High Value Body CT: Patient and Protocol Selection

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Vice Chair of Quality and Safety
Disclosures Summary

• Consultant/Advisory Board of Oliver Wynam, Practicing Wisely
• Funding: Agency for Healthcare Research and Quality (AHRQ) Conference Grant number 1R13HS026350-01
• No references to unapproved/unlabeled uses of drugs or products.
Objectives

• Discuss the importance of patient selection for body CT
  – Risks (radiation, IV contrast)
  – Patient experience (anxiety, time off work)
  – Cost of the CT exam and incidental findings

• Review protocol selection for CT of the chest, abdomen and pelvis
  – Demystify CT with vs CT w&wo vs CT without
  – Updates on IV and oral contrast
Health Care Debt…
Broken Promise to Do No Harm

Bankruptcy

Exhaustion of personal savings

Care avoidance

Home foreclosure

Health Care Debt

Medical Bankruptcy in the United States, 2007: Results of a National Study

Medical Bankruptcy in Massachusetts: Has Health Reform Made a Difference?

Foreclosure: It’s Not Just about the Mortgage


Poll: Young People More Likely To Defer Health Care Because Of Cost

66% of Americans avoid or delay treatment due to cost of medical care: 5 survey insights
Health Care Debt…
Biggest Share of Patients’ Bills

- (1) Emergency department visits
- (2) Hospitalizations
- (4) Radiology exams like MRI

Care Redesign to Reduce Patient Medical Debt

- (1) Decrease emergency department visits
- (2) Prevent avoidable hospitalizations
- (4) Optimize advanced imaging (CT, MR, etc)

Maryland Reimbursement Models

Maryland TCOC Model projected to save $1 billion by 2023

Maryland All-Payer Global Budget Revenue Model saved CMS $586 million in 5 years

https://innovation.cms.gov/initiatives/Maryland-All-Payer-Model/
High Value Radiology Practice

• Improve appropriate use of imaging exams by decreasing low value tests
• Use imaging tests that increase early diagnosis and protect patients from unnecessary surgery, emergency department visits and hospitalizations
• Perform high quality imaging and deliver high value interpretations that optimize use of downstream tests and treatments
Quality & Safety in CT Radiation, IV contrast and Costs

- 82 million CT scans performed in 2016 in the U.S.
- Highest CT utilization in world
- CT accounts for ~ 50% of all U.S. medical radiation exposure
- Abdomen CT ~ 40% of all CT scans


# Radiation Exposure from Imaging

<table>
<thead>
<tr>
<th>Imaging Procedure</th>
<th>Effective Dose (mSv)</th>
<th>Background Radiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CXR</td>
<td>0.02 mSv</td>
<td>2.4 days</td>
</tr>
<tr>
<td>Lumbar spine film</td>
<td>0.1 mSv</td>
<td>12 days</td>
</tr>
<tr>
<td>Upper GI</td>
<td>6 mSv</td>
<td>2 years</td>
</tr>
<tr>
<td>CT head*</td>
<td>2-4 mSv</td>
<td>0.6-1.3 years</td>
</tr>
<tr>
<td>CT abdomen &amp; pelvis*</td>
<td>8-56 mSv</td>
<td>3-19 years</td>
</tr>
<tr>
<td>PET/CT</td>
<td>14-32 mSv</td>
<td>4-10 years</td>
</tr>
</tbody>
</table>

*Multiple CT acquisitions add 2-4x the radiation exposure

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www.imagewisely.org

## Relative Imaging Exam Charges

<table>
<thead>
<tr>
<th>Dx Procedure</th>
<th>Relative Charge (not necessarily payment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CXR, AP portable</td>
<td>$150</td>
</tr>
<tr>
<td>CT brain with contrast</td>
<td>$600</td>
</tr>
<tr>
<td>CT brain w&amp;w/o</td>
<td>$800</td>
</tr>
<tr>
<td>US abdomen</td>
<td>$900</td>
</tr>
<tr>
<td>MRI lumbar spine w/o</td>
<td>$900</td>
</tr>
<tr>
<td>CT A/P with contrast</td>
<td>$1300</td>
</tr>
<tr>
<td>CT A/P w&amp;w/o</td>
<td>$1500</td>
</tr>
<tr>
<td>PET/CT</td>
<td>$5000</td>
</tr>
</tbody>
</table>
The Cost of Incidental Findings: Case Report

• 65 year old man underwent CT colonography revealing 3 incidental findings:
  – Multiple lung nodules → wedge resection
  – Renal lesion → CT confirmed cyst
  – Liver mass → inconclusive biopsy → PET/CT

• All findings proved benign
• Costs exceeded $50,000
• 4 week disability

Casarella WJ. A patient's viewpoint on a current controversy. Radiology 2002; 224:927
PAMA and CMS
Appropriate Use Criteria Program

Appropriate Use Criteria Program

Section 218(b) of the Protecting Access to Medicare Act of 2014 amended Title XVIII of the Social Security Act to add section 1834(q) directing CMS to establish a program to promote the use of appropriate use criteria (AUC) for advanced diagnostic imaging services. In section 1834(q)(1)(B) of the Act, AUC are defined as criteria that are evidence-based (to the extent feasible) and assist professionals who order and furnish applicable imaging services to make the most appropriate treatment decisions for a specific clinical condition.


