Radiation: Separating Fact from Fantasy

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Imaging benefits

- Imaging has become integral to the diagnostic algorithm
  - Decrease in false positive surgical diagnoses
    - 24-3% from 1996-2006 for appendicitis
  - Earlier cancer detection
  - Image-guided interventional diagnosis and therapies

Imaging risks

- CT use has increased 20x since early 1990s
- Some authors are predicting thousands of radiation induced cancers in the future

The New York Times

Radiation Overdoses Point Up Dangers of CT Scans

A week ago, Cedars-Sinai Medical Center in Los Angeles disclosed that it had mistakenly administered up to eight times the normal radiation dose to 206 possible stroke victims over an 18-month period during a procedure intended to get clearer images of the brain. State and federal health officials are investigating the cause.

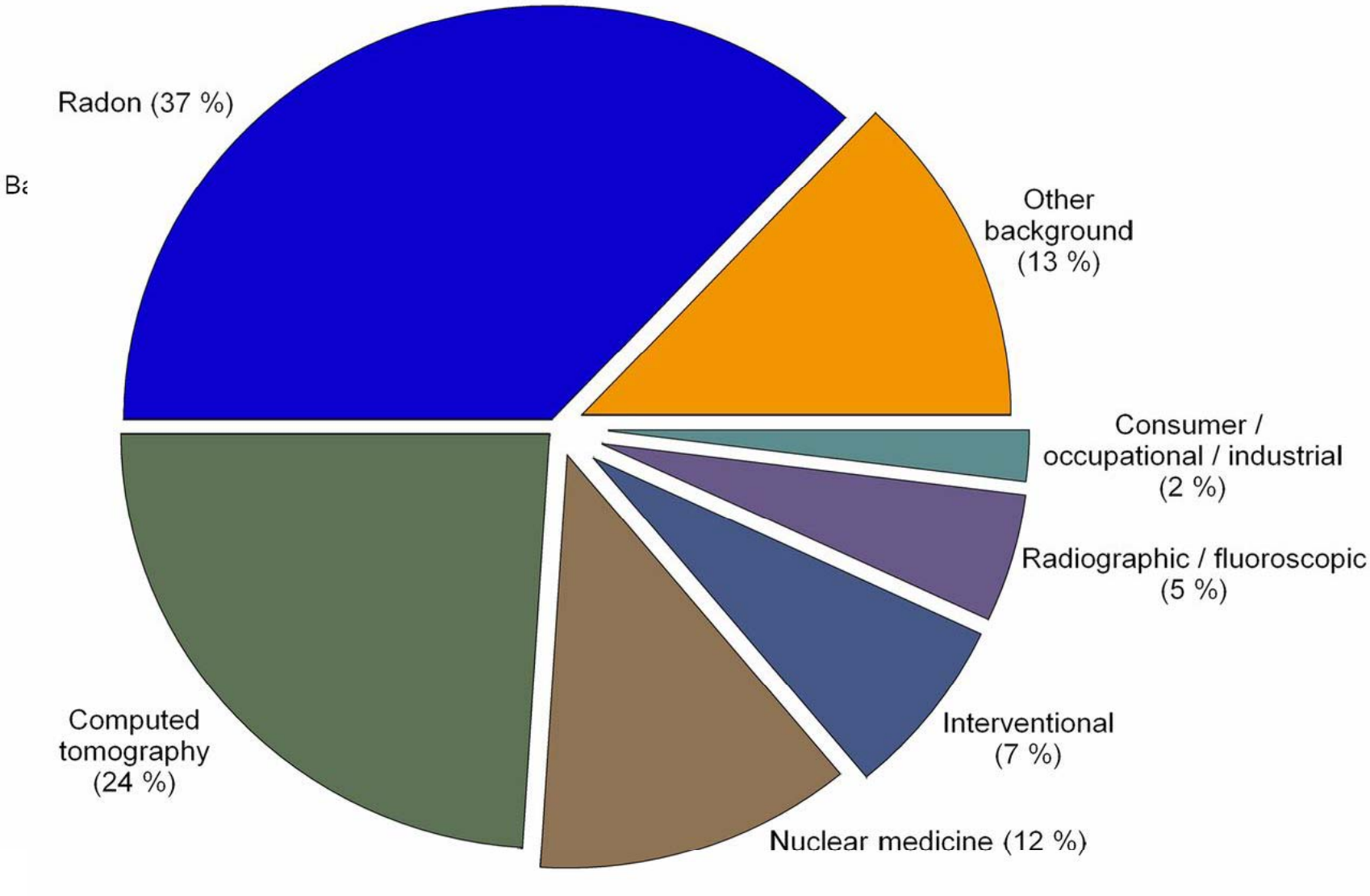
Hundreds of miles north at Mad River Community Hospital in Arcata, the other case — involving a 2 ½-year-old boy complaining of neck pain after falling off his bed — has led to the revocation of an X-ray technician's state license for subjecting the child to more than an hour of CT

