Confused about with and without:?

Assessment of medical providers' knowledge of abdominal CT protocol appropriateness

Alice Yu, MD; Yoshimi Anzai, MD (University of Utah), PhD; Brandyn D Lau, MPH; Matthew Alvin, MD, MBA; Mahadevappa Mahesh, PhD; Elliot K Fishman, MD; Pamela T Johnson, MD

Johns Hopkins Hospital, Department of Radiology

Disclosures: Pamela T. Johnson: Consultant & Advisory Board, Oliver Wyman
Elliot K. Fishman: Grant funding from Siemens and GE Healthcare; Co-Founder & Stock Holder HipGraphics
Alice Yu, Yoshimi Anzai, Brandyn Lau, Matthew Alvin, Mahadevappa Mahesh have no disclosures.

1

Abdominal CT: Radiation Exposure

- Abdominal and pelvic CT is a leading contributor to medical radiation exposure[1]
- 53% of abdominal & pelvic CTs include an unnecessary phase[2]
  - 78% of these are unnecessary delayed phase
  - 12% of these are unnecessary precontrast phase
- Each additional phase adds 8 to 14 mSv of radiation or approximately 3 to 4 years of background radiation[1,3]
- Ideally, radiologists select the most appropriate protocol; however, ordering providers are tasked with choosing between CT with IV, CT without IV or CT with & without IV when imaging the abdomen and pelvis
- The purpose of this project was to evaluate ordering providers' understanding of abdominal and pelvic CT protocol parameters, appropriateness and cost

1. Mahesh M. NCRP Report Number 160: its significance to medical imaging. J Am Coll Radiol. 2009; 6:890-892.
2. Guite KM, et al. Ionizing radiation in abdominal CT: unindicated multiphase scans are an important source of medically unnecessary exposure. J Am Coll Radiol. 2011;8(11):756-61.
3. Radiological Society of North America (2018). Patient Safety - Radiation Dose in X-Ray and CT Exams. RadiologyInfo.org. https://www.radiologyinfo.org/en/info.cfm?pg=safety-xray. Accessed July 29, 2018.

Abdominal & Pelvic CT Protocols: Radiation & Cost Considerations

	Phases	Radiation Exposure[1]	Cost (Healthcare Blue Book Fair Price[2])
CT AP without IV contrast	Noncontrast only	14 mSv	$550
CT AP with IV contrast	1 or more phases • Venous only most common • Arterial & venous (eg. pancreas) • Venous & delayed (eg. urogram) • Arterial, venous & delayed (eg. HCC in cirrhosis)	14-28 mSv	$630
CT AP with & without IV contrast	2 or more phases • Precontrast plus • Any combination of arterial, venous +/- delayed	22-56 mSv	$720

1. https://www.healthcarebluebook.com
2. Mettler, F.A., Huda, W., Yoshizumi, T.T., and Mahesh, M. Effective doses in radiology and nuclear medicine: a catalog. *Radiology*. 2008; 248: 254–263

Abdominal +/- Pelvic CT: Indications for CT with & without IV

Indication	Rationale
Renal lesion characterization or hematuria work-up *	In patients with hematuria, unenhanced scan demonstrates small stones that may be obscured after IV contrast. Unenhanced serves as a baseline to distinguish cyst from enhancing renal mass.
Adrenal nodule characterization	If unenhanced discloses lipid rich adenoma (≤10 HU), post-contrast acquisitions are not necessary. To evaluate lipid poor lesions, precontrast attenuation is incorporated into the Absolute Percentage Washout calculation.
Abdominal aortic endovascular stent evaluation*	Unenhanced scan distinguishes calcification from endoleak in the aneurysm sac revealed after IV contrast administration.
Gastrointestinal bleeding*	Unenhanced scan provides baseline to elucidate high-density material in the bowel lumen, which could be confused for intraluminal hemorrhage after contrast. However, interval change between arterial and venous phases may be sufficient to clarify.
Focal liver mass	A precontrast scan can add information about relative enhancement when characterizing a focal liver mass.

*Caveat: Several studies have shown that dual energy CT with a virtual noncontrast dataset can serve as an alternative to pre-contrast acquisition for several indications.

1. Johnson PT, Bello JA, Chatfield MB, Flug JA, Pandharipande PV, Rohatgi S, Fishman EK, Megibow AJ. New ACR Choosing Wisely Recommendations: Judicious Use of Multiphase Abdominal CT Protocols. J Am Coll Radiol. 2018 Sep 12 [Epub ahead of print]
2. http://www.choosingwisely.org/clinician-lists/acr-abdominal-ct-with-unenhanced-ct-followed-by-iv-contrast-enhanced-ct/

Methods: Survey/Quiz

A 14 question survey was designed to measure knowledge of protocol appropriateness by asking participants to select best protocol for 10 clinical presentations. Additional questions addressed protocol parameters and costs.