Additional policies related to this program are included in the CY 2017 PFS Final Rule, which is available at https://www.gpo.gov/fdsys/pkg/FR-2016-11-15/pdf/2016-26668.pdf (pages 80403-80428 and pages 80554-80555).

The CY 2018 PFS proposed rule proposes requirements for consulting and reporting under the Medicare AUC program, which is available at https://www.federalregister.gov/documents/2017/07/21/2017-14639/medicare-program-revisions-to-payment-policies-under-the-physician-fee-schedule-and-other-revisions. In conjunction with the CY 2018 PFS proposed rule, CMS posted the list of newly qualified Provider-Led Entities and Clinical Decision Support Mechanisms.

These policies are codified in our regulations at 42 CFR 414.94.

# Overview

## Chest CT
- **Protocol selection**
  - Noncontrast CT
  - CT with IV contrast
  - CT with & without IV contrast
  - CT angiography
- **Patient selection**
  - Lung screening
  - Lung nodule follow up
  - Suspected PE
  - Coronary CTA
- **Incidental Findings**
  - Thyroid nodule
  - Lung nodule

## Abdominal/pelvic CT
- **Protocol selection**
  - Noncontrast CT
  - CT with IV contrast
  - CT with & without IV contrast
  - CT angiography
- **Patient selection**
  - Abdominal pain
  - Jaundice
  - Inflammatory bowel disease
  - Mesenteric ischemia
  - GI bleeding
  - Flank pain
  - Pyelonephritis
  - Hospital Acquired AKI
Noncontrast Chest CT

- Lung cancer screening
- Lung nodule follow up
- Interstitial lung disease
- Immunocompromised patient with fever
- Coronary artery calcium screening
Lung Cancer Screening: Medicare Reimbursement

- Age 55-77
- Asymptomatic
- Current smoker OR quit within 15 years
- $\geq$ 30 pack per year smoking history
- Written order from qualified medical provider
- Low dose CT chest without contrast

https://www.medicare.gov/coverage/lung-cancer-screening.html
Chest CT with IV Contrast

- Mediastinal mass
- Adenopathy/lymphoma
- Lobar atelectasis
- Suspect lung cancer
- Lung cancer staging
- Metastatic work up
- Pleural disease
- Chest wall disease
Chest CT with & without IV Contrast

- Coronary CTA includes Calcium score
- Suspect intramural hematoma
- First exam after surgical repair of aorta
- Status post aortic stent graft
CTA: Vascular Thoracic Pathology

- Pulmonary embolism
- Aortic aneurysm and pseudoaneurysm
- Aortic dissection or Intramural Hematoma
- Vasculitis (Takayasu’s)
- Penetrating atherosclerotic ulcer
- Bronchial artery CTA (Cystic Fibrosis)
- Coronary CTA
Vascular Chest CT Timing

Start contrast infusion

20 seconds

30 seconds

60 s
Routine abdominal CT

Pulmonary arteries

Systemic arteries
ACR Appropriateness Criteria®
Pulmonary Artery CTA

CTA indicated
• intermediate probability & positive D-Dimer
• high pretest probability
• +/- lower extremity doppler

CTA **not** indicated
• low or intermediate probability & negative D-Dimer
• Risk of VTE without treatment is 0.14%

https://acsearch.acr.org/docs/69404/Narrative/
Risk Stratification: PERC
Low Risk: All criteria must be (-)

- Age $\geq 50$
- HR $\geq 100$
- SaO$_2$ on RA $< 95$
- Unilateral leg swelling on physical exam
- Hemoptysis
- Recent surgery or trauma requiring ETT or hospitalization in last $\leq 4$ weeks
- Prior PE or DVT
- Exogenous estrogen use

PERC: PROPER Trial

- Cross-over, cluster, randomization
- 1749 patients: PERC or no PERC
- Endpoint: VTE within 3 months

<table>
<thead>
<tr>
<th></th>
<th>PERC</th>
<th>No PERC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of subjects</td>
<td>962</td>
<td>954</td>
</tr>
<tr>
<td>Percent imaged with CTA</td>
<td>129 (13%)*</td>
<td>220 (23%)</td>
</tr>
<tr>
<td>Percent diagnosed with PE</td>
<td>14 (1.5%)*</td>
<td>26 (2.7%)</td>
</tr>
<tr>
<td>PE missed</td>
<td>1 (0.1%)</td>
<td>0</td>
</tr>
<tr>
<td>ED LOS</td>
<td>4 h 36 min*</td>
<td>5 h 14 min</td>
</tr>
<tr>
<td>Hospital admissions</td>
<td>121 (13%)*</td>
<td>152 (16%)</td>
</tr>
</tbody>
</table>

