NCRP 1929 2009

Computed Tomography in Emergency Medicine: Ensuring Appropriate Use

September 23 – 24, 2009

Bethesda-Chevy Chase Rescue Squad Building
Anastasi Conference Room
5020 Battery Lane
Bethesda, Maryland

agenda

September 23, 2009

8:00 am	Registration and continental breakfast
8:30	Welcome and Introduction Thomas S. Tenforde and Otha W. Linton
8:40	Self-Introductions of Participants

Exposure of Members of the U.S. Population to Medical Radiation & Growth in Applications of Computed Tomography

9:00	Major Sources of Exposure from Diagnostic Imaging Procedures Bruce R. Thomadsen
9:20	Uses and Misuses of CT in Medicine James A. Brink
9:50	Coffee break

Applications of Computed Tomography in Emergency Medicine

10:10	CT Imaging Utilization: Emergency Department Perspective Scott W. Melanson
10:40	CT Imaging Utilization: Radiology Perspective Stuart E. Mirvis

Current Practices in Computed Tomography

- External factors that influence clinical use of CT
- Referral of the patient for CT examination
- Assimilation of clinical diagnostic information into patient management strategy
- Other imaging specialties and their requirements
- Institutional requirements on imaging practices
- Patient expectations

11:10	CT Practices: Emergency Medicine Perspectives Louis K. Wagner
11:35	CT Practices: Radiologist Perspectives Stephen R. Baker
12:00 pm	Lunch break

Regulatory & Legal Aspects of Computed Tomography Applications in Emergency Medicine Procedures

1:20	Federal (FDA) and State-Level (CRCPD) Requirements on Manufacturers Stanley H. Stern
1:50	International Perspectives on Use of CT Imaging (WHO initiative) María del Rosario Pérez
2:05	Emergency Radiology: Legal and Regulatory Challenges Thomas W. Greeson

Clinical Decision Making & Implications for Reducing or Eliminating Computed Tomography Dose

- Critical patients (*e.g.,* patients with chest or abdominal pain)
- Role of alternative imaging procedures
- Role of decision support systems in determining efficacy (*e.g.,* American College of Radiology appropriateness criteria, European Union referral guidelines)
- Role of portable (electronic) records (current status and new possibilities)
- Evaluation of diagnostic yield (efficiency in achieving clinical results)

2:30	Clinical Decisions: Radiology Perspective Robert A. Novelline
2:55	Clinical Decisions: Emergency Physician Perspective Paul R. Sierzenski
3:20	Coffee break

Conduct of Computed Tomography Procedures & Radiation Dose Optimization

3:40	CT Basic Physics, Equipment Operations, and Dose Optimization Mahadevappa Mahesh
4:10	Radiation Doses and Risks in Medical Imaging of Trauma Patients Walter Huda
4:25	Technical Imaging Issues, Including Procedures for Adults and Pediatric Patients, Physician Referrals, and Quality Control Donald P. Frush
4:45	Appropriateness Criteria for CT Procedures Paul A. Larson
5:00	Adjourn first day

September 24, 2009

Analysis, Perception and Communication of Applications of "As Low as Reasonable Achievable" Principles in Use of Computed Tomography in Emergency Medicine

8:30 am	Potential Health Implications of Dose in CT Imaging David J. Brenner
8:45	Views of Emergency Department Physicians and Staff Michael Blaivas
9:00	Views of Radiologists Fred A. Mettler
9:15	Perceptions of Patients, Parents, and Pregnant Women Deborah B. Diercks

Summaries, Conclusions, & Consensus Building

9:30	Rapporteur Summaries and Conclusions E. Stephen Amis and Paul R. Sierzenski
10:30	Coffee break

General Question & Answer Session

Approaches to Consensus Building

11:20 Representatives of sponsoring organizations:

- American College of Radiology, James H. Thrall
- Society Academic Emergency Medicine, D. Mark Courtney
- American Association of Physicists in Medicine, J. Anthony Seibert
- American Society of Emergency Radiology, O. Clark West
- National Council on Radiation Protection and Measurements, Jerrold T. Bushberg

12:10 pm Concluding Remarks
Thomas S. Tenforde

12:20 Adjourn meeting

Co-sponsors

American Association of Physicists in Medicine

American College of Emergency Physicians

American College of Radiology

American Society of Emergency Radiology

Center for Disease Control and Prevention

Landauer, Inc.

Society for Academic Emergency Medicine

U.S. Environmental Protection Agency

National Council on Radiation Protection & Measurements
7910 Woodmont Avenue, Suite 400
Bethesda, MD 20814-3095
voice: 301.657.2652
fax: 301.907.8768
http://NCRPonline.org
http://NCRPpublications.org

Welcome to All Workshop Participants, Discussants and Observers from NCRP and Co-sponsoring Organizations:

American Association of Physicists in Medicine
American College of Emergency Physicians
American College of Radiology
American Society of Emergency Radiology
Centers for Disease Control and Prevention
Landauer, Inc.
Society for Academic Emergency Medicine
U.S. Environmental Protection Agency

Workshop History

- Discussions of ACR and NCRP in Fall, 2007 on holding workshop on CT Dose Control

  [follow up to November, 2002 NCRP symposium – AJR 181: 321-329 (2003)]
- Focus on overutilization of CT in emergency medicine [consistent with recommendations in ACR White Paper on Radiation Dose in Medicine – JACR 4: 272-284 (2007)]
- Program Committee formed with representatives of sponsoring organizations and preliminary agenda was planned during teleconference on February 25, 2009
- Agenda then refined with broad input and the workshop scheduled for September, 2009

Workshop Outcomes and Next Steps

- Workshop summary to be prepared by Otha Linton and Thomas Tenforde for review by co-sponsoring organizations
- Summary intended as framework for preparation of a consensus paper on “Appropriateness Guidelines for Applications of CT in Emergency Medicine”
- Drafting team to be formed and will prepare a consensus paper for review, revisions and final approval by co-sponsoring organizations
- Consensus paper to be published for wide dissemination among emergency medicine physicians and radiologists

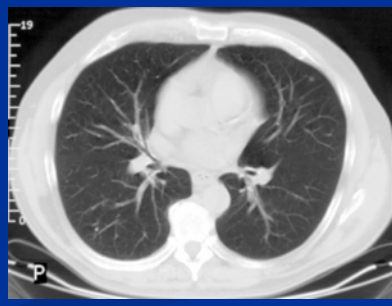
Estimate of Medical Radiation Exposure in the U.S. 2006

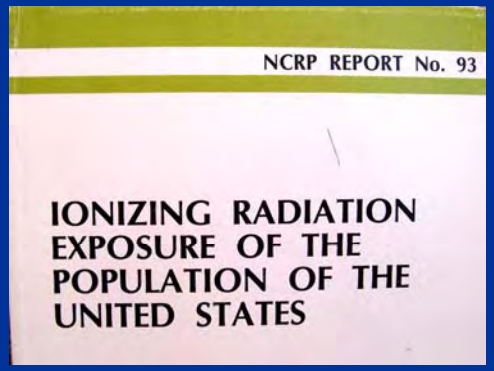
Results of NCRP SC 6-2 Medical Subgroup: NCRP Report 160

Bruce Thomadsen, Fred Mettler Jr.,
Mahesh Mahadevappa, Mythreyi Bhargavan, Debbie Gilley, Joel Gray, Jill Lipoti,
John McCrohan, Terry Yoshizumi

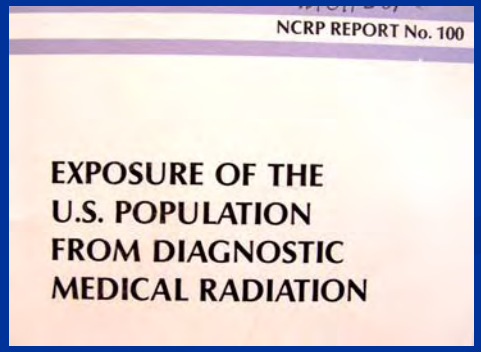
Purpose of NCRP SC 06-02

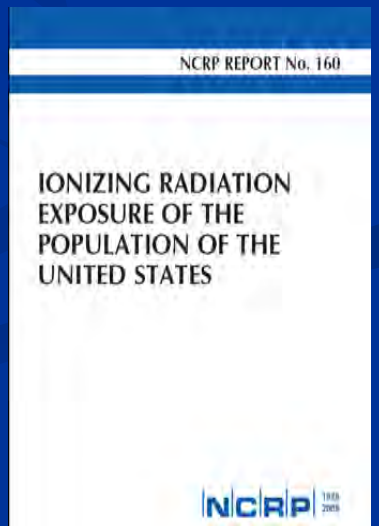
- Evaluate the collective and effective dose to the US population in 2006
- Last major radiological data 1980 (28 years before) and nuclear medicine 1982.
- Estimate current
  - Number and types of procedures
  - Dose per procedure and collective dose
  - Examine past and future trends





1989





2009

Medical Subgroup SC 6-2

- B. Thomadsen, Chairman, Univ of Wisc.
- M. Bhargavan, American College of Radiology
- D. Gilley, State of Florida
- J. Gray, DIQUAD, LLC
- J. Lipoti, State of New Jersey
- M. Mahesh, Johns Hopkins Univ.
- J. McCrohan, U.S. F.D.A.
- F. Mettler, Univ of New Mexico VA
- T. Yoshizumi, Duke Univ.

- M. Rosenstein, Scientific NCRP Consultant
- K. Kase, Stanford SC 6-2 Chair

- Tom Shope Original Chairman,

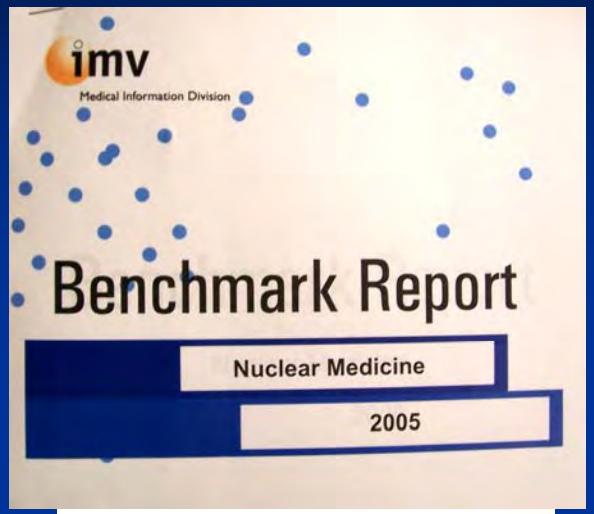
- T. Tenforte, President NCRP

Data

- Data sources: No one complete data set. Incomplete data sets require assumptions and cross checking between data sets
- RBE = 1
- Weighting Factors: Used ICRP 60 (1990). Past reports used older ICRP 26 (1977) and new factors are suggested
- Issue not examined in this report: Benefit and risk:

Major and minor data sources

- Commercial (IMV Benchmark)
- Medicare payment data (2003-2005)



Based on responses from 4,365 hospital and non-hospital sites out of an identified universe of 7,207 hospital and non-hospital sites

- VA Health Care System
- Claims data from large national employer plan
- US FDA
- CRCPD
- State radiation programs
- Large hospitals
- American College of Radiology
- Industry sources
- Literature

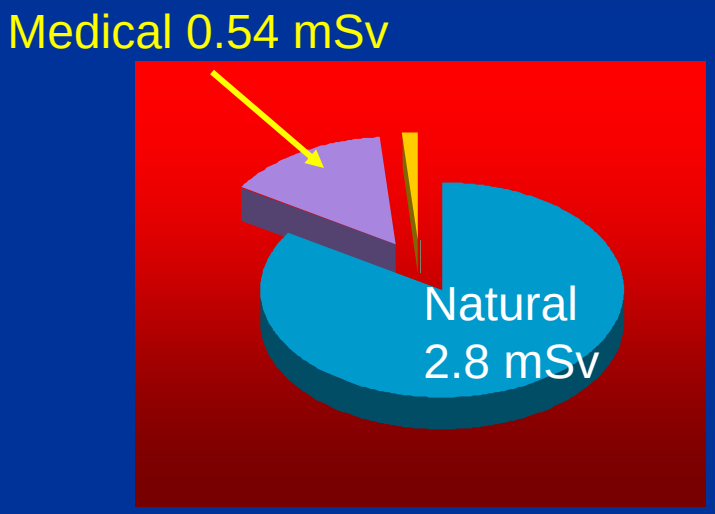
Results (2006)

	Number procedures	%	Collective dose (Person-Sv)	%	Per capita (mSv)
Radiography	293 million	74	100,000	11	0.3
Mammography	34 million	8	3,300	<0.4	0.01
Dental	125 million	31	2,100	<0.2	0.01
Interventional	17 million	4	128,000	14	0.4
CT	67 million	17	440,000	49	1.5
Nuclear Medicine	18 million	5	231,000	26	0.8
Radiotherapy	1 million pts	NA	NA	--	--

Total x ray + NM = ~ 395 million ~ 899,000 ~ 3.0

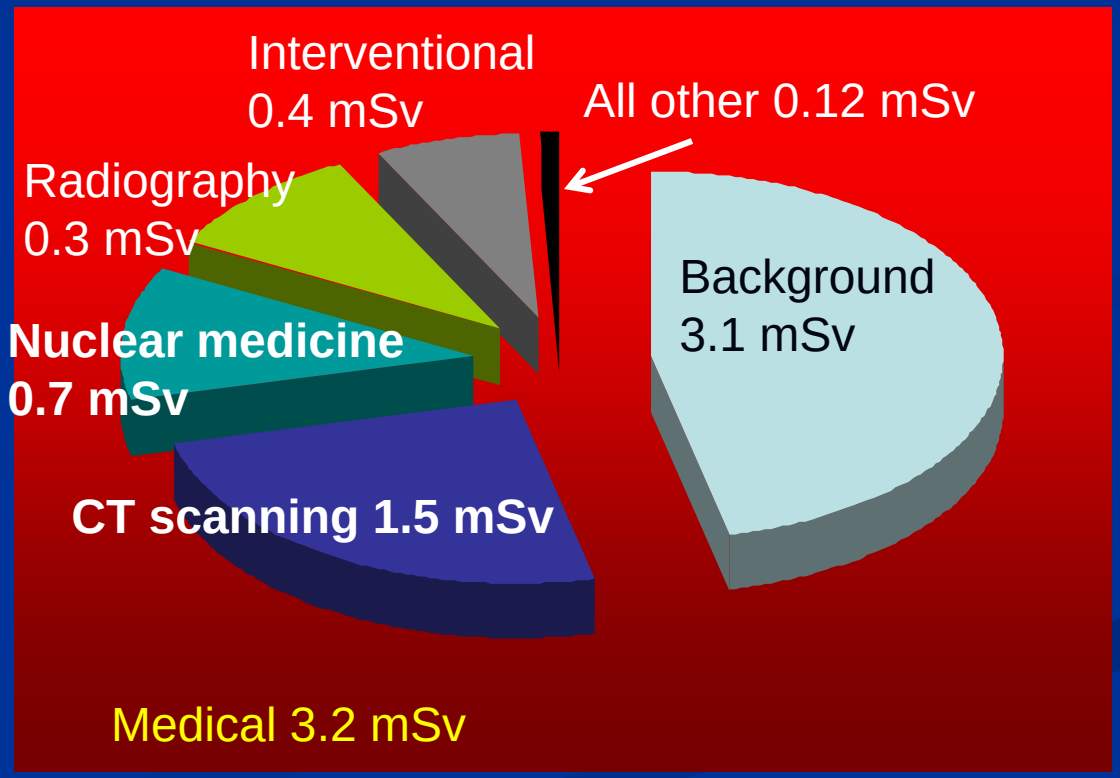
Changes in U. S. Medical Radiation Exposure

U.S. 1980



Total 3.6 mSv per capita

U.S. 2006



Total 6.2 mSv per capita

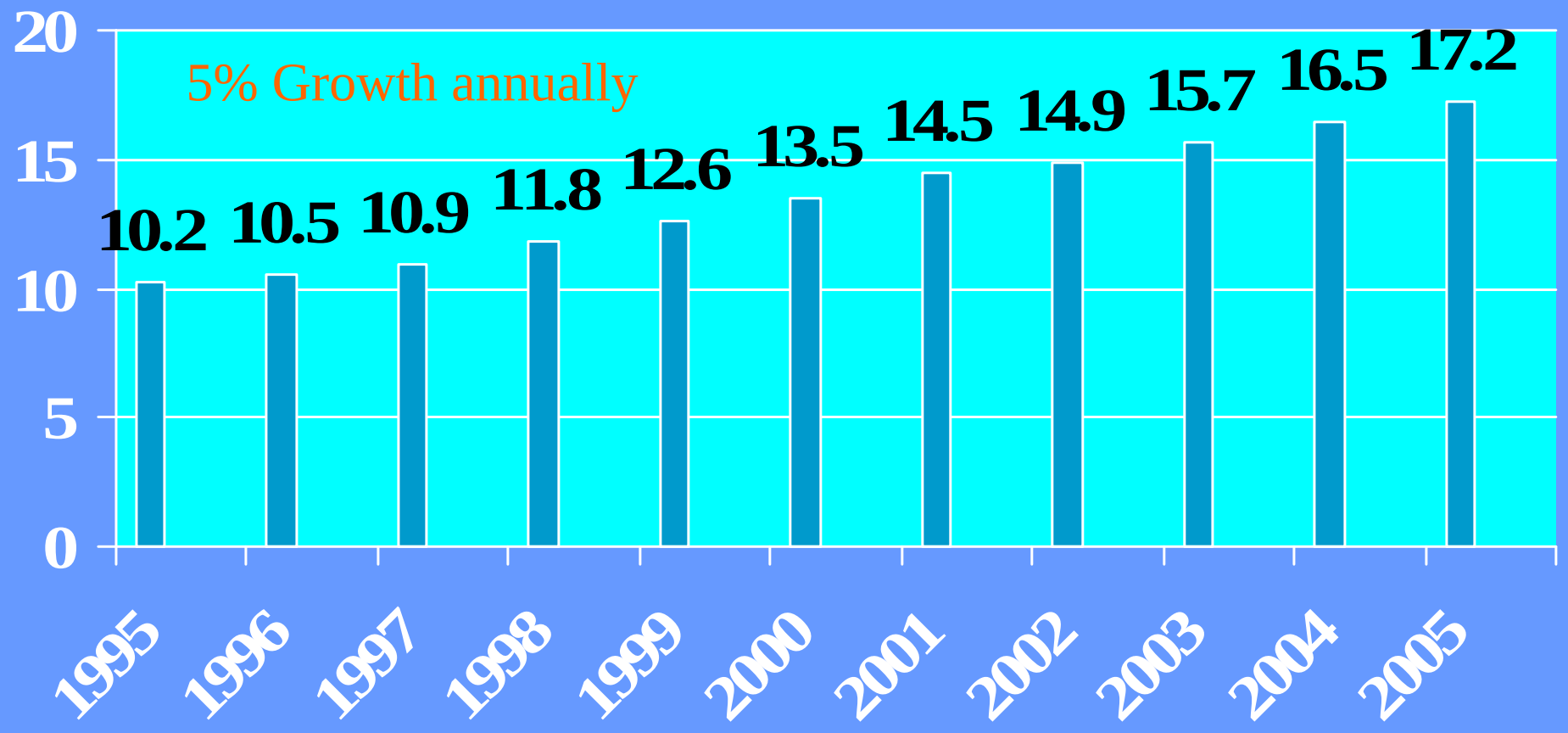
Change between Reports

	1980/82[a] (NCRP, 1989a) NCRP Report No. 100		2006 This Report		Ratio (2006) / (1980/1982)	
U.S. Population (million)	(1980) 226.5 (1982) 231.6		300		1.32 1.30	
Procedure	$\underline{E}_{US}$ (mSv)	Collective Effective Dose (person-Sv)	$\underline{E}_{US}$ (mSv)	Collective Effective Dose (person-Sv)	$\underline{E}_{US}$	Collective Effective Dose
CT	0.02	3,700	1.47	440,000	92	120
Radiographic	0.37	83,100	0.33	100,000	0.9	1.2
Interventional	0.02	4,200	0.43	128,000	24	31
Nuclear Medicine	0.14	32,424	0.77	231,000	5.5	7.2
Total	**0.54**	**123,424**	**3.00**	**899,000**	**5.7**	**7.3**

Results for Nuclear Medicine (2005)

	Number millions	%	Collective dose Person Sv	%
Brain	<0.1	<2	260	0.1
Thyroid	< 0.1	<2	400	0.2
Lung	0.74	4	2,000	0.9
Cardiac	9.80	57	188,000	85.2
GI	1.21	7	3500	1.6
Renal	0.47	3	650	0.3
Bone	3.45	20	20500	9.3
Infection	0.38	2	1300	0.6
Tumor	0.34	2	4000	1.8
Total	19	100	220000	100

Nuclear medicine visits by year U.S.(millions)



Currently approximately 1 nuclear medicine procedure annually per 15 persons

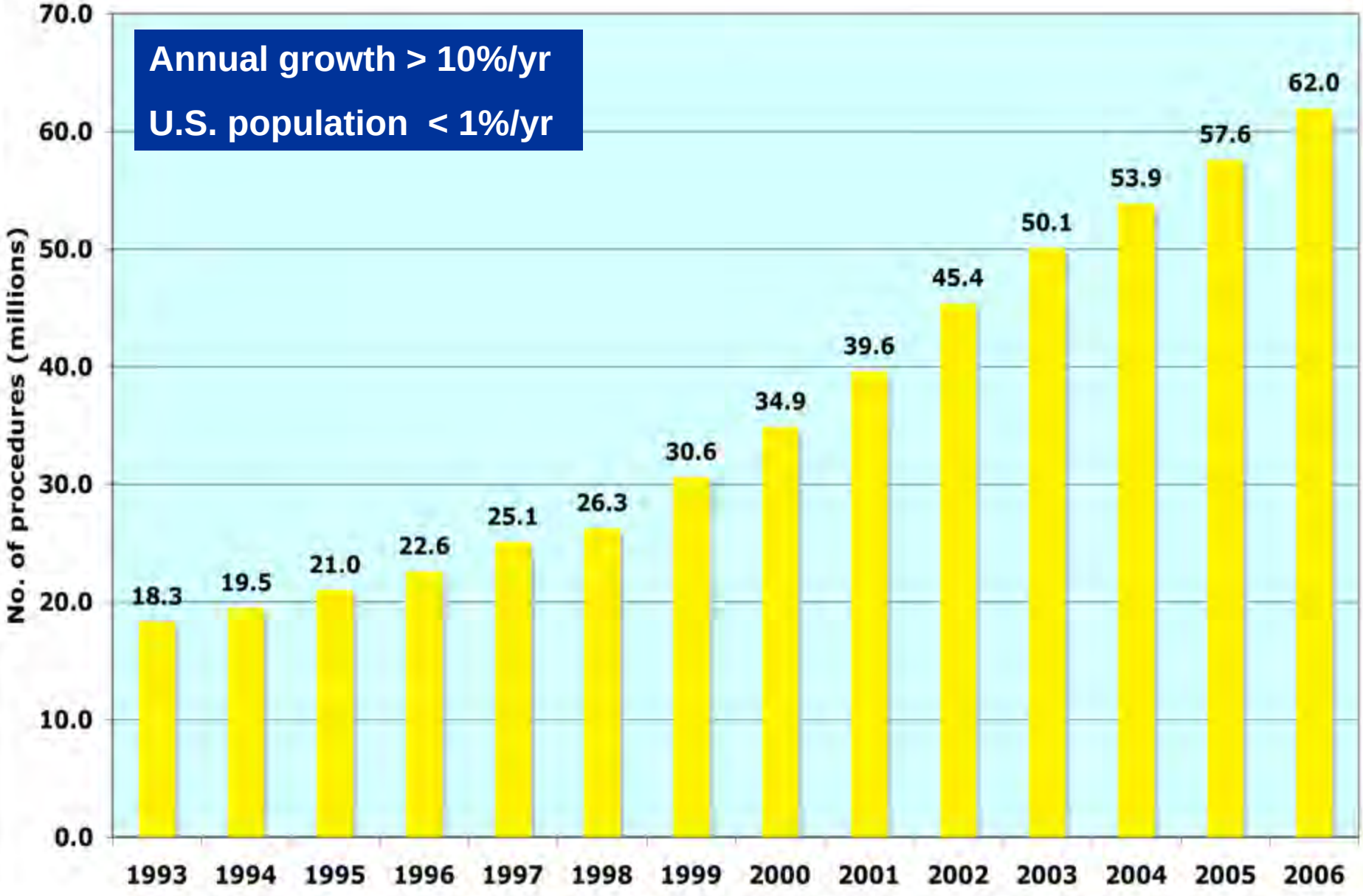
Nuclear Medicine Note

In 1982, there was almost no nuclear cardiology!

Results for CT

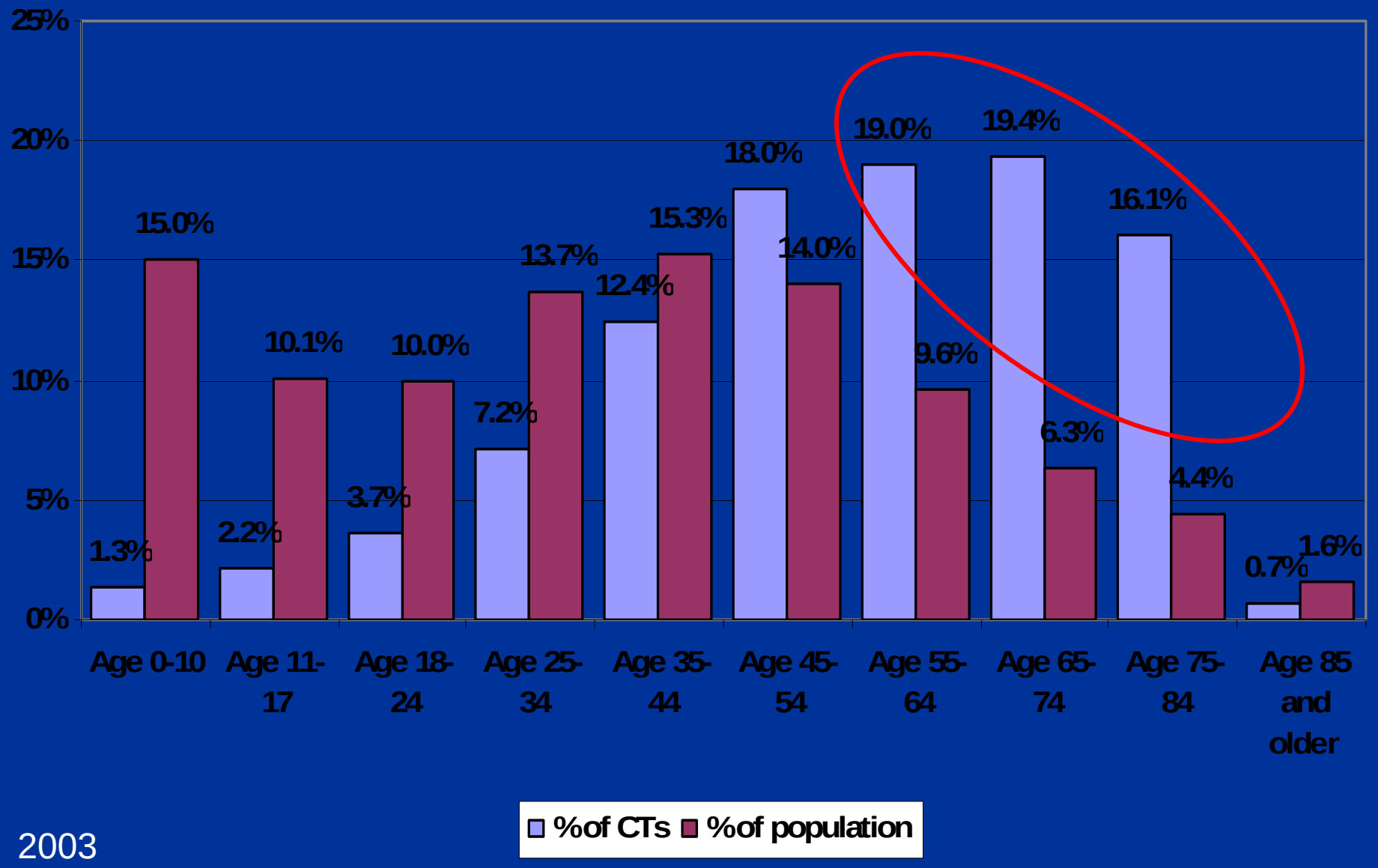
	Number (millions)	%	Collective dose person Sv	%
Head	19	28	38,000	8.7
Chest	11	16	74,000	17.0
Abd/Pelvis	21	32	212,500	48
Extremity	3.5	5	515	0.1
CT Angiogram	4	6	56,000	12.8
Miscellaneous	8	11	55,700	12.7
TOTAL	**67**	**100**	**437,000**	**100**

CT procedures by year (millions)



CT scans of abdomen and pelvis

Exam distribution vs U.S. population



2003

CT History

- Released in 1972 as head scanners.
- Body scanners in 1974.
- By 1982
  - Body scanners were new and expensive.
  - Mostly still in major centers.
  - Images were great, unless you compare them with modern devices.
  - Most facilities that had one, had…one.
  - They were still sloooow and throughput was low.

Points of interest

- The numbers and percentages of procedures appear robust and consistent across databases.
- Doses of procedures are averages. For an individual procedure the range may vary over factor of about 3-20
- Medical exposures have grown greatly since the last report.
- The greatest increases are where procedures did not exist in the early 1980s.
- The effect in medicine and the benefit for patients have been much greater than the increase in dose.

