Cost Effective Use of Diagnostic Imaging

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Growth of Medical Imaging

- Increased utilization of medical imaging:
  - introduction of new technologies (PET, MRA, CTA, etc.)
  - new uses for existing technologies
  - self-referral
  - patient demand
  - defensive medicine

Overutilization of Imaging

- Over 1 billion radiology exams annually.
- The overall cost of diagnostic imaging is estimated over $100 billion annually in the United States alone.
- According to the ACP, all unnecessary tests cost $200-$250 billion a year.

**Increased Utilization – Self Referral**

- Some providers boost utilization to pay off imaging technology investments
- Physicians who own their own imaging equipment are 2-7 times more likely to order an imaging test.


**Increased Utilization – Patient Demand**

- Physicians face increasing patient demands for specific diagnostic imaging tests.
  - A survey of 7,7320 patients and 300 physicians indicates that patients were more satisfied with physicians who used a “participatory style” of discussion options (Annals of Internal Medicine).


**Increased Utilization – Defensive Medicine**

- Physicians worry about malpractice lawsuits
  - The Mount Sinai School of Medicine conducted a survey of 2,416 physicians, which showed 92% of physicians believe that concerns over malpractice lawsuits result in “defensive” medicine. Estimated cost is $60 billion annually.
  - 18-28% of tests, procedures, referral and consultations were ordered to avoid lawsuits


**Solutions**

- Education on appropriate use of imaging
  - Patients
  - Physicians
  - Health care system administrators
  - Radiologists need to open doors of communication with ordering clinicians

**ACR Select**

- Can be integrated with computerized ordering and electronic health record (EHR) systems.
- Healthcare organizations can ensure that the right patient gets the right scan for the right indication.

ACR Appropriateness Criteria®

- Evidence-based guidelines to assist referring physicians and other providers in making the most appropriate imaging or treatment decision for a specific clinical condition.
- 186 topics with over 900 variants in the February 2013 version.

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

ACR Select

http://www.acselect.org
Questions to ask

- Do I need imaging to answer question?
- Does a prior imaging study already answer question?
- What imaging study do I need?
- What general imaging protocol to order?
- Is this really the best imaging study for THIS patient? Contraindications?
- Have I used the tools at my disposable to clarify any confusion?

10 Items

- Routine ICU chest x-rays
- Routine pre-operative chest x-rays
- Incidental pulmonary nodules
- Headache
- Low back pain
- Incidental thyroid nodules
- Incidental adrenal nodules
- Renal cysts
- Ovarian cysts
- Non-contrast vs contrast vs both CT

CXR in the ICU Setting

- Meta-analysis of eight trials comprising 7,078 ICU patients, half of whom received daily chest and the other half who received chest radiographs for specific clinical indication.
- Eliminating routine daily chest radiographs did not affect mortality, length of stay in the hospital or ICU, or ventilator days in either group.


CXR in the ICU Setting

- Routine daily chest radiographs are not indicated.
- Follow up radiographs should be obtained only for specific clinical indications (increasing hypoxia, initial line or tube placement, etc.)

Methodist Hospital: 140 ICU beds
Wishard Hospital: 24 ICU beds, 29 PICU beds
St. Vincent: 40 ICU beds, 16 Trauma/NICU beds.
Community Hospital North: 24 ICU beds
Community Hospital East: 12 ICU beds

Chest Xray: $42
(estimated payment from insurance)

Healthcare Blue Book 2013

- Systematic review of 14 published articles
  - No association between preop CXR and morbidity or mortality
  - Postoperative pulmonary complications in those with preop CXR was 13% vs 16% in those without

**Solitary Pulmonary Nodule**

- Rounded opacity <3 cm without other lung abnormalities.
- Benign pattern of calcification or stability of nodule size for over 2 years for solid pulmonary nodules

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**Granuloma, Pleural Effusion**

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**Nodules, Largest 7 mm → High Risk → Stable 2 years**

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**Chest Imaging Costs**

- CT Chest without contrast: $312
- CT Chest with contrast: $396 (est. payment from insurance)

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**Pulmonary Nodules**

**Fleischner Society Recommendations**

Incidental Pulmonary Nodule Follow-up

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**Healthcare Blue Book 2013**
19 yo woman presents to PCP office
Frontal headache for 1 day
Onset at rest, "pressure-like pain"
Studying for finals this week
Similar symptoms every few months

What is the next appropriate step?
A) CT head without contrast
B) MRI head without contrast
C) MRA head and neck
D) EEG
E) Patient reassurance