## Risk Stratification: Well’s

<table>
<thead>
<tr>
<th>Metric</th>
<th>Score</th>
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</thead>
<tbody>
<tr>
<td>Clinical signs/symptom of DVT</td>
<td>3</td>
</tr>
<tr>
<td>Alternative diagnosis less likely than PE</td>
<td>3</td>
</tr>
<tr>
<td>Previous history of PE or DVT</td>
<td>1.5</td>
</tr>
<tr>
<td>Heart rate &gt; 100 beats/min</td>
<td>1.5</td>
</tr>
<tr>
<td>Recent surgery prior 4 weeks or immobilization ≥ 3 days</td>
<td>1.5</td>
</tr>
<tr>
<td>Hemoptysis</td>
<td>1</td>
</tr>
<tr>
<td>Active malignancy</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Probability Level</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Probability</td>
<td>≤ 2</td>
</tr>
<tr>
<td>Moderate Probability</td>
<td>2-6</td>
</tr>
<tr>
<td>High Probability</td>
<td>≥ 6</td>
</tr>
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## Risk Stratification: Well’s

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<td>1</td>
</tr>
<tr>
<td>Active malignancy</td>
<td>1</td>
</tr>
<tr>
<td>PE unlikely</td>
<td>≤ 4</td>
</tr>
<tr>
<td>PE likely</td>
<td>&gt;4</td>
</tr>
</tbody>
</table>

Suspected Pulmonary Embolism: Optimizing Resource Utilization

Low pretest probability: PERC

PERC (-) Consider alternative diagnosis

PERC (+)

Moderate pretest probability

D-Dimer

Positive D-Dimer: No CTA

Positive D-Dimer: Pulmonary CTA

High pretest probability

CT Findings of PE: Main PA Pulmonary Emboli
CT Findings of PE: Right Heart Strain

Clockwise rotation

Flattening of IVS
Isolated Subsegmental PE: Other end of the spectrum

TOO MUCH MEDICINE

When a test is too good: how CT pulmonary angiograms find pulmonary emboli that do not need to be found

Renda Soylemez Wiener assistant professor¹², Lisa M Schwartz professor³⁴, Steven Woloshin professor³⁴
Isolated Subsegmental PE

JAMA Clinical Guidelines Synopsis
May 16, 2017

Antithrombotic Therapy for Venous Thromboembolic Disease

Atul Jain, MD, MS¹; Adam S. Cifu, MD²

Author Affiliations  |  Article Information


- In patients with subsegmental PE (no involvement of more proximal pulmonary arteries) and no proximal DVT in the legs who have a low risk of recurrent venous thromboembolism (VTE; not hospitalized, normal mobility, no active cancer, and presence of reversible risk factor), clinical surveillance is suggested over anticoagulation (grade 2C). In similar patients without these markers of low risk, anticoagulation is suggested (grade 2C).
55 year old man on heparin who became hypotensive and required emergent IR embolization of inferior epigastric artery for large rectus bleed.
55 year old man on anticoagulation with large, acute retroperitoneal bleed that required operative evacuation for femoral nerve impingement.
False Positive CTA

- 937 pulmonary CTA studies
- 3 chest radiologists re-reviewed
- discordance in 45 of 174 (26%) of cases
- 59% of SSPE diagnoses on original report deemed negative by expert review
Suboptimal Study → False (+)

Saddle Embolism

Mixing Artifact
Pseudothrombus due to Mixing

Mixing artifact due to low contrast enhancement

Repeat study
Coronary calcium screening

- asymptomatic patient at intermediate risk for CAD
- low risk patients with family history

Coronary CTA

- acute nonspecific chest pain and low probability of coronary artery disease (good test to rule out)

https://acsearch.acr.org/docs/69401/Narrative/
https://acsearch.acr.org/docs/3082570/Narrative/
When to Avoid Cardiac CT
Choosing Wisely®

Avoid coronary calcium score
• low risk asymptomatic patient (unless family history of premature CAD)
• preoperative evaluation
• patients with known CAD, especially those with stent(s) or graft(s)

Avoid coronary CTA
• screening asymptomatic patients
• patient with acute coronary syndrome
Incidental Thyroid Nodule
On CT or MR

- **ACR rules for US**
  - Age < 35 year: nodules ≥ 1 cm
  - Age ≥ 35 year: nodules ≥ 1.5 cm

- **ATA rules for US**
  - All nodules > 1 cm
Incidental Lung Nodule on CT
2017 Fleischner Guidelines