CT as an Exemplar for:
The Use and Misuse of Radiation in Medicine

James A. Brink, M.D.
Yale University School of Medicine

DISCLOSURE

- General Electric: Medical Advisory Board

Acknowledgement

T. Rob Goodman, M.D.
Yale University School of Medicine

Radiation in Medicine

Diagnostic Uses

Therapeutic Uses

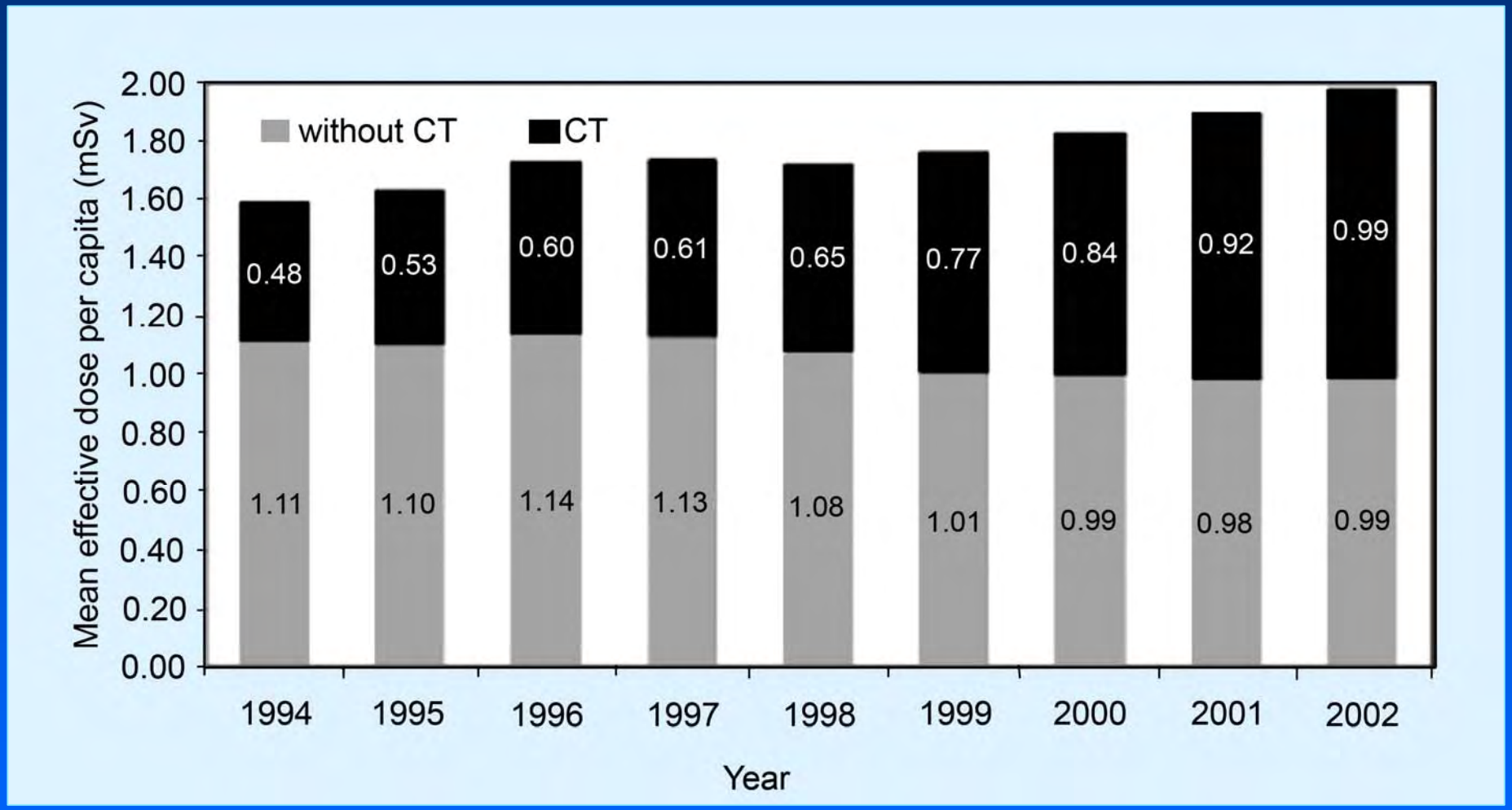
Medical Radiation Exposure

See: Fred Mettler, MD: "Magnitude of Radiation Uses and Doses in the US: NCRP Scientific Committee 6-2 Analysis of Medical Exposures"

Tom Tenforde, Ph.D., President, NCRP:
"Medical exposures have risen by a factor of at least five since the 1980s, primarily due to the greatly increased use of CT and nuclear cardiology procedures."

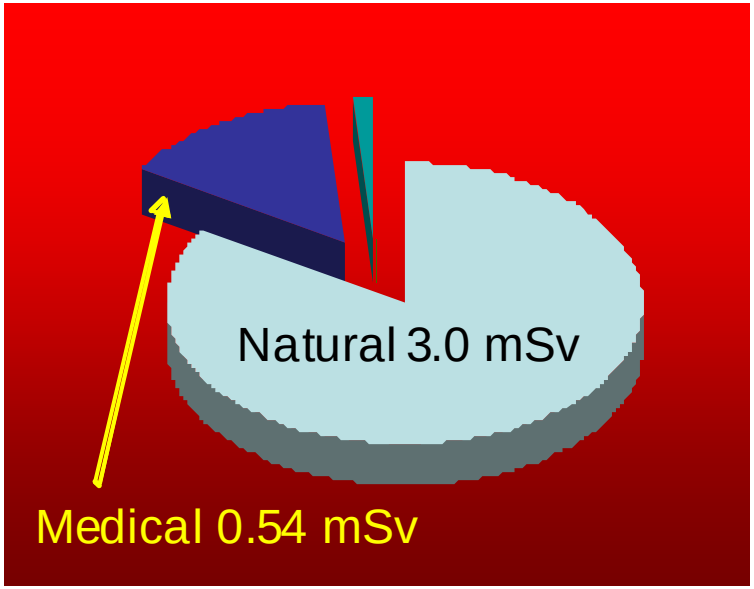
2006	Number of Procedures (millions)	%	Collective dose (Person-Sv)	%	Per capita (mSv)
Radiography	276	52	182,000	19	0.6
Interventional	13	2	112,000	12	0.4
CT	67	12	440,000	46	1.45
Mammography	34	6	3,300	< 0.5	0.01
Dental	125	23	2,300	<0.5	0.01
Nuclear Medicine	21	4	230,000	23	0.7
Total	~ 544	100	~ 970,000	100	3.2

Europe: 0.7 to 2.0 mSv per capita



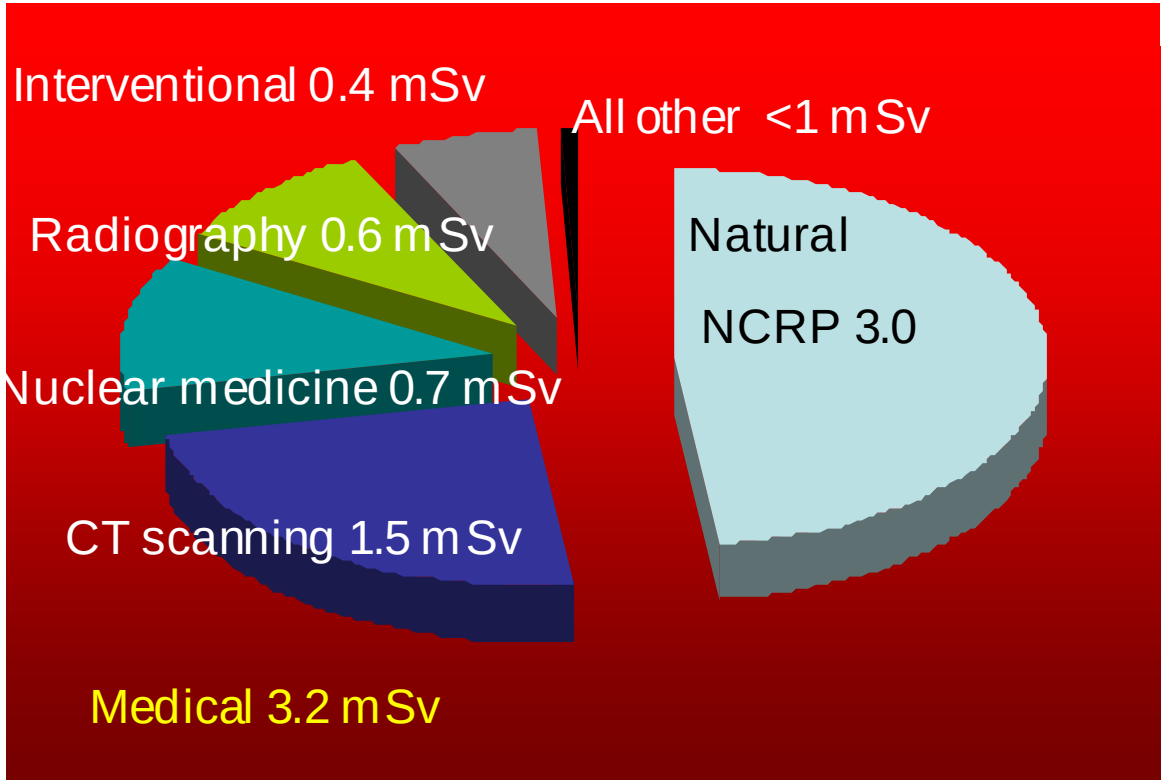
Shannoun F et al. Medical exposure of the population from diagnostic use of ionizing radiation In Luxembourg between 1994 and 2002. Health Phys 2006;91:154-62

U.S. 1980



Total 3.6 mSv per capita

U.S. 2006



Total ~ 6.2 mSv per capita

Medical: 600% increase

Diagnostic Uses for Radiation

Computed Tomography

Nuclear Medicine

Radiography

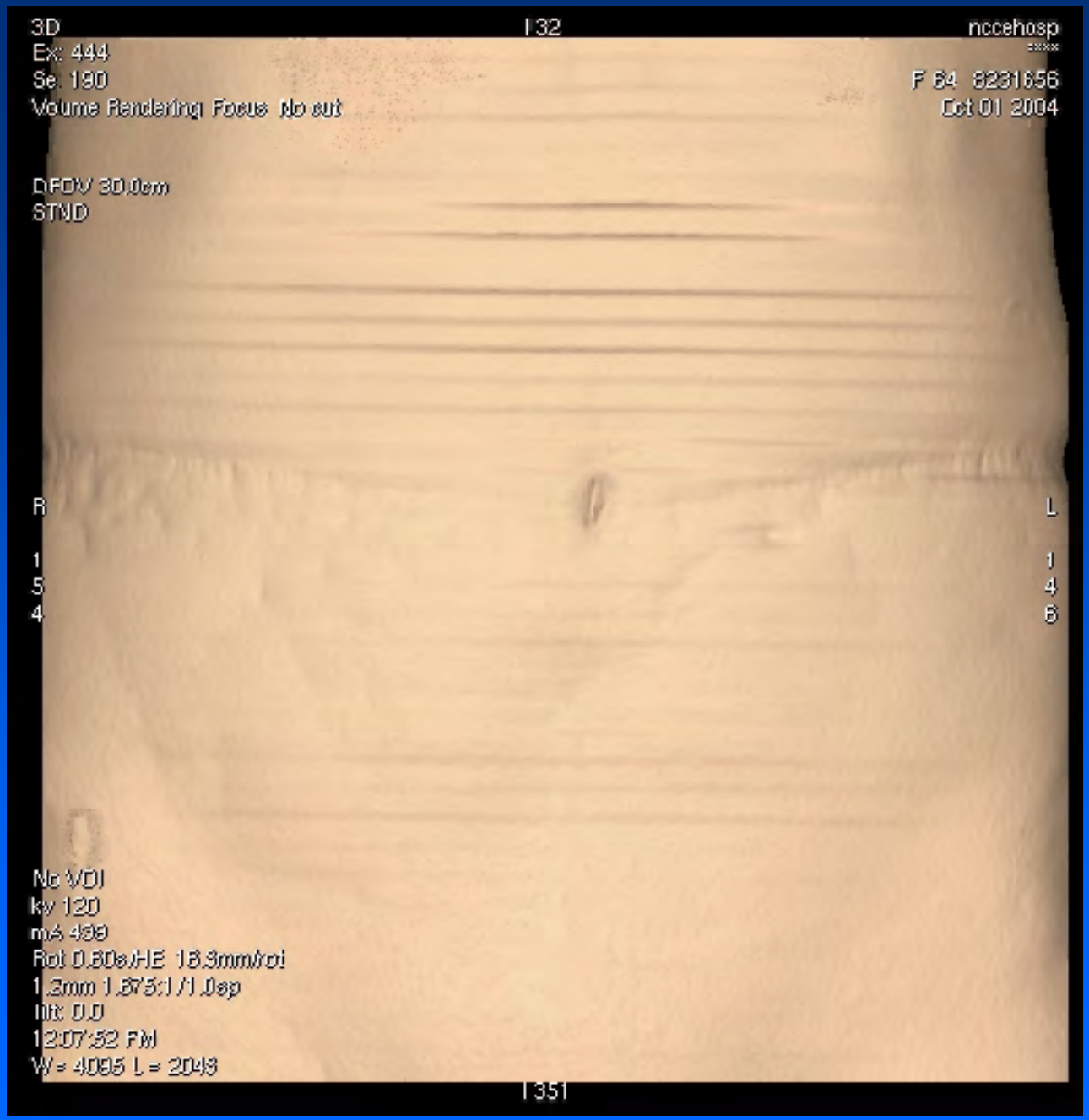
Fluoroscopy

‘Benefits’ of CT

- Standard Axial Imaging
  - Superb Anatomic Depiction
    - Head to toe
  - Innumerable Diagnoses
    - Confirmed
    - Excluded

‘Benefits’ of MDCT

- New uses of CT imaging
  - Renal/Ureteral Stone CT
  - CT “Virtual” Colonoscopy
  - CT Angiography of Head, Pulmonary Vessels, Aorta and Extremities
  - Coronary CT Angiography



Hybrid Imaging:

- PET/CT
- CT Colon
- CT Angio

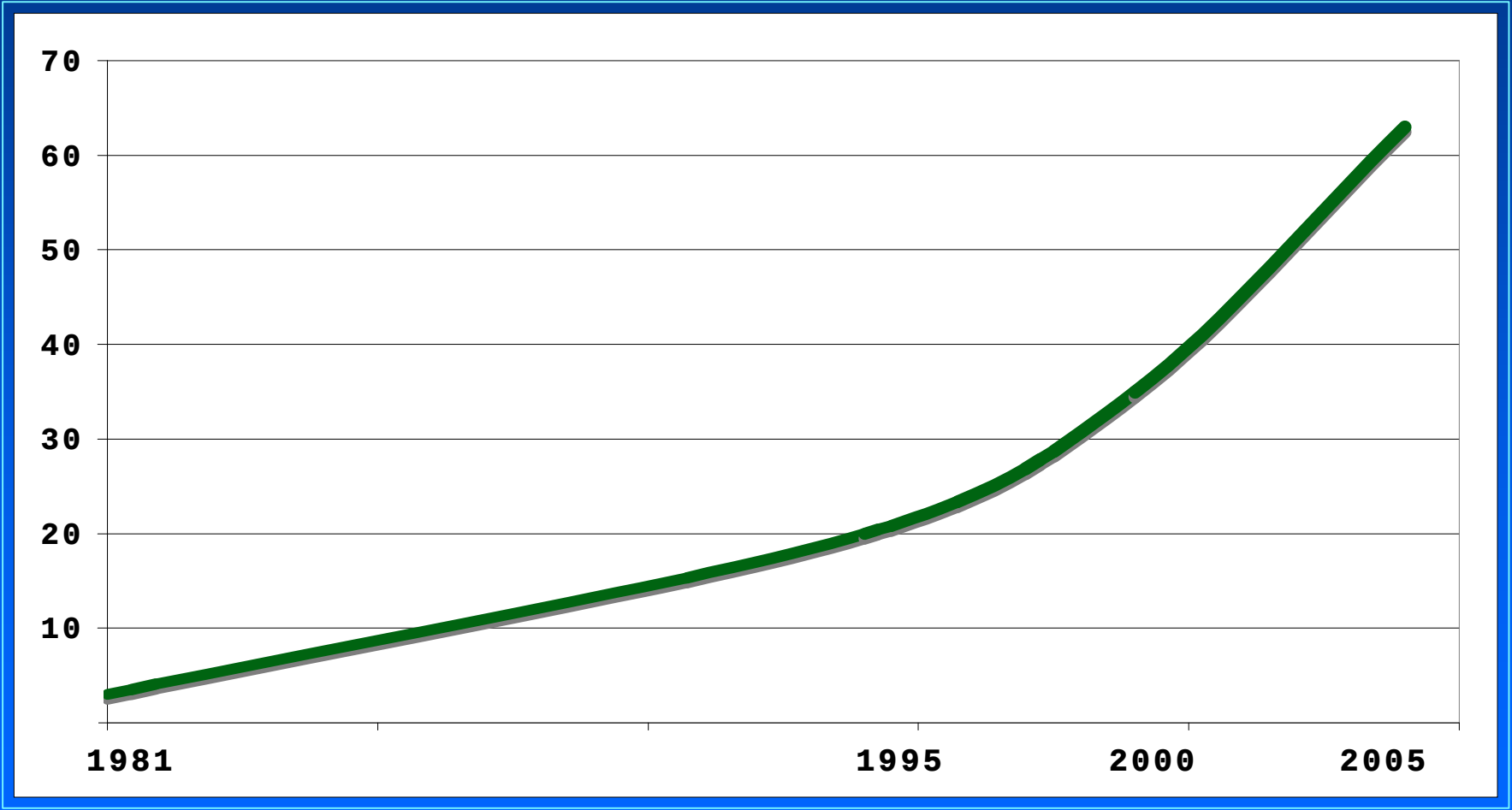
GEMS, Inc.

Radiation Dose

- CT has grown dramatically:
  - 3 million CT exams in 1981
  - 20 million CT exams in 1995
  - 35 million CT exams in 2000
  - 63 million CT exams in 2005

Mettler FA. Radiation Protection and Dosimetry, 2001
Niagara Health Quality Coalition, 2004

Millions of CT Exams



Typical Doses

• Chest study	0.10 mSv
• Cervical spine	0.11 mSv
• Pelvis	0.27 mSv
• Skull	0.31 mSv
• Upper GI	1.17 mSv
• Barium enema	2.98 mSv
• CT scan	18.0 mSv

Linnemann, 2001. Managing Radiation Medical Emergencies

Question

- Based on the linear, no-threshold hypothesis and empiric data from atomic bomb blast survivors, the fatal cancer risk from a CT scan with a 10 mSv exposure is approximately:
  a. 1 in 100
  b. 1 in 200
  c. 1 in 1,000
  d. 1 in 2,000
  e. 1 in 10,000

  Answer: d

Cancer Risk

- Fatal cancer risk to population 5% per Sv
  - Female neonate 30% per Sv
  - Male neonate 15% per Sv
  - Late middle-age 1% per Sv
- Presuming linear extrapolation to low dose:
  - Effective dose of 10 mSv Risk = 1 in 2000

*Dixon, A.K. and P. Dendy, Spiral CT: how much does radiation dose matter? Lancet, 1998. **352**: p. 1082-3.*

Atomic Bomb Survivor Data

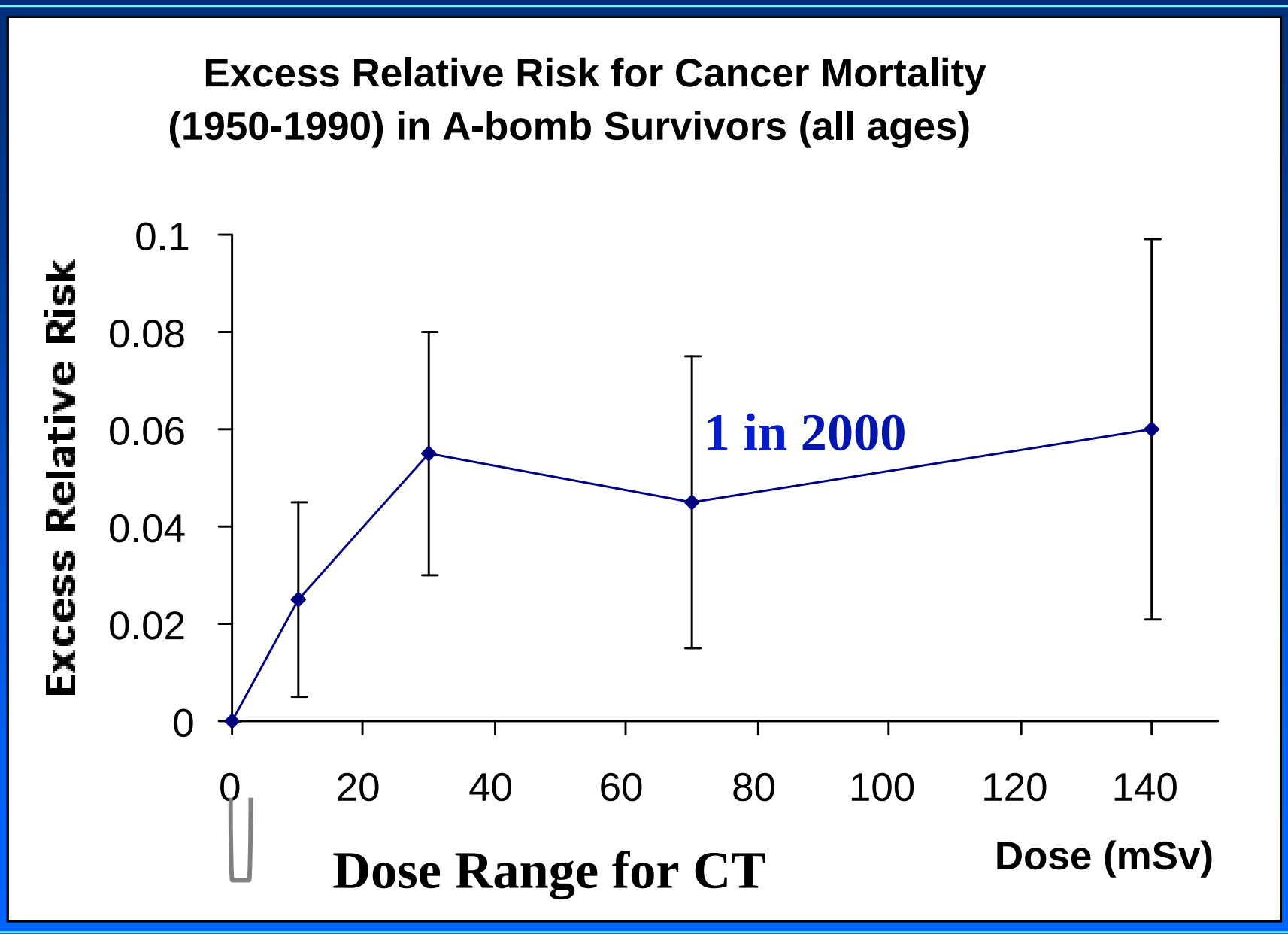
- Biggest longitudinal study to date
  - 35,000 survivors exposed to doses < 150 mSv
  - Followed for cancer incidence over 55 years
  - Direct, statistically significant evidence for risk in the dose range from 5 to 150 mSv

*Pierce, DA and Preston, DL. Radiation-related cancer risks at low doses among atomic bomb survivors. Radiation Research, 2000. **154**(2): p. 178-86.*

Cancer Risk: No Extrapolation

- Japanese survivors (lowest dose) 5 - 150 mSv
  - Small but statistically significant increased risk of developing cancer due to radiation
- Diagnostic CT 5 - 20 mSv

*Pierce, DA and Preston, DL. Radiation-related cancer risks at low doses among atomic bomb survivors. Radiation Research, 2000. **154**(2): p. 178-86.*



Adapted from Pierce, D.A. and Preston, D.L.

Cancer Risk from CCTA

- Phantom Data and Monte Carlo Simulation
  - BEIR VII report from atomic bomb survivors
  - Lungs: 42 - 91 mSv
  - Breasts: 50 - 80 mSv
  - Lifetime Cancer Risks:

		w/ gating
• Male, age 80	1 in 3261	1 in 5017
• Female, age 20	1 in 143	1 in 219

Einstein AJ, et al. JAMA. July, 2007; 298: 317-323 (Columbia U.)

The NEW ENGLAND JOURNAL *of* MEDICINE

Medical Radiation Risk

"On the basis of such risk estimates and data on CT use from 1991 through 1996, it has been estimated that about 0.4% of all cancers in the US may be attributed to the radiation from CT studies. By adjusting this estimate for current CT use, this estimate might now be in the range of 1.5 to 2.0%."

Brenner DJ, Hall EJ. Computed Tomography -- An Increasing Source of Radiation Exposure. NEJM 2007; 357:2277-84 (November 29, 2007)

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FINAL SCORES

Johan Santana: Twins ace may be trade fodder.

What your AL team wants

■ Teams gather in Nashville for annual winter meetings, 10C

Thursday, November 29, 2007

Unnecessary CT scans exposing patients to excessive radiation

Study: Cancer cases could spike as result

By Steve Sternberg
USA TODAY

Overuse of diagnostic CT scans may cause as many as 3 million excess cancers in the USA over the next two to three decades, doctors report today.

Researchers say they're not trying to discourage all use of CT scans — CT stands for computed tomography — which superimpose multiple X-ray images to make 3-D pictures. Rather, they say, CT scanning is an invaluable tool in many cases. The problem is that doctors too often overlook its risks.

"About one-third of all CT scans that are done right now are medically unnecessary," says David Brenner of Columbia University, lead author of the study reported in today's *New England Journal of Medicine*.

CT scans offer an unparalleled window into the human body, and their use has grown dramatically in recent decades as doctors use them to identify ailments in the head, abdomen and heart.

Today, about 62 million CT scans are performed nationwide every year, up from 3 million in 1980, the authors say. Medical exposure to radiation, mainly through CT scans, has replaced environmental radon as the dominant source of radiation exposure for the U.S. population, the doctors say.

"On average, we now get double the radiation exposure we got in 1980 because of increased CT scans," Brenner says. "Virtually anyone who presents in the emergency room with pain in the belly or a chronic headache will automatically get a CT scan. Is that justified?"

University of New Mexico radiologist Fred Mettler, who was not part of the study, agrees that CT scans are overused. "We're always behind on CT scans because of demand from clinicians," he says.

As many as 5 million scans are now done in children, who are 10 times more sensitive to radiation than adults. The increase was driven by technical advances that allow doctors to capture images in less than a second, eliminating the need for anesthesia to keep a child from moving.

And the use of the scans continues to grow, Brenner says. Doctors are scanning smokers and ex-smokers for early-stage lung cancer, a highly controversial practice; they're using non-invasive "virtual" colonoscopies to check for colon cancer; and CT angiography is now being tested as a possible complement to ordinary angiography as a way to diagnose blockages in arteries leading to the heart.

In critiquing a study on CT angiography at an American Heart Association meeting in Orlando last month, Michael Lauer of the National Heart, Lung and Blood Institute called that practice into question. He said there is no evidence of benefit from the technology and a real concern for harm.

New machines being developed by Philips and Toshiba for CT angiograms, however, may be safer because they emit 80% less radiation than standard CT scanners, Brenner says.

Brenner and his co-author, Eric Hall, also of Columbia, say many doctors don't realize that just a scan or two can bathe a patient in roughly the same amount of radiation as the atomic bomb delivered to the Japanese survivors of Hiroshima and Nagasaki standing a mile or two from ground zero. And many people receive multiple scans over a lifetime.

The amount of radiation delivered during a single CT scan can range from 1,000 to 10,000 millirems, depending on the machine and the protocol. Japanese survivors a mile or two from ground zero received about 3,000 millirems on average.

The cancer rates in the new study were drawn directly from a joint $1 billion study of the bomb survivors financed by the United States and Japan.

Radiation risk

An ordinary CT scan delivers roughly the same average amount of radiation, 3,000 millirems, as Japanese survivors of the atomic bombs in World War II received a mile or two from ground zero.

Studies of those survivors showed that a person's individual risk is low but that excess cancers slowly accumulate in a large population. The following risk estimates are based on scans delivering 1,000 millirems, the lowest likely dose:

Age	Gender	Lifetime odds of getting cancer
Infant	female	5 in 1,000
10	female	2.5 in 1,000
30	female	1 in 1,000
Infant	male	2.5 in 1,000
10	male	2 in 1,000
30	male	7 in 10,000

Source: Owen Hoffman, SENES, Oak Ridge Tn.

