - Friday 8 am - 6 pm. Please page Perciop Support at pager #86499 during off hours.

For a faster response, please be sure to enter a direct call back number in the space provided below.

Click the "SEND PAGE" button for peer-to-peer consultation.

**Name:** Lumbar Spine, MRI

**Telephone:** None

**Pager:** 17032

**Call Back #:** (e.g. 1112223333)

Enter the peer-to-peer consultation number here: 

Please note: If you have not received a callback within 15 minutes of clicking the "SEND PAGE" button, please page Perciop Support at pager #86499

Submit  Reset Order
Reference:
<table>
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<tr>
<th>Outcome Measure</th>
<th>Pre-Intervention</th>
<th>Post-Intervention</th>
<th>p-value</th>
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</thead>
<tbody>
<tr>
<td>Lumbar Spine MRI ordered by PCP on Day of Office Visit</td>
<td>443 (5.3%)</td>
<td>477 (3.7%)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Lumbar Spine MRI ordered by any outpatient providers within 30 days of index primary care visit</td>
<td>753 (8.9%)</td>
<td>1009 (7.8%)</td>
<td>0.0023*</td>
</tr>
<tr>
<td>Lumbar Spine MRI ordered by Specialty Clinics within 30 days</td>
<td>188 (2.2%)</td>
<td>352 (2.7%)</td>
<td>0.0292*</td>
</tr>
<tr>
<td>Lumbar Spine MRI ordered by primary care outpatient providers within 30 days</td>
<td>565 (6.7%)</td>
<td>657 (5.1%)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Follow-up PCP Visit within 30 days</td>
<td>855 (10.1%)</td>
<td>1224 (9.4%)</td>
<td>0.080</td>
</tr>
<tr>
<td>Guideline adherence rate in the use of lumbar spine MRI based on manual chart review</td>
<td>78/100 (78%)</td>
<td>96/100 (96%)</td>
<td>0.0002*</td>
</tr>
</tbody>
</table>

Use of Public Data to Target Variation in Providers’ Use of CT and MR Imaging among Medicare Beneficiaries

Heatmap of CT Utilization by Payment ($)

Heatmap of Impact Hospital Referral Region for Diagnostic CT (overlapping intensity and payment)
Use of Public Data to Target Variation in Providers’ Use of CT and MR Imaging among Medicare Beneficiaries

Heatmap of MR Utilization by Payment ($)
Protecting Access To Medicare Act (PAMA; 2014)

Section 218b: Promoting Evidence Based Care

Through the use of Imaging CDS

The imaging CDS requirement is not in MACRA
What is “MACRA”? 

The **Medicare Access and CHIP Reauthorization Act of 2015 (MACRA)** is a bipartisan legislation signed into law on April 16, 2015.

**What does Title I of MACRA do?**

- **Repeals** the Sustainable Growth Rate (SGR) Formula
- **Changes the way that Medicare** rewards clinicians for **value** over volume
- **Streamlines** multiple quality programs under the new **Merit-Based Incentive Payments System (MIPS)**
- **Provides bonus payments** for participation in **eligible alternative payment models (APMs)**
Protecting Access to Medicare Act (HR 4302; 2014)- Section 218b

Promoting Evidence-Based Care

• New Requirement: Ordering professionals for ambulatory and ED ‘applicable’ advanced imaging services must be exposed to specified Appropriate Use Criteria (AUC) via a certified CDS mechanism
  – Consequence for failure—imaging provider (pro to tech) will not be paid
  – Implementation date January 1, 2018

• *AUC: evidence-based criteria linking a clinical condition to an imaging service with an assessment of appropriateness
PAMA rules: Key provisions

• Specified AUC will be developed and published by “qualified provider-led entities” (qPLE)
  – qPLE must have rigorous processes to assess, grade the evidence and publish evidence-based criteria on web-site
  – Excludes ‘RBMs’
  – Enables accommodation for local best practices
  – First application cycle January 1, 2016, then annually

• Implication: Providers can meet PAMA by implementing a ‘certified CDS mechanism’ with an AUC set from any qPLE
  – CDS mechanism applications March 2017; certifications –expected summer 2017
Key provisions under PAMA 218(b)