<table>
<thead>
<tr>
<th>Low risk, single nodule</th>
<th>High risk, single nodule</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>&lt; 6 mm</strong></td>
<td><strong>&lt; 6 mm</strong></td>
</tr>
<tr>
<td>– no follow up</td>
<td>– 12 month CT</td>
</tr>
<tr>
<td><strong>6-8 mm</strong></td>
<td><strong>6-8 mm</strong></td>
</tr>
<tr>
<td>– 6-12 month follow up</td>
<td>– 6-12 month follow up</td>
</tr>
<tr>
<td>– Consider 18-24 month 2nd follow up</td>
<td>– 18-24 month 2nd follow up</td>
</tr>
<tr>
<td><strong>&gt; 8 mm</strong></td>
<td><strong>&gt; 8 mm</strong></td>
</tr>
<tr>
<td>– 3 month CT, PET/CT or biopsy</td>
<td>– 3 month CT, PET/CT or biopsy</td>
</tr>
</tbody>
</table>

Shorter follow up duration for multiple nodules.
Separate recommendations for subsolid and ground glass nodules.

http://pubs.rsna.org/doi/abs/10.1148/radiol.2017161659
Abdominal Imaging: Modalities

• **Ultrasound**
  – Widely available
  – Operator and patient dependent

• **CT**
  – Ionizing radiation
  – Iodinated IV contrast
  – Very fast exam (performed in seconds)

• **MRI**
  – Gadolinium contrast
  – Long exam time limits anatomic coverage
  – Motion artifact degrades image quality
Abdominal Imaging: Patient Safety

- **Start with US** in young adults with RLQ pain and women with pelvic pain
- **B-HCG** for all women of child bearing age before CT
- Consider **hydrating** patients prior to IV contrast
- Patients with **allergy to iodinated contrast**
  - Mild to moderate: premedicate with prednisone and benadryl
  - Severe: risk/benefit
  - Anaphylaxis: avoid iodinated contrast

http://www.aafp.org/afp/2015/0401/p452.html
High Value Abdominal CT: Protocol Design Considerations

• IV contrast
  – Updates in contrast induced nephropathy
  – Use of IV contrast saves lives

• Oral contrast
  – positive PO contrast vs PO water

• Protocol selection
  – CT with IV contrast vs CT with & w/o IV contrast

www.CTisus.com
IV Contrast and Renal Function: Considerations

- Acute vs chronic creatinine elevation
- Concomitant nephrotoxic agents
- Volume of IV contrast can be reduced for routine and vascular imaging
- Low IV contrast volume compromises diagnosis in oncology patients
Contrast Induced Nephrotoxicity: Risk Factors

Concurrent use of ≥4 nephrotoxic agents

- vancomycin
- diuretics
- antiarrythmics
- digoxin
- NSAIDs

Co-morbidities

- heart failure
- creatinine < 0.7 mg/dL
- creatinine ≥ 1.3 mg/dL
- hemoglobin < 9.3 g/dL

When to Avoid IV Contrast in Oncology Patients

- Neutropenic patients with fever
- Oncology patients on nephrotoxic drugs
- Patients receiving methotrexate or interleukin-2

Typhlitis: diagnosis can be made without oral or IV contrast
Contrast Induced Nephrotoxicity: Recent Published Evidence

<table>
<thead>
<tr>
<th>Ref</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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</thead>
<tbody>
<tr>
<td># patients</td>
<td>17,934</td>
<td>21,346</td>
<td>6,902 w/CKD</td>
<td>12,508</td>
<td>20,242</td>
<td>17,652</td>
</tr>
<tr>
<td>Comparison</td>
<td>contrast CT noncon CT no CT</td>
<td>contrast CT vs noncon CT</td>
<td>contrast CT vs noncon CT</td>
<td>contrast CT vs noncon CT</td>
<td>contrast CT vs noncon CT</td>
<td>contrast CT vs noncon CT</td>
</tr>
<tr>
<td>Outcomes</td>
<td>AKI, CKD, dialysis, transplant</td>
<td>AKI, dialysis, death</td>
<td>AKI, dialysis, death</td>
<td>AKI</td>
<td>AKI</td>
<td>AKI</td>
</tr>
<tr>
<td>Results</td>
<td>No difference</td>
<td>No difference</td>
<td>No difference</td>
<td>No difference</td>
<td>risk if SCr &gt; 1.5</td>
<td>risk if eGFR &lt; 45</td>
</tr>
</tbody>
</table>

Use of IV Contrast Saves Lives: Ascending Ao Pseudoaneurysm

Noncontrast: hemopericardium

IV contrast:
Ascending aortic pseudoaneurysm
Emergent aortic root repair

Diagnosis was missed on noncontrast CT
Use of IV Contrast Saves Lives: Renal Infarct from LV Thrombus

Indication was rule out appendicitis. Diagnosis would be missed on a noncontrast CT.
Use of IV Contrast Saves Lives:
SMA Thrombus & Ischemic Bowel

Diagnosis would be missed on a noncontrast CT
Oral Contrast

- **Positive contrast**
  - White on CT
  - Usually iodine based
  - Barium based if iodine allergy
  - Use dramatically declined

- **Negative/neutral contrast**
  - Water
  - Grey on CT
  - Better for visualization of bowel wall when used with IV
Oral Contrast