Utilization

Technology

Relative Risk

- To individual:
  - Lifetime risk of cancer: 20-25% (1 in 4 or 5)
  - Added risk: 0.05% (negligible, 1 in 2000)
- To population:
  - 62M CT scans year
  - Without CT: 13.778M will die of cancer
  - With CT: an additional 31K will die of cancer (13.809M)

Question

- Which of the following statements about radiation-induced cancers is <u>incorrect</u>:

a. The risks persist throughout life

b. Radiation-induced cancers appear at the same age as spontaneous cancers of the same type

c. Children and adults are equally susceptible to radiation induced cancers

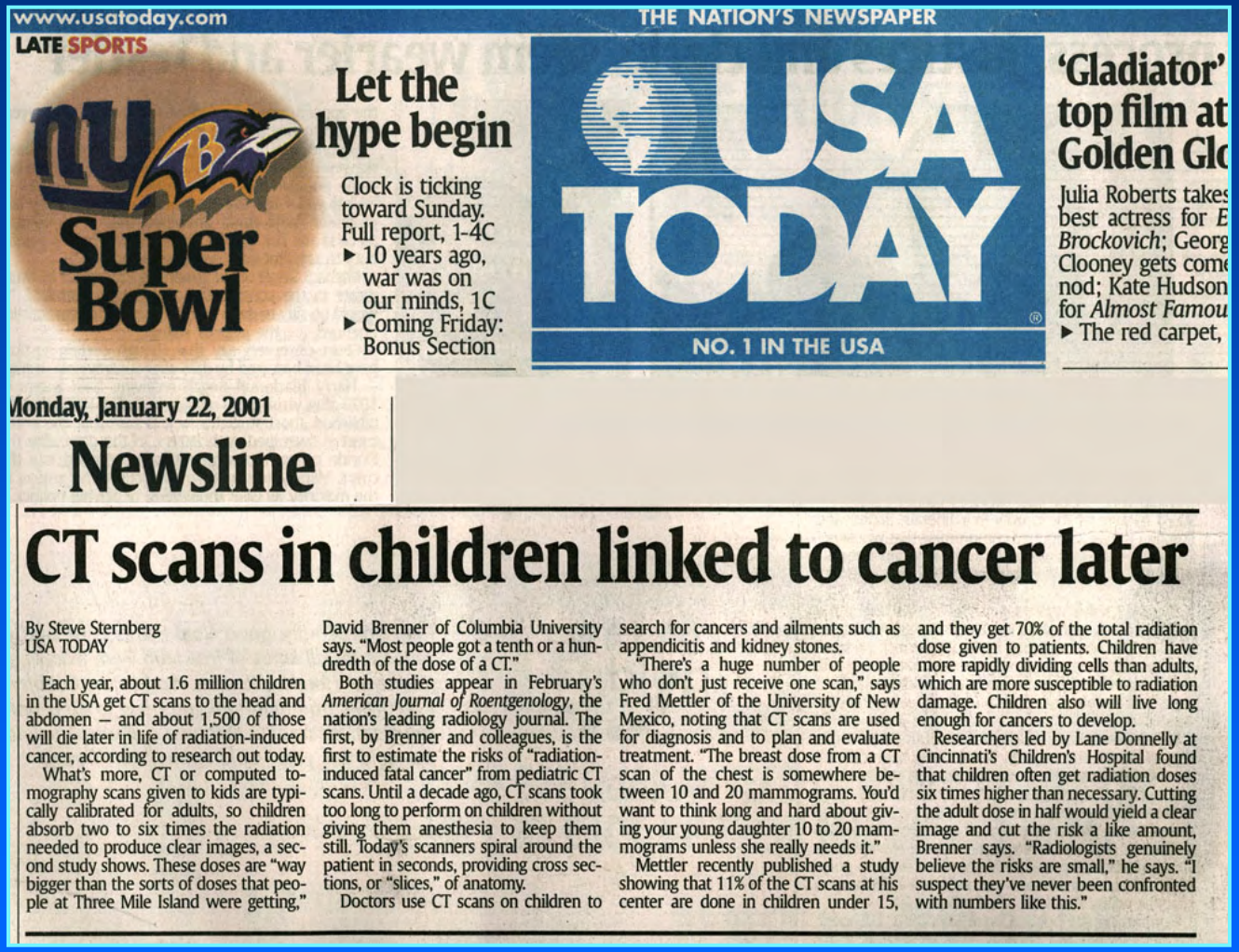
d. The bone marrow, thyroid, breast and lung are at greatest risk

Answer: c

Atomic Bomb - Additional Lessons

- Radiation-induced cancers appear at the same age as spontaneous cancers of the same type
- Risks persist throughout life
- Children are 10x more sensitive to radiation induced cancers than adults (girls > boys)
- Bone marrow, thyroid, breast, and lung are at greatest risk
- Risk from acute exposure appears similar to fractionated exposure (fluoro-->breast cancer)

Media attention has heightened awareness



www.usatoday.com THE NATION'S NEWSPAPER

LATE SPORTS

Super Bowl

Let the hype begin

Clock is ticking toward Sunday. Full report, 1-4C
▸ 10 years ago, war was on our minds, 1C
▸ Coming Friday: Bonus Section

USA TODAY

NO. 1 IN THE USA

'Gladiator' top film at Golden Glo

Julia Roberts takes best actress for *E Brockovich*; Georg Clooney gets com nod; Kate Hudson for *Almost Famou*
▸ The red carpet,

Monday, January 22, 2001

Newsline

CT scans in children linked to cancer later

By Steve Sternberg
USA TODAY

Each year, about 1.6 million children in the USA get CT scans to the head and abdomen — and about 1,500 of those will die later in life of radiation-induced cancer, according to research out today.

What's more, CT or computed tomography scans given to kids are typically calibrated for adults, so children absorb two to six times the radiation needed to produce clear images, a second study shows. These doses are "way bigger than the sorts of doses that people at Three Mile Island were getting," David Brenner of Columbia University says. "Most people got a tenth or a hundredth of the dose of a CT."

Both studies appear in February's *American Journal of Roentgenology*, the nation's leading radiology journal. The first, by Brenner and colleagues, is the first to estimate the risks of "radiation-induced fatal cancer" from pediatric CT scans. Until a decade ago, CT scans took too long to perform on children without giving them anesthesia to keep them still. Today's scanners spiral around the patient in seconds, providing cross sections, or "slices," of anatomy.

Doctors use CT scans on children to search for cancers and ailments such as appendicitis and kidney stones.

"There's a huge number of people who don't just receive one scan," says Fred Mettler of the University of New Mexico, noting that CT scans are used for diagnosis and to plan and evaluate treatment. "The breast dose from a CT scan of the chest is somewhere between 10 and 20 mammograms. You'd want to think long and hard about giving your young daughter 10 to 20 mammograms unless she really needs it."

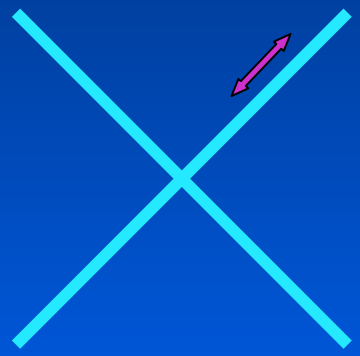
Mettler recently published a study showing that 11% of the CT scans at his center are done in children under 15, and they get 70% of the total radiation dose given to patients. Children have more rapidly dividing cells than adults, which are more susceptible to radiation damage. Children also will live long enough for cancers to develop.

Researchers led by Lane Donnelly at Cincinnati's Children's Hospital found that children often get radiation doses six times higher than necessary. Cutting the adult dose in half would yield a clear image and cut the risk a like amount, Brenner says. "Radiologists genuinely believe the risks are small," he says. "I suspect they've never been confronted with numbers like this."

MDCT has been criticized for excessive radiation dose

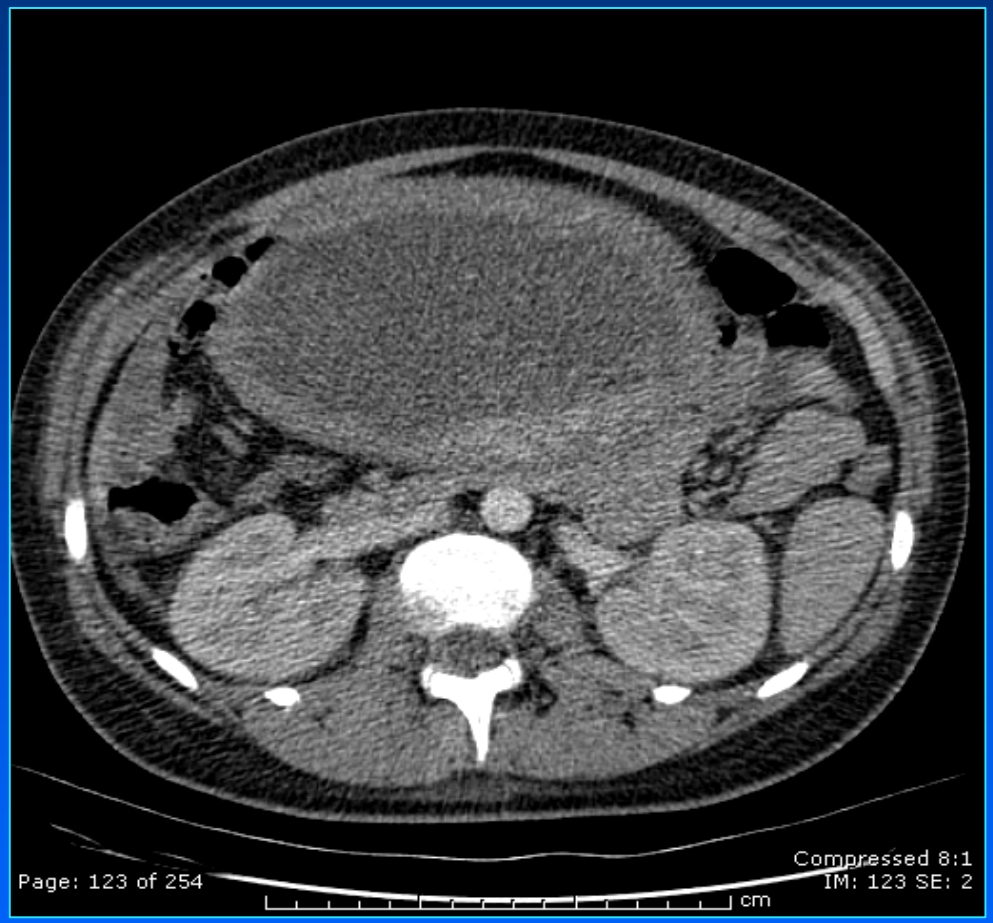
Radiography

Image Quality

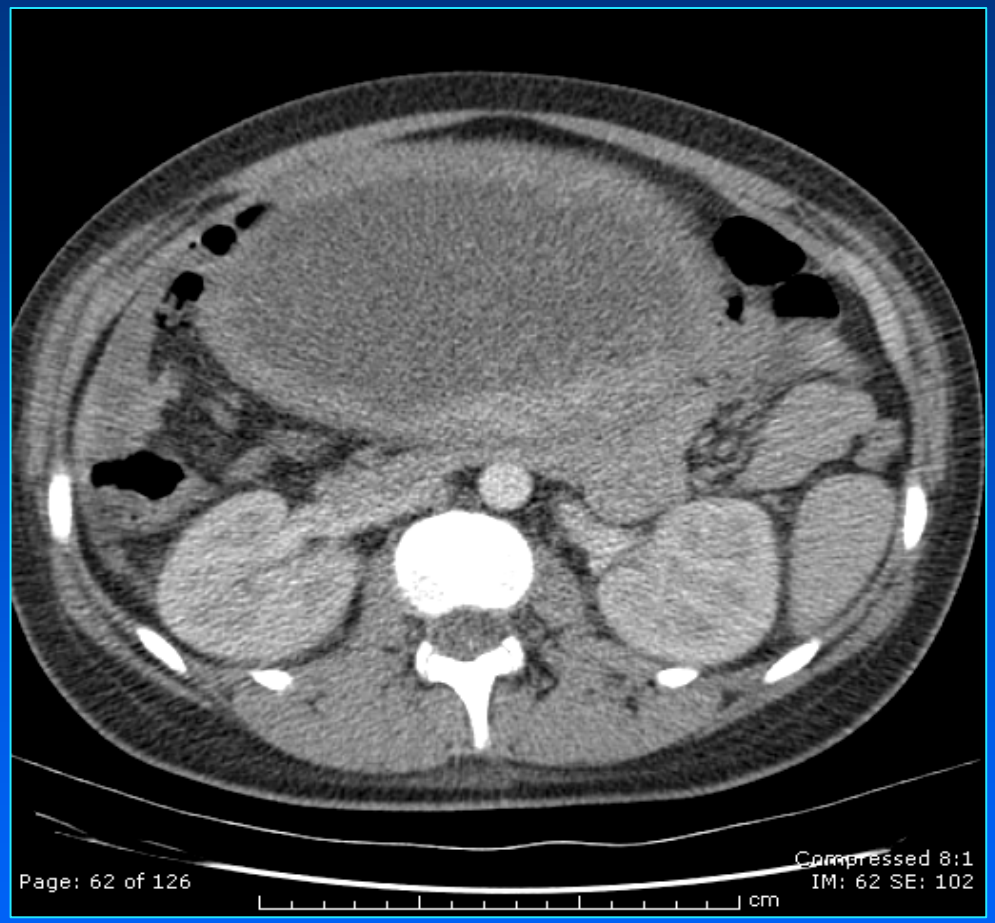


Radiation Dose

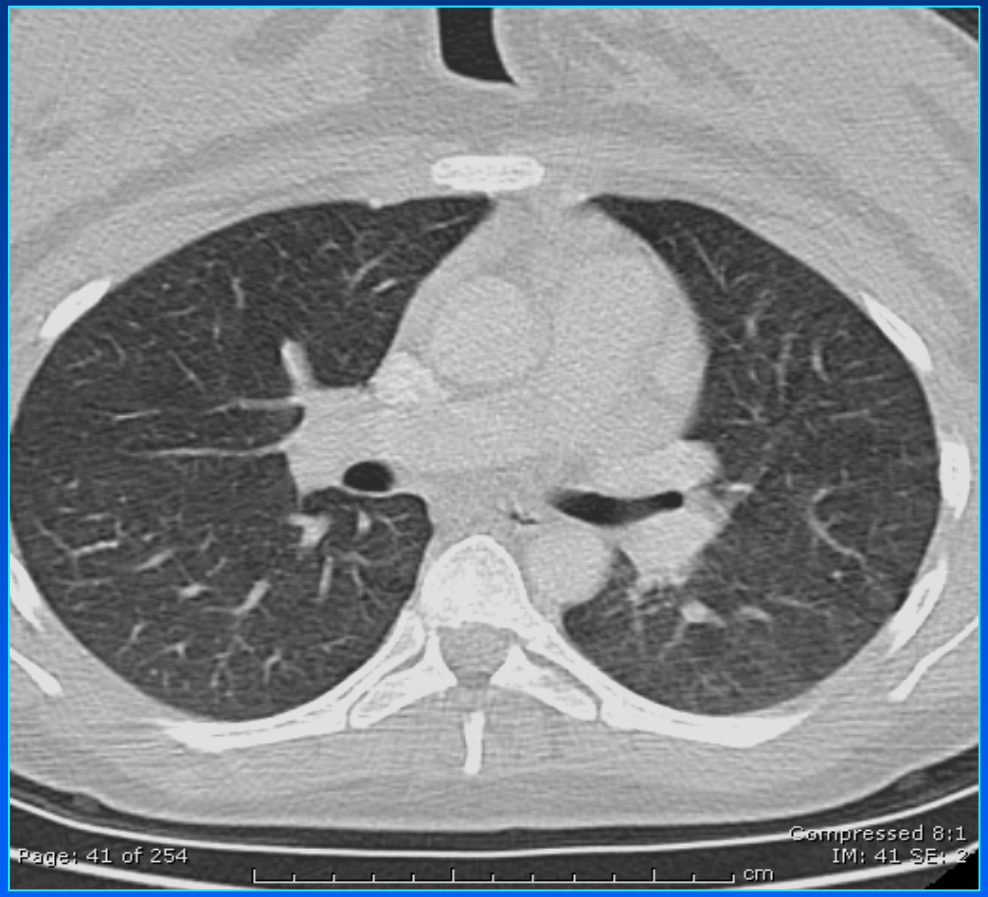
Computed Tomography



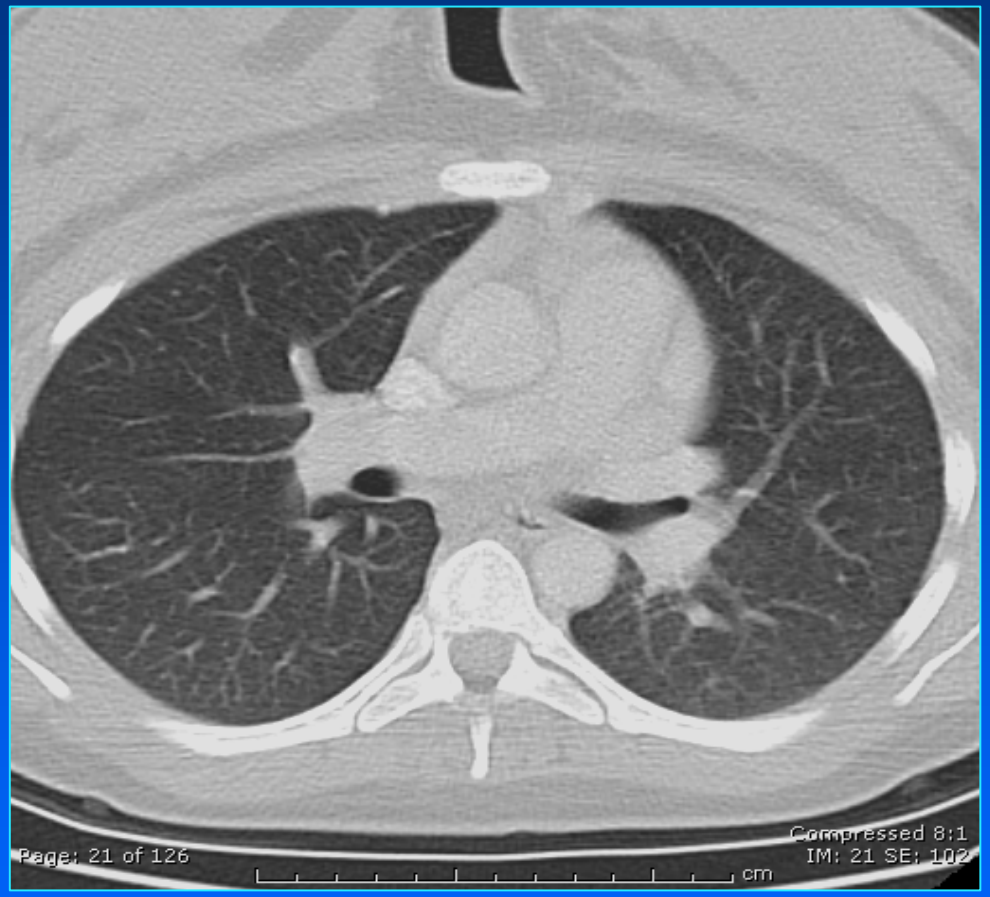
Underexposed



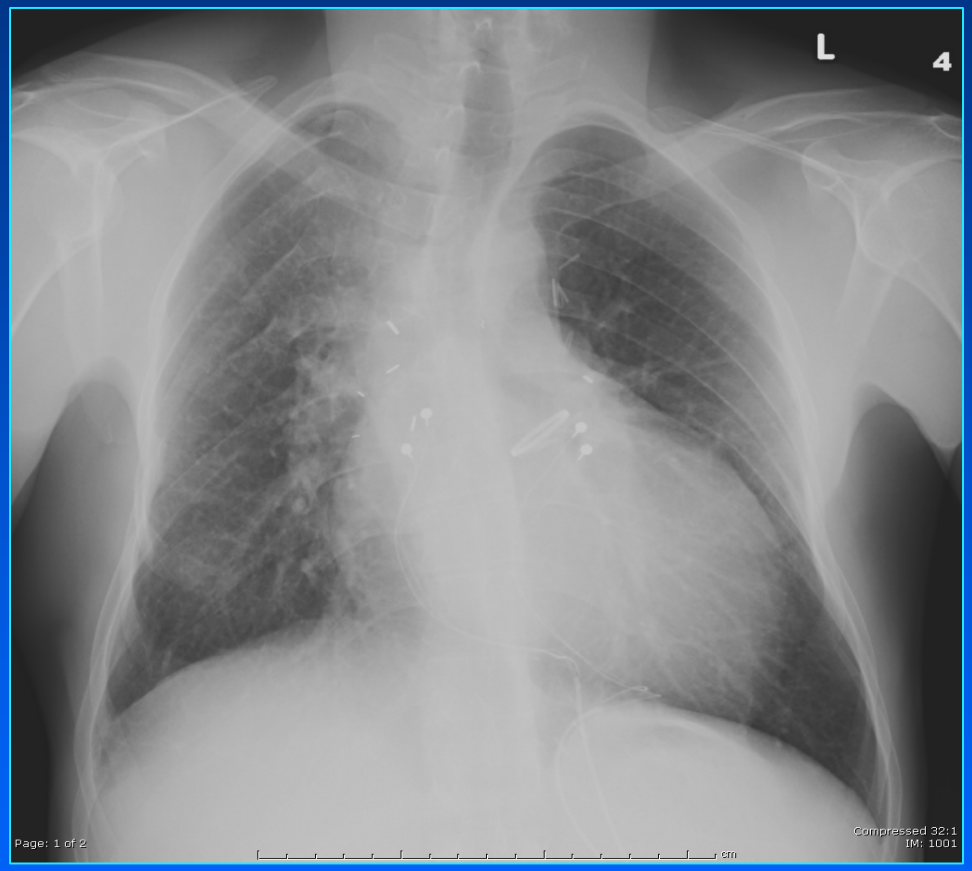
Normal



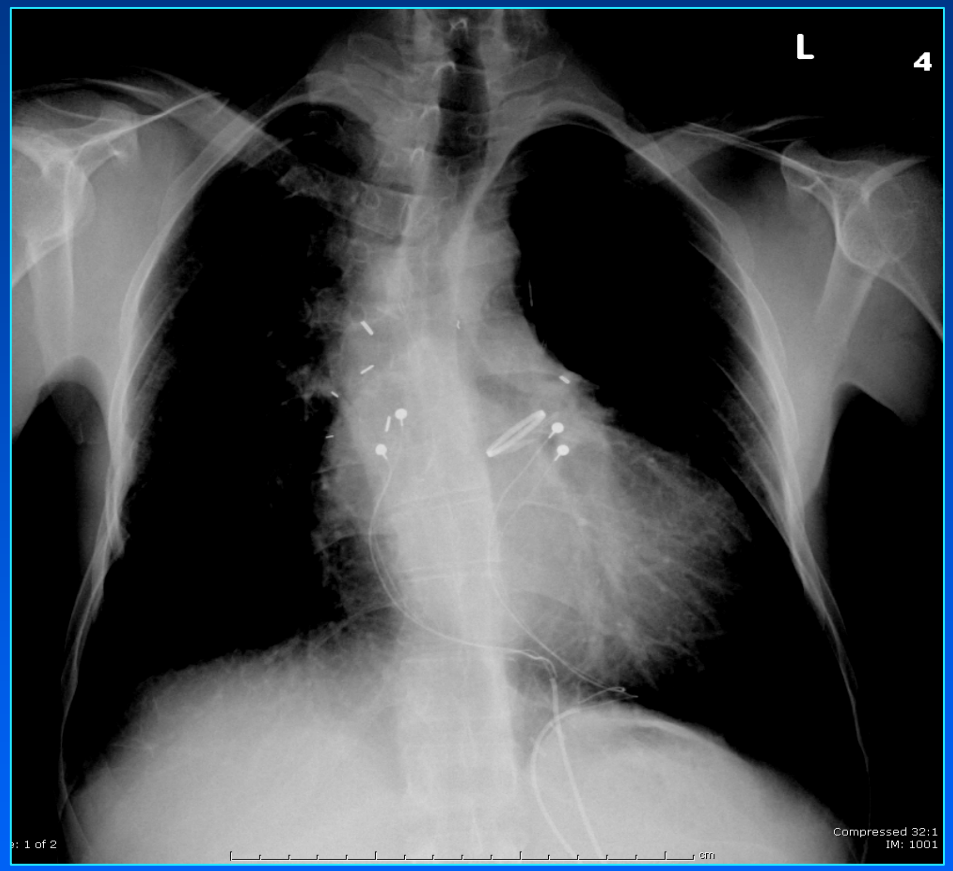
Normal exposure



Over exposure



Correct exposure



Over exposure

Radiation Exposure from CT

Collective dose to population rising

- High radiation dose per examination
- Increasing number of indications
- Increasing availability
- Easier to perform
- Faster

Steps to Control Radiation Exposure

Appropriate Utilization

- CT vs. other imaging tests
- Avoid repetitive studies
- Tailor exam to the patient
- Tailor exam to the application
  - Reduce dose as such as possible

Appropriate Utilization

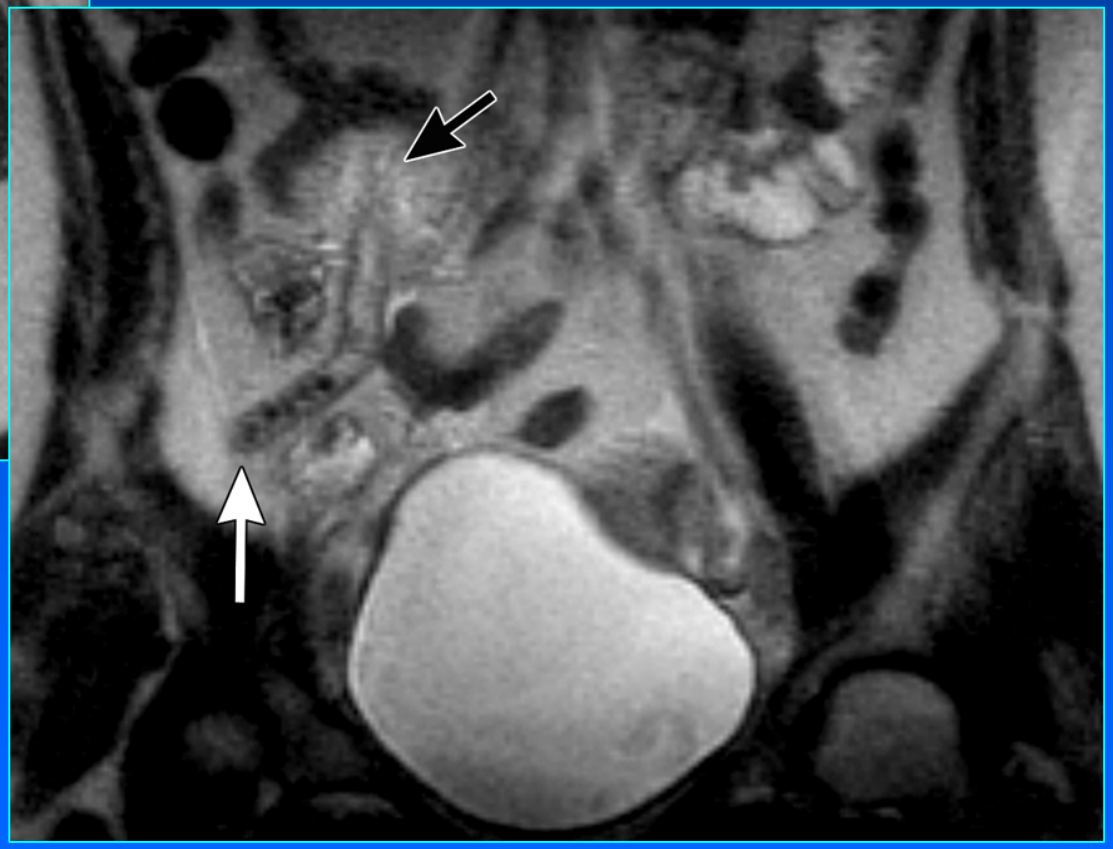
"I am an adult and a physician! I don't need your approval for CT scans that are necessary for my patients"

Anon (emergency physician)

Appropriate Utilization

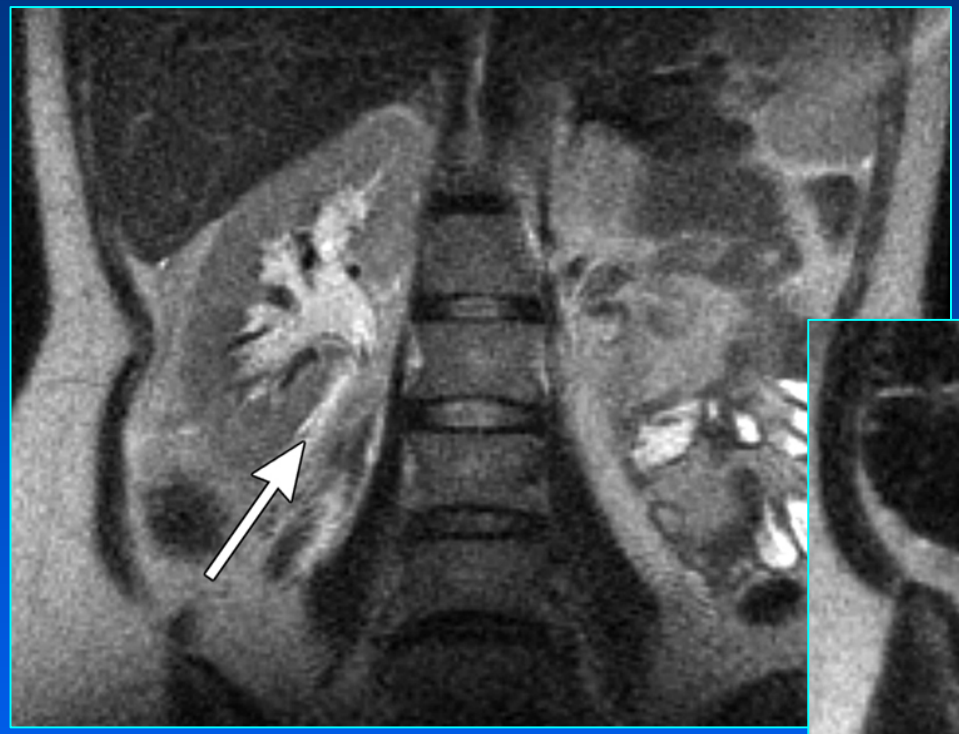
"CT should be avoided when an ultrasound or MRI is of comparable diagnostic utility"

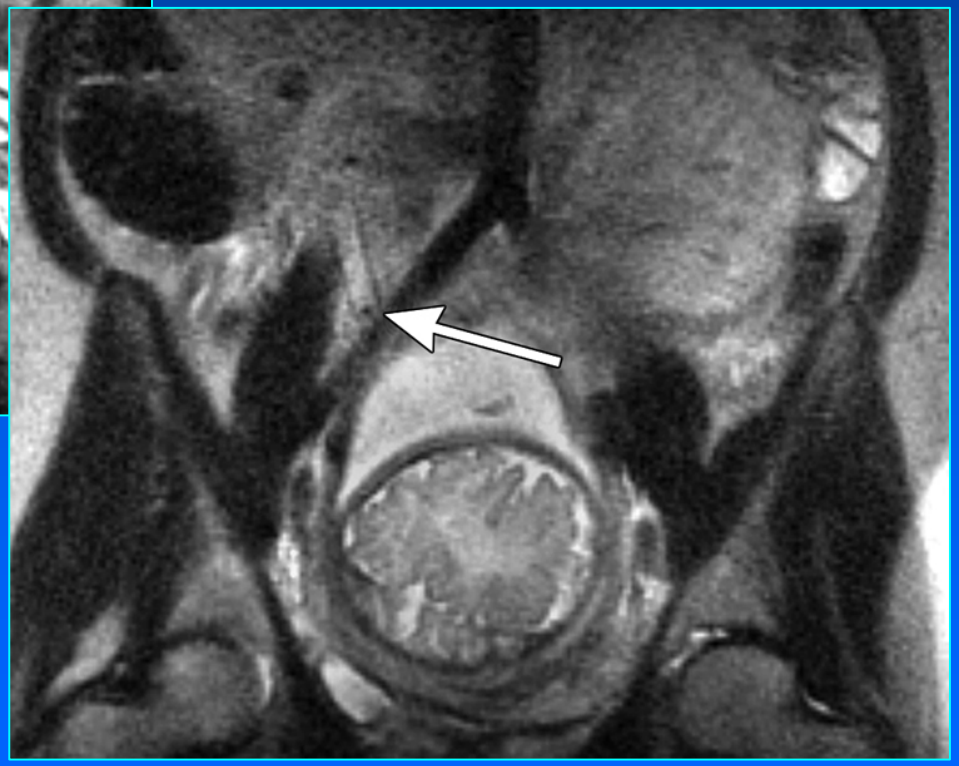
RLQ Pain: Pregnant (26 wks)



Appendicoliths

RLQ Pain: Pregnant (32 wks)





Ureteral Calculus

Physician Education

- Adult CT patients for abdominal pain
- Questioned about consent, radiation risk and CXR equivalents
- Same questions asked of ED physicians and radiologists

Lee CI, Haims AH, Monico EP, Brink JA, Forman HP. Diagnostic CT scans: assessment of patient, physician, and radiologist awareness of radiation dose and possible risks. Radiology 2004; 231: 393-398.