Clinical Presentation

1. Appendicitis
2. Lymphoma
3. AAA s/p repair
4. Painless, gross hematuria
5. Painless jaundice
6. Adrenal nodule
7. GI bleeding
8. Severe pancreatitis
9. Refractory pyelonephritis
10. Splenic infarct from cardiac source

Best Protocol

A. CT without oral or IV contrast
B. CT with oral contrast
C. CT with oral and IV contrast
D. CT with IV contrast only
E. CT with and without IV contrast
F. Unsure

After completing the survey, participants provided with correct answers and links to ACR information sources.

101 Respondents

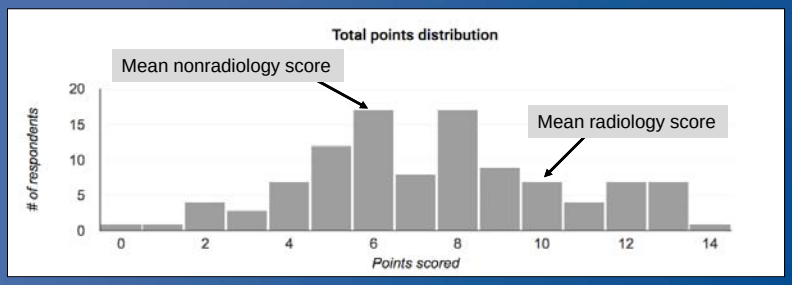
Radiology (n=28)

- 25 radiology residents
- 3 radiology attendings

Non-Radiology (n=73)

- 39 residents
  - 16 surgery
  - 10 emergency medicine (EM)
  - 10 internal medicine (IM)
  - 3 other
- 22 advanced practice providers (nurse practitioner or physician assistant)
- 12 attendings

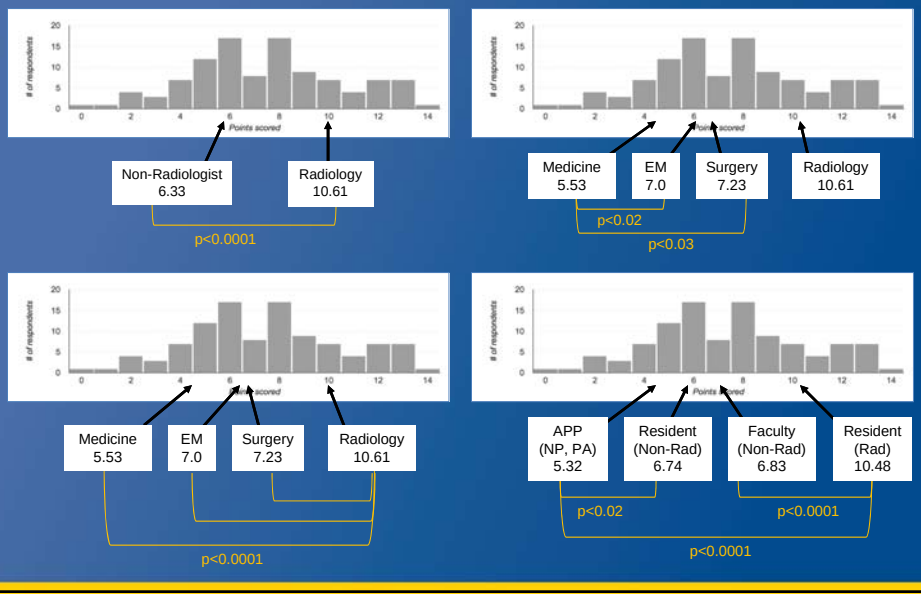
101 Respondents



Performance
- Average score for all participants 7.51 out of 14 points
- Average score for radiology 10.61 of 14 points
- Average score for nonradiology 6.33 out of 14 points (p<0.0001).

Do you know how CT with & without contrast is performed?
- 83% correct
- 9% incorrect
- 8% unsure

Score Comparison by Specialty



Commonly missed questions

- Do you know when to select abdominal/pelvic CT with & without IV contrast:
  - 49% sometimes, 33% yes, 18% no
- How does cost of CT with & without IV compare to dual phase IV contrast enhanced CT?
  - 47% unsure, 21% higher cost, 31% equal or lower cost
- Best protocol for painless hematuria
  - 59% selected wrong protocol, 38% selected CT with & without, 4% unsure
- Best protocol for lymphoma
  - 60% selected incorrect protocol (14% chose CT with & without IV), 35% selected correct protocol, 5% unsure

Conclusions

- Non-radiology medical providers at all levels of experience lack understanding about abdominal CT protocol appropriateness
- Further education of non-radiology community is required to improve adherence to ACR recommendations, and thus improve patient care
- To perform imaging of the highest quality, safety, and value radiologists must be responsible for appropriate protocol selection, particularly when patients undergo CT imaging as protocols differ significantly in radiation exposure and cost