- **Positive contrast**
  - White on CT
  - Usually iodine based
  - Barium based if iodine allergy
  - Use dramatically declined

- **Negative/neutral contrast**
  - Water
  - Grey on CT
  - Better for visualization of bowel wall when used with IV
If enteritis or colitis is suspected, optimal technique is administration of water PO and use of IV contrast. IV contrast will show inflammation in the wall of the small bowel and colon, better appreciated against neutral or negative contrast in the gastrointestinal lumen. Water for Oral Contrast: Bowel Wall Detail.
Positive Oral Contrast: Aids in Diagnosis

• Ileus vs obstruction
• Enterocutaneous fistula
• Suspect abdominal abscess
• Oncology patients
High Grade SBO: ACR Appropriateness Criteria

Do not administer oral contrast in high grade SBO

- Will not reach the site of obstruction
- Wastes time
- Induces further patient discomfort
- Does not add to diagnostic accuracy
- Can lead to complications
  - Vomiting and aspiration

No oral contrast

ACR Appropriateness Criteria®: Small Bowel Obstruction
https://acsearch.acr.org/docs/69476/Narrative/
Optimal Scan Timing
Importance of Detailed History

Start contrast infusion

- **20 seconds**
  - Pulmonary Arteries
  - Pulmonary Embolism

- **25 seconds**
  - Systemic Arteries
  - Coronary, aorta, CTA

- **35 seconds**
  - Late arterial
    - Vascular malignancies
    - Neuroendocrine, RCC...

- **60 seconds**
  - Venous
    - Routine abdominal CT
    - Most malignancies

- **5-15 minutes**
  - Delayed TCC
Multiphase MDCT: Balancing Diagnostic Efficacy with Radiation

- Noncontrast
- Arterial \(20-40 \text{ s}\)
- Venous \(60-80 \text{ s}\)
- Delayed \(\text{variable}\)
# Abdomen CT: Protocol Selection

<table>
<thead>
<tr>
<th>CT with IV contrast</th>
<th>CT with &amp; without IV</th>
<th>CT without IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>most indications</td>
<td>&lt;10% of your orders</td>
<td>contraindication to IV contrast</td>
</tr>
<tr>
<td>abdominal pain</td>
<td>2-4x radiation dose</td>
<td>select indications</td>
</tr>
<tr>
<td>acute abdomen</td>
<td>adrenal nodule work up (indeterminate)</td>
<td>renal colic</td>
</tr>
<tr>
<td>oncology</td>
<td>renal mass vs cyst or hematuria</td>
<td>dropping Hgb</td>
</tr>
<tr>
<td></td>
<td>s/p aortoiliac stent repair</td>
<td>– prefer IV contrast</td>
</tr>
<tr>
<td></td>
<td>GI bleeding</td>
<td>neutropenic fever</td>
</tr>
</tbody>
</table>

Abdomen CT: CT with & without IV contrast

- Adrenal mass characterization (< 4 cm)
- Hematuria or renal mass vs cyst
- Status post aortoiliac endovascular stent
- Gastrointestinal bleeding

No oral contrast
## Relative Exam Charges

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<td><strong>CT A/P w&amp;w/o</strong></td>
<td><strong>$1500</strong></td>
</tr>
<tr>
<td>CT brain with contrast</td>
<td>$600</td>
</tr>
<tr>
<td><strong>CT brain w&amp;w/o</strong></td>
<td><strong>$800</strong></td>
</tr>
</tbody>
</table>

82 million CT scans/year
### Abdominal CT: Patient Selection & Protocol Design

#### Gastrointestinal
- Abdominal pain
- Jaundice
- IBD
- Mesenteric ischemia
- GI bleeding

#### Genitourinary
- Flank pain
- Pyelonephritis
- Hospital acquired AKI

#### Vascular Updates
- Coronary CTA
- AAA screening & surveillance

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Which patients should be imaged with CT and what is the optimal protocol?
Abdominal Pain

- RUQ pain
- RLQ pain
- LUQ pain
- LLQ pain
RUQ Pain: Cholecystitis & Choledocholithiasis

• Ultrasound is imaging test of choice if biliary pathology suspected
  – Sensitive & specific for cholelithiasis, cholecystitis
  – Limitations: low sensitivity for choledocholithiasis and visualization of the distal common bile duct

• 25% of gallstones not visualized on CT
  – Relates to cholesterol composition

• CT valuable for complicated cholecystitis

Baron RL et al. CT evaluation of gallstones in vitro: correlation with chemical analysis. AJR 1998; 151:1123-1128
Cholelithiasis: most stones are visible because of calcium or gas

Visible stones: 75%

Invisible stones: 25%
Choledocholithiasis

Calcified stones in dilated duct = easy CT diagnosis
Noncalcified Choledocholithiasis: MRI is better than CT

Noncalcified stones are less conspicuous on CT. Better seen with MRI.
Cholecystitis: CT with IV contrast