Physician Education

- 9% of referring physicians believed that there was an increased cancer risk from CT
- CXR Equivalents (%):

	<1	1-10	10-100	100-250	>500
MDs	7	44	22	22	4
Rads	5	56	15	13	10
Pts	28	64	7	0	0

UK: IRMER* (2000)

- Medical Exposures Directive of Council of the European Union**
  - Strict referral criteria
  - Strict justification criteria
  - Dose optimization requirement
  - Dose exposure reference levels

**Ionizing Radiation (Medical Exposures) Regulations*
***Council Directive 97/43 Euratom*

Appropriate Utilization

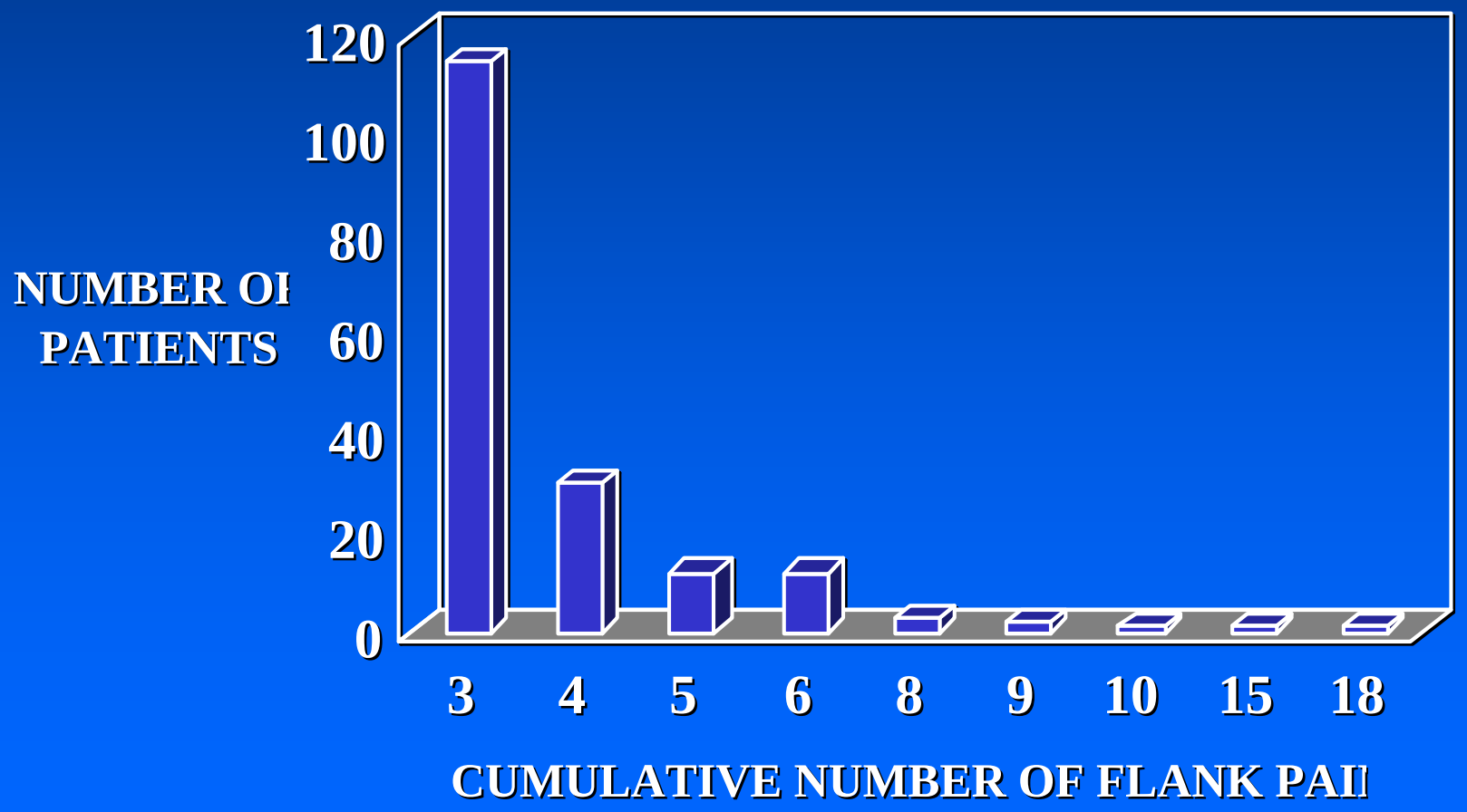
"CT should be avoided when prior diagnostic radiation exposure is excessive"

Repetitive CT for Renal Colic

- 6 year period
- 4562 patients
- 5564 CT examinations
- Mean age: 45 years
  - 4% of exams were in children

Katz S, Saluja S, Brink JA, Forman HP. Radiation dose associated with unenhanced CT for suspected renal colic: impact of repetitive studies. AJR 2006;186:1120-1124.

176 Pts (4%) had 3 or more Flank Pain CTs



Average Flank Pain CT Dose

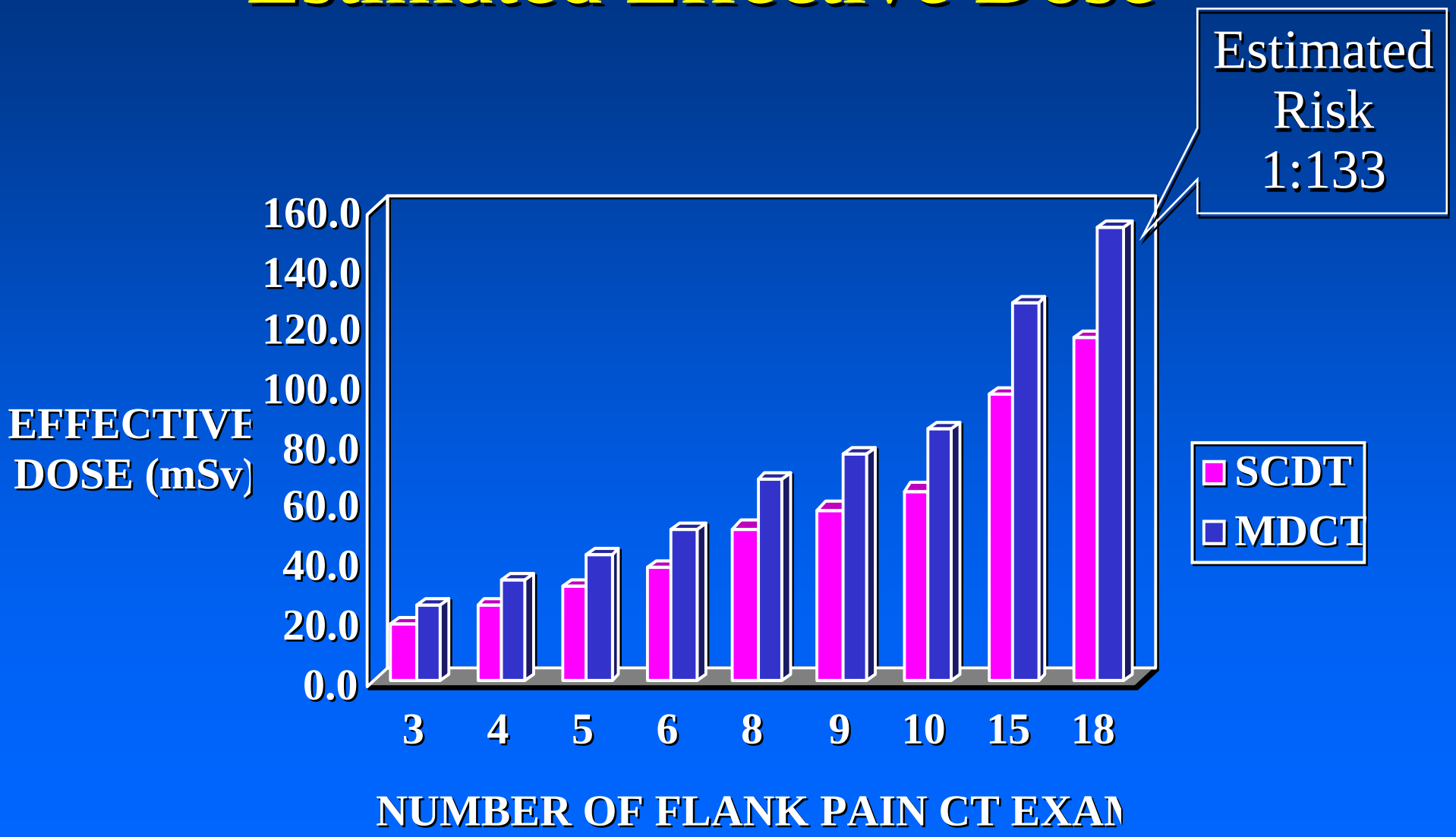
Mean Dose Length Product (DLP)

15 Randomly Selected Patients

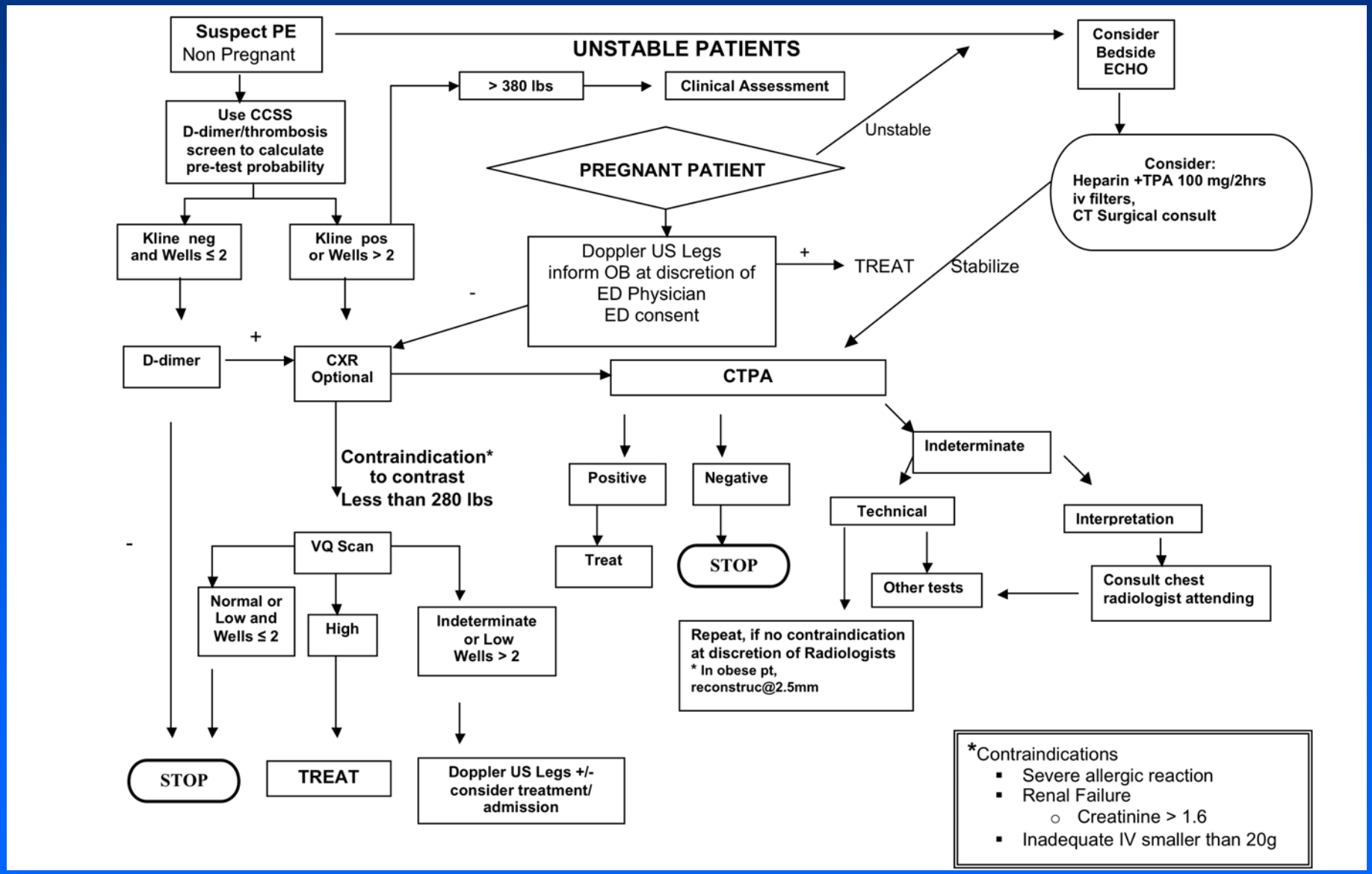
SDCT = 460 mGy cm (6.5 mSv)

MDCT = 610 mGy cm (8.5 mSv)

Estimated Effective Dose



Diagnostic Algorithm for Suspected PE



Appropriate Utilization

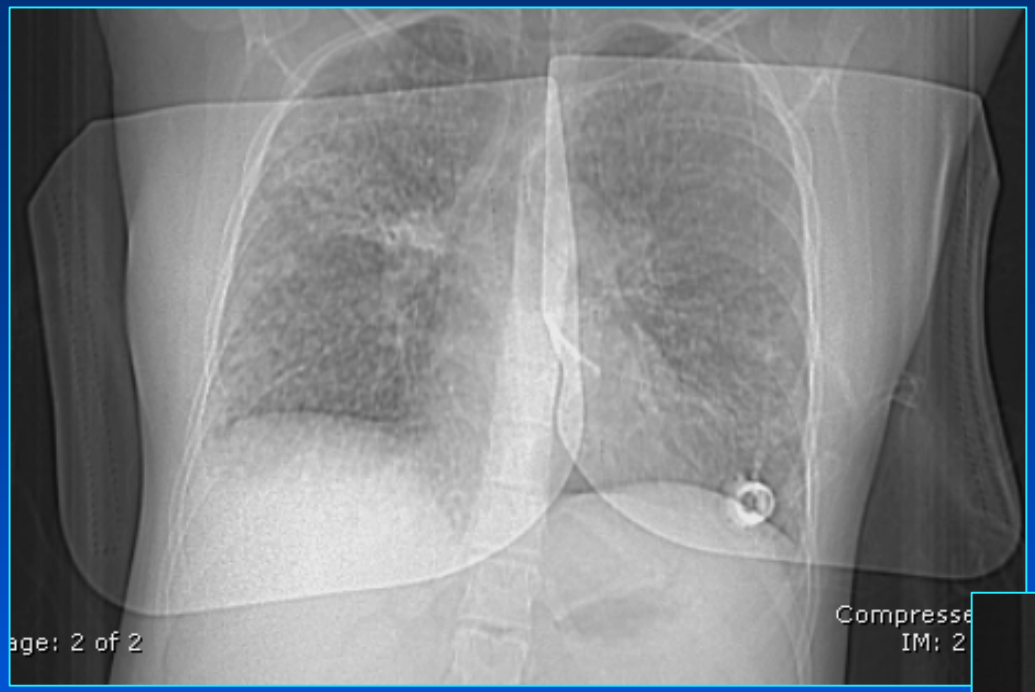
"CT technique should be tailored to the patient and his/her body habitus"

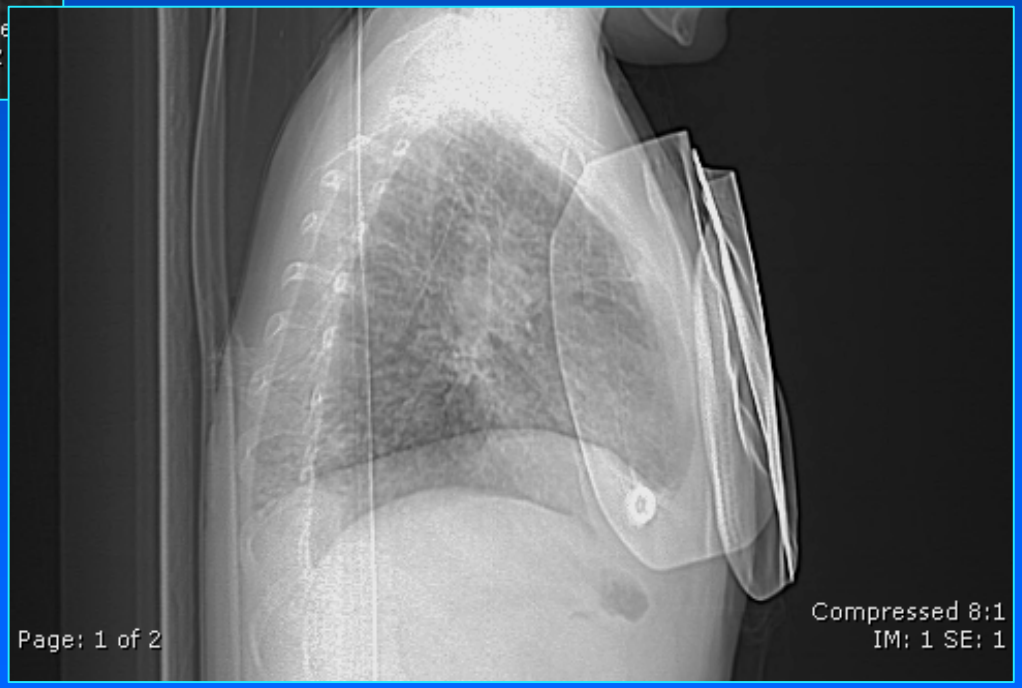
Patient Gender

- Breast Shields (?)
  - Bismuth latex
  - Several sizes
  - Attenuates primary beam
  - Little effect on image quality


REVERSE
Foam Backing
FRONT
Bismuth

Breast Shields





Breast Shields

- Reduced dose to:
  - breasts by 30%
  - lungs by 15%
- Increase in image noise
- "Reduction in organ dose could be realized more efficiently with a reduction in tube current"

Geleijns J et al. Quantitative assessment of selective in-plane shielding of tissues in CT. European Radiology 2006:16:2334-2340

Appropriate Utilization

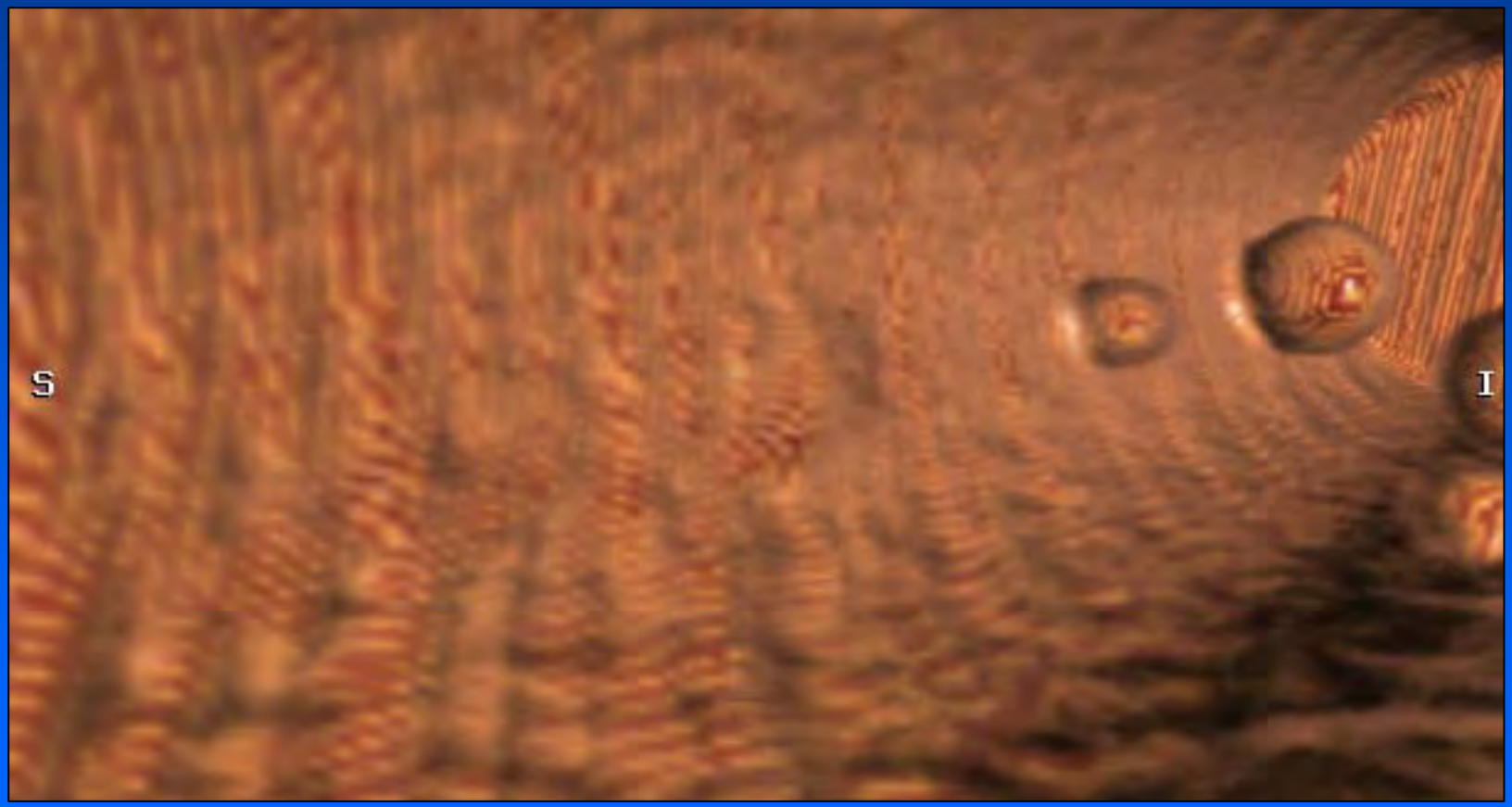
"CT technique should be monitored and controlled to insure that dose is as low as reasonably achievable"

Tube Current (mA)

Virtual Colon Phantom, “High Dose”

Courtesy of Beth McFarland, M.D.

Virtual Colon Phantom, “Medium Dose”



Courtesy of Beth McFarland, M.D.

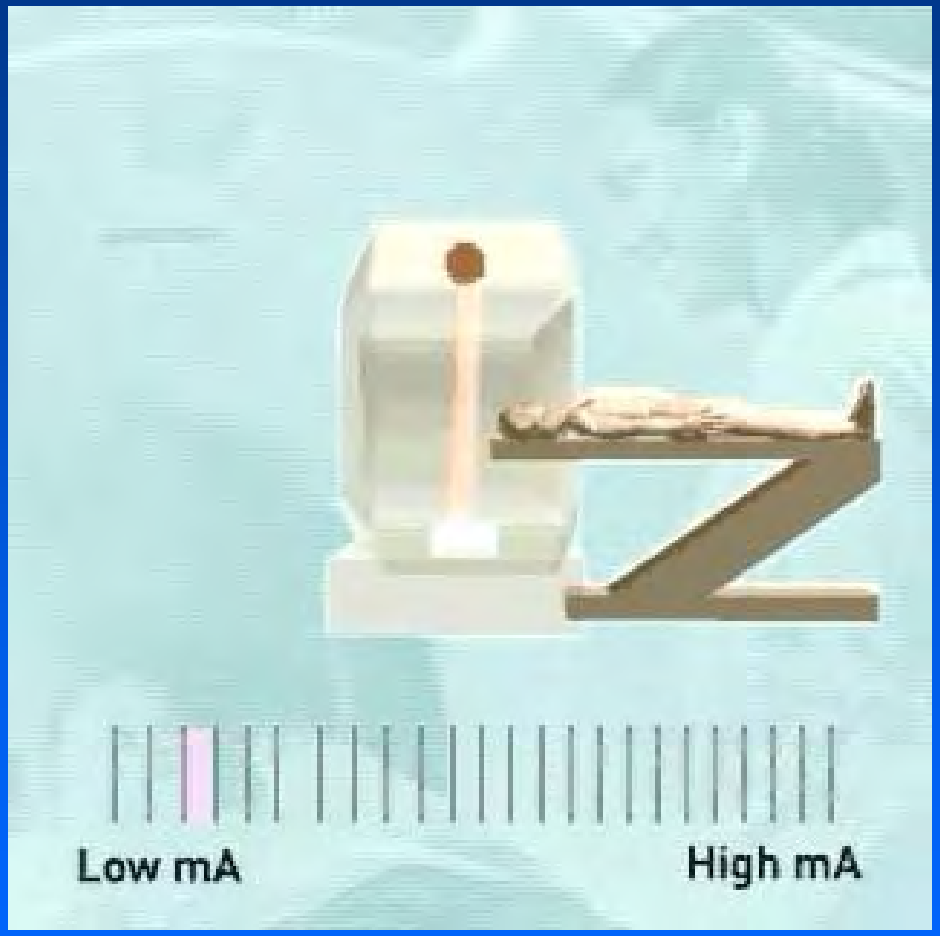
Virtual Colon Phantom, “Low Dose”

Courtesy of Beth McFarland, M.D.