Reducing CT radiation is **top priority** among hospitals' health technology initiatives

ECRI Institute

The Discipline of Science. The Integrity of Independence.

Average effective dose per capita to the U.S. population from major sources of exposure.



Hendee W R , O'Connor M K Radiology 2012;264:312-321

Goals

- 1) Clarify what we know and (don't know) about:
  - Radiation induced cancers
  - Dose
- 2) Who is most at risk?
- 3) How do we minimize radiation?

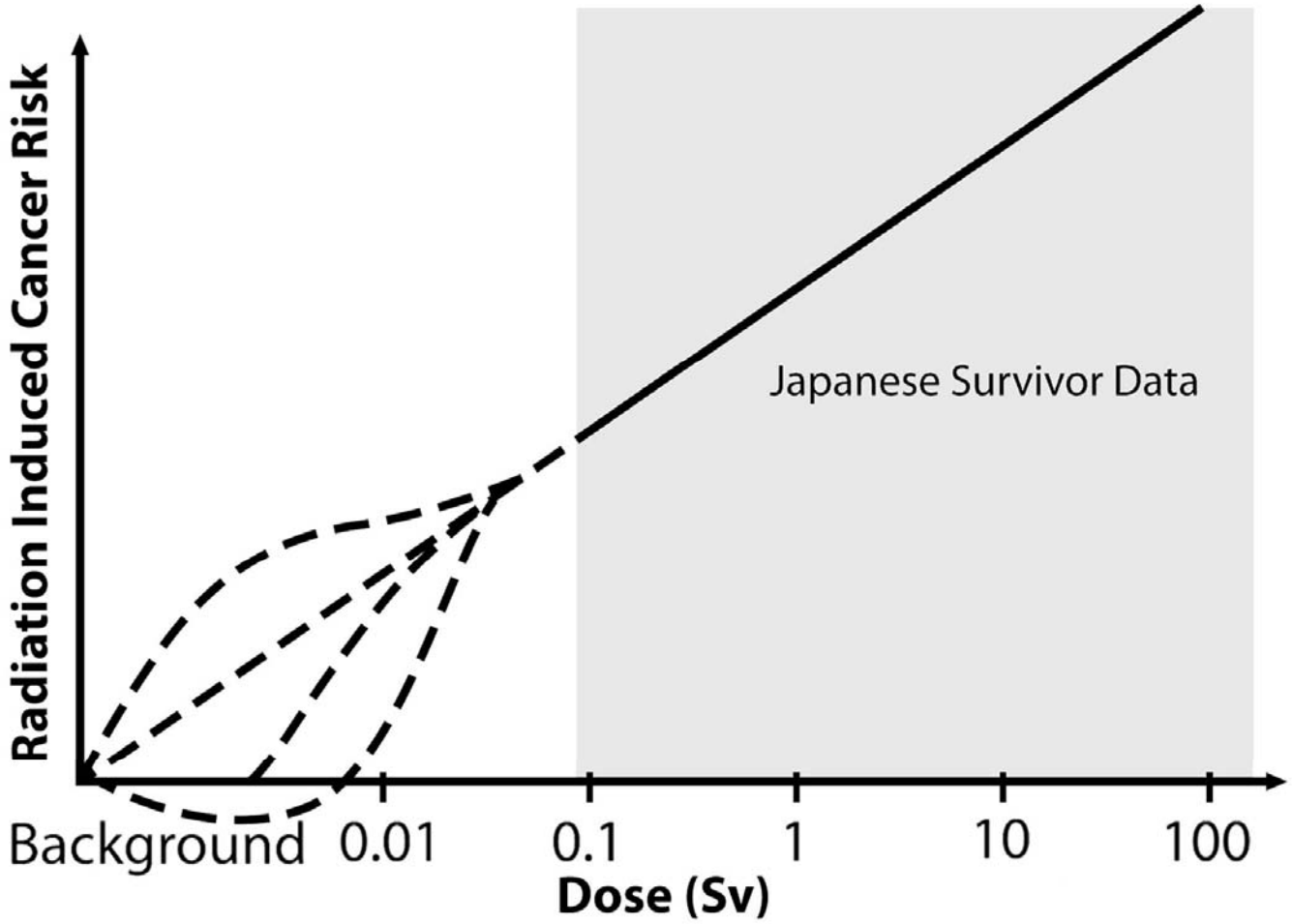
Quantifying risk: data sources

- Atomic bomb survivors
  - Hiroshima and Nagasaki
  - Greatest emphasis
- People exposed to medical radiation
- Workers in radiation and nuclear industries
- Survivors of environmental radiation exposure
  - Chernobyl