- IV contrast important
  - Gallbladder wall
  - Adjacent liver
- Hepatic hyperemia
- Complicated cases
  - Perforation
  - Gangrenous cholecystitis
  - Emphysematous cholecystitis
  - Hemorrhagic cholecystitis

Yamashita K et al. CT finding of transient focal increased attenuation of the liver adjacent to the gallbladder in acute cholecystitis. AJR 1995;164:343-346
RUQ Pain: Labs & Clinical Information

- **Patient selection**
  - CT no value for acute hepatitis
  - CT misses 25% of gallstones in GB and CBD

- **Protocol design**
  - Single phase venous: pyelonephritis, cholecystitis, duodenal or colon pathology
  - Dual phase arterial & venous: Hepatic mass, biliary obstruction, periampullary mass, pancreatitis
RUQ Pain: Inflammatory (Any-itis)
Single Venous Phase

- Pyelonephritis
- Duodenitis
- Perforated duodenal ulcer
RUQ Pain: Vascular or Oncologic Arterial & Venous Phase MDCT

Pancreatitis with GDA pseudoaneurysm

Biliary obstruction due to pancreatic cancer

Hepatic mass with active hemorrhage
Right Lower Quadrant Pain
CT with IV Contrast

- Appendicitis
- Enterocolitis
- Cecal or ileal diverticulitis
- Meckel’s diverticulitis
- Perforated colon cancer

Caveat
- ovarian pathology best evaluated by ultrasound followed by MRI as needed

ACR Appropriateness Criteria: RLQ pain
https://acsearch.acr.org/docs/69357/Narrative/
Appendicitis

- Ultrasound is 1\textsuperscript{st} line for children, adolescents and pregnant patients
- CT with IV for adults
- IV contrast very helpful
- Oral contrast not necessary
- Mild cases: some treated with IV antibiotics and observation

ACR Appropriateness Criteria: RLQ pain
https://acsearch.acr.org/docs/69357/Narrative/
Appendicitis with Perforation

- Perforation changes management
- Nonoperative initially
- Percutaneous drainage if large collection
- IV antibiotics and follow up for small abscess

ACR Appropriateness Criteria: RLQ pain
https://acsearch.acr.org/docs/69357/Narrative/
Left Upper Quadrant Pain: CT with IV Contrast

- Splenic infarct or rupture
- Pancreatitis
- Pyelonephritis
- Renal infarct
- Jejunal diverticulitis
- Left colon diverticulitis
Left Lower Quadrant Pain CT with IV contrast

- Diverticulitis
- Colitis (infectious vs inflammatory vs ischemic)
- Perforated colon cancer
- Epiploic appendagitis
- Caveat
  - Ovarian pathology best evaluated by ultrasound followed by MRI as needed

ACR Appropriateness Criteria: LLQ pain
https://acsearch.acr.org/docs/69356/Narrative/
Diverticulitis

- IV contrast very helpful
- Oral contrast takes hours to reach colon
- CT shows complications that alter management
  - Perforation
  - Abscess
  - Septic thrombophlebitis
  - Fistula formation

Perforated diverticulitis with extraluminal gas: IV antibiotics
Diverticulitis

- IV contrast very helpful
- Oral contrast takes hours to reach colon
- CT shows complications that alter management
  - Perforation
  - Abscess
  - Septic thrombophlebitis
  - Fistula formation

IMV septic thrombophlebitis: IV antibiotics and anticoagulation
Jaundice: Imaging Exam Selection

- Suspect primary GB or biliary pathology
  - Fever, cholelithiasis, history of biliary surgery
  - Ultrasound first
  - MRI better than CT for choledocholithiasis

- Painless jaundice
  - Weight loss, fatigue, anorexia, symptoms > 3 months
  - CT with IV contrast: arterial and venous phases
  - Identifies presence of obstruction and cause

- Characterize hepatic parenchymal disease
  - Clinical and lab evidence of liver disease
  - Liver MRI
Inflammatory Bowel Disease: When to Choose CT vs MR

• **Children:** MR enterography preferred
  – Child initial presentation
  – Child with acute fever, increasing pain, leukocytosis
  – Child mild symptoms or surveillance

• **Adult:**
  – Adult with acute pain: **CT with IV contrast preferred**
  – Adult with indolent presentation: **CT or MR enterography**
  – Adult mild symptoms/surveillance: **MR enterography or CT**
Inflammatory Bowel Disease: When to Choose CT vs MR

CT with IV contrast

MR Enterography

Motion artifact
Mesenteric Ischemia: CT with IV Contrast

- Acute mesenteric ischemia
- Chronic mesenteric ischemia
- Caveat:
  - MRI/MRA with gad if CT contraindicated
  - MRA without gad if gad contraindicated
Mesenteric Ischemia: CT with IV Contrast