Tube Current Modulation: In Plane

Tube Current Modulation: Through Plane

Tube Current Modulation: Combined



AEC:
Automatic
Exposure
Control

Radiation Dose Savings of up to 50%

Tube Potential (kVp)

Question

- Use of a low kVp setting (80 or 100 kVp) as a means to control radiation dose at CT scanning may be appropriate in the following clinical situations except?
  a. Thin patients
  b. Pediatric patients
  c. CT of the pelvis without IV contrast material
  d. CT angiography of the thorax

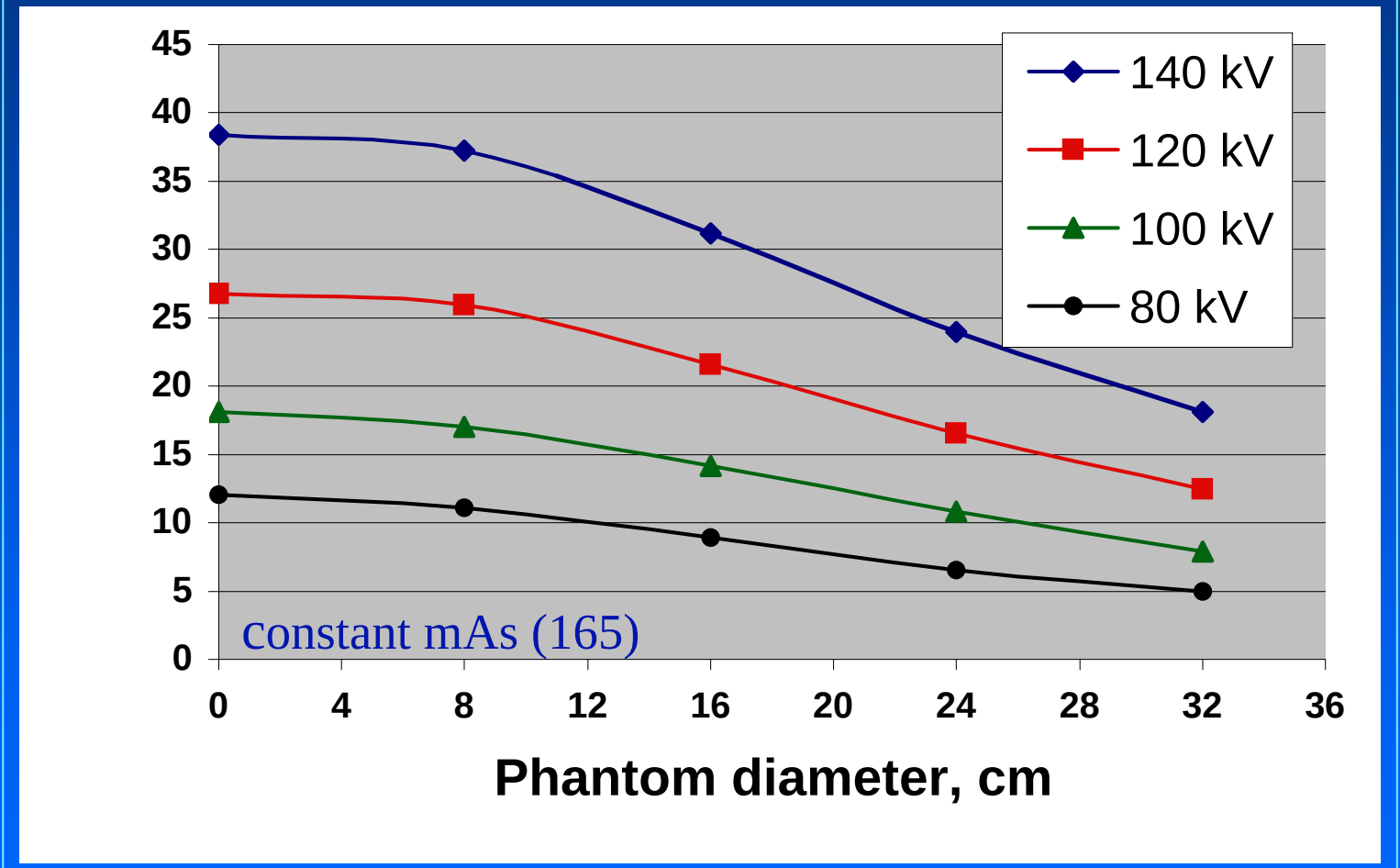
Answer: d

Low kVp: Rationale

- K-edge of Iodine 32 keV
- Mean photon energy
  - 80 kVp 44 keV
  - 100 kVp 52 keV
  - 120 kVp 57 keV
  - 140 kVp 62 keV

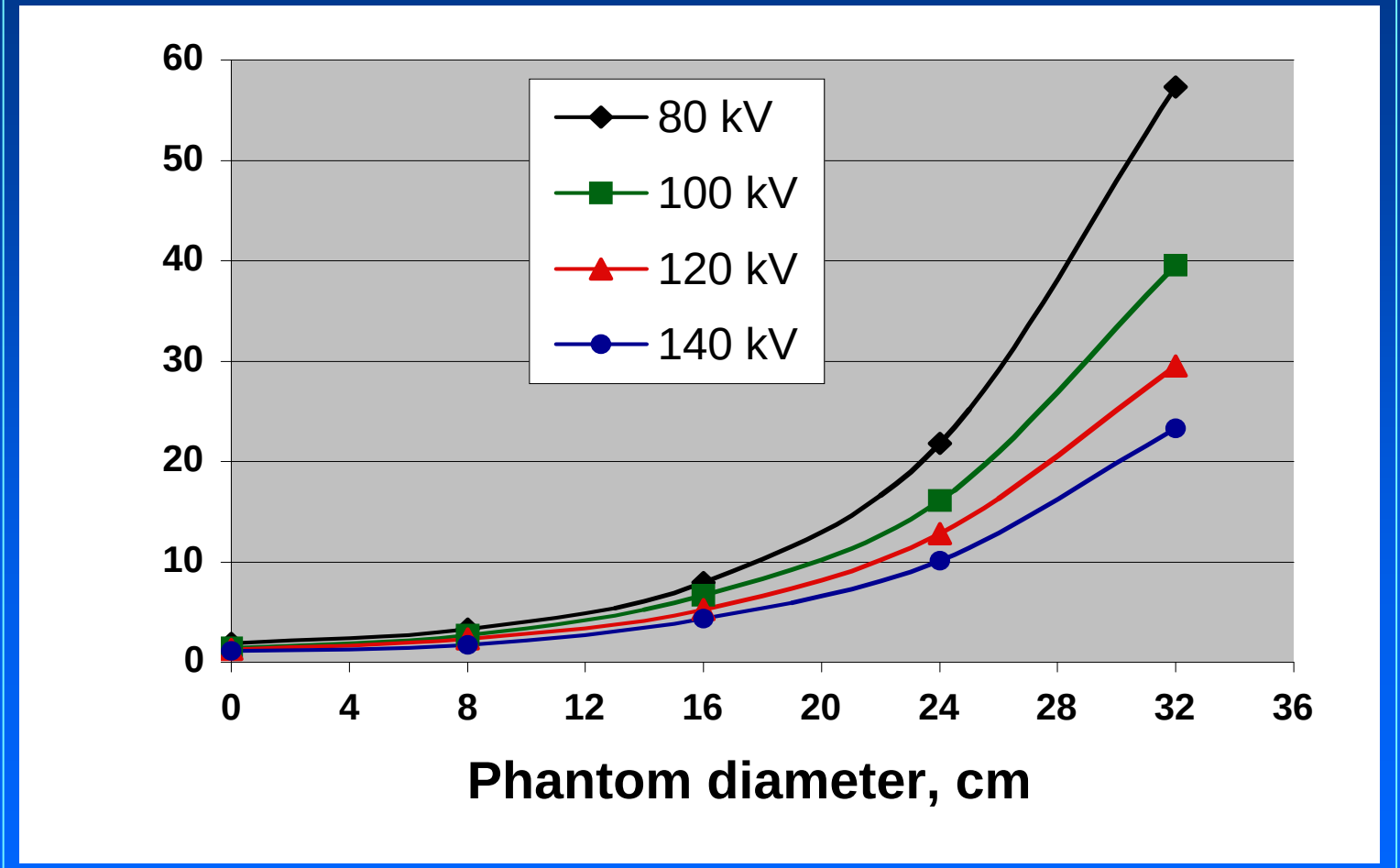
Huda W, et al. Radiology 2000; 217:430

Effect of kV on Dose



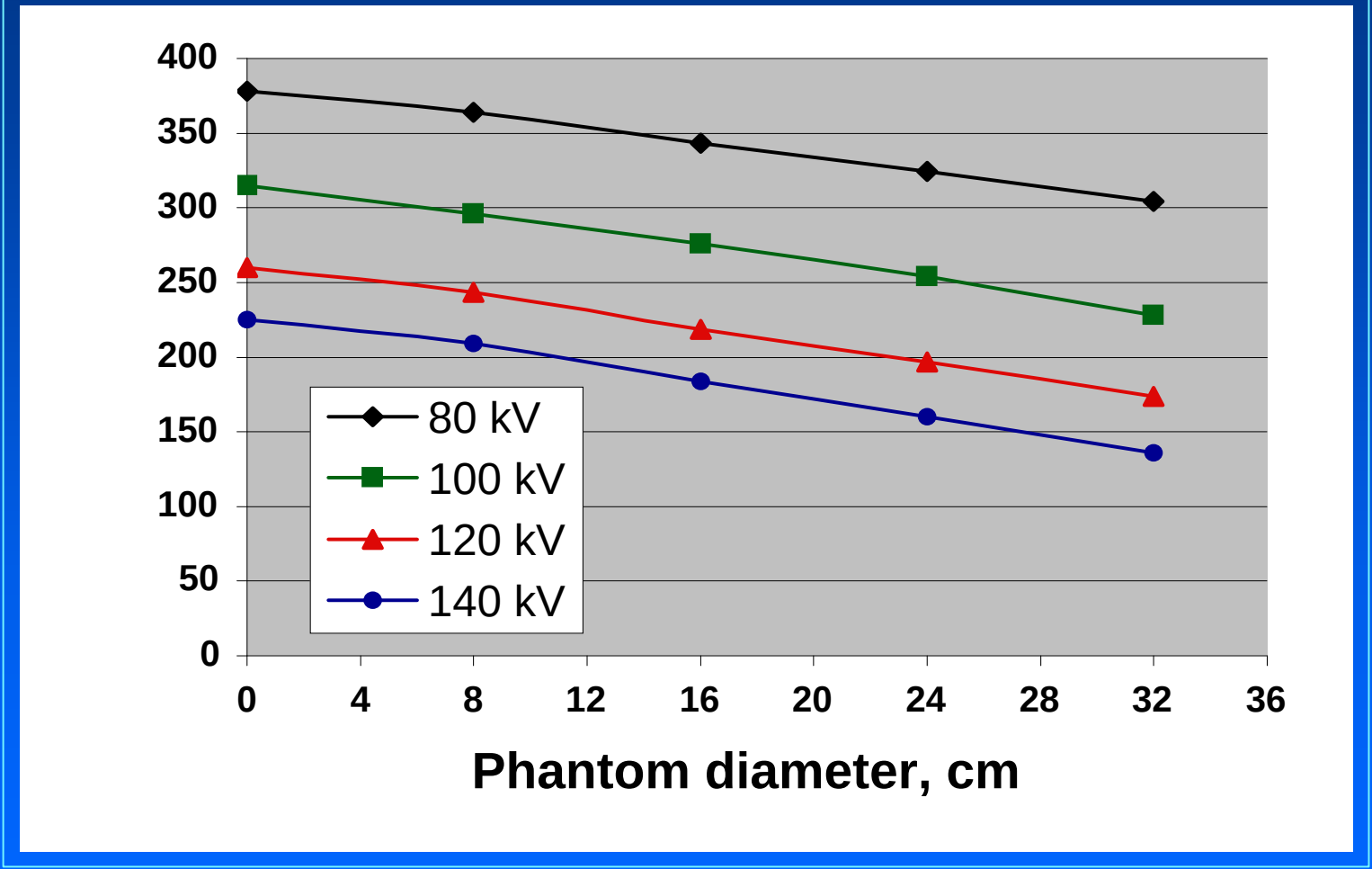
Courtesy of Marilyn Siegel, MD

Effective of kV on Image Noise



Courtesy of Marilyn Siegel, MD

Effect of kV on Iodine Contrast



Courtesy of Marilyn Siegel, MD

Low kV

- Chest CT: Improved detection of PE
  - 100 vs. 140 kVp
  - Reduced radiation dose by 3x
    - 140 kVp -- 10.4 mGy
    - 100 kVp -- 3.4 mGy

Schueller-Weidekamm, et al. Radiology 2006;241:899

Low kV

- Coronary CTA: 100 patients (≤ 85 kg)
  - Siemens Dual Source 64DCT
  - Retrospective gating
  - 120 kVp / 330 mAs: 12 mSv
  - 100 kVp / 330 mAs: <8 mSv
  - Best for HR < 65 bpm

Pflederer T, et al. (Univ. of Erlangen). SCCT, 2007

Dose Monitoring

Anatomical Reference

SN

Filming

AutoFilm Setup

Camera
Dicom Camera

Patient Orientation
Feet First

Patient Position
Supine

Auto Store

Auto Transfer

Show Localizer

Series Description

Images	CTDIw mGy	DLP mGy·cm	Dose Efficiency %
1–41	11.77	207.39	77.41
42–82	11.77	207.39	77.41

DLP

Projected series DLP: 414.79 mGy·cm

Accumulated exam DLP: 0.00 mGy·cm

Add Group | Split Current Group | Delete Selected Group | Biopsy Rx | Smart Prep Rx | Preview | Optimize not Needed | Gating | Prior | Next

Images	Scan Type	Start Location	End Location	No. of Images	Thick Speed	Interval (mm)	Gantry Tilt	SFOV	kV	mA	DFOV (cm)	R/L Center (mm)	A/P Center (mm)	Recon Type	Matrix Size	Peris.	Direct 3D
1-41	Helical Full 0.8 sec.	S0.00	I200.00	41	5.0 11.25 HQ	5.00	30.0	Large	120	120	36.0	R0.0	A0.0	Std	512	N	On New
42-82	Helical Full 0.8 sec.	I205.00	I405.00	41	5.0 11.25 HQ	5.00	30.0	Large	120	120	36.0	R0.0	A0.0	Std	512	N	On New

Gated: No Tube Current Modulation

Exam Description: CT CHEST/ABD DISSECTIO

HFS

Dose Report

Series	Type	Scan Range (mm)	CTDIvol (mGy)	DLP (mGy-cm)	Phantom cm
1	Scout	-	-	-	-
2	Helical	S3.250-I271.750	17.42	591.82	Body 32
202	Axial	I100.000-I100.000	10.41	5.22	Body 32
3	Cardiac Helical	I2.000-I218.250	68.21	1713.89	Body 32
3	Cardiac Helical	I219.000-I399.000	50.58	1087.53	Body 32
			Total Exam DLP:	3398.46	

Effective Dose = DLP x 0.016 mSv/mGy-cm
= 54.4 mSv

Effective Dose

Estimate effective dose from DLP

Region	mSv / (mGy cm)
Head	0.0023
Chest	.017
Abdomen	.015
Pelvis	.019

Jessen KA. Applied Radiation and Isotopes, 1999; 165-172
(This method is used in the ACR CT Accreditation Program)

‘Broselow/Luten’ Pediatric Emergency System (Color-coded)

‘Color Coding for Kids’ Selection

One size does not fit all...

There's no question – CT helps us save kids' lives!
But...When we image, radiation matters!
Children are more sensitive to radiation.
What we do now lasts their lifetime.
So, when we image, let's image gently.
More is often not better.

When CT is the right thing to do:

- Child size the kVp and mA
- One scan (single phase) is often enough
- Scan only the indicated area

A timely message from the Alliance for Radiation Safety in Pediatric Imaging.

image gently℠

Visit www.imagegently.org.

Made possible by an unrestricted educational grant from GE Healthcare.

The Alliance for Radiation Safety in Pediatric Imaging is:

The Society for Pediatric Radiology - American Association of Physicists in Medicine - American College of Radiology - American Society of Radiologic Technologists - American Academy of Pediatrics - American Osteopathic College of Radiology - American Registry of Radiologic Technologists
American Roentgen Ray Society - Association of University Radiologists - Conference of Radiation Control Program Directors - National Council on Radiation Protection - Radiological Society of North America - Society of Computed Body Tomography and Magnetic Resonance

ACR CT Accreditation

- Dose data required for:
  - Adult Head
  - Adult Abdomen
  - Pedi (5yr old) Abdomen
- Dose metrics to be measured
  - CTDIw
  - DLP
  - Effective Dose

ACR CT Accreditation

- Dose metrics to be judged
  - CTDIw
  - DLP
  - Effective Dose
- Recommended CTDIw

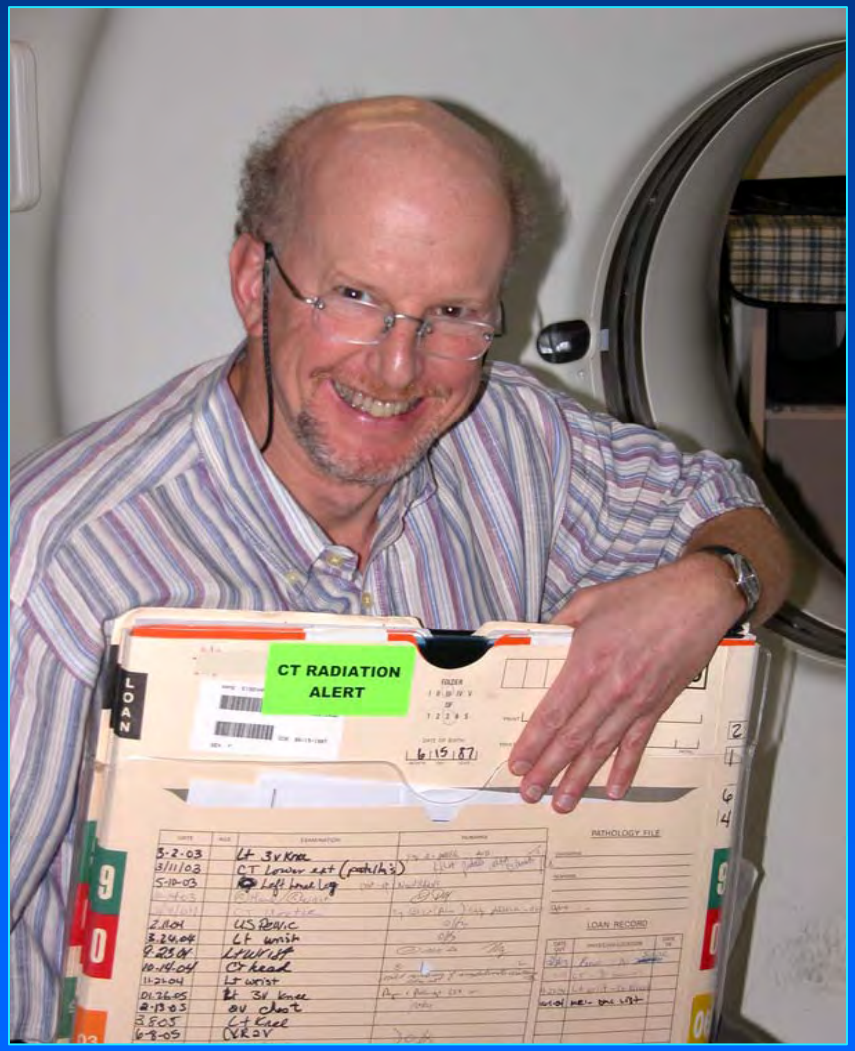
	Revised	Initial
– Adult Head	60 mGy	75 mGy
– Adult Abdomen	35 mGy	25 mGy
– Pedi Abdomen	25 mGy	20 mGy

European Guidelines

Exam	CTDIw	DLP	Eff. Dose
Head	60	1050	2.4
Chest	30	650	11.1
Abd	35	800	12.0
Pelvis	35	600	11.4
Chest/Abd/Pel		2050	34.5

From Commissione Europea EUR 16260, EUR 16261, EUR 16262 ed EUR 16263

Radiation Monitoring and Alerts



Steven Birnbaum, M.D.

Radiation Safety Officer

Southern New Hampshire
Medical Center

Steps To Minimize Exposure

Southern NH Med Center Order Requisition

*****RADIATION SAFETY ALERT*****

ACC #: 293384 Exam: Renal w Contrast CT (74160) (CTRENAL*)

Date: 08/30/2006 7:35

Name: TEST, EDTEST
MRN: (SNHMC) XXXXXX
Isolation Indicator:

Requesting MD: [redacted]
Dr. Phone: [redacted]

PCP: [redacted]
Dr. Phone: [redacted]

Room: CT-VR
Patient Loc: E343-A
History: abd pain
Diagnosis: KIDNEY PAIN
Comments:
Patient Allergies:

DOB: 07/23/1960 AGE: 46 Y SEX: M
Visit / Billing #: 75286724

Patient Status: E
All mammo, BD and Breast US must only be in status "C"!

Courtesy of Steven Birnbaum, MD

Elements of a Successful Radiation Protection Program

- Education of Clinicians and Radiologists
- Technical Modifications
  - Algorithms for Utilizing Non-ionizing Modalities
- Identification of Patients w/ Elevated Exposure
  - 5 scans in patients < 40yrs with benign conditions (≥50 mSv)
  - Notification of referring physician
  - Notation in the patient's imaging record (like contrast allergy)
- Investigation of Extreme Exposure
  - Further history and counseling for exposures > 100 mSv

Courtesy of Steven Birnbaum, MD

That’s all…

CT Utilization in Emergency Medicine

Scott W. Melanson, MD, FACEP

***Program Director*,**
Emergency Medicine Residency,
St. Luke's Hospital,
***Associate Professor*,**
Temple University Hospital

CT in EM

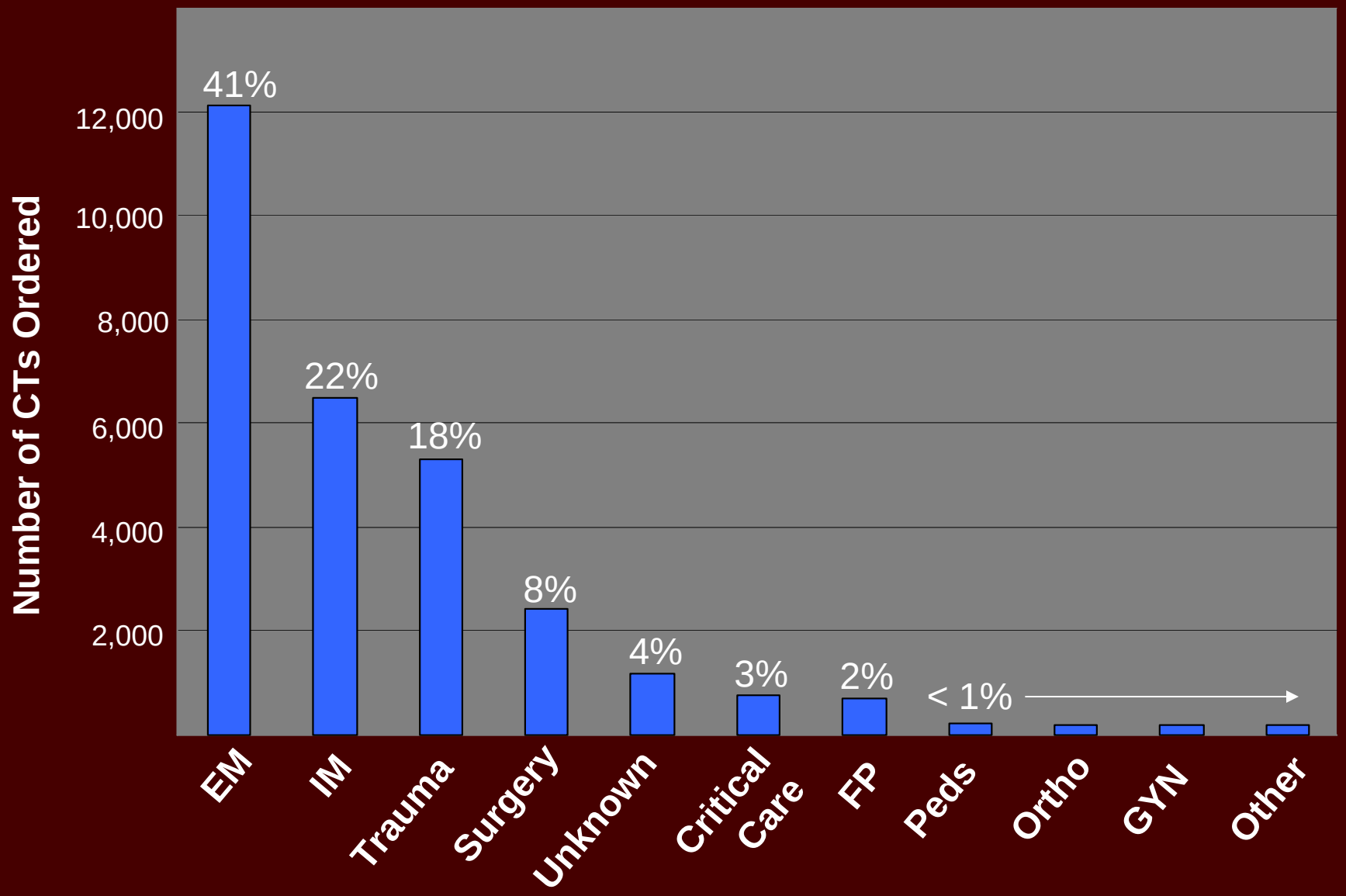
- Advances in CT technology → improved imaging

- Expanded ED applications
  - PE: CT better than VQ
  - Appendicitis: had only clinical judgment
  - Spine: CT more accurate than plain films
  - Renal colic: CT more accurate, more info than U/S
  - ACS: stress test / catheterization

Who is Ordering All the CTs?

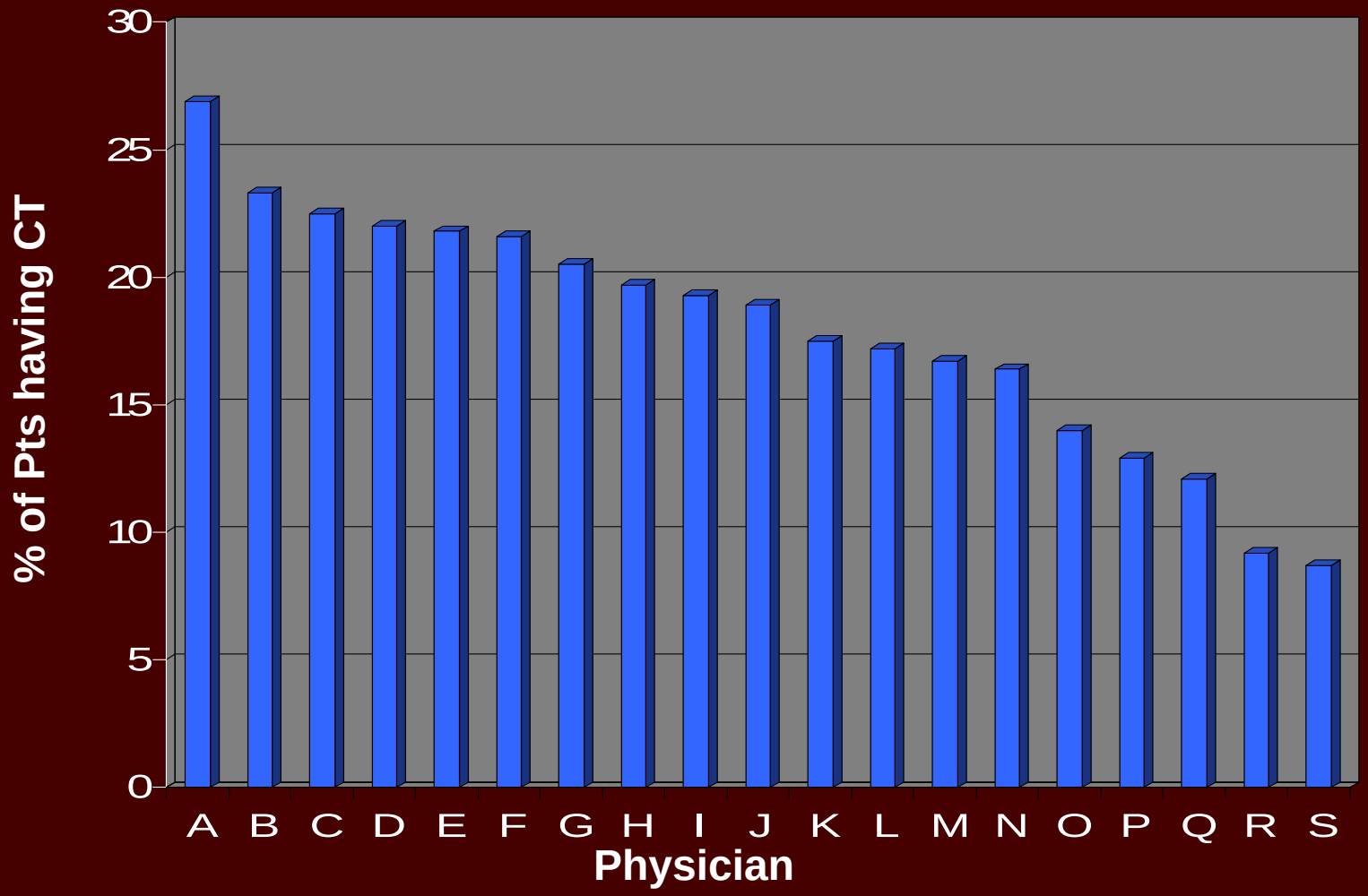
- Examined CT ordering at community, academic center
  - 500 beds, 70,000 ED patients / year
  - Level 1 Trauma Center, Stroke & Chest Pain Center
- All CTs: December 2006 – December 2007
  - Inpatient and outpatient studies
  - Reviewed to determine ordering physician / dept

Number of CTs Ordered by Department



EP CT Ordering Variability

- 18.7% ED pts had CT



EP CT Ordering Variability

- Factors responsible for variability
  - Training?
  - Age?
  - Risk tolerance?
  - Malpractice experience?

ED Indications

- Head
- Cervical Spine
- Thoracic & Lumbar Spine
- Chest
- Abdomen / Pelvis
- Extremities
  - CTV
  - Fractures
  - Infections

Head CT

- Most commonly ordered CT in ED
  - Trauma
    - Routine in any anticoagulated elderly pt with CHI
    - Guidelines for adults
      - New Orleans Criteria*
      - Canadian CT Head Rules**
      - Nexus II***
    - Little guidance for very young

*NEJM 2000;343:100

**Lancet 2001;357:1391

*** J Trauma 2005;59:954

Head CT

- Other Indications:
  - Stroke
  - Altered mental status
  - 1st episode of seizure
  - “Worst HA of life”

Head CT: CT Before LP?

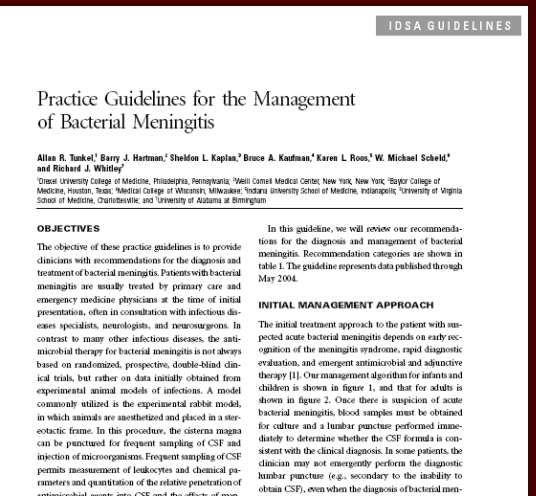
- Prospective study, N = 113*
  - Predictors of lesion on CT:
    - Altered mental status (LR 2.2)
    - Focal neurological deficit (LR 4.3)
    - Papilledema (LR 11.1)
- Prospective study, N = 301**
  - CT could be omitted if:
    - Age < 60
    - Not immunocompromised (e.g. HIV, immunosuppressives)
    - No hx of CNS disease (e.g. stroke, mass lesion)
    - No seizure within last week
    - No abnormal results on neurologic examination

*Arch Intern Med 1999;159(22):2681-2685

**N Engl J Med 2001;345(24)1727-1733

Head CT: CT Before LP?