  - Three Mile Island

Hiroshima and Nagasaki

- Radiation from atomic bombs was different than radiation in medical imaging
  - Whole body radiation and radiation fallout
  - Different radiation particles
  - Difficult to extrapolate relevance to medical imaging
- At doses greater than 100 mSv, increased incidence of cancer
- At doses less than 100 mSv, no increased incidence of cancer

Graph shows models for extrapolating radiation-induced cancer risk to low doses (dashed line and curves).



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Radiology

Common effective doses

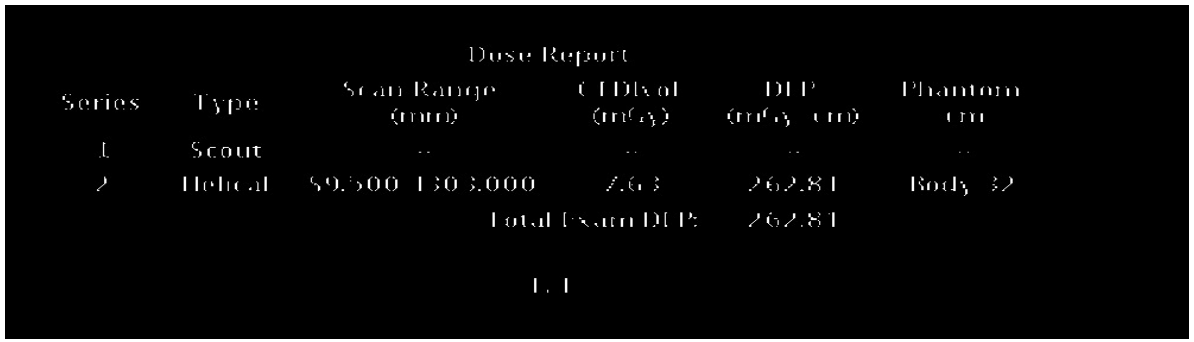
- Background radiation = 3 mSv
- CT head = 2 mSv
- CT abd/pelvis = 8 mSv
- Nuclear stress test = 5 mSv
- Coronary CTA = 1 mSv
- Barium enema = 10-15 mSv

