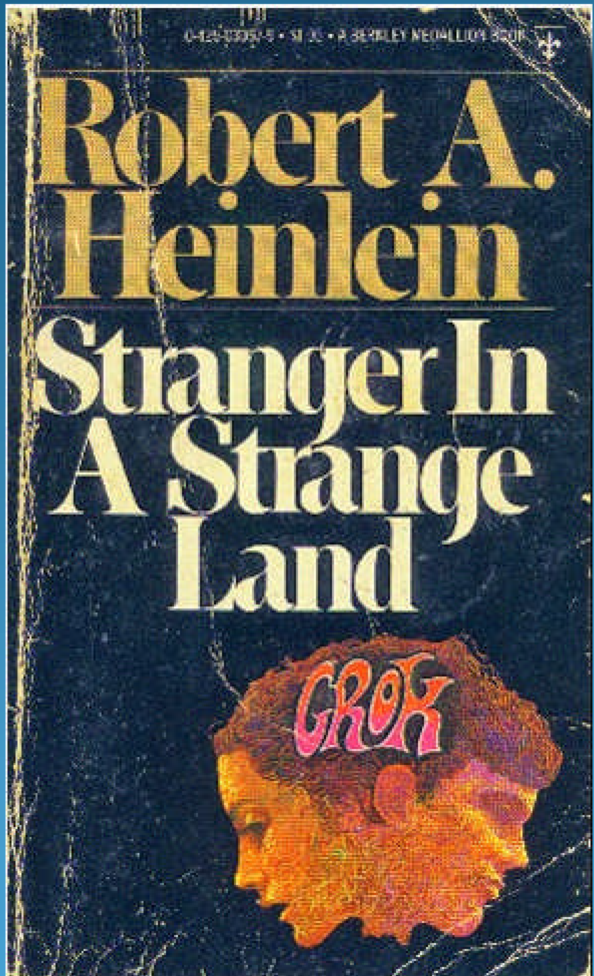
But I already have a full-time job!