Chronic headache, no new features:
None

Chronic headache, new features:
MRI head without +/- with IV contrast

Sudden onset severe headache:
CT head without contrast

Sudden onset unilateral headache, ipsilateral Horner's syndrome, suspected carotid/vertebral dissection:
CTA or MRA head and neck

Suspected complication of sinusitis:
CT paranasal sinuses without IV contrast

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

36 year old male with increasing low back pain x 10 days
No trauma
No fevers, chills, neurological deficit
Past medical history unremarkable

CT head without contrast: $340
CT head with and without contrast: $676
MRI head without contrast: $660
MRI head without and with contrast: $779
(est. payment from insurance)
**Low Back Pain**

- Next step
  - A) Pain management and physical therapy
  - B) X-ray lumbar spine
  - C) CT lumbar spine
  - D) MRI lumbar spine
  - E) Fluoroscopic myelogram

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

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- 56-year-old male.
- Low back pain especially on left side for 6 weeks.
- History of prostate cancer.

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- Next step:
  - A) X-ray lumbar spine
  - B) CT lumbar spine
  - C) MR lumbar spine
  - D) Pain management and physical therapy

http://www.acr.org/Quality-Safety/Appropriateness-Criteria
**Low Back Pain**

- Imaging considered if no improvement within 6 weeks
- Or red flags:
  - Cauda equina syndrome
  - Cancer - insidious onset, weight loss
  - Fracture - age >50, osteoporosis, cumulative trauma
  - Neurologic deficit
  - Symptomatic spinal stenosis
  - Infection - IV drug use, immunosuppression, diabetes

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

**Thyroid Nodules**

- 5% thyroid nodules are malignant.
- On CT, thyroid nodules with size > 1 cm, calcifications, or septations should be further evaluated for malignancy with US.
- Risk factors: age <15 or >60, male sex, history of head/neck radiation, family history


**Lower Back Imaging**

- X-ray lumbar spine: $200-$300
- CT lumbar spine: $549
- MRI lumbar spine: $780

(est. payment from insurance*)

**Calcified thyroid nodule, > 1 cm. US followed by biopsy = benign**

Healthcare Blue Book 2013
Heterogenous thyroid nodule, Ca ++, > 1 cm

Septated nodule, > 1 cm. US revealed multiple cysts and benign sponge-like nodules

Hyperdense nodule on CT, US revealed multiple benign sponge-like nodules

Thyroid Nodules
- Neck Ultrasound: $113
  (est. payment from insurance)

Adrenal Incidentaloma
- Up to 5% of thoracic and abdominal CT may reveal an adrenal incidentaloma
- 83% are non-functioning benign lesions
- Differentiate benign from mass that warrants treatment (metastasis, pheochromocytoma, adrenal carcinoma)

Adrenal Incidentaloma

- Less than 1 cm, ignore
- Stable 6 – 12 months = benign
- <10 HU = benign
- <4 cm nodule without known malignancy → <0.2% likelihood of malignancy
- 1-4 cm may be followed up in 1 year
- > 4 cm → biopsy, surgery, or PET-CT

Adrenal Carcinoma s/p Biopsy

Right Adrenal Mass – under 1 cm – leave alone --- also present on CT chest

MRI instead --- Right Adrenal Adenoma, Chemical Shift Dropout

Left Adrenal Myelolipoma --- leave alone
Abdominal Imaging

- Abdomen CT without contrast: $314
- Abdomen CT with contrast: $398
- Abdomen CT with and without contrast: $465
- Abdomen and Pelvis without contrast: $393
- Abdomen and Pelvis with contrast: $618
- Abdomen and Pelvis with and without contrast: $782
  (est. payment from insurance*)

*Healthcare Blue Book 2013

Renal Cysts

- Simple cyst (Bosniak Type I)
  imperceptible wall
  rounded

Work up: none

Type 1 ~0% are malignant
Renal Cysts

Mildly complex (Bosniak type 2)
- Thin septa
- Thin calcification

Work up: none

Type 2 – 0% are malignant

Ovarian Cysts

Premenopausal Women
- Simple or hemorrhagic cysts < 5 cm
  - No follow-up
- Simple cysts 5 - 7 cm
  - Annual US follow up to ensure lesion stability
- Hemorrhagic cysts 5 - 7 cm
  - 6-12-week follow-up US to ensure resolution
- Simple cysts > 7 cm
  - Further imaging (e.g., MRI) or surgery