Vascular patency: SMA clot is life threatening

Evaluation of bowel wall enhancement: Infarcted small intestine

IV contrast saves lives
GI Bleeding: CT with & without IV Contrast

- Upper GI bleeding: endoscopy
- Lower GI bleeding: CT with and without IV contrast
- Occult GI bleeding
  - Capsule endoscopy
  - CT with and without IV contrast
  - Nuclear medicine tagged RBC scan

No oral contrast

ACR Appropriateness Criteria: GI Bleeding
https://acsearch.acr.org/docs/69477/Narrative/
Descending Colon GI Bleeding: IV contrast leaks into bowel lumen
Abdominal CT: Patient Selection & Protocol Design

Gastrointestinal
- Abdominal pain
- Jaundice
- IBD
- Mesenteric ischemia
- GI bleeding

Genitourinary
- Flank pain
- Pyelonephritis
- Hospital acquired AKI

CTA Updates
- AAA screening & surveillance
- Coronary CTA

Which patients should be imaged with CT and what is the optimal protocol?
Noncontrast CT
Flank Pain and Hematuria

- Great test for kidney stones
- Important GU pathology can be missed
- Reserve for true renal colic & hematuria
- Do not order in patients with pyuria
  - CT not indicated for acute, uncomplicated pyelonephritis
  - IV contrast needed for pyelonephritis
Noncontrast CT
Pathology Missed or Misdiagnosed

- Arteriovenous Malformation
- Large renal artery aneurysm look like cyst
- Pyelonephritis
- Renal cell carcinoma
- Renal infarct
Pyelonephritis

- Imaging not indicated for acute uncomplicated pyelonephritis in most patients
  - CT if no response to treatment at 72 hours
- Indications for CT in acute pyelonephritis
  - Diabetics: emphysematous pyelonephritis
  - Immunocompromised
  - Recurrent pyelonephritis
  - History of stones/potential obstruction
  - Prior renal surgery

ACR Appropriateness Criteria: Pyelonephritis
https://acsearch.acr.org/docs/69489/Narrative/
Pyelonephritis

- **Protocol:** CT with IV contrast only
  - Diagnosis will be missed on noncontrast CT
  - Do not order with & without (ACR updating)

ACR Appropriateness Criteria: Pyelonephritis
https://acsearch.acr.org/docs/69489/Narrative/
CT with IV Contrast
Complicated Pyelonephritis

Small left renal abscess: IV antibiotics
Larger right renal abscess: Drainage & IV antibiotics
Pyelo and obstruction: Percutaneous nephrostomy & IV antibiotics
Emphysematous pyelonephritis: Emergent nephrectomy
Hospital Acquired Acute Kidney Injury (AKI)

- Hospital-acquired AKI often due >1 insult:
  - aminoglycosides in setting of sepsis
  - radiocontrast agents with ACE inhibitors
  - (NSAIDs) in the presence of CHF
- Obstruction is not the cause in most patients
  - 10% of patients have hydronephrosis
  - 3% have obstruction requiring intervention


Risk Factors for Obstruction as Cause of Hospital Acquired AKI

Increased Risk
- history of hydronephrosis
- history of recurrent UTI
- neurogenic bladder
- prior pelvic or renal surgery
- history of abdominal or pelvic cancer; pelvic mass
- single functional kidney
- hematuria during admission

Decreased Likelihood
- hypotension during admission
- medications during admission
  - aspirin (>81 mg/d)
  - diuretic
  - ACE inhibitor
  - IV vancomycin
- history of CHF or diabetes
- granular casts on UA
- WBC> 16,000/μL


Updates in Vascular Imaging: Relevance to Total Cost of Care

- AAA Screening and Surveillance
- Coronary CTA
AAA Screening: USPSTF

- one-time US screening in men 65-75 years of age who have ever smoked
- selective one-time US screening in men 65-75 years of age who have never smoked
- Insufficient evidence regarding screening women age 65-75 years of age who have ever smoked
- No screening for women who have never smoked

US Preventative Services Task Force
AAA Screening: SVS

- one time US screening for patients 65-75 who have 1st degree relative with AAA
- one time US screening for healthy patients >75 years who have 1st degree relative with AAA
- one time US screening in men and women 65-75 years of age with smoking history
- one time US screening in healthy men and women >75 years of age with smoking history

https://www.jvascsurg.org/article/S0741-5214(17)32369-8/fulltext#sec1.3
AAA Surveillance

ACR Recommendations
- 2.6-2.9 cm: US or CT in 5 years
- 3.0-3.4 cm: US or CT in 3 years
- 3.5-3.9 cm: US or CT in 1 year
- 4.0-4.4 cm: CTA in 1 year
- 4.5-5.4 cm: CTA in 6 months
- \( \geq 5.5 \) cm: elective repair

SVS Recommendations
- Vascular surgery referral at diagnosis
- 2.5-2.9 cm: US or CT in 10 years
- 3.0-3.9 cm: US or CT in 3 years
- 4.0-4.9 cm: CTA in 1 year
- 5.0-5.4 cm: CTA in 6 months
- \( \geq 5.5 \) cm: elective repair
Coronary CTA in ACS: ED LOS and Hospital Admission

- ROMITCAT II trial: patients in the ED with suspected ACS
- Early CCTA reduced length of stay in the hospital by 7.6 hours (p<0.001)
- More patients were discharged directly from the emergency department (47% vs 12%, p<0.001)

Coronary CTA in ACS: Total Cost of Care

- CCTA precipitated more downstream testing and higher radiation exposure.
- No difference in cumulative mean cost of care between CCTA group and the standard-evaluation group.