- IDSA Guidelines
  - CT recommended before LP if:
    - Immunocompromised
    - History of CNS disease
    - New-onset seizure within 1 week of presentation
    - Abnormal neurologic exam
      - Papilledema
      - Abnormal mental status



IDSA GUIDELINES

Practice Guidelines for the Management of Bacterial Meningitis

Allan R. Tunkel,[1] Barry J. Hartman,[2] Sheldon L. Kaplan,[3] Bruce A. Kaufman,[4] Karen L. Roos,[5] W. Michael Scheld,[6] and Richard J. Whitley[7]

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OBJECTIVES

The objective of these practice guidelines is to provide clinicians with recommendations for the diagnosis and treatment of bacterial meningitis. Patients with bacterial meningitis are usually treated by primary care and emergency medicine physicians at the time of initial presentation, often in consultation with infectious diseases specialists, neurologists, and neurosurgeons. In contrast to many other infectious diseases, the antimicrobial therapy for bacterial meningitis is not always based on randomized, prospective, double-blind clinical trials, but rather on data initially obtained from experimental animal models of infections. A model commonly utilized is the experimental rabbit model, in which animals are anesthetized and placed in a stereotactic frame. In this procedure, the cisterna magna can be punctured for frequent sampling of CSF and injection of microorganisms. Frequent sampling of CSF permits measurement of leukocytes and chemical parameters and quantitation of the relative penetration of

In this guideline, we will review our recommendations for the diagnosis and management of bacterial meningitis. Recommendation categories are shown in table 1. The guideline represents data published through May 2004.

INITIAL MANAGEMENT APPROACH

The initial treatment approach to the patient with suspected acute bacterial meningitis depends on early recognition of the meningitis syndrome, rapid diagnostic evaluation, and emergent antimicrobial and adjunctive therapy [1]. Our management algorithm for infants and children is shown in figure 1, and that for adults is shown in figure 2. Once there is suspicion of acute bacterial meningitis, blood samples must be obtained for culture and a lumbar punctuse performed immediately to determine whether the CSF formula is consistent with the clinical diagnosis. In some patients, the clinician may not emergently perform the diagnostic lumbar puncture (e.g., secondary to the inability to obtain CSF), even when the diagnosis of bacterial men-

*Clin Infect Dis 2004;39(9):1267-1284

Abdomen / Pelvis

- **Appendicitis**
  - Has become virtually required for surgery
  - Scoring systems being investigated*
- **Diverticulitis**
  - Dx can be made clinically
  - No guidelines on when CT necessary / helpful
- **Renal colic**
  - Low dose protocol
  - Necessary with each episode?
    - Recurrent stones?

Acad Emerg Med 2009;16:591-596

Abdomen / Pelvis

- **Bowel obstruction**
  - Compared with plain films, CT
    - More sensitive
    - More specific
    - More accurate at defining point of obstruction
    - More accurate at defining etiology of obstruction
- **Aortic aneurysm**
  - Fast, easily available, broad spectrum test
  - Ultrasound accurate, less available

Abdomen / Pelvis

- Trauma
  - Clinical exam not sensitive or specific for injury
  - FAST helpful in detecting need for immediate laparotomy
    - Not accurate for identifying hollow viscus or solid organ injury
  - CT rapid, readily available

Trauma Patients

- Quantitative Assessment of Diagnostic Radiation Doses in Adult Blunt Trauma Patients
  - Wake Forest University
    - Level 1 trauma center
  - Case series 100 patients
- Median number of CT scans = 3 (range = 2-10)
- Median # of plain series = 9.5 (range = 2-64)
- Median effective dose total dose = 40.2 mSv

Ann Emerg Med 2008;52:93-97

Trauma Pan Scan

- Head, C-spine, Chest, Abd/Pelvis CT
- Archives Surgery 2006*
  - Inclusion criteria
    - No visible evidence of chest or abd injury
    - Hemodynamically stable
    - Normal abd exam or unevaluable
    - Significant mechanism of injury
  - 1000 trauma pts
    - 592 mechanism of injury
    - 408 depressed LOC

PAPER

Whole Body Imaging in Blunt Multisystem Trauma Patients Without Obvious Signs of Injury

Results of a Prospective Study

Ali Salim, MD; Burapat Sangthong, MD; Matthew Martin, MD; Carlos Brown, MD; David Plurad, MD; Demetrius Demetriades, MD

Hypothesis: The use of liberal whole body imaging (pan scan) in patients based on mechanism is warranted, even in evaluable patients with no obvious signs of chest or abdominal injury.

Design: Prospective observational study.

Setting: Academic level I trauma center.

Patients: All patients admitted following blunt multisystem trauma.

Intervention: Pan scan, including computed tomography (CT) of the head, cervical spine, chest, abdomen, and pelvis, with the following inclusion criteria: (1) no visible evidence of chest or abdominal injury, (2) hemodynamically stable, (3) normal abdominal examination results in a neurologically intact patient or unevaluable abdominal examination results secondary to a depressed level of consciousness, and (4) significant mechanisms of injury. Radiological findings and changes in treatment based on these findings were recorded.

Main Outcome Measure: Any alteration in the normal treatment plan as a direct result of CT scan findings. These alterations include early hospital discharge, admission for observation, operative intervention, and additional diagnostic studies or interventions.

Results: One thousand patients underwent pan scan during the 18-month observation period, of which 592 were evaluable patients with no obvious signs of abdominal injury. Clinically significant abnormalities were found in 3.5% of head CT scans, 5.1% of cervical spine CT scans, 19.6% of chest CT scans, and 7.1% of abdominal CT scans. Overall treatment was changed in 18.9% of patients based on abnormal CT scan findings.

Conclusions: The use of pan scan based on mechanism in awake, evaluable patients is warranted. Clinically significant abnormalities are not uncommon, resulting in a change in treatment in nearly 19% of patients.

Arch Surg. 2006;141:468-475

**Arch Surg*. 2006;141:468-473

Pan Scan in Trauma

- Clinically significant abnormalities:
  - 3.5% of head CT scans
  - 5.1% of cervical spine CT scans
  - 19.6% of chest CT scans
  - 7.1% of abdominal CT scans.

Treatment was changed in 18.9% based on abnormal CT scan findings

**Arch Surg*. 2006;141:468-473

Chest

- Pulmonary embolism
  - Increased mortality if missed
  - Heightened awareness of PE → increased likelihood to investigate
  - D-dimer helpful in R/O in low risk patients
  - Up to 1/3 will have repeat CTA w/in 5 years*
    - Index scans: 5.3% + for PE
    - Subsequent scans: 3.4% + for PE

*Ann Emerg Med 2009;54:49

Chest

- Aortic dissection
  - Other tests available (e.g., MRI, TEE)
  - None faster, easier, more accurate than CT
  - PE often also in differential

- Cardiac
  - Could have huge impact in utilization

The Holy Grail

Triple Rule Out Protocol

Spine

- Cervical >> lumbar, thoracic
- CT more accurate than plain films
- Some argue that CT should completely replace radiographs
- Definite indications with trauma
  - High risk injury
  - Neurologic deficit
  - Fracture identified on plain film
  - Patients undergoing head CT?

CT in EM

- Many CT scans are ordered from the ED
  - Improved accuracy
  - Increasing number of applications
- Educational efforts to insure appropriate utilization of CT should focus on EM

CT Imaging in Emergency Medicine

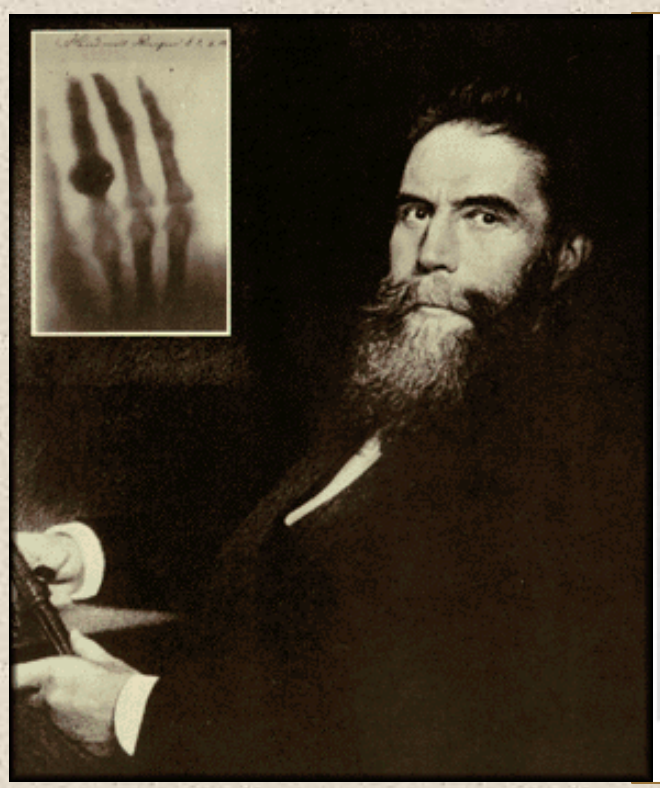
Washington D.C. September 23rd, 2009

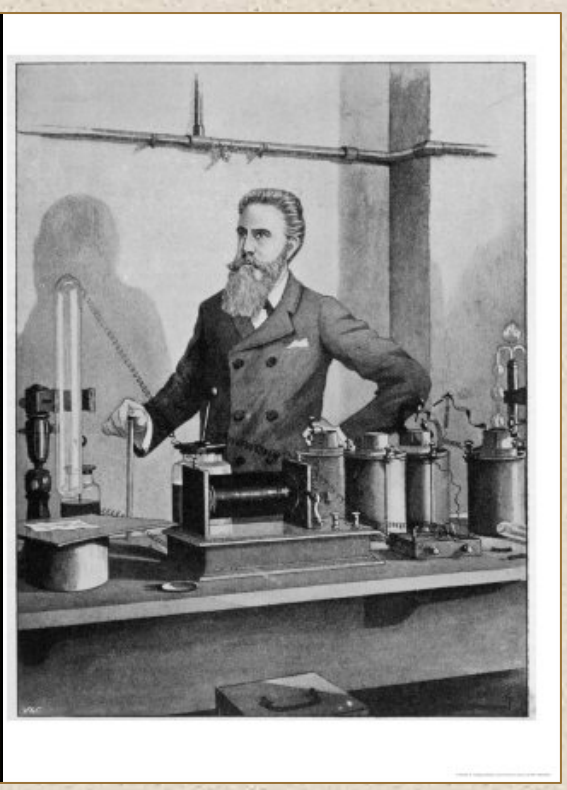
Stuart E. Mirvis, MD, FACR
Professor of Radiology
Department of Radiology and Maryland Shock-Trauma Center
University of Maryland School of Medicine

CT scans contribute approximately 45% of the U.S. population's collective radiation dose from all medical x-ray examinations. CT is the <u>largest contributor to medical exposure to the U.S. population</u>.

The “trouble maker”!!

William Konrad Roentgen [1845-1923]





Mysterious ray from Hittorf tube caused salt barium platinum-cyanide coating to glow

November 8, 1895, at the University of Wurzburg

He was a productive author of 48 careful, unspectacular papers at the age of 50

By mid-Feb. 1896 X-rays were used to set the broken arm of a young boy in Dartmouth, New Hampshire. Within a year, a thousand papers were published on the phenomenon.

Received the first Nobel Prize for Physics in 1901

Died in poverty during the post-war inflation at the age of 73

Radiation Terminology

- One **gray** is the absorption of one joule of radiation energy by one kilogram of matter.
- **Absorbed dose** (also known as *Total Ionizing Dose, TID*) is measured in gray (Gy).
- The risk of stochastic effects due to radiation exposure can be quantified using the **effective dose**, which is a weighted average of the equivalent dose to each organ depending upon its **radiosensitivity**. Note that the absorbed dose is not a good indicator of the likely biological effect. 1 Gy of alpha radiation would be much more biologically damaging than 1 Gy of photon radiation for example.
- A **non-stochastic** or deterministic health effect has a severity that is dependent on dose and is believed to have a *threshold level* for which no effect is seen. **Stochastic** health effects occur by chance, generally occurring without a threshold level of dose, whose probability is proportional to the dose and whose severity is independent of the dose, such as cancer and genetic effects.

Radiation Terminology

- The **equivalent dose** (**H_T**) is a measure of radiation dose to tissue where an attempt has been made to allow for the different relative biological effect of different types of ionizing radiation. Equivalent dose is a less fundamental quantity than radiation absorbed dose, but is more biologically significant. Equivalent dose has units of **sieverts**.
- For a given amount of radiation (measured in grays), the biological effect (measured in sieverts) can vary considerably as a result of the radiation weighting factor W_R.
- The average radiation dose from an abdominal x-ray is 1.4 mGy, that from an abdominal CT scan is 8.0 mGy, that from a pelvic CT scan is 25 mGy, and that from a selective spiral CT scan of the abdomen and the pelvis is 30 mGy.

FDA
Center for devices and radiologic health – Update Aug. 6th 2008

http://www.fda.gov/cdrh/ct/

Diagnostic Procedure	Typical Effective Dose (mSv)[1]	Number of Chest X rays (PA film) for Equivalent Effective Dose[2]	Time Period for Equivalent Effective Dose from Natural Background Radiation[3]
Chest x ray (PA film)	0.02	1	2.4 days
Skull x ray	0.07	4	8.5 days
Lumbar spine	1.3	65	158 days
I.V. urogram	2.5	125	304 days
Upper G.I. exam	3.0	150	1.0 year
Barium enema	7.0	350	2.3 years
CT head	2.0	100	243 days
CT abdomen	10.0	500	3.3 years

Radiation dose fears color coronary CTA guidelines

- Heart association science panel warns against modality if no clear clinical benefit can be established
- Recommendations from a 14-member AHA science advisory panel
- The panel reported that the average lifetime risk of developing a malignancy from all causes is 41% and of death from that malignancy is 21%. The typical 10-mSv coronary CT angiogram induces about a 0.05% additional lifetime risk of death from a malignancy

Diagnostic Imaging 31: April 1, 2009

Risk versus Dose

- Even very low doses of **radiation** pose a **risk** of cancer over a person's lifetime, a National Academy of Sciences panel concluded. It rejected some scientists' arguments that tiny doses are harmless or may in fact be beneficial.
- The panel also said that approximately one person out of 1,000 would develop cancer from exposure to the amount of radiation from a single, average whole body CT-scan.

The Associated Press State & Local Wire June 29, 2005

Do we really have something to worry about?

- No trend in incidence of total cancer, leukemia or solid tumors with increasing radiation dose was observed in the standardized incidence ratio (SIR) or in the multivariate Poisson regression.
- Overall, while no increase in cancer risk with diagnostic radiation was observed, the results are compatible with a broad range of risk estimates.

Hammer GP et al. A cohort study of childhood cancer incidence after postnatal diagnostic X-ray exposure. Radiat Res. 2009;171:504-12.

Relative Risk for Mortality in Radiation Workers (Internal Analysis)

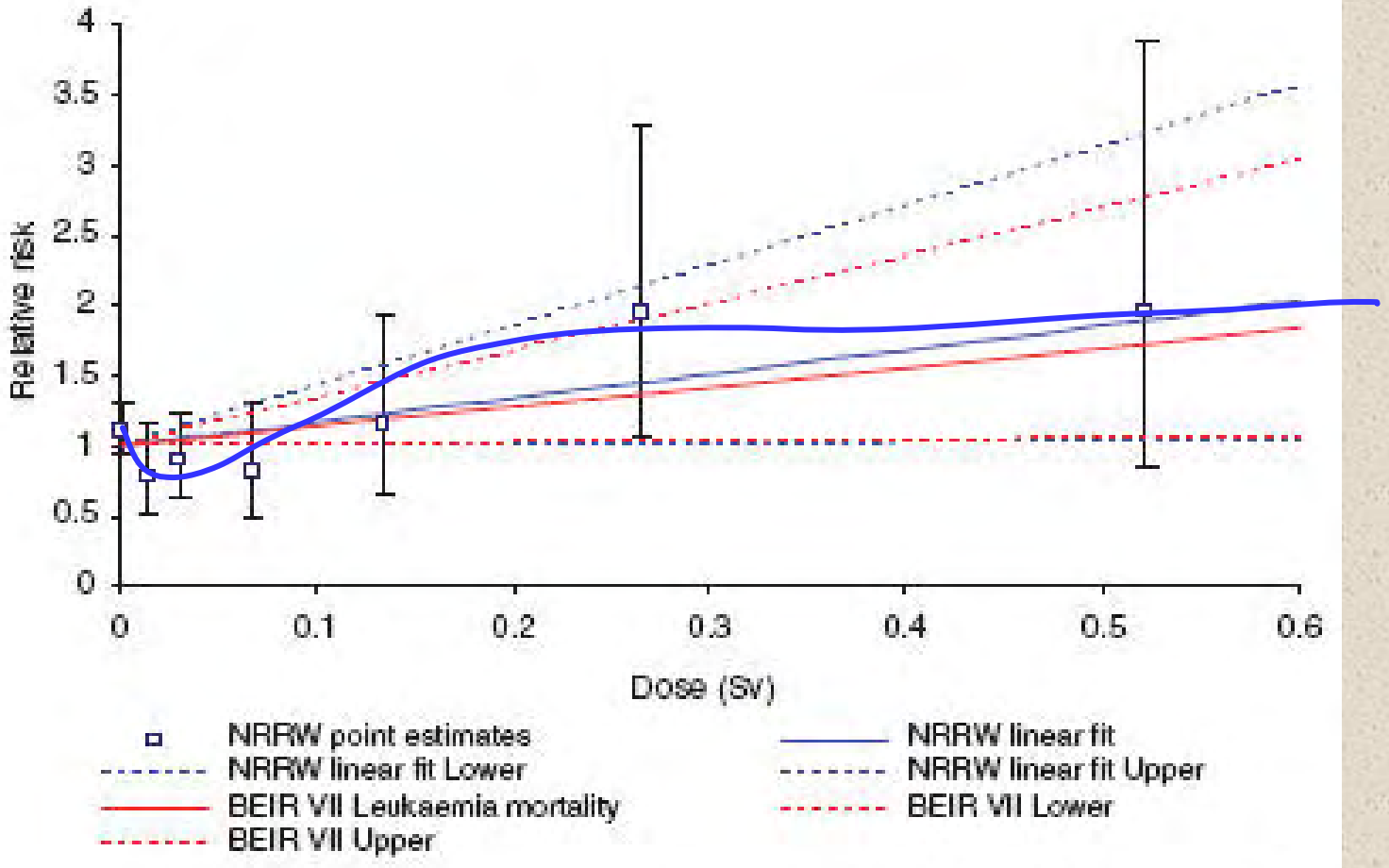


Figure 1 Trends with dose in relative risk (and 90% CI) for mortality from leukaemia excluding CLL.

- I always compare a CT ... for instance, coronary CTA to a cardiac stress test; compare it to something of similar information content. Remember, we have all a one-in-three chance, anyway, of getting cancer. And so I used to be the "reduce dose, reduce dose." And I still am. "Reduce dose, reduce dose." But people have to remember the alarmist press is, I think, concerning too many patients. We had an 84-year-old man, with an aortic aneurysm refuse a CT, after The New England Journal paper came out, because he didn't want that cancer-causing stuff. So if it's medically appropriate, we're good**. If it's protective medicine, or just triage them through the ER faster, that's what we have to address**. But if it's medically warranted, the risk is negligible, or very, very low. But, still, drop the dose.
- **It has not been scientifically demonstrated that there is any risk at doses below 100 milliseverts. However, for the purpose of erring on the side of safety, we assume there is, and we act as if there is, and we do dose reduction, and we're prudent**. If you go to solid-organ tumors, here's the relative risk of one again. A hundred milliseverts. Look where these error bars are. Look at these error bars out here, with 500 milliseverts, **and the error bars still include no risk.**

- In the final analysis, physicians must request the imaging examination that best addresses the specific medical question without allowing worries about radiation to dissuade them or their patients from obtaining needed CT examinations. Ongoing efforts to ensure that CT examinations are both medically justified and optimally performed must continue, and education must be provided to the medical community and general public that put both the potential risks—and benefits—of CT examinations into proper perspective.

McCollough CH, Guimarães L, Fletcher JG. In Defense of Body CT. *AJR* 2009; 193:28-39.

ER Patient Exposure to Radiation

- Orlando Regional and Washington Hospital Center
- Patients had an average cumulative estimated effective radiation dose of 45.0 milliseiverts over 5-yrs., CT scans and nuclear medicine studies contributing the most radiation.
- 12% of the sample population was estimated to have received 100 or more millisieverts of radiation.
- If study patients are representative of the general emergency department population, then a substantial number of people may be at increased risk of developing cancer over their lifetime from diagnostic imaging studies as a result of these exposures.

Cumulative radiation exposure shows increased cancer risk for emergency department patients
Science Centric | 22 May 2008 18:38 GMT

From 2000 to 2006, pediatric ED patient volume increased by 2%, while triage acuity remained stable. During this same period, head CT increased by 23%, cervical spine CT by 366%, chest CT by 435%, abdominal CT by 49%, and miscellaneous CT by 96%. Increases in CT utilization were most pronounced in adolescents ages 13 to 17 years. Increases in CT utilization in this age group met or exceeded increases seen in the adult population.

Broder J. Increasing utilization of computed tomography in the pediatric emergency department, 2000-2006. Emerg Radiol. 2007;14(4):227-32.

MDCT exposure vs. treatable/actionable findings

- University Texas – Galveston
- Retrospective analysis 770 emerg. Pts. (total 1094 CT studies)
- Actionable results in 341; treatable finding in 105
- Mean radiation dose 163.27 mGy CTDIvol (Computed Tomography Dose Index) - actionable
- Mean radiation dose 530.23 mGy CTDIvol - emergency treatable

Baskerville JR, et al. Dose versus diagnosis: iatrogenic radiation exposure by multidetector computerised tomography in an academic emergency department with measurement of clinically actionable results and emergently treatable findings. Emerg Med J .2009:26(1):15-19.

CTPA studies October 2001 and September 2005 reviewed.
N = 3421 CTPA examinations.

Average CTPA examinations per month increased 227%, from 33.4 to 109.2 for the first and last 24-month periods

Diagnoses of PE per month increased 89% from 4.0 to 7.5; percentage of positive CTPA examinations dropped from 9.8% to 6.8%.

Availability of CT in the emergency department and lower physician thresholds for test utilization have increased the use of CT pulmonary angiography and increased detection of PE

Donohoo JH. Utilization patterns and diagnostic yield of 3421 consecutive multidetector row computed tomography pulmonary angiograms in a busy emergency department J Comput Assist Tomogr. 2008 May-Jun;32(3):421-5.

Radiation Exposure: Total-Body Screening MDCT

- Average size adult; < 50 yr.
- 1st run arterial phase; 2nd scan -portal venous
- Dry head = 2 mSv eff
- 100 cm scan = 33 mSv eff (120 kV, 250 mAs)
- 100 cm scan = 22 mSv eff or 35 cm scan = 10 mSv eff (120 kV, 200 mAs/slice
- Total = 45-57 mSv

Shock -Trauma Center CT volume scanned body regions

- 7/06 to 6/07 = 36,461
- 7/07 to 6/08 = 38,422
- 7/08 to 6/08 = 37,391

Stable admission rate and stable use of MDCT

What has gone wrong

- Too much reliance on CT and testing displacing clinical acumen / judgement
- Fear of malpractice
- Little appreciation for risks associated with radiation exposure
- Little reliance on clinical verified diagnostic pathways
- Negative feedback for <u>not</u> getting “studies”
- Knee-jerk reaction to uncertainty
- Patient expectations

Reasons for Increased CT Utilization in Emergency Radiology

- High confidence in accuracy
- Concern about missing important finding – consequences
- Move patients quickly through the system – rapid triage
- Removes diagnostic uncertainty
- Covers “a lot of waterfront” – abdominal pain/chest pain/headache
- Readily available

Malpractice fear accounts for significant variability in ED decision making and is associated with increased hospitalization of low-risk patients and increased use of diagnostic tests.

Katz DA, Emergency physicians' fear of malpractice in evaluating patients with possible acute cardiac ischemia. Ann Emerg Med. 2005;46(6):525-33

Common Good Fear of Litigation Study

The Impact on Medicine Final Report

April 11, 2002

Conducted for: Common Good

March 4-20, 2002

Project Managers:

- Humphrey Taylor, Chairman, *The Harris Poll*
- David Krane, Senior Vice President
- Amy Cottreau, Project Manager
- Diana Gravitch, Senior Research Associate

commongood*.org/assets/attachments/68.pdf*

Fear of Liability is a Real Issue

Physicians report that the fear of malpractice claims causes themselves and/or other physicians to order more tests than they would based only on professional judgment of what is medically needed. (91% have noticed other physicians, and 79% report they themselves do this due to concerns about malpractice liability)

Common Good Fear of Litigation Study

Advantages of MDCT in ED practice

- Requires decreased use of more invasive, expensive, or difficult to obtain studies (sonography, angiography, nuclear medicine, MRI)
- Low operator dependence
- Probably decreases costs by high negative predictive value and decreasing length of stay and additional testing
- Provides details of diagnosis beyond clinical assessment

Decreasing the Dose – some methods

- Accept more image “noise”
- Avoid overlapping fields
- Tube current modulation
- Gating
- Low-dose technique- adaptive statistical iterative reconstruction (ASIR)
- Table speed
- Scan length
- Higher scan pitch
- Thicker scan collimation
- Shielding
- Body habitus factors
- Beam filtration

CT and Radiation Exposure

- We still do not know the clinical significance, if any, of diagnostic radiation. There are strong arguments on both sides. Radiologists have decided to adopt a conservative approach on this and move to controlling radiation exposure (decrease) as much as possible while performing clinically needed and diagnostically adequate imaging.
- There is a great deal of controversy regarding what we should be measuring to determine biologically meaningful exposure, what terminology should be used in describing radiation exposure, and how standardized guidelines for exposure could or should be established.
- CT manufacturers are targeting radiation measurement and dose optimalization as worthy efforts to promote their machines and are coming up with some very impressive technology that will progressively lower dose for a given study.
- Radiologists, in general, are probably not as familiar with current concepts of radiation biology, dose modulation techniques, and optimizing dose requirements for particular clinical situations as they need to be and mass education efforts require improvement.

Applied Radiology Radiation Utilization Symposium 2009 San Diego

CT and Radiation Exposure

- Our clinical referrers, in most cases, have little specific knowledge about the potential harm of medical radiation, the need for tighter control in "susceptible" patients, and the import of formulating a particular clinical question in the decision to use ionizing radiation, versus other imaging techniques, or to modify the CT dose appropriate to a given clinical issue.
- Radiation exposure and dose modulation strategies need to receive more attention during radiology residency training.
- Radiology departments should have on-going programs as part of quality control to monitor radiation exposure as compared to national and internationally established ranges for equipment, examination type, and patient specific factors. They should have an on-going policy of achieving an exposure as low as possible.
- A method to track individual patient dose overtime is necessary to guide future use of medical radiation.

2009 Minimizing Radiation Risks in CT Imaging: General Questions

- How do we educate referring physicians and the public about risk?
- Should we be doing fewer CT scans? Who decides which scans are medically indicated?
- Will we create an “over-reaction” concerning CT radiation risk that precludes performing necessary studies?
- Should we limit our radiation concerns mainly to the “young” and fertile/pregnant population?

2009 Minimizing Radiation Risks in CT Imaging: General Questions

- What is the best way to determine “biologically relevant” dose?
- How do you track patients’ accumulated dose? When do we say… “no more CT scans for you”?
- How can we best modify CT studies to obtained with lower dose without compromising diagnostic accuracy?
- How do you obtain “informed consent” for radiation exposure?
- Should everyone undergoing CT get informed consent? Under what circumstances?

CT and Emergency Medicine

The Impress of Malpractice Considerations

A Skeptical Radiologist’s View

Dr. Stephen R. Baker

A Common Perception

The function of the treating physician in the ER is to be risk averse.

Yet the responsibility of all physicians caring for ER patients is to be mindful of the principles of Evidence-Based Medicine.

How frequent are malpractice claims related to CT use or their avoidance in the E.R. setting involving radiologists and the implications for the potential concomitant liability of E.R. physicians?

The interrelationship of ER physicians and radiologist can be assessed from three vantage points:

1) What is the data regarding malpractice claims against radiologists, and how do they relate to the frequency of specific ER CT examinations?

Top Five Medical Misadventures All specialties 1985-2003

Improper performance	50,000
No misadventures	40,000
Error in diagnosis	40,000
Failure to supervise or monitor	12,000
Medication error	6,800
PIAA	

Closed Claims between 1985-2002

OB/GYN	25,594
Int. Med.	24,791
Gen/Fam. Practice	21,483
General Surgery	20,157
Orthopedics	18,157
Radiology	10,473
Plastic Surgery	7,424
Anesthesia	7,232
PIAA	

% of Claims Paid to Close

Dentists	42.84%
OB/GYN	36.06%
General Surgery	35.47%
Radiology	29.78%
Orthopedics	29.78%
Plastic Surgery	27.06%
PIAA	

Average Indemnity – 2001 to 2003

Radiology	300,000
Neurosurgery	465,000
OB/GYN	440,000
Cardiology	417,000
GI	265,000

1997 PIAA Survey - Radiology

Most prevalent patient conditions

- Malignant neoplasm of female breast
- Lung cancer
- Vertebral fracture
- Fracture of foot
- Fracture of wrist

Top Five Medical Conditions Claims Closed for All Specialties 1985-2003

Condition	All specialties Closed Claims	Ave. Indemnity
Breast Cancer	3,717	223,380
Brain damaged infant	3,700	509,280
Pregnancy	3,198	194,094
MI	2,634	206,880
Slipped disc	2,479	221,226
PIAA		

1997 Survey of Most Common Causes of Claims-Radiology PIAA

- Errors in diagnosis
- Improper performance
- Complication of treatment-failure to recognize
- Performed test when not indicated or contraindicated
- Failure to supervise or monitor case

- Performed test when not indicated or contraindicated – 4th most common
- Did not perform test – rare cause

- Radiologists = 30,000
- Cardiologists = 16,000
- Gastroenterologists = 8,000

If the number of radiologists, gastroenterologists and cardiologists were equal, radiologists would have approximately **67% more claims** than cardiologists and **90% more claims** than gastroenterologists

With respect to paid claims, radiologists would have had **3.6 times** more adverse judgments than gastroenterologists and **4 times** more adverse judgments than cardiologists

Closed claims between 1985-2005

Radiology	10,473
Cardiology	3,814
Gastroenterology	1,610

Ratio % Paid to Closed Claims

Radiology	29.78%
Cardiology	18.58%
Gastroenterology	19.01%

Why is there such a marked difference between the frequency of suits against radiologists and the frequency of suits against gastroenterologists and cardiologists?