Other data sources

- Occupational exposure
  - 500k nuclear power plant workers = no increase in cancers
- Most population studies have revealed no or small demonstrable health effects of radiation exposure
- Chernobyl
  - Increased risk of thyroid cancer in persons exposed to downwind radiation in utero
  - Compare this with 15 million people who exhibited psychosomatic disorders from the radiation exposure

Dose

- Effective dose: mSv
  - Dose which if delivered uniformly to the whole body would produce same health consequences as those caused by a dose to one organ
  - What we use to "score" radiation dose
- Effective dose is what we calculate on every CT



Dose Report

Series	Type	Scan Range (mm)	CTDIvol (mGy)	DLP (mGy · cm)	Phantom cm
1	Scout	--	--	--	--
2	Helical	59.500 - 130.3.000	7.63	262.81	Body 32
		Total Exam DLP:		262.81	

The problem with effective dose

- "Effective dose is intended for use as a protection quantity. The main uses of effective dose are the prospective dose assessment for planning and optimization in radiological protection….Effective dose is not recommended for epidemiological evaluations, nor should it be used for detailed specific retrospective investigations of individual exposure and risk."

Fact from fantasy

- Commonly cited number is fatal cancer risk of 1:2000 per 10 mSv.
- No prospective epidemiologic studies demonstrating increased cancer risk for doses less than 100 mSv
- Putting data in perspective
  - Recent retrospective cohort study demonstrated EAR of 0.83 cases of leukemia per 10k children with multiple head CT

Statement from AAPM

- "Risks of medical imaging at patient doses below 50 mSv for single procedures or 100 mSv for multiple procedures over short time periods are too low to be detectable and may be nonexistent. Predictions of hypothetical cancer incidence and deaths in patient populations exposed to such low doses are highly speculative and should be discouraged."

Who is at risk?

- Study by Zondervan et al. compared risk of dying within 3 years after a CT in young (18-35 yo) patients vs. theoretical risk of dying from future cancer
  - CT abdomen: 35x more likely to die from condition than theoretical radiation induced cancer
  - CT chest: 70x more likely to die from condition than theoretical radiation induced cancer