• Priority clinical areas
  – Coronary artery disease (suspected or diagnosed)
  – Suspected pulmonary embolism
  – Headache (traumatic and non-traumatic)
  – Hip pain
  – Low back pain.
  – Shoulder pain (to include suspected rotator cuff injury)
  – Cancer of the lung (primary or metastatic, suspected or diagnosed)
  – Cervical or neck pain

• Outlier ordering professionals after 2020 to be potentially exposed to pre-authorization
<table>
<thead>
<tr>
<th>Dx/Symptom</th>
<th>Source Type</th>
<th>Publisher</th>
<th>Choosing Wisely</th>
<th>Endorsed by Professional Society</th>
<th>Imaging Modality</th>
<th>Body Region</th>
<th>Contrast</th>
<th>Final Oxford Grade</th>
<th>Strength of Evidence</th>
<th>Final USPSTF</th>
<th>Select All</th>
<th>Select None</th>
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<tbody>
<tr>
<td>Minor Head Trauma</td>
<td>Local best practice</td>
<td>N</td>
<td>CT</td>
<td>Head</td>
<td>N/A</td>
<td>1a</td>
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</tbody>
</table>

**Source Title:** BWH Perc ellos - Minor Head Trauma

**Source Type:** Local best practice

**Source Link:** Piece of Clinical Logic:

Case 9

• 32 Y.O. Female with Braca1 gene mutation. Need to screen for breast cancer.

• Best study to do first:

• If the first study is normal, the next test:
42 y/o  BRCA 1  
ER/PR Her2/Neu Negative  
High Grade Invasive Ductal Carcinoma (IDC)  
No Ductal Carcinoma In situ (DCIS)

MR post contrast shows round rim enhancing mass  
Axial delayed MR shows washout delayed kinetics  
Ultrasound shows an oval mass with irregular margins
56 y/o, Strong Family History; BRCA Negative
ER/PR Her2/neu Negative
High Grade IDC
High grade DCIS

Contrast enhanced MRI shows an oval mass with irregular margins and rim enhancement. Around the mass is non-masslike enhancement worrisome for DCIS
Breast MRI and breast cancer

- Established yearly screening tool adjunct to mammography in high risk population - e.g. Braca1 gene mutation
- It is being used [with large variation in practice] in staging of newly diagnosed breast cancer primarily to look for multi-centric disease
  - Need to develop evidence on use of MRI in this context to improve patient outcomes
- Other screening use not supported by current evidence
  - ‘dense breast legislation’ adjunct screening with ultrasound or MRI
Case 10

• 42 F with acute onset lower abdominal pain, N/V, no fever, normal WBC, no prior surgical history, you are worried about an acute small bowel obstruction

• Best study to do first:

If the first study is normal, the next test:
Abdomen
utility of “KUB”

- Excellent for suspected perforation (supine abdomen, erect CXR),
- If suspected bowel obstruction with history of prior obstruction (supine and upright)
- In most other instances not very helpful as negative or positive result usually leads to another imaging test such as CT or US
Abdomen-Clinical Problem: 
? Small bowel obstruction

• “KUB” good first test if:
  – prior surgery, obstruction;
  – may be normal rarely in acute obstruction

• Acute SBO:
  – if further imaging, CT far better than small bowel follow through (barium study) to diagnose obstruction and its etiology

• Unexplained chronic or recurrent SBO:
  – CT/MRI enterography

• CT to look for other etiologies for pain
mucosal hyperenhancement: segmental attenuation greater than adjacent jejunum or ileum (± wall thickening [> 3mm])
Case 11

- 24 F, with 2 day history of RLQ pain, anorexia, fever, no prior surgical history, peritoneal signs in the RLQ, WBC = 12k, negative BHCG

- Best study to do first

If first study is normal, the next test:
Case 12

• 24 M diabetic with 2 day history of RLQ pain, fever, WBC = 6k, elevated blood sugars, could be acute appendicitis

• Best study to do first:

• If first study is normal, the next test:
Case 12 variant

- RLQ pain x2days, 16 wks pregnant

- Best study to do first:

- If first study is normal, the next test:
Abdomen-Clinical Problem: appendicitis

- Clinical diagnosis, imaging not routinely indicated
- If equivocal clinical diagnosis: CT is test of choice in this scenario with sensitivity and specificity > 95%
- In pregnancy, ultrasound in expert hands, MRI best test
- NEJM
  - 1/98: CT on all patients with RLQ pain-not standard of care
  - 2008- CT decreased negative appendectomy rate to <2%
- BWH
  - NAR 30% in females, 12% in males in 1990
  - NAR 1.5% females, 1.8% males in 2007
  - >95% of appendectomies had preoperative CT
  - 14.6% of CT for appendicitis went to OR
  - Estimate 20 CT per 1 less appendectomy-need further studies
How about harm from radiation exposure?