It is because of suits involving breast disease.

Our Studies

Credentialing Data 14% of radiologists

One Call Medical Inc.

A specialty PPO network for MR and CT services

One Call Medical

- Three year credentialing cycle
- Malpractice History
  - National Practitioner Data Bank
  - Usually several sentence summary
  - Salient feature of claim
  - Claim need not result in suit
  - Announcement – not resolution

Every radiologist’s file is assessed.
Radiologists are not consulted personally.

Data Assessed for…

- Overall percentage of radiologists with at least one malpractice claim.
- Relationship between locational differences likelihood of claim (by state)
- Causes of claims
- Changes in claim profile through time (Pre and Post 1995)
- Relationship between gender differences and likelihood of claims

  claims per radiologist

  claims per exam performed

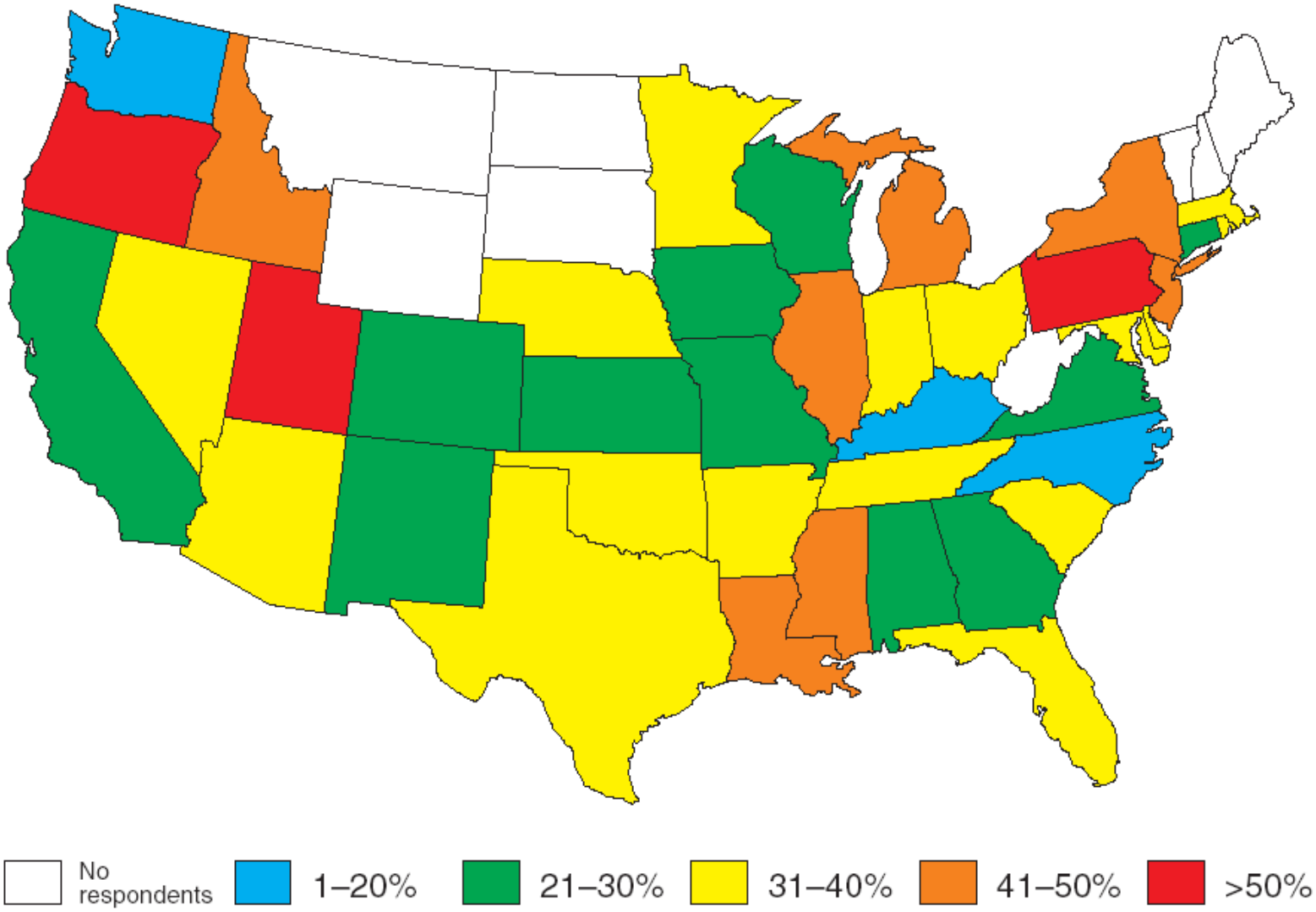
Radiologists	=	3937
Without Claim(s)	=	2600
With Claims(s)	=	1337
% With Claim(s)	=	33.9%
Total Claims	=	3231

The number of radiologists in the One-Call Network and thus those available for review of malpractice history is approximately one-seventh of all American radiologists (3,900 vs. 29,000)

GEOGRAPHIC VARIATIONS BY STATE

Percent of Radiologists with at least one malpractice claim

Percent of Radiologists with at least One Malpractice Claim



Causes of Malpractice Claims All Years, Both Genders

Predominant cause for Malpractice Claims determined from narrative summary in NPDB and supplemented by additional information supplied in the Radiologist's credentialing or re-credentialing application to further explain reasons for the claim.

- For most claims, failure to diagnose is the primary allegation
  - Others include failure to communicate, procedure complications, and the lack of follow-up

Failure to Diagnose	1752
Complications of Therapy	204
Failure to Communicate	75
Negligence	183
Peripheral Role	328
Contrast Reaction	52
Failure to do additional testing	**21**
Other	616
Total	3231

Disaggregation of Claims against Radiologists- Primary Causes (%)

All	100
Unknown	25.4
Breast Cancer	10.3
FTD-illness unknown	9.8
Peripheral Role	8.5
Fracture (mostly wrist & rib, spine third commonest)	7.4
Fracture (other sites)	6.5
Failure to diagnose (Vascular)	4.7
Failure to diagnose (Lung Cancer)	2.4
Failure to diagnose (Ob/Gyn)	1.4

Disaggregation of Claims against Radiologists- Primary Causes (%)

Procedural Complications	6.7
Failure to communicate results	3.4
Contrast Reaction	1.6
Neurologic disease	< 1.0
Failure to do additional testing	< 1.0

Why are Radiologists Sued?

- Of the various organ systems, breast disease comprises the majority of all claims against radiologists
- Thoracic disease is second
- Third most common is the extremities, with fracture most frequent
- Fourth most common is the G.I. Tract

Thoracic Cases

- 3231 – Claims – All conditions
- 310 – Thoracic causes

9.4% of claims involve chest conditions

Thoracic Cases		
Issue	Total claims	Average Award
Failure to diagnose	217	262,582
Communication Insufficiency	22	197,443
Peripheral Issue	17	48,341
Proc. Complication	10	268,750

Most lung cancer cases result from misdiagnoses of a nodule on chest X-ray, often compounded by delayed communication of results and inadequate call back system

Thoracic Malpractice Cases

Pathology	Total	% Settled	% Dismissed	Average Award
Lung Cancer	109	45%	19%	262,371
Aortic Dissection	9	44%	22%	751,250
Tube position	9	33%	11%	36,667
Line position	8	38%	50%	172,787
PE	8	50%	25%	455,275
Pneumonia	6	67%	17%	71,667

PE and Aortic Dissection (likely acute presentations) requiring CT comprised only 15 malpractice claims of >3000 radiologists registered over their entire careers

Types of GI Claims

Allegation	# of cases	% of total
Failure to Diagnose	124	63%
Peripheral Involvement	21	11%
Procedure Complication	16	8%
Communication Deficiency	6	3%

Pathology Associated with GI Claims		
	# of cases	% of total
Cancer	46	23%
Perforated Viscus	19	10%
Abscess	7	4%
Appendicitis	4	2%
Bowel Obstruction	4	2%
Tube position	4	2%
Foreign body	3	2%
Pancreatitis	3	2%

Sites of Neoplastic Lesions		
	# cases	% of total
Colon	28	14%
Gastric	4	2%
Liver	4	2%
Rectal	2	1%
Pancreatic	1	1%
Esophageal	1	1%
Metastasis	1	1%
Unknown	5	3%
Total	46	23%

All Cancers

- For approximately 67% of cancer related GI claims, the final result of the claim is known.
- 54% of all cancer related claims resulted in an adverse outcome for the radiologist
- The average payout in all these cases was $247,109 including settlements and trials

Colon Cancer

- For approximately 71% of colon cancer related claims, the final result of the claim is known.
- 64% of all colon cancer related claims resulted in an adverse outcome for the radiologist.
- The average payout in these cases was $289,156

G.I. Cases

Of the GI cases, only some cancers are diagnosed in ER presentations and only some by CT. Perforated viscus, abscess, appendicitis and bowel obstruction and other ER CT diagnoses totaled just 32 cases for these same radiologists

Perforated Viscus

- For all cases related to perforated viscus, 47% of the studied claims have a known result
- 26% of all claims related to perforation resulted in an adverse outcome for the radiologist
- The average payout was $858,333

Limitations of these data

- Claims only to 2005 (from 1975 – 2005)
- Before recent acceleration of CT use
- Possible disjunction of claims against Radiologists from claims against Emergency physicians, or are they often co-defendants?

These data relate to all practice venues – outpatient, inpatient, and E.R. Thus the fraction of cases that are E.R. based suits cannot be known precisely

Further Limitations

- Criticism - Use of CT “maxed” out.
- Hence, there are many instances of doing a test even when evidence-based studies indicate it should not be done.
- But are there locations where it is likely to <u>not</u> do a test when not indicated? For this to be possible or frequent, one must demonstrate regional variations in utilization.

NEJM- 8/27/09

"Exposure to Low dose Ionizing Radiation from Medical Imaging Procedures"

5 Health Care Markets

- Annual effective doses of ionizing radiation analyzed for age and sex
- CT and Nuclear- 75% of cumulative effective dose

Rates of Exposure- Number/1000 enrollees

Market	Mod dose 3-20mSv	High dose 20-50 mSv
Arizona	132.3	12.8
Dallas	125.2	12.7
Orlando	147.6	14.4
S. Florida	168.5	15.4
Wisconsin	105.6	9.4

South Florida vs. Wisconsin

- There is approximately 67% greater dose deposition in South Florida for moderate and high dose CTs
- Consequently, if E.R. utilization is reflective of total utilization, some CT examinations done for emergency patients in South Florida are not performed routinely in Wisconsin.

2) What are the virtues and drawbacks of the American College of Radiology appropriateness initiative in general and specifically?

Appropriateness Criteria- ACR

Recommendations for an optimal evaluation paradigm using imaging tests pertinent to a specific clinical presentation.

Purpose

- Conceived to be advisory in intent
- Designed to be applied often even without discussion with a radiologist prior to implementation

Effect

- Inferred as a “standard” by plaintiff lawyers
- Limited direct relevance in contemporary E.R. practice
- Excellent example of the substitution of proxy proclamations for consultation by direct communication

Conceptual and Semantic Issues with Appropriateness Criteria

- What is a deviation from what is considered
  - Inappropriate?
  - Appropriate?
  - Or possibly not appropriate in context

Major Issue

Appropriateness criteria presume only a "horizontal" interaction. No consideration for "vertical" characteristics of the presentation and progression or resolution of an illness or injury.

Appropriateness Criteria ignore historical, episodic antecedents, patient participation, referrer's experience and judgment. And they also ignore diagnostic radiation exposure records by encounter and dose!

Example - ACR criteria for Small Bowel Obstruction.

S.B.O Considerations

- Presence – Always
- Site - Sometimes
- Cause - Sometimes

- For site and cause, CT superior to radiography
- But for presence alone the plain film and CT are similar in sensitivity (Maglinte 1996)
- Consider, the patient with recurrent S.B.O. due to adhesions

3) If the use (or overuse) of CT is based on either clinical parameters, personal predilections or perceptions of evidence-based protocols related to the ER, what is the participation of the radiologist in validating or substantiating them?

The Role of the Radiologist as a participant in the decision making process for E.R. CT utilization- A study of the test ordering practice of ER physicians and college physicians.

Two Clinical Scenarios

1) Suggestive of Appendicitis
2) One day of Abdominal Pain- no sign of disease
   - Both genders
   - Age 18-21
   - College Physicians- E.R. Physicians
   - ACR Appropriateness Criteria only for appendicitis and not for the one day of abdominal pain presentation

Table 1. Affirmative responses to ordering CT per clinical presentation

	Emergency department (622 total)	**College health service (208 total)**	**P value**
RLQ pain, tenderness, fever, increased white count, male pt	426 (68%)	157 (75%)	.069
RLQ pain, tenderness, fever, increased white count, female pt	516 (83%)	158 (76%)	.033
Diffuse pain, no guarding, normal white count, male pt	216 (35%)	22 (11%)	<.001
Diffuse pain, no guarding, normal white count, female pt	210 (34%)	28 (13%)	<.001

Seven Possible Influential Factors Regarding CT Choice

- Physical Exam
- Parental Influence
- Protocol
- Costs
- Insurance Considerations
- Medical Literature
- Relationship with Radiologist

Factor Importance	Rank
Not Important	1
Little Importance	2
Some importance	3
Very Important	4

Table 2. Level of importance of factors influencing CT ordering, **Male patients**

	Emergency Department	**College Health Service**	**P value**
Results of Physical Exam	3.88	3.90	.470
Parental Complaints/Influence	2.49	2.39	.101
Protocol	2.08	2.85	<.001
Costs	2.10	3.10	<.001
Insurance/Reimbursement considerations	1.42	2.67	<.001
Medical Literature	3.24	3.51	<.001
Relationship with Radiologist	1.63	1.72	.180

Table 3. Level of Importance of Factors influencing CT ordering, **Female patients**

	Emergency Department	**College Health Service**	**P value**
Results of Physical Exam	3.86	3.92	.072
Parental Complaints/Influence	2.50	2.39	.106
Protocol	2.09	2.86	<.001
Costs	2.10	3.11	<.001
Insurance/Reimbursement considerations	1.42	2.69	<.001
Medical Literature	3.24	3.51	<.001
Relationship with Radiologist	1.63	1.75	.083

Inferences

1) The decision to seek CT by E.R. physicians is not based on evidence derived from large scale controlled studies.

Inferences

2) The often uncritical decision to seek CT by E.R. physicians certainly increases collective dose to ER patients.

Inferences

3) “Possible” risks of this widespread practice is passed onto patients to “minimize” putative, heightened risks to E.R. physicians which may not be significant in the aggregate to the extent that a defensive posture is validly career-protective as well as psychologically self-serving.

Inferences

4) The number of instances of career E.R. based malpractice claims involving CT misdiagnosis is low when compared with the number of radiologists (24,000) and E.R. physicians (22,000).

These slides were prepared with the assistance of John Cho, Kim Clarkin, and Tim Meehan.

FDA Promotion of CT Radiation Safety: Federal Regulations, IEC Standards, Research, Outreach

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Food and Drug Administration
Center for Devices and Radiological Health
Office of Communications, Education, and Radiation Programs
Division of Mammography Quality and Radiation Programs
Radiation Programs Branch

NCRP Workshop on CT in Emergency Medicine, September 23-24, 2009

United States Department of Health & Human Services
Leading America to Better Health, Safety and Well-Being

FDA

Federal Radiation Protection

Current U.S. Standard for CT Equipment[1]

- ***21 CFR 1020.33*** (since 1984): for mfrs, *not* clinical facilities
- No ceiling on patient dose or dose rate
- Mfrs must ***provide users with info*** for each CT scanner model
  CTDI, dose profile, sensitivity profile
- Mfrs must ***certify equipment*** and ***submit reports*** to FDA
- ***Few technical requirements***:
  - Visual indication of beam on, pre-selected conditions of operation
  - Indication, positioning, alignment of tomographic plane
  - Emergency termination of x-ray exposure
  - Minimum HVL
- ***Has not been updated for***
  electron-beam, spiral, multi-slice, fluoroscopic, cone-beam CT

U.S. Medical Device Law

Medical Device Amendment, FFDCA (1976)[2]

CT imaging systems are class-II (medium risk) devices

- Mfrs, importers must register their companies, list their devices with FDA
- Mfrs need FDA clearance of device as "substantially equivalent" in its characteristics, performance, safety to predicate device (510(k), 21 CFR 807)

FDA cleared 320-slice, dual source, and dual-energy scanners

- Mfrs must comply with the quality system regulation and good manufacturing practices (QSI/GMP) in designing, manufacturing, labeling, storing, installing, servicing equipment (21 CFR 820)
- Equipment may be subject to general and special control requirements

FDA Modernization Act (1997)[3]

In lieu of submitting independently generated safety data to support pre-marketing notifications, mfrs can certify CT-equipment compliance with standards officially recognized by FDA

IEC 60601-2-44 Ed. 3, Feb 2009
Basic Safety and Essential Performance of X-ray Equipment for Computed Tomography[4]

Most Important Radiation-Safety Features

- Automatic Exposure Control (AEC)
- Standardization, display, recording of dose indices
- Radiation geometrical efficiency
- Other significant features

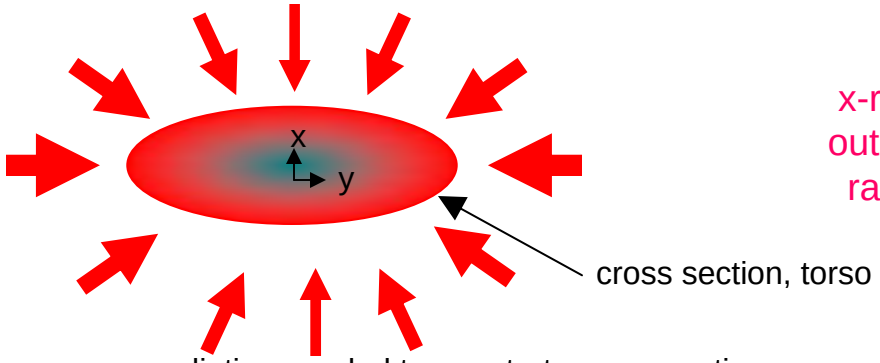
Automatic Exposure Control

(AEC) e.g. Anatomically Adapted X-Ray-Output Modulation[5,6]

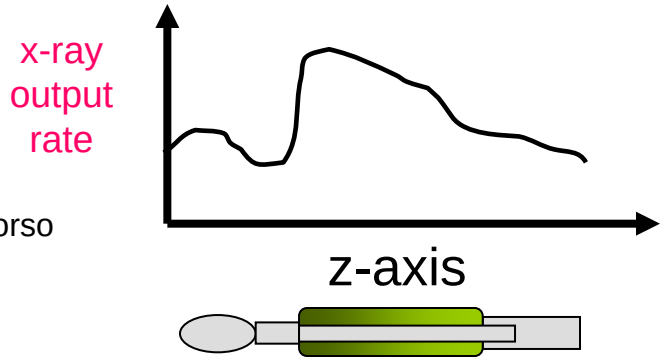
- CT system would **automatically adjust** x-ray emissions to amounts **needed** to image particular patient anatomy
- Pediatric, thinner adult patients: lower doses than thicker patients

IEC 60601-2-44 Ed. 3: 203.106 Control of radiation output....

On each CT SCANNER, AUTOMATIC EXPOSURE CONTROL (AEC) shall be provided as a MODES(S) OF OPERATION alternative to the manual selection of CT CONDITIONS OF OPERATION.[4]



thicker arrows: more radiation needed to penetrate cross section
thinner arrows: less radiation need to penetrate cross section



- **Potential impact: reduce patient CT dose ~ 30%** [7,8]

Patient Examination Dose-Indices

Display and Recording for QA

IEC 60601-2-44 Ed. 3: 203.112 Display and recording of *$CTDI_{vol}$* and *DLP*....

The actual mean values of *$CTDI_{vol}$* and *DLP* along with the PHANTOM type shall be recorded according to the DICOM CT radiation dose structured report (SR) templates of ISO 12052....[4]

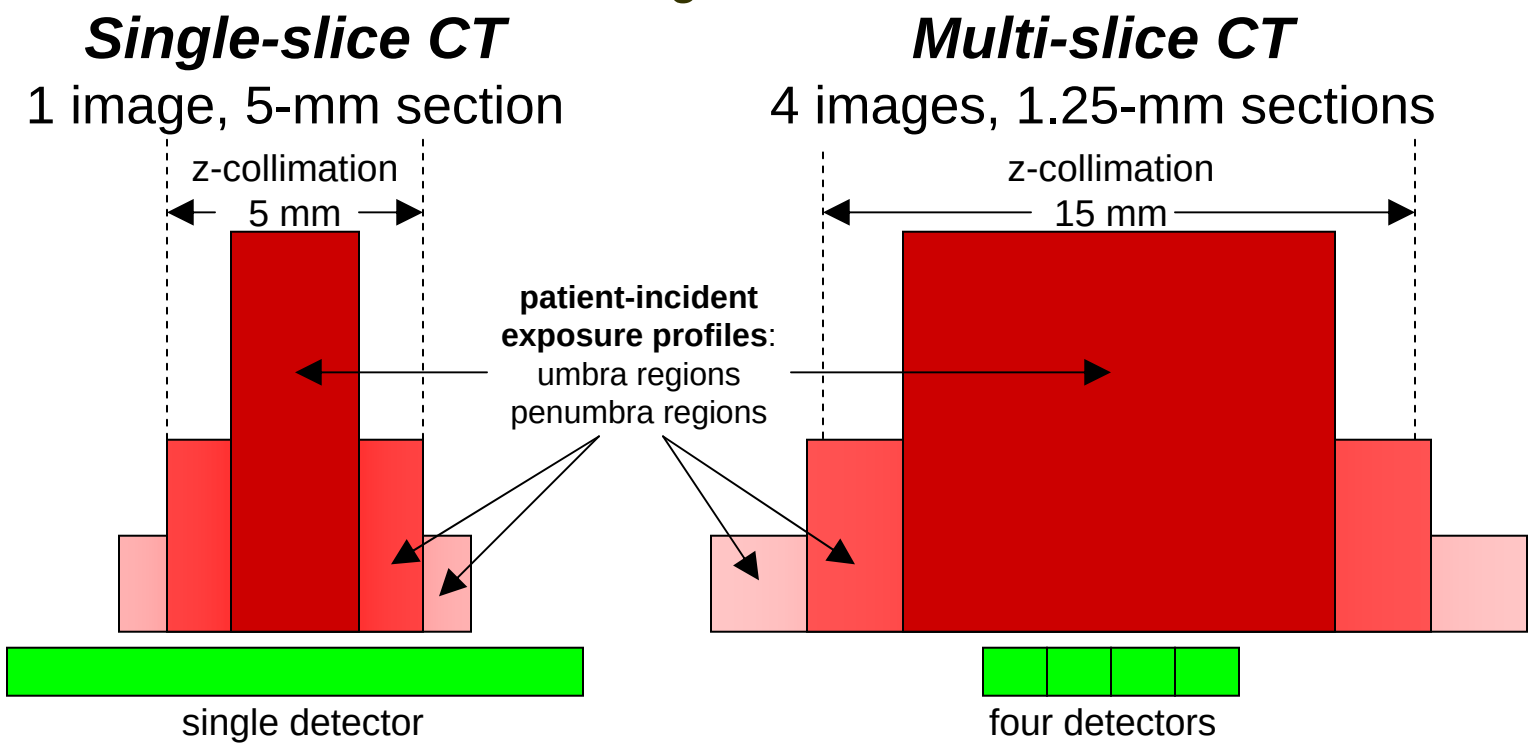
- Facilities could audit indices *versus* "reference values" [9-14]

compare dose indices to norms from which facilities could
investigate anomalies and optimize CT settings, protocols[15]

- **Potential impact: reduce patient CT dose on average ~ 15%** [16-19]

Radiation Geometric Efficiency

"Over-beaming" in Multi-slice CT[20-22]



IEC 60601-2-44 Ed. 3: 203.113 Geometric efficiency in the z direction

For those CT CONDITIONS OF OPERATION with a GEOMETRIC EFFICIENCY IN THE Z DIRECTION of less than 70 %, the value shall be displayed. Additionally, under this condition, there shall be a warning on the OPERATOR'S CONTROL PANEL, and the OPERATOR shall be required to confirm before continuing.

A table of GEOMETRIC EFFICIENCY IN THE Z DIRECTION at all beam collimations shall be provided in the ACCOMPANYING DOCUMENTS.[4]

IEC CT 60601-2-44: Other Radiation-Safety Features[4]

- Definition of Computed Tomography Dose Index $CTDI_{100}$ extended to accommodate wider collimations

- Reproducibility of radiation output tightened from ± 20% to ± 10%

- Following scanning, any CT condition of operation that has varied or changed during scan must be displayed

- The accompanying documents must contain a cautionary statement regarding the potential detrimental interaction of CT x radiation with electronically active medical devices either implanted or worn by a patient

- More information regarding stray radiation

What's missing from the IEC standards?

- *$CTDI_{100}$* underestimates body-scanning dose by 20-40% [23]

AAPM TG 111 new dose metric:[24] $pD_{eq} = \frac{p}{\Delta d}\int_{-\infty}^{\infty} D(z)dz$

- No pediatric or patient-specific (gender, height, weight) dosimetry

FDA initiative[25,26] *for IEC*

- Inadequate metrics for image quality
- No applicability to cone-beam or portable systems without a toroid-shaped gantry cover
- Should automatic exposure control be "on" by default and require a technologist to turn it "off" to enable manual-mode operation?

FDA Initiative[25,26] *for IEC*

Decouple Dose Metrics: Quality Assurance, Safety

- **Q/A: testing and display**
  - table moves (helical or axial CT): pD_{eq}
  - table stays put (fluoroscopic or cone-beam CT): $ND(z = 0)$
  - long, physical phantoms with compartments for *NPS*, *MTF*
- **Safety: radiation risk to patients**
  - *Organ doses*: anthropomorphic, computational phantoms ↔ patients
  - Record in DICOM Dose Structured Report

    All organ doses, pD_{eq} and $ND(z = 0)$

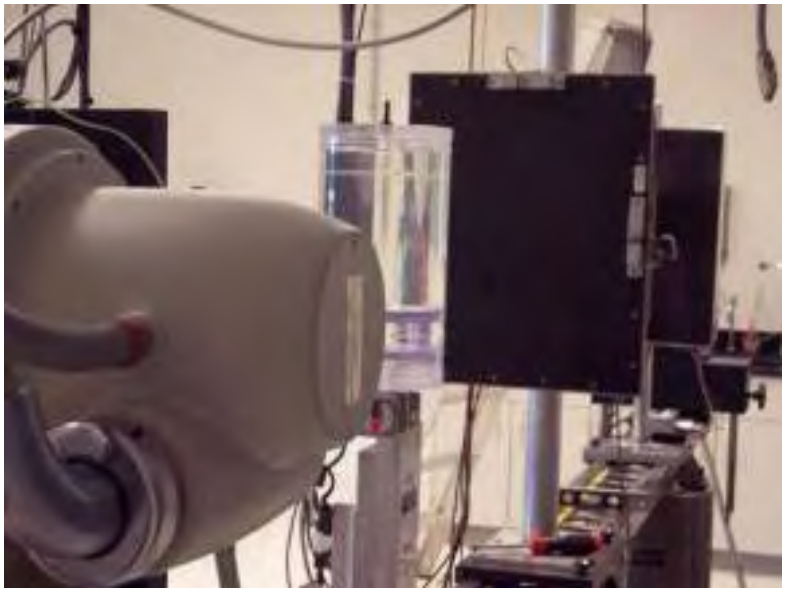
Conference of Radiation Control Program Directors, Inc.[27]

- Non-profit, non-govt organization promoting radiological health
  membership: state and local radiation control personnel
- Supported in part via FDA cooperative agreement
  - Nationwide Evaluation of X-Ray Trends Program (*NEXT*)
  - Suggested State Regulations for the Control of Radiation (*SSRCR*)
- States license and regulate *users*, not mfrs, of x-ray equipment
  - CT *equipment* requirements are *identical* to those of 21 CFR 1020.33
  - For CT, *SSRCR* contain additional requirements
    - Facility design: aural communication, viewing systems between patient and operator
    - Med physics survey, periodic calibration, spot checks of rad output, phantom images
    - Operating procedures: user training, availability of operational information
- States can require CT dose estimates from facilities and can exercise control over the business and practice of medicine

CT-related Research at FDA/CDRH

- Office of Science and Engineering Laboratories
  - Theory, computer simulation, measurement methodology for image quality, assessment of diagnostic efficacy of radiological equipment[28-41]
  - FDA Office of Women's Health sponsoring study[42]

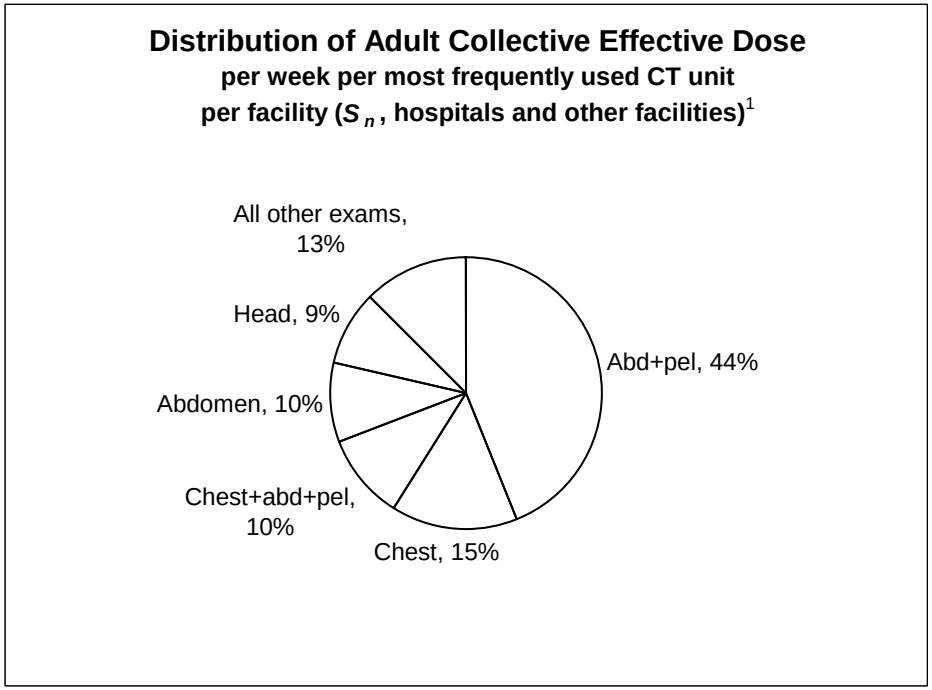
Radiation Dose and Excess Cancer Risk in Women Undergoing X-Ray Computed Tomography: Quantification and Risk Mitigation



Bench-top cone beam CT scanner

CT-related Research at FDA/CDRH

- Office of Communication, Education, and Radiation Programs
  - Nationwide Evaluation of X-Ray Trends: Computed Tomography[43,44]



U.S., 2000

[1]Distribution of **Total S_n = 756** person-mSv per week per most frequently used CT unit per facility. See Table 2.4.