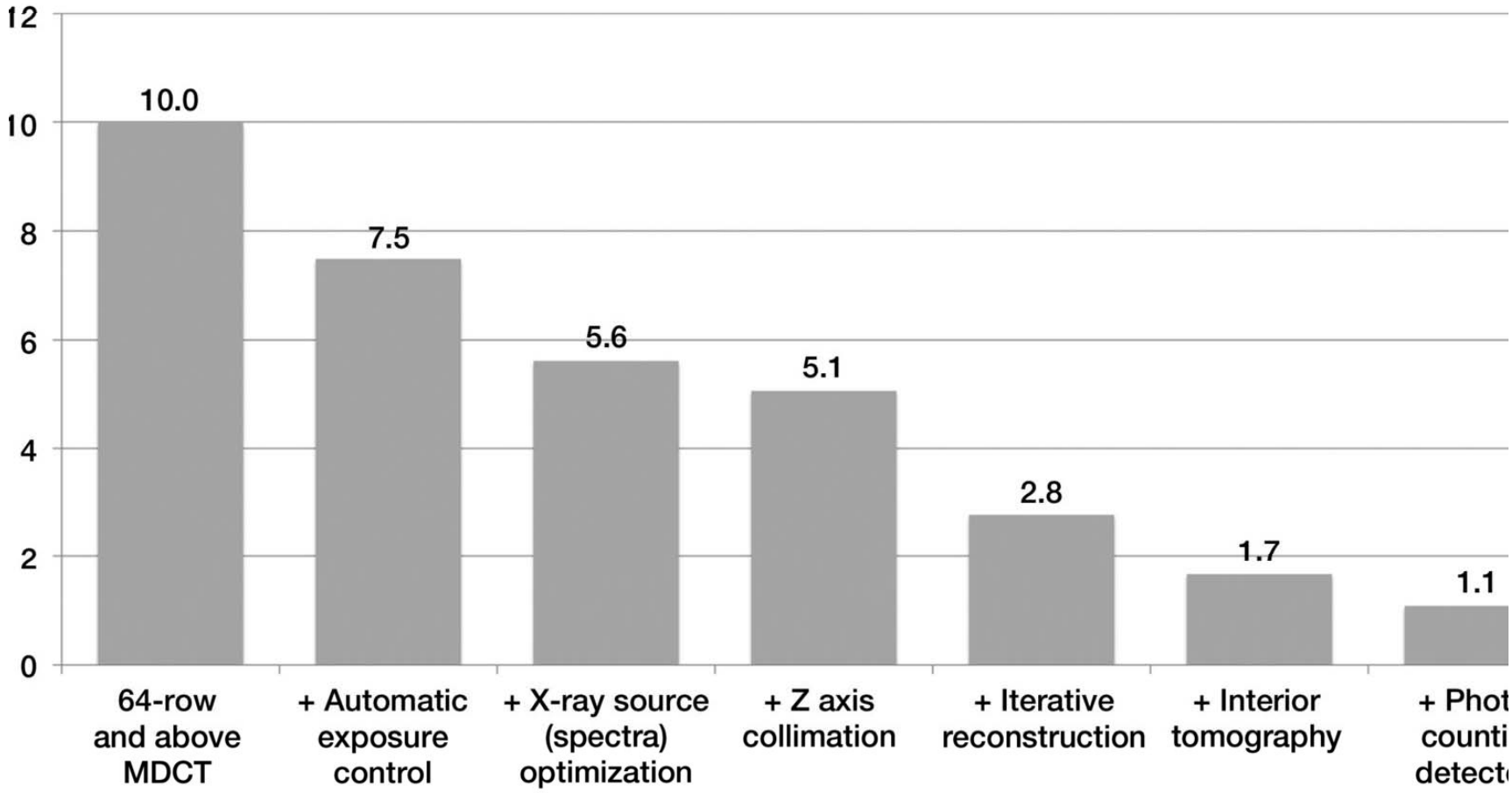
Radiation risk: we just don't know

- Virtually all imaging procedures deliver doses way below 100 mSv
- Predictions of cancer incidence and death are at best controversial and at worst lack supportive evidence and are speculative
- Patients often delay or defer necessary imaging due to these fears