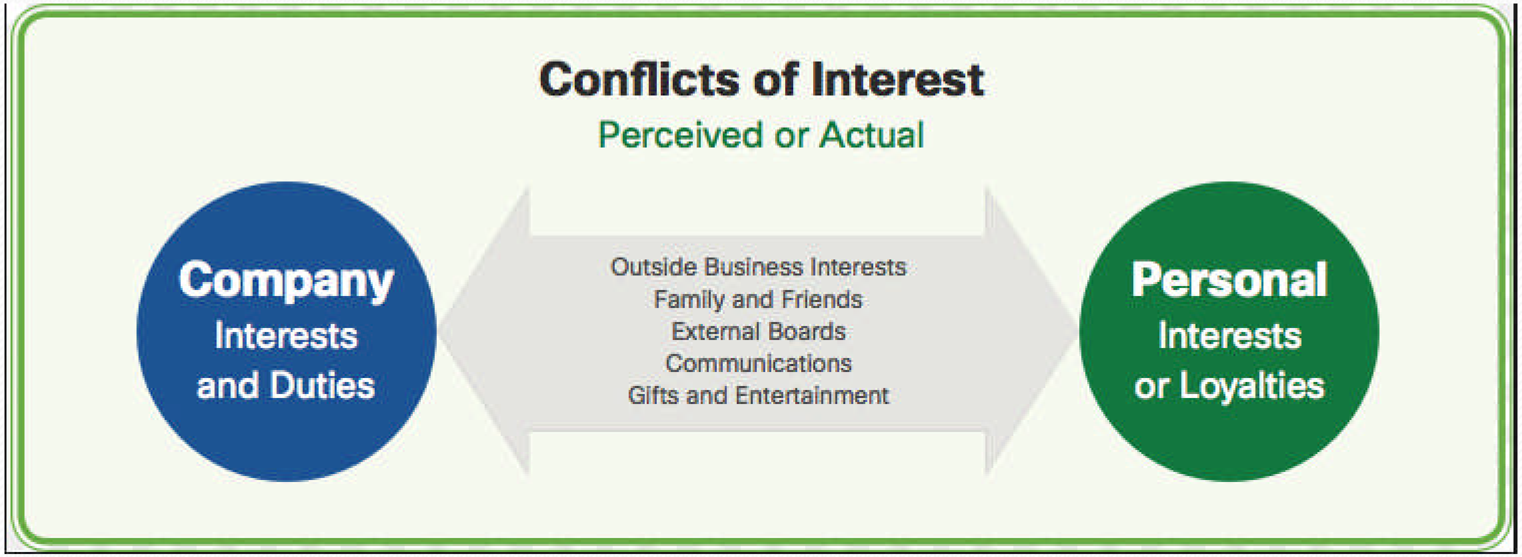


A Radiation Oncology Medical Physicist as Radiation Safety Officer

Dan Pavord, MS
AVP Oncology Services
Chief Medical Physicist
Radiation Safety Officer

Conflicts of Interest

- None



Learning Objectives

1. To review common imaging procedures with expected ranges of exposure.
2. To discuss strategies for the reduction of exposure.
3. To discuss real-life scenarios that illustrate the range of physics consults that might be encountered in diagnostic imaging.

I work in Radiation Oncology, these Imaging doses are puny.

Radiation Oncology

Diagnostic Imaging

Think again…

I am a stranger in your area

- What is my authority?
- Who are my “customers”?
- What types of procedures do you do?
- What are the ranges of patient dose?
- What are the potential side effects?
- What are your workflows?

RSO Authority (10CFR35.24)

- (g) A licensee shall provide the Radiation Safety Officer sufficient authority, organizational freedom, time, resources, and management prerogative, to--
- (1) Identify radiation safety problems;
- (2) Initiate, recommend, or provide corrective actions;
- (3) Stop unsafe operations; and,
- (4) Verify implementation of corrective actions.

Who are your “customers”?

- Patients
- Family members of patients
- General public
- Staff
- Physicians

- You MUST be seen by your customers.

Communication is the key

Communicating with patients

PC Symposium: Communicating with patients, a vital skill for a medical physicist, Sunday, July 30

9:30	Welcome and opening remarks	Dan Pavord
9:35	How to speak to patients	Bob Pizzutiello
10:00	Strategies for learning and teaching patient communication skills.	Derek Brown
10:15	Q&A	

AAPM 2017 JUL 30–AUG 3

CONNECTING OUR PATHWAYS. UNIFYING OUR PROFESSION.

59TH ANNUAL MEETING & EXHIBITION | DENVER, CO

Are patients aware of the risk?

- “The majority of patients were unaware of the radiation-induced cancer risk, with a weighted average of **7%** (30/434; range, 3–13%) reporting that there was an increase in risk of cancer from ionizing radiation.”

- Communicating Potential Radiation-induced Cancer Risks from Medical Imaging Directly to Patients, Diana L. Lam; et al, American Journal of Roentgenology, Vol 205, pp 962-970, 2015.

What do units of radiation mean to patients?

- Ὅτι μὲν ὑμεῖς, ὦ ἄνδρες Ἀθηναῖοι, πεπόνθατε ὑπὸ τῶν ἐμῶν κατηγόρων, οὐκ οἶδα: ἐγὼ δ' οὖν καὶ αὐτὸς ὑπ' αὐτῶν ὀλίγου ἐμαυτοῦ ἐπελαθόμην, οὕτω πιθανῶς ἔλεγον. Καίτοι ἀληθές γε ὡς ἔπος εἰπεῖν οὐδὲν εἰρήκασιν.

- from the beginning of Apology by Plato:

From Image Wisely

- **D.1. How to Convey Technical Information to the Public**
- Avoid using technical/medical jargon
- Translate technical/medical terms (e.g., dose) into everyday language
- Write short sentences that convey a single point
- Use headings and other formatting techniques to provide a clear and organized structure to the presentation of information

- http://www.imagewisely.org/imaging-modalities/computed-tomography/medical-physicists/articles/how-to-understand-and-communicate-radiation-risk

Communicating with staff

- Wear your badges!
- Wear them in the right location
- Use shielding
- Use proper techniques

Communicating with Physicians

- Wear your badges!
- Wear them in the right location
  - EDE 1, EDE 2
- Use shielding

Range of doses in Diagnostic Imaging

Table 3. Medical Imaging Procedures with Largest Contribution to Cumulative Effective Dose.*

Procedure	Average Effective Dose	Annual Effective Dose per Person	Proportion of the Total Effective Dose from All Study Procedures
	millisieverts		%
Myocardial perfusion imaging	15.6†	0.540	22.1
CT of the abdomen	8	0.446	18.3
CT of the pelvis	6	0.297	12.2
CT of the chest	7	0.184	7.5
Diagnostic cardiac catheterization	7	0.113	4.6
Radiography of the lumbar spine	1.5	0.080	3.3
Mammography	0.4	0.076	3.1
CT angiography of the chest (noncoronary)	15	0.075	3.1
Upper gastrointestinal series	6	0.058	2.4
CT of the head or brain	2	0.049	2.0
Percutaneous coronary intervention	15	0.043	1.8
Nuclear bone imaging	6.3	0.035	1.4
Radiograph of the abdomen	0.7	0.028	1.1
CT of the cervical spine	6	0.020	0.8
CT of the lumbar spine	6	0.018	0.7
Chest radiograph	0.02‡	0.016	0.7
Thyroid uptake	1.9	0.016	0.7
Intravenous urography	3	0.014	0.6
CT of the neck	3	0.014	0.6
Cardiac resting ventriculography	7.8	0.014	0.6

* Average effective doses for these imaging procedures are based on data from Mettler et al.[10]
† Calculation of the average radiation dose for myocardial perfusion imaging with the use of single-photon-emission CT relied on dose coefficients from a detailed review of radiation dosimetry of specific cardiac radiopharmaceuticals,[17] median injected radiopharmaceutical doses (millicuries) from the guidelines of the American Society of Nuclear Cardiology,[19] and distributions of the use of various protocols in the United States.[20]
‡ This dose is the effective dose for a posteroanterior study of the chest.

Table 3. Medical Imaging Procedures with Largest Contribution to Cumulative Effective Dose.

Exposure to Low-Dose Ionizing Radiation from Medical Imaging Procedures, Reza Fazel, MD; et al The New England Journal of Medicine, Vol 361, pp 849-857, 2009.

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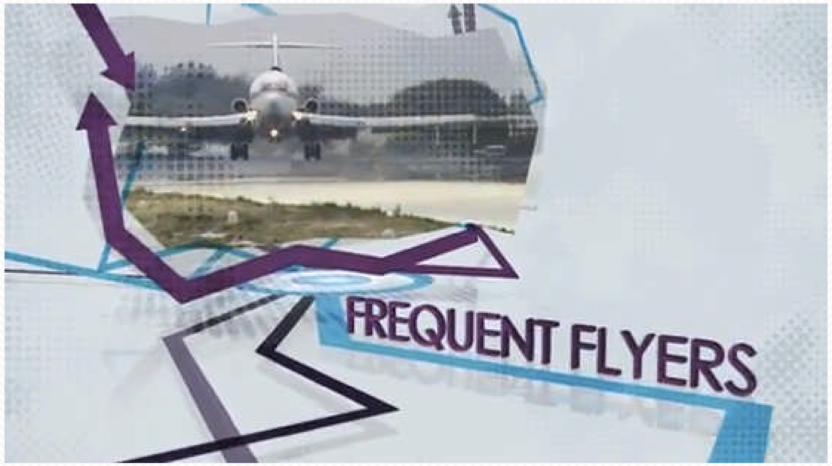
Nuclear bone imaging	6.3	0.035	1.4

CT with all procedures combined is ~50%

Single vs. Multiple Exposure

- A dose received in shorter time is more effective in causing tissue reactions than the same dose protracted in time. This is due to the fact that when dose is received during a longer period of time tissue cells have the time to repair themselves through cellular repair mechanisms between successive irradiations.

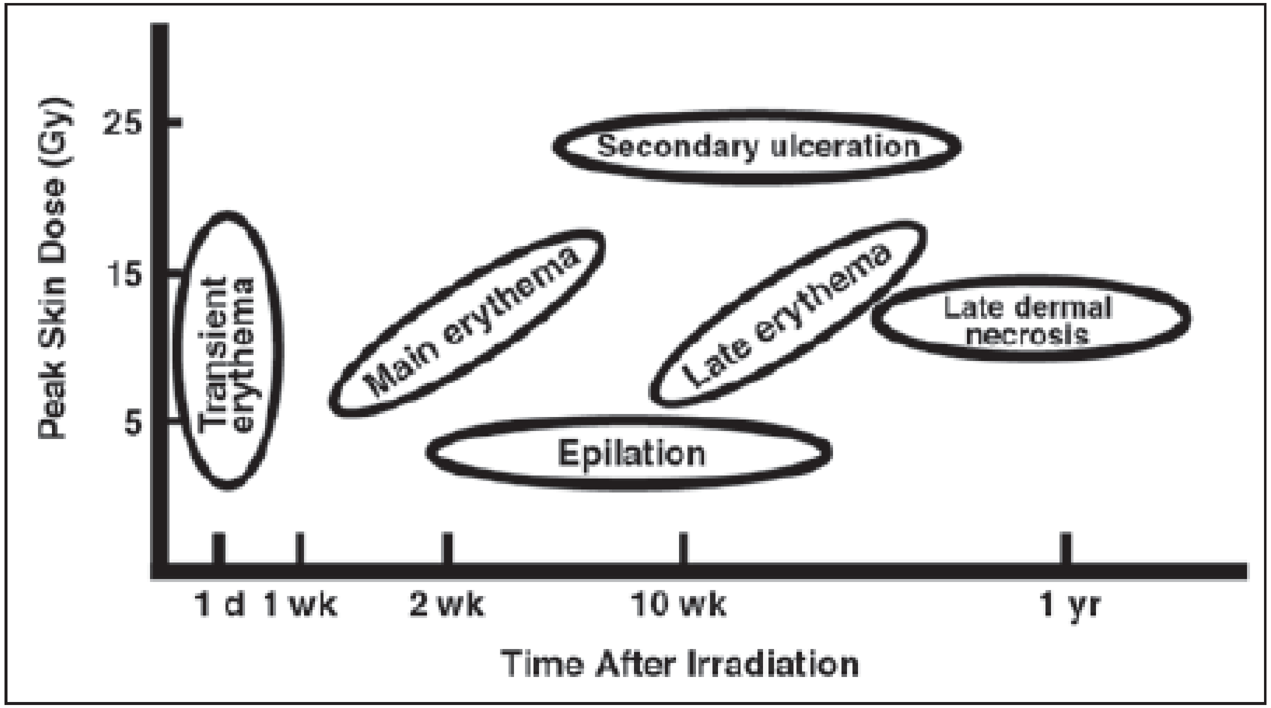
IAEA Radiation Protection of Patients (RPOP)
Health Professionals>>Interventional Fluoroscopy>>Fluoroscopy in Operating Theatres>>Patient Radiation Protection



Radiation Side Effects

- Late effects
  - Cancer
  - Skin burns
  - Cataracts
  - Sterility

Timing of skin injury



Patient Skin Reactions From Interventional Fluoroscopy Procedures, Stephen Balter; Donald L. Miller; American Journal of Roentgenology, Vol 202, pp W335-W342, 2014

Induction of Cancer

- Most common types are breast, thyroid, leukemia
- Lowest observed cancer induction ~100 mSv (10 cGy)

Balancing image quality with radiation dose (from IAEA)

- Medical imaging is used to accurately and timely diagnose health problems, allowing for a more effective treatment of patients. The use of ionizing radiation for imaging has seen a dramatic increase in recent years but is also associated with some amount of risk. Unfortunately, **improving the quality of medical images always means increasing the radiation dose** to the patient, which in turn increases the radiation risks.
- For this reason, **the objective of medical imaging is not to deliver the perfect image but one that is diagnostically adequate for the specific health problem**. This is the essence of optimization: balancing image quality with radiation dose.
- The application of this optimization principle to medical exposure requires a special approach, since **too low a radiation dose could be as bad as a too high one: the images obtained could be of unsuitable diagnostic quality**.

https://www.iaea.org/topics/optimising-image-quality

Dose reduction

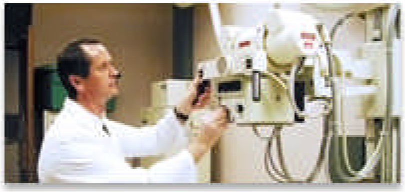
- **FDA Initiative to Reduce Unnecessary Radiation Exposure from Medical Imaging**
  - Through this initiative, the FDA strives to promote patient safety through two principles of radiation protection developed by the International Commission on Radiological Protection
  - Justification
  - Dose optimization

  - https://www.fda.gov/Radiation-EmittingProducts/RadiationSafety/RadiationDoseReduction/ucm199994.htm

Multidisciplinary Effort

» Imaging Physicians

Radiologists make daily decisions about how to balance effective studies and treatment with safe radiation dose. The information provided here focuses on the aspects of imaging of greatest relevance to imaging physicians and which influence dose, either directly or indirectly.



» Medical Physicists

Medical physicists contribute valuable knowledge and experience to the maintenance of quality in CT images and to reducing radiation dose to patients from CT examinations. Medical physicists help design and select optimum imaging protocols to acquire necessary information at the lowest possible radiation dose.

» Imaging Technologists

Imaging technologists carry out the vital role of dispensing the ionizing radiation necessary for producing image data. The resources presented here cover the physics and principles of operating modern CT devices, best practices for CT exam protocols, and peer-to-peer discussion boards.

- http://www.imagewisely.org/Imaging-Modalities/Computed-Tomography

Justification

- ACR Appropriateness Criteria
  - https://www.acr.org/Quality-Safety/Appropriateness-Criteria

Table 10: Acute Abdominal Pain and Fever Patient presenting with fever, non-localized abdominal pain and no recent operation*		
Exam	Rating 1 = least appropriate 9 = most appropriate	RRL scale
CT abdomen and pelvis w/contrast	8	☢☢☢☢
CT abdomen and pelvis w/o contrast	6	☢☢☢☢
US abdomen	6	None
X-ray abdomen	6	☢☢☢
X-ray upper GI series with small bowel	5	☢☢☢
X-ray colon contrast enema	5	☢☢☢
Nuclear ImagingGa-67 of abdomen	5	☢☢☢☢
Nuclear Imaging Tc99m WBC abdomen and pelvis	5	☢☢☢
MRI abdomen and pelvis w/o contrast	5	None
MRI abdomen and pelvis w/contrast	5	None
Interventional arteriography visceral	2	☢☢☢
*adapted from ACR Appropriateness Criteria October 2008.		

http://www.imagewisely.org/imaging-modalities/computed-tomography/medical-physicists/articles/how-to-understand-and-communicate-radiation-risk

Table 11: Acute Abdominal Pain and Fever in a *Pregnant Patient* Patient presenting with fever, non-localized abdominal pain and no recent operation*		
Exam	Rating 1 = least appropriate 9 = most appropriate	RRL scale
US abdomen	8	None
MRI abdomen and pelvis w/o contrast	7	None
MRI abdomen and pelvis w/contrast	7	None
CT abdomen and pelvis w/contrast**	5	☢☢☢☢
CT abdomen and pelvis w/o contrast	5	☢☢☢☢
X-ray abdomen	4	☢☢☢
X-ray upper GI series with small bowel	2	☢☢☢
X-ray colon contrast enema	2	☢☢☢
Nuclear Imaging Ga-67 of abdomen	2	☢☢☢☢
Nuclear Imaging Tc99m WBC abdomen and pelvis	2	☢☢☢
Interventional arteriography visceral	2	☢☢☢

*adapted from ACR Appropriateness Criteria® October 2008

** only after all exams that do not use ionizing radiation have been used or ruled out as possible.

http://www.imagewisely.org/imaging-modalities/computed-tomography/medical-physicists/articles/how-to-understand-and-communicate-radiation-risk

Dose Optimization

Journal of Applied Clinical Medical Physics

Explore this journal >

AAPM Reports & Documents

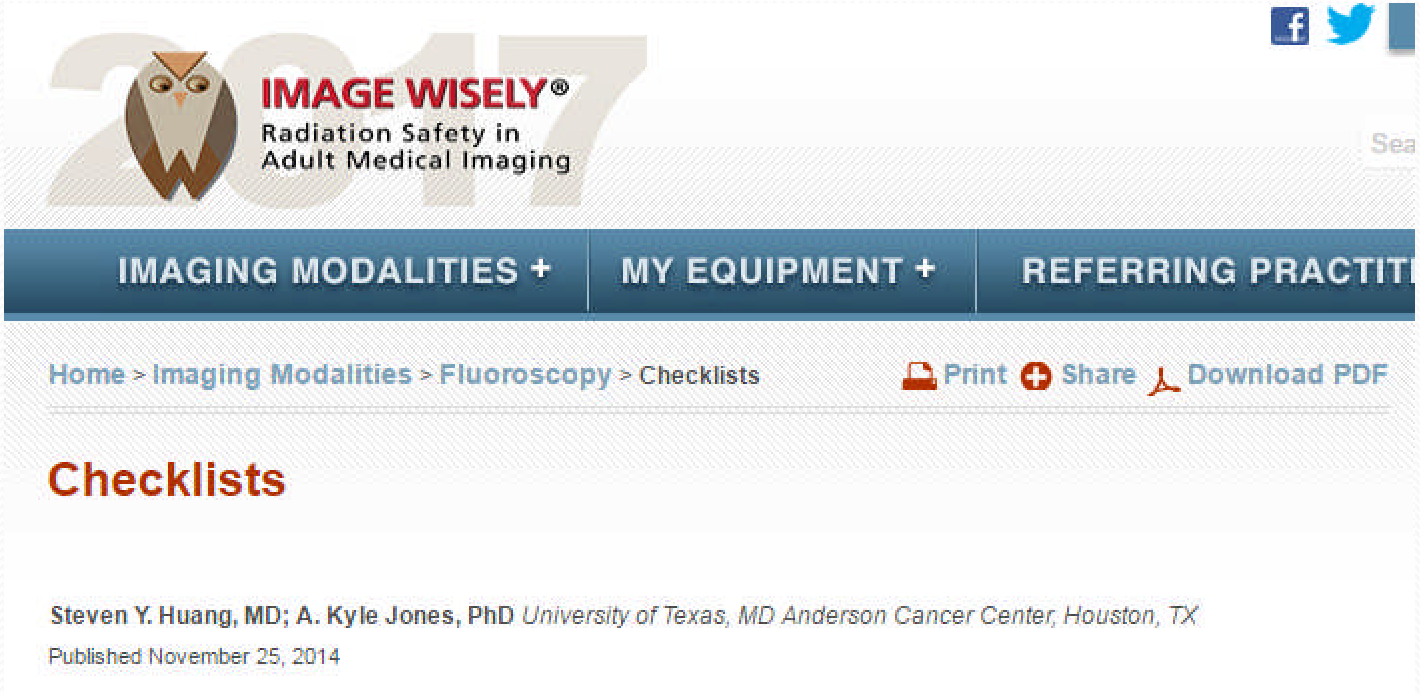
AAPM Medical Physics Practice Guideline 1.a: CT Protocol Management and Review Practice Guideline

First published: 6 September 2013 Full publication history

Dose Reduction: CT

- Reduce scan volume
- Smaller kV for smaller patients
- Use appropriate filters
- Use larger pitch if possible (peds 0.9-1.5)
- Shorter rotation times
- Dose modulation

Dose Reduction: Fluoro



http://www.imagewisely.org/Imaging-Modalities/Fluoroscopy/Articles/Huang-Checklists

Pre-Procedure (READ-DO)

1. Prior Radiation
2. For cases in which high radiation exposure is expected, informed consent should include discussion of radiation risk.
3. Use ultrasound, if possible.
4. Wear appropriate radiation protection.
5. Wear radiation dosimeters
6. Maximize use of shielding.
7. Appropriate anatomical program set for the desired study.
8. Determine if patient is pregnant.

Intra-Procedure(DO-CONFIRM)

1. Use proper collimation.
2. Use last image hold.
3. Use largest source-to-object distance possible
4. Place II as close to patient as possible.
5. Minimize path length through patient.
6. Minimize overlap of fields.
7. Use tubing extensions for hand injections.
8. Use power injector if possible.
9. Communicate with team about technical factors.
10. All unnecessary personnel behind shields or outside room.
11. If dose levels are exceeded, reduce exposures and consider delaying completion.

Post-Procedure (READ-DO)

1. Review and record dose metrics.
2. If dose metrics are exceeded, advise patient of risk and instruct on proper follow-up.

Dose Reduction: Nuclear Medicine

- Radiopharmaceutical Selection
- Injected Radioactivity
- Collimator selection and imaging time
- Image restoration (filters)

- http://www.imagewisely.org/imaging-modalities/nuclear-medicine/articles/dose-reduction

Real-life Scenarios

- Time for a Medical Physics Consult