- FDA Commissioner's Fellowship Program sponsoring project[45]

Development of a Handbook of Radiation Doses in Organs of Patients undergoing X-ray Computed Tomography

Outreach: Professional Organizations and the Public

- IEC, CRCPD, AAPM, NEMA/MITA, Alliance for Radiation Safety in Pediatric Imaging
- FDA Public Health Notifications
  - *Reducing Radiation Risk from Computed Tomography for Pediatric and Small Adult Patients,*[46] November 2001
  - *Possible Malfunction of Electronic Medical Devices Caused by Computed Tomography (CT) Scanning,*[47] July 2008
- FDA web pages: information and resource links
  - *CT Whole-Body Screening and Risk,*[48] April 2002, updated July 2009
  - *Radiation Dose Reduction,*[49] updated May 2009: link to ACR appropriateness criteria
- FDA-convened stakeholders' meeting, Nov 2005

  suggested educational initiatives, collaborations for efficient regulations, sharing of information to monitor high-risk procedures[50]
- We welcome comments, suggestions, and ideas for collaboration!

References and Notes

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2. For an overview of FDA regulation of medical devices, see http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/Overview/default.htm.

3. http://www.fda.gov/RegulatoryInformation/Legislation/FederalFoodDrugandCosmeticActFDCAct/SignificantAmendmentstotheFDCAct/FDAMA/default.htm.

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13. European Council, “Council Directive 97/43/Euratom of 30 June 1997 on Health Protection of Individuals Against the Dangers of Ionizing Radiation in Relation to Medical Exposure, and Repealing Directive 84/466/Euratom,” *Official Journal of the European Communities*, No. L 180, pp. 22-27, July 9, 1997.

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15. K.A. Jessen et al., “Quality Criteria Development within the Fourth Framework Research Programme: Computed Tomography,” *Radiation Protection Dosimetry* Vol. 90, Nos. 1-2, pp. 79-83, 2000, and reference 23 cited therein: A. Jurik et al., “Clinical Use of Image Quality Criteria in Computed Tomography: A Pilot Study,” *Radiation Protection Dosimetry* Vol. 90, Nos. 1-2, pp. 47-52, 2000. Also see P.C. Shrimpton and B.F. Wall, “Reference Doses for Paediatric Computed Tomography,” *Radiation Protection Dosimetry* Vol. 90, Nos. 1-2, pp. 249-252, 2000, and S.J. Golding and P.C. Shrimpton, “Radiation Dose in CT: Are We Meeting the Challenge?” *The British Journal of Radiology*, Vol 75, pp. 1-4, 2002.

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World Health Organization

International Perspectives on Use of CT Imaging: the WHO Global Initiative in Radiation Safety in Health Care Settings

Dr Maria del Rosario Pérez

Department of Public Health and Environment

Computed Tomography in Emergency Medicine-Ensuring Appropriate Use

Bethesda, Maryland, US - September 23-24, 2009

Radiation in Health Care

The use of radiation in health care is by far the largest contributor to the exposure of the general population from artificial sources

Annually worldwide

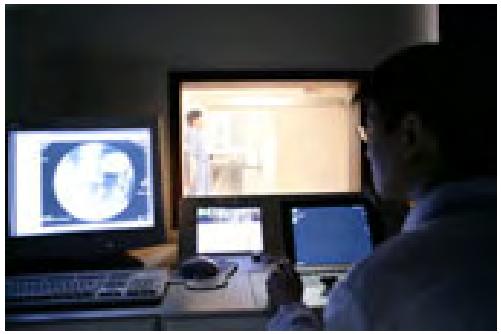
3,600 million X-ray exams (> 300 million in children)

37 million nuclear medicine procedures

7.5 million radiation oncology treatments

Radiation in Health Care

- As the benefits for patients gain recognition, the use of radiation in the diagnosis and treatment of human diseases increases.

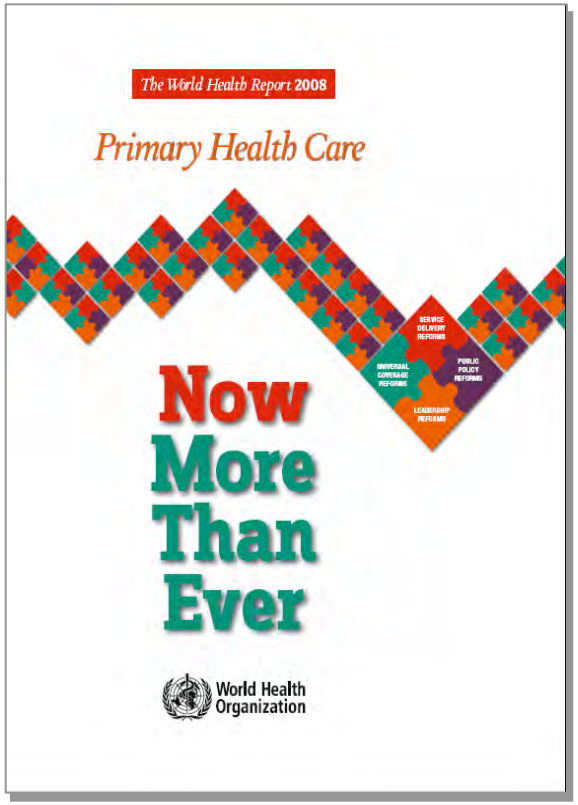


- While the development of modern health technology makes new applications safer, their inappropriate use can lead to unnecessary or unintended radiation doses, and can imply potential health hazards for patients and staff.

World Health Report 2008

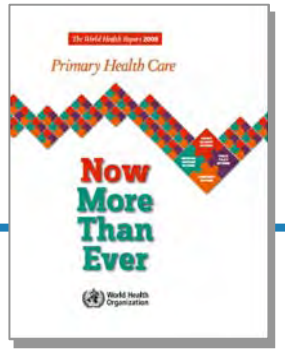
- Global health is receiving unprecedented attention
- Clear signs of willingness to work together in building sustainable health systems

PRIMARY HEALTH CARE



http://www.who.int/whr/2008/en/index.html

Primary Health Care (PHC) Reform

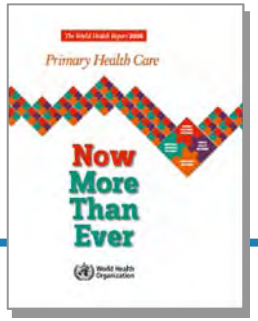


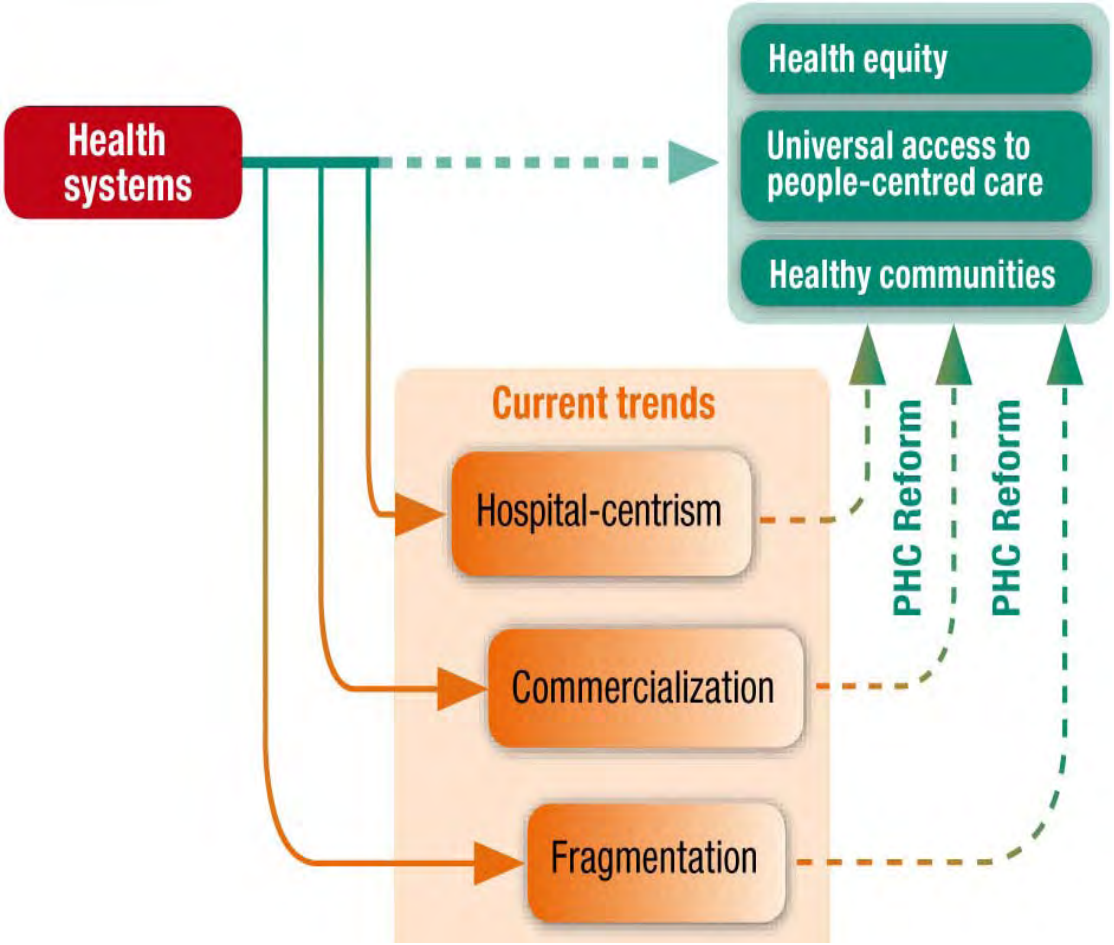
- **Primary health care** as a set of values and principles for guiding the development of health systems (4 sets of reforms)

Emphasis on 4 areas of strategic importance to deal with current and future challenges to health:

- *addressing health inequalities;*
- *people-centred care;*
- *better public policies;*
- *stronger leadership*

Primary Health Care Reform

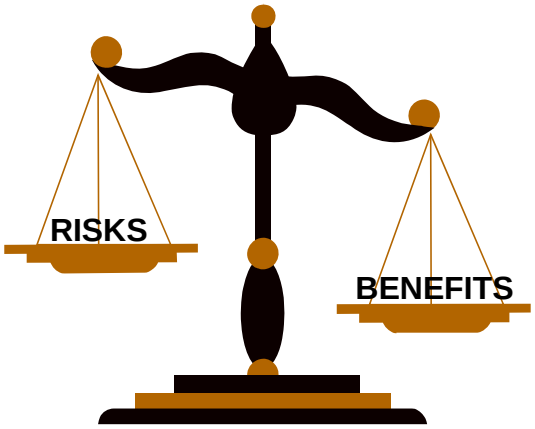




Mobilization of all forces in society –government, health professionals, institutions and civil society – around an agenda to transform health systems, driven by the values of ethics, equity, solidarity, social justice and participation.

The challenge

Although individual risks associated with diagnostic exposures are rather low, the wide use of radiation in medicine calls for a **public health** approach to control and minimize health **risks**, while maximizing the **benefits**

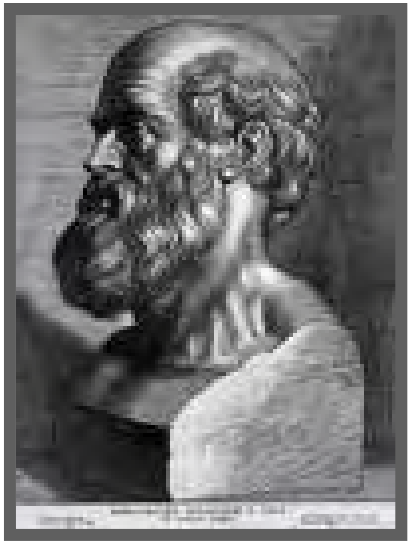


JUSTIFICATION **OPTIMIZATION**

The two principles of radiation protection in medical exposures are implicit in the hippocratic oath taken by doctors swearing to ethically practice medicine :

"… I will prescribe regimens for the good of my patients according to my ability and my judgment and never do harm to anyone…"

"Primum non nocere" *("First do no harm")*



Hippocrates
(460 BC - 377 BC)

Justification: ICRP Recommendations (I)

(330) Medical exposure of patients calls for a different and more detailed approach to the process of justification. The medical use of radiation should be justified, as is any other planned exposure situation, although that justification lies usually with the medical profession rather than with government or regulatory authorities. The principal aim of medical exposures is to do more good than harm to the patient, subsidiary account being taken of the radiation detriment from the exposure of the radiological staff and of other individuals. The responsibility for the justification of the use of a particular procedure falls on the relevant medical practitioners. Justification of medical procedures therefore remains a principal part of the Commission's Recommendations.

Justification: ICRP Recommendations (II)

(331) The principle of justification applies at three levels in the use of radiation in medicine.

- At the first level, the use of radiation in medicine is accepted as doing more good than harm to the patient. This level of justification can now be taken for granted and is not discussed further below.
- At the second level, a specified procedure with a specified objective is defined and justified (e.g., chest radiographs for patients showing relevant symptoms, or a group of individuals at risk to a condition that can be detected and treated). The aim of the second level of justification is to judge whether the radiological procedure will usually improve the diagnosis or treatment or will provide necessary information about the exposed individuals.
- At the third level, the application of the procedure to an individual patient should be justified (i.e., the particular application should be judged to do more good than harm to the individual patient). Hence all individual medical exposures should be justified in advance, taking into account the specific objectives of the exposure and the characteristics of the individual involved.

Justification: appropriateness criteria

Systematically developed statements to assist practitioner and patient decision about appropriate healthcare for specific clinical circumstances

- To adopt such evidence-based decision-aiding tools in diagnostic imaging may reduce 20-40% unjustified procedures. Need to advocate for their wider use into day-to-day practice, raising awareness of the impact of such behavior on population radiation dose and health costs.
- The use of educational reminders on the radiological reports contributes to the reduction in referrals for investigations of limited value (feedback strategy).
- Clinical audits for quality improvement should include evaluation of compliance with referral guidelines.

Optimization of protection

- Optimization of protection in medical exposures requires the management of the **radiation dose** to the patient to be **commensurate with the medical purpose**.

- **Diagnostic reference levels** are useful tools for optimization of protection in diagnostic applications: do the physicians understand how to use DRLs? (need for education, training, guidance)

- Methods for **dose reduction** (operational parameters, equipment and software design); to tailor the protocols according to patient size and level of acceptable noise for a given clinical indication (important in paediatric CT).

Currents trends in CT in the ED (I)

- The number of CT studies performed in ED showed a **five-fold increase** over one decade. Over half of ED CT studies are performed during the shift hours, involving smaller and less experienced teams.

- The "Golden Hour' rule" for **trauma** patients: ED doctors seem to feel more comfortable with CT images than with ultrasound.

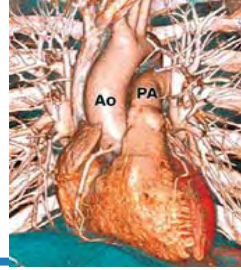
- In addition to trauma, the most common **clinical reasons** given by adult patients for visiting the ED include: chest pain, abdominal pain, back pain, headache and shortness of breath.

- Higher increase in **body CT studies** *(e.g. renal colic, appendicitis, acute abdomen, bowel obstruction)* **over neurological CT**.

Currents trends in CT in the ED (II)

- Time per CT examination has decreased, resulting in increased throughput.
- However, the radiologist's reading & reporting time is prolonged (i.e. more images to read, more reconstructions to perform).
- CT velocity of execution and accuracy make it an ideal tool for emergency use, particularly beneficial in the investigation of high-speed **trauma patients** including mass casualties events (quick mode to evaluate the extent of injury, shrapnel localization and detection of unsuspected injuries).

CT in the ED: an example



- Major life-threatening causes of chest pain (i.e. acute coronary syndrome, acute aortic syndrome and pulmonary embolism) can simultaneously be assessed now by the so-called "**triple rule-out**" CT angiography with a single scan (TRO CTA).

- In an appropriately selected ED patient population TRO CTA can safely eliminate the need for further diagnostic testing in over 75% of patients (e.g. *"low to intermediate risk for acute coronary syndrome and whose symptoms may also be attributed to acute pathologic conditions of the aorta or pulmonary arteries"*). **Need to consider appropriateness criteria**.

- Once the procedure is justified, a process of **optimization** can significantly reduce radiation dose without loss of image quality (e.g. *more than 50% dose reduction can be achieved for TRO CTA with ECG-based tube current modulation*).

CT in paediatric ED

- **CT** scan utilization in the **pediatric ED** has dramatically increased during last years (wider availability & improved diagnostic capability)

- CT implies a **higher radiation exposure** to children, who are especially vulnerable to environmental threats and have longer life-span to develop long-term radiation induced health effects like **cancer**.

- **Justification** of such procedures is essential. In addition, dose protocols and techniques have to be adapted to children and young adult patients to reduce radiation dose while providing the required diagnostic information (**optimization**).

CT in paediatric ED

Pediatr Radiol (2008) 38 (Suppl 4):S664–S669
DOI 10.1007/s00247-008-0892-z

ALARA: BUILDING BRIDGES BETWEEN RADIOLOGY AND EMERGENCY MEDICINE

CT utilization: the emergency department perspective

Joshua Seth Broder

Type of CT	Percent increase, patient age 0–2 years	Percent increase, patient age 3–12 years	Percent increase, patient age 13–17 years	Percent increase, patient age ≥18 years
Head	2	8	62	66
Cervical spine	180	175	731	557
Chest	100	283	675	309
Abdomen	−31	41	72	104
Miscellaneous	50	34	217	280

Percentage increase in CT utilization in the ED by patient age (2000-2006)

Use of CT in ED: driving forces

- New/sophisticated technology & vendor marketing
- Self-referral and other financial incentives
- Defensive medicine
- High valuation placed on imaging (instead of "*touching/ asking the patient*")
- Consumer model (patient's and/or family's expectations)
- Lack of awareness about CT radiation doses & associated risks
- Insufficient clinical knowledge/expertise in ED referrers
- Appropriateness criteria/referral guidelines not available/ignored
- Absence of radiologists for consultation during nightshifts
- Pressure from other specialists e.g. "W*hat does the CT shows?*"; "*Repeat the CT scan*"; "*Request a CT scan prior patient release from the ED*" … etc.

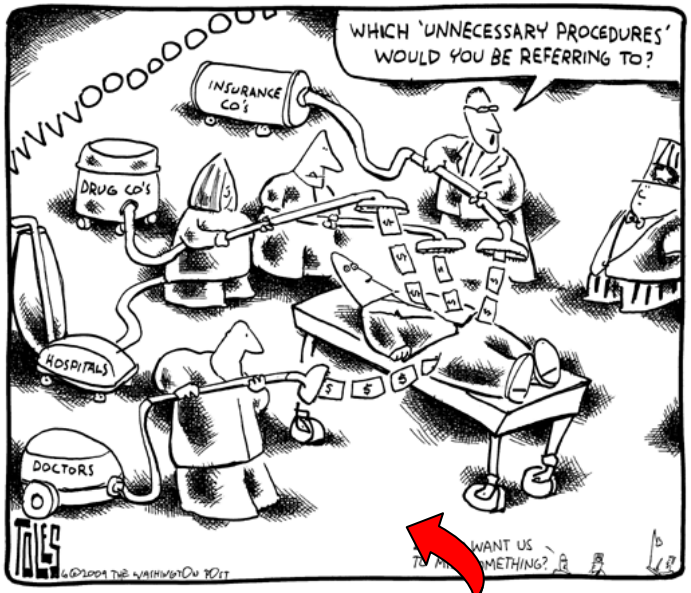
Diagnostic imaging & health care costs

- US medical imaging annual cost: almost $ 100 billion;
- Medicare pays for U$ 14 billion of that;
- Medical imaging: one of the fastest growth rates (~10% / year)
- Annual imaging costs per capita: $ 229 in 1997 to $ 443 in 2006

"OVERUSE" ?

"Application of an imaging procedure where it is unlikely to improve patient outcome" (unnecessary, unjustified).

The increasing use of radiation in healthcare "per se" cannot be take as evidence of "OVERUSE"



However …

Turf Wars in Radiology: The Overutilization of Imaging Resulting from Self-Referral

David C. Levin, MD[a,b], Vijay M. Rao, MD[a]

A recent report by the Medicare Payment Advisory Commission to Congress indicated that the utilization of diagnostic imaging is growing more rapidly than that of any other type of physician service. This has engendered concern among those who pay for health care. In this article, the authors review the role of self-referral in driving up imaging utilization.

A number of studies of the self-referral factor in imaging have been conducted over the past three decades. These have consistently shown that when nonradiologist physicians operate their own imaging equipment and have the opportunity to self-refer, their utilization is substantially higher than among other physicians who refer their patients to radiologists. It has also been shown that the vast bulk of the recent increases in imaging utilization are attributable to nonradiologists who self-refer. The authors estimate that the cost to the American health care system of unnecessary imaging resulting from self-referral by nonradiologists is $16 billion per year.

Key Words: Medical economics, diagnostic radiology, radiology, radiologists, departmental management, socioeconomic issues

J Am Coll Radiol 2004;1:169-172.

Defensive medicine

"*Physicians may respond to the perceived threat of litigation by ordering more referrals and more tests, some of which may be recommended by clinical guidelines and beneficial, but others might be wasteful and harmful*"

Massachussets Statewide Survey on DM (3650 physicians; 2007-2008)

- 83% reported that they practiced DM;
- Plain film X-rays: 22%;
- CT scans: 33% among emergency physicians & obstetrics/gynaecologists and 20% in other specialties;
- Laboratory tests: 18%;
- Hospital admissions: 13%

Doctors' knowledge of radiation doses

Dose for chest x ray used as single unit dose of radiation; figures are numbers (percentage) of doctors with correct answer for each investigation

Shiralkar et al. BMJ 327(7411): 371–372 (2003)

Radiological investigation	Equivalent No of chest x rays	No of correct answers (n=130)
Abdominal x ray	75	2 (1.5)
Lumbar spine x ray	120	3 (2)
Thoracic spine x ray	50	4 (3)
Barium swallow	100	6 (5)
CT of abdomen	400	8 (6)
Spiral CT of abdomen	300	9 (7)

Risk communication

- Lack/insufficient awareness of radiation doses & risks among ED physicians and other referrers, and even among radiological practitioners.
- Informed consent: when it might be waved in ED ? is the information understood? (need for guidance)
- Deficiencies in risk communication e.g. plain language, tailored messages to reach the target audience, use variety of channels, to develop a strategy:
  - What must be communicated?
  - Who is/are the target audiences?
  - How can they best be reached?
  - What actions/activities should take place?
  - What are the resources needed?
  - How can we monitor output & impact?

Improving RP culture in health care settings: a culture shift to change practice

- Three organizational **culture** levels:
  - Basic underlying assumptions (beliefs, perceptions, unconscious thoughts);
  - Espoused/adopted shared values (strategies, objectives, operating principles, recommendations, standards, guidelines); and
  - Artifacts/visible products (behaviour, practices, decisions, attitudes)

- **RP culture** as part of good medical practice (for both users and prescribers of radiation in health-care).

- Creating a strong **RP culture** in hospitals is today a challenging task for health policy- and decision-makers.

How to improve RP culture in health care?

Behaviour decisions

Espoused shared values

Underlying assumptions

Weak !!

Behaviour, decisions

Espoused shared values

Underlying assumptions

Strong

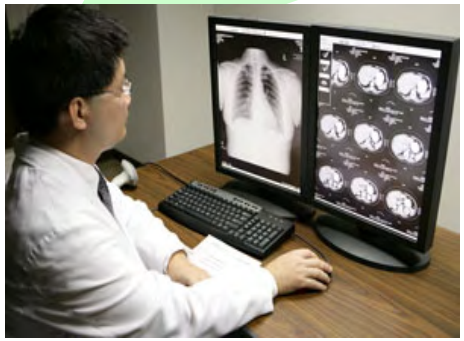
Practice: appropriate use

Referral guidelines, norms, standards

Advocacy, awareness raising, education

Ensuring that underlying assumptions line up with espoused values, which in turn line up with behaviour

WHO Global Initiative on Radiation Safety in Health Care Settings



Diagnostic radiology

Interventional radiology

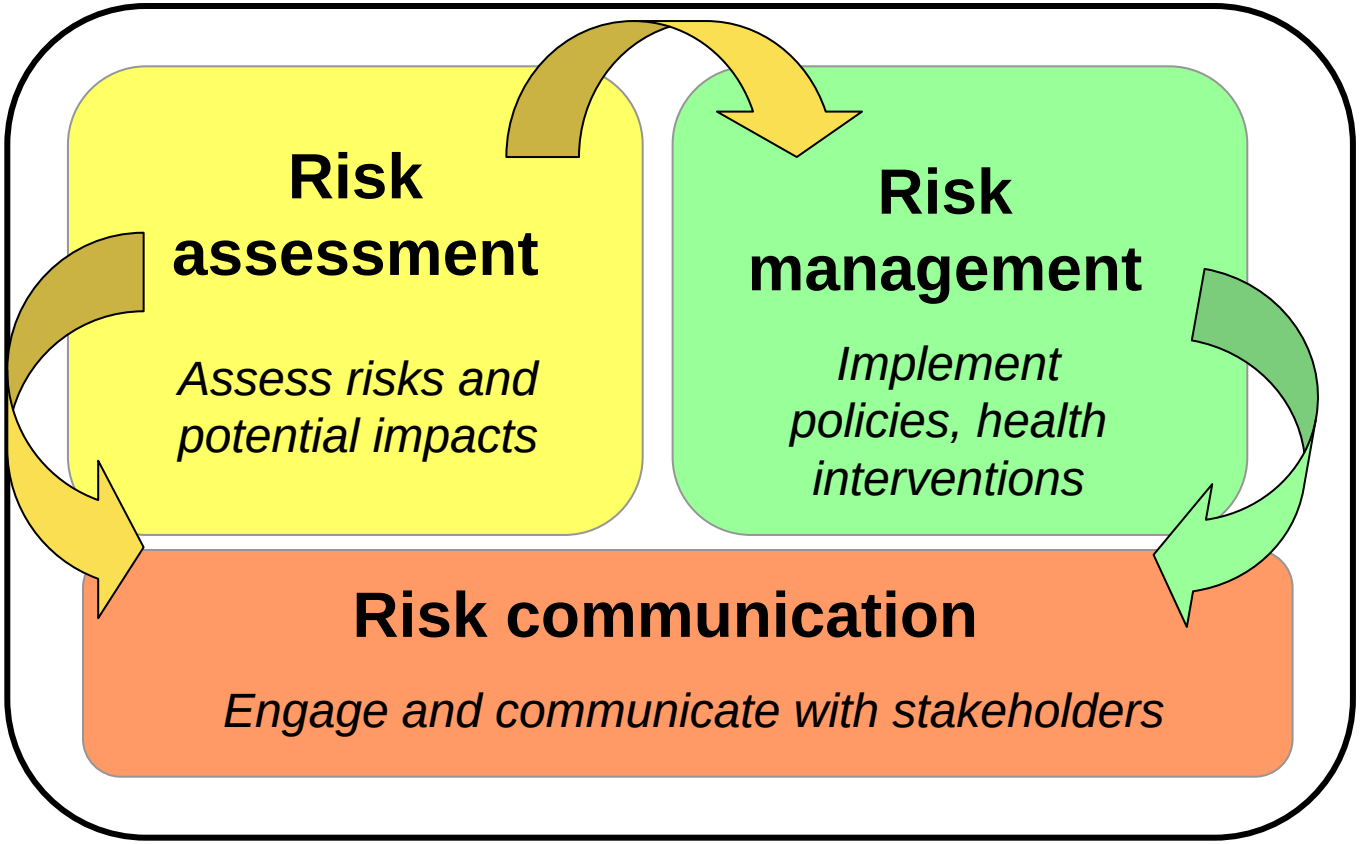
Radiotherapy

Nuclear Medicine

Focusing on Public Health aspects related to the risks and benefits of the use of radiation in health care

Strategic Approach