Post Menopausal Women
- Simple cysts < 1 cm
  - No follow-up
- Simple cysts 1 – 7 cm mention on report
  - Annual US
  - After 2 years or if size ↓ longer interval follow up
- Simple cysts > 7 cm – as in premenopausal women

25 yo woman premenopausal woman with bilateral adnexal cysts < 3 cm → No FU

6 cm hemorrhagic cyst in premenopausal patient → needs 6 - 12 week FU

6 week FU → ↓ size

postmenopausal woman, 6 cm simple cyst → 5.5 cm on 1 year FU

To contrast or not to contrast? That is the question

CT without contrast prior to CT with IV contrast

- Aortic dissection
- Adrenal mass workup (may only need non-contrast)
- Renal mass workup
- HCC follow-up status post non-surgical treatment
- AAA status post endovascular stent graft repair
- CT Urogram
- CT Cystogram

CT with IV contrast

- Metastatic cancer work-up / follow-up
- Trauma (head & C/T/L-spine without)
- Abdominal / pelvic / chest pain, weight loss, infection, inflammatory processes, most other indications
- For artery evaluation, CTA
- Some indications require multiple post contrast phases (HCC screening → dual or triple phase, pancreatic → dual phase)

Oral contrast

- Gastrografin --- if pt < 150 lbs, recent GI surgery/enteric leak
- Water --- pancreatic protocol
- Volumen --- enterography
59 year old man with history of heroin abuse complaining of excruciating chest pain radiating to his back.
- HTN: medication non-compliance, presenting with BP of 214/110.
- Prior ischemic stroke without current neurological deficits, diabetes mellitus.

EKG and Chest X-ray are normal. Next step?
- A) CTA Chest with IV contrast
- B) CT Chest without IV contrast, CTA chest with IV contrast
- C) CT Chest with IV contrast
- D) MRI Chest without and with IV contrast
- E) CT Chest without IV contrast
- F) No imaging

Non-contrast chest CT shows hyperdense intramural aortic hematoma

Followed by CTA chest

65 yo AAM on hemodialysis, needs imaging for renal mass work-up. Order what?

CT abdomen without contrast followed by 2 phase IV contrast
63 year old man with history of alcohol abuse, hepatitis C, elevated AFP

What is the next imaging modality to order?

- A) Abdominal ultrasound
- B) MRI abdomen without contrast
- C) CT abdomen single phase
- D) CT abdomen triple phase
- E) MRI abdomen without and with IV contrast

CT abdomen with IV contrast triple (or dual) phase, typical HCC

Typical HCC

Hep C, Elevated AFP Classic HCC but MRI still Obtained without Adding New Info

Bonus Question – What is the Next Step?

- A) US guided core biopsy
- B) Abdomen MRI without & with IV contrast
- C) Abdomen Ultrasound
- D) No further imaging to confirm diagnosis
- E) CT guided FNA & core biopsy
Scenario – Contrast?

- Adrenal mass in recent immigrant from Burma.

Non-contrast CT confirms adrenal adenoma → stop (but got add phases)

65 yo man s/p endovascular stent graft repair for AAA. No acute symptoms. Presents for AAA stent graft evaluation.

Scenario – Contrast?

- 65 yo man s/p endovascular stent graft repair for AAA. No acute symptoms. Presents for AAA stent graft evaluation.

CT abdomen and pelvis without contrast followed by CTA abdomen and pelvis with delayed phase

Conclusions

- Ask if imaging is really needed?
- Use radiologist as a consultant rather than lab service. Radiologists can add value to patient care and help eliminate extra imaging, costs and anxiety.
- Eliminate routine ICU chest x-rays, only post procedure or specific indications
- Eliminate preoperative chest x-rays in patients without cardiopulmonary disease
For incidental pulmonary nodules, follow Fleisher society guidelines. Ignore 4 mm pulmonary nodules in low risk patients.

- Chronic headaches without new features generally do not need imaging.
- Most low back pain without red flags will respond to conservative management without imaging intervention.

Incidental adrenal nodules under 1 cm can be ignored. Those 1-4 cm may be followed up in 1 year.

Incidental thyroid nodules on CT can usually be ignored if under 1 cm without calcifications or septations.

- Most renal cysts are simple or mildly complex (thin septa or calcification) and require no further imaging.

If confused or uncertain, call or email radiology colleagues.

References:

8. ACR. ACR Appropriateness Criteria® routine chest radiographs in ICU patients. American College of Radiology (ACR); 2011. 20 p. [87 references]
Thank you

- Please feel free to email with questions:
  btahir@iupui.edu
- Look forward to speaking on similar/other topics in future.