- ‘Substantial’ concern for harm from radiation exposure from Medical Imaging, esp CT-
  - Real but overblown in the media

- 1-2% potential (many assumptions) incrementally increased risk of malignancy over baseline of approximately 40% lifetime cancer risk in US
How about harm from CT radiation exposure?

- If CT is clinically appropriate and superior to other imaging modalities, its benefits substantially exceed the potential harm.
- We do need better science to more accurately assess risk.
Case 14

- 45 F with an incidental 2.5 cm right adrenal mass found on CT, performed to elevate an incidental liver lesion on RUQ US looking for gallstones!

- Best study to do first:

If the first study is normal, the next test:
“Lipid-poor” Delayed Washout

A: Unenhanced CT HU = 29
B: Enhanced HU = 73
C: 15 min. HU = 44

Absolute enhancement washout = \( \frac{(73-44)}{(73-29)} \times 100 = 66\% \)
Abdomen-Clinical Problem: adrenal lesion

- Adrenal imaging predominantly anatomic, diagnosis of functional adrenal tumors requires biochemistry.
- In patients with an incidental adrenal lesion or those with a primary malignancy, a non-contrast CT, limited adrenal MR, washout CT, or occasionally PET CT may obviate the need for follow up or biopsy.
Case 15

- 45 M, medical malpractice lawyer, found to have an incidental 6 cm simple right renal cyst on abdominal ultrasound

- Best study to do first:

- If first study is normal, the next test:
Case 16

- 73 F, who has a 2 cm echogenic mass in the liver found incidentally on ultrasound, no prior medical history

- Best study to do first:

- If first study is normal, the next test:
CT with Contrast

T2 Weighted MRI
Dynamic MRI sequence with Gadolinium: FNH
Incidental Liver lesions

- Great majority are benign cysts, hemangiomas- diagnosis can be made on ultrasound, CT, MRI
- If no prior malignancy, indeterminate solitary <15 mm hepatic lesion is highly likely to be benign (>98%), options:
  - Do nothing
  - Re-image in 6-12 months-show stability-then stop
  - Make benign diagnosis with MRI then stop
Incidental Liver lesions

• Modality of choice for characterization is MRI
Case 17

- 52 M physician, s/p fall with right hip pain, unable to move right hip

- Best study to do first:

- If the first study is normal, the next test:
Best study to do first: Plain films
Next imaging study?:

• MRI
Musculoskeletal Clinical Problem: ? Hip fracture

- Plain films are the first choice
- Normal plain films, high clinical suspicion: MRI is the study of choice to exclude occult fracture
Case 23

• 25 y.o F with presentation suggestive of appendicitis. There is a 30% chance in your estimation that she has appendicitis. We have a test with 95% sensitivity, 95% specificity. The test is positive. What is the chance that she has appendicitis?

<30%  30-75%  75-90%  >90%
Case 24

- 25 y.o F with presentation unlikely of appendicitis. There is a 2% chance in your estimation that she has appendicitis. We have a test with 95% sensitivity, 95% specificity. The test is positive. What is the chance that she has appendicitis?

<30%  30-75%  75-90%  >90%
Prevalence 30%

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<th>Appy</th>
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<tr>
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## Prevalence 2%

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</table>
III. Recommendations

• Think of how the result of an imaging test may change the management of your patient BEFORE you request an examination.
• Give as much clinical information as reasonable on the requisition:
  – history more helpful than “rule out”s!!
  – blank requisition may result in a radiologist missing a subtle but important finding.
III. Recommendations

• Use your radiologist as a consultant, this is her/his Job!!

• Get familiar with the new Law pertaining to Imaging CDS-begins January 2017

• Slides at Center for Evidence-Based Imaging web-site