Coronary CTA in Stable Chest Pain

- SCOT-HEART trial
- Compared utility of adding CCTA to standard care in patients with suspected stable angina
- Follow up ranging from 0.1 to 4 years (median 1.7 years)
- CCTA cohort had a 38% reduction in coronary heart disease death and non-fatal myocardial infarction (p=0.0527).

Summary: High Value Body CT

- Abdominal CT with & without for aortic stent, adrenal, GU tumor, GI bleeding
- IV contrast very important for detection and characterization of pathology
- Do not order PO contrast in SBO & GI bleed
- Appropriate imaging = avoiding low value indications and using for high value practice
- Call a radiologist!

www.ChoosingWisely.org
https://www.acr.org/Quality-Safety/Appropriateness-Criteria
PAMA and CMS
Appropriate Use Criteria Program

Appropriate Use Criteria Program

Section 218(b) of the Protecting Access to Medicare Act of 2014 amended Title XVII of the Social Security Act to add section 1834(q) directing CMS to establish a program to promote the use of appropriate use criteria (AUC) for advanced diagnostic imaging services. In section 1834(q)(1)(B) of the Act, AUC are defined as criteria that are evidence-based (to the extent feasible) and assist professionals who order and furnish applicable imaging services to make the most appropriate treatment decisions for a specific clinical condition.


These policies are codified in our regulations at 42 CFR 414.94.

CMS Rule: CDS for Imaging
Beginning January 2020

- CT Scans
- MRI Scans
- Nuclear Medicine

Outpatient Care

Emergency Department

- Headache
- Neck Pain
- Low Back Pain
- Shoulder Pain
- Hip Pain
- Chest Pain
- Pulmonary Embolism
- Lung Cancer
# CMS Approved PLEs & CDSM Vendors

## Provider Led Entities
- American College of Cardiology Foundation
- American College of Radiology
- Banner University Medical Group-Tucson U of Arizona
- CDI Quality Institute
- Cedars-Sinai Health System
- High Value Practice Academic Alliance
- Intermountain Healthcare
- Massachusetts General Hospital, Radiology
- Medical Guidelines Institute
- Memorial Sloan Kettering Cancer Center
- National Comprehensive Cancer Network
- Sage Evidence-based Medicine & Practice Institute
- Society for Nuclear Medicine and Molecular Imaging
- University of California Medical Campuses
- University of Pennsylvania Health System
- University of Texas MD Anderson Cancer Center
- University of Utah Health
- University of Washington School of Medicine
- Virginia Mason Medical Center
- Weill Cornell Medicine Physicians Organization

## CDSM Vendors
- AIM Specialty Health ProviderPortal®
- Applied Pathways CURION™ Platform
- Cranberry Peak ezCDS
- eviCore healthcare’s CDS Mechanism
- MedCurrent OrderWise™
- Medicalis Clinical Decision Support Mechanism
- National Decision Support Co CareSelect™
- National Imaging Associates RadMD
- Sage Health Mgt Solutions Inc. RadWise®
- Stanson Health’s Stanson CDS
- Test Appropriate CDSM
High Value Practice Academic Alliance

Order Wisely®: Appropriate use of tests & treatments

A leading principle of high-value practice is avoidance of unnecessary tests and treatments in accordance with established clinical practice guidelines. To reinforce this practice, we designed a full-day educational program that reviews appropriate use of imaging exams, lab tests, medications, transfusions and procedures. An understanding of the evidence behind appropriate ordering and prescribing is important to change long-standing practice habits and overcome concerns about missed diagnoses. Included are presentations on best imaging exam selection for the 8 CMS Priority Clinical areas, to ensure that providers are prepared for the CMS Appropriate Use Program, which will include evaluation of their ordering appropriateness beginning in January 2020.

Appropriate Imaging for CMS AUC Priority Clinical Areas* & more

- Headache | Sachin Gujar, MBBS, MD
- Dizziness | Ari Blitz, MD, PhD
- Traumatic neck pain* | Ari Blitz, MD, PhD
- Low back pain* | Gary Gong, MD
- Shoulder pain* | Shivani Ahlawat, MD, PhD
- Acute hip pain* | Shadpour Demehri, MD, PhD
- Acute chest pain* | Jeff Trost, MD
- Pulmonary embolism* | Pamela Johnson, MD

Brief (< 15 minutes) targeted presentations by subspecialist radiologist on appropriate use of imaging (free!)

http://hvpaa.org/order-wisely

@hvpaa
Thank you for your attention!

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