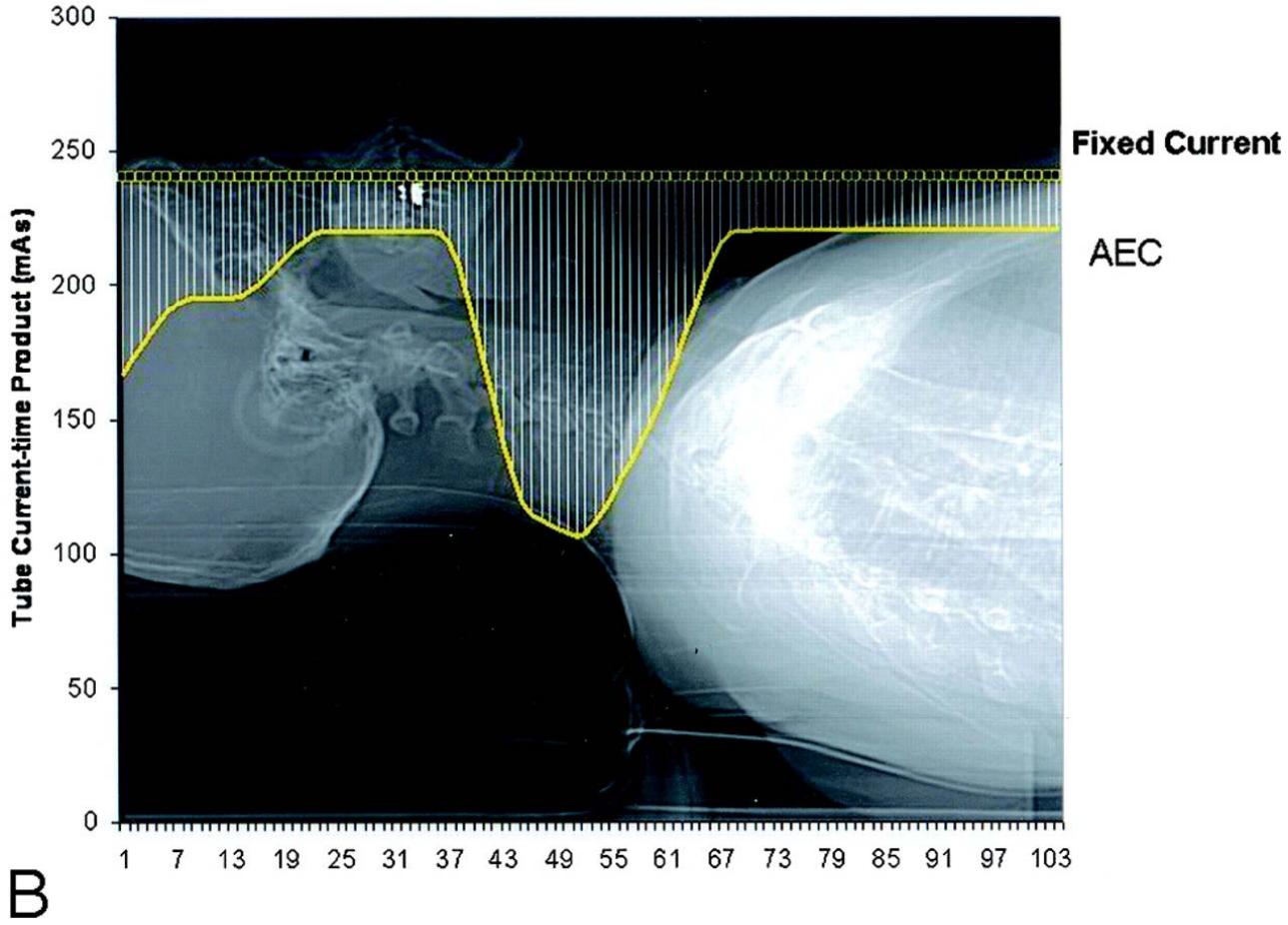
What we do know

- Age matters
- Weight matters
- Location matters

What we do know: dose reduction

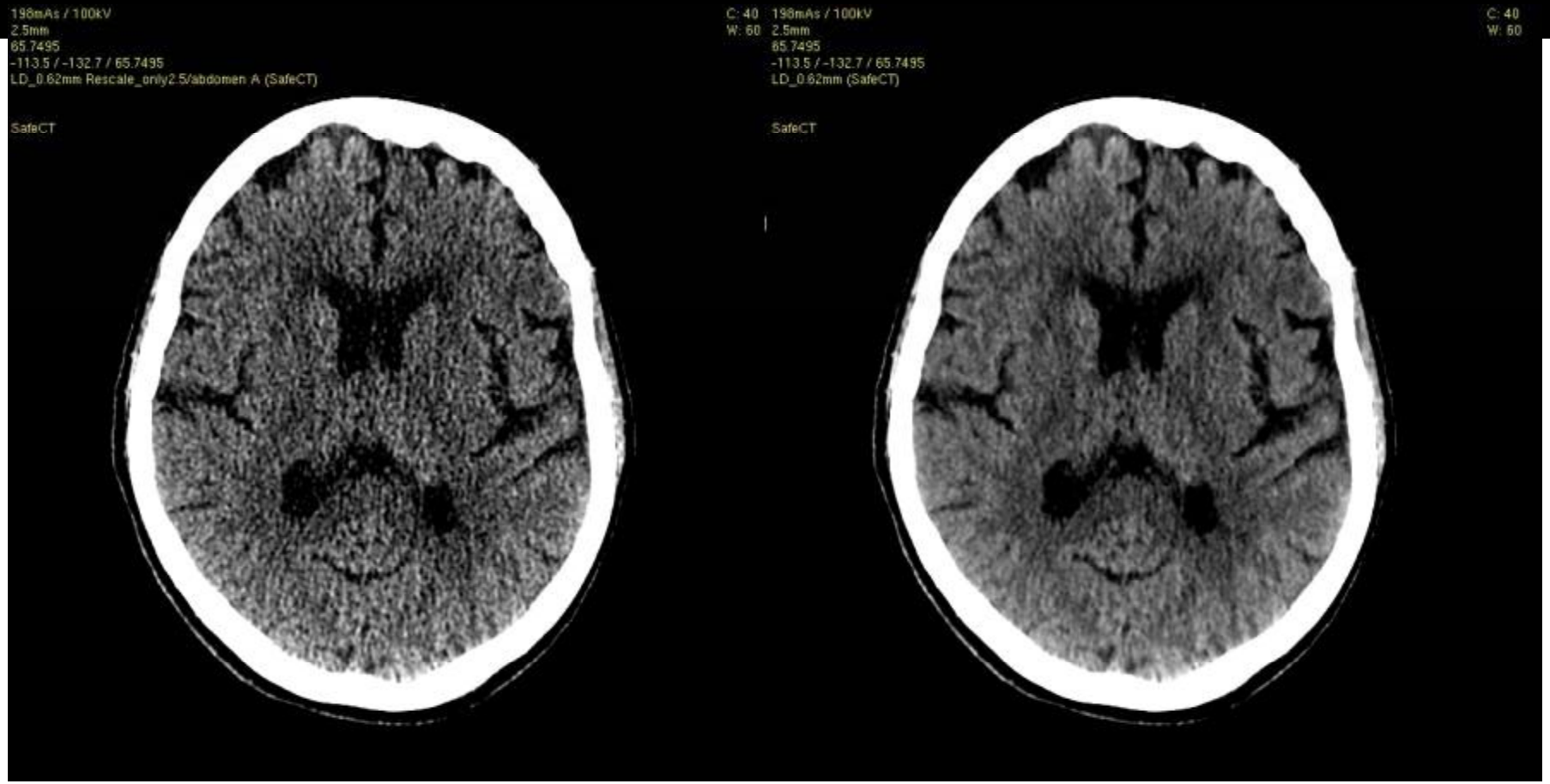


Radiation Exposure Reduction



Namasivayam S et al. AJNR Am J Neuroradiol 2006;27:2221-2225

Dose reduction software

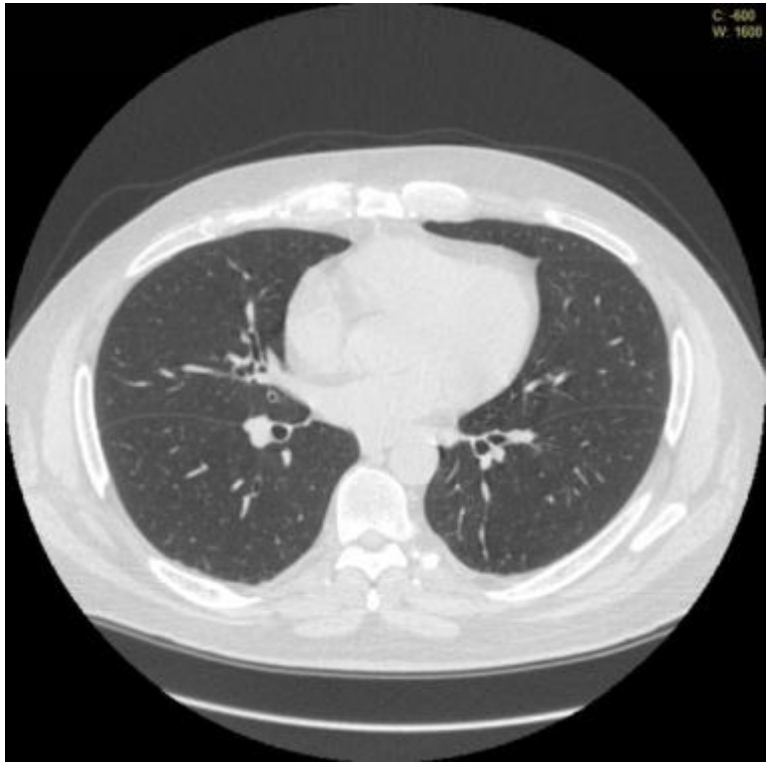


198mAs, 100kV,
2.5 mm slice thickness
Unprocessed

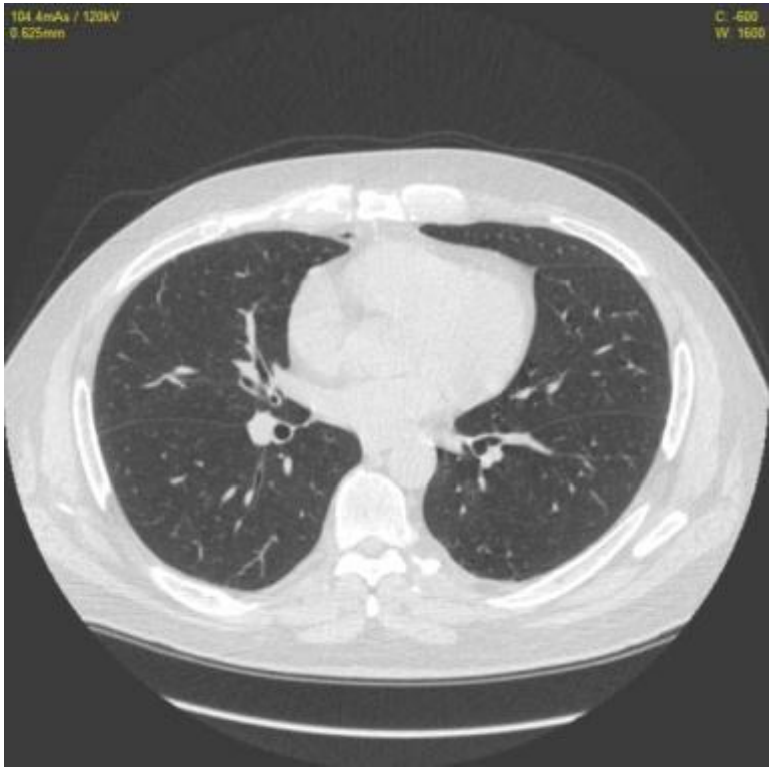
198mAs, 100kV,
2.5 mm slice thickness
Post-processed by SafeCT

21

Dose reduction software



Full-dose CT at 200mAs



Half-dose SafeCT-processed image of the same patient (104mAs)

Benefit vs. risk

- While risk is theoretical, we must minimize dose as much as possible (ALARA)
  - Using best technology possible
  - Using best protocols
  - Considering if there is another test we can use
  - Dose minimization most important in children, but try to minimize dose to everyone
- We must focus on the benefits of imaging (AHARA), realizing that the theoretical risk is small

Your patients

- If you believe that your patient needs a CT, then you should not hesitate to order it
- Council them on:
  - Dose: http://hps.org/physicians/documents/doses_from_medical_x-ray_procedures.pdf
  - Theoretical risks
  - Why the CT is necessary
- Appropriateness of imaging tests
  - http://www.acr.org/Quality-Safety/Appropriateness-Criteria
- Make sure your radiologists are doing everything possible to minimize your patient's dose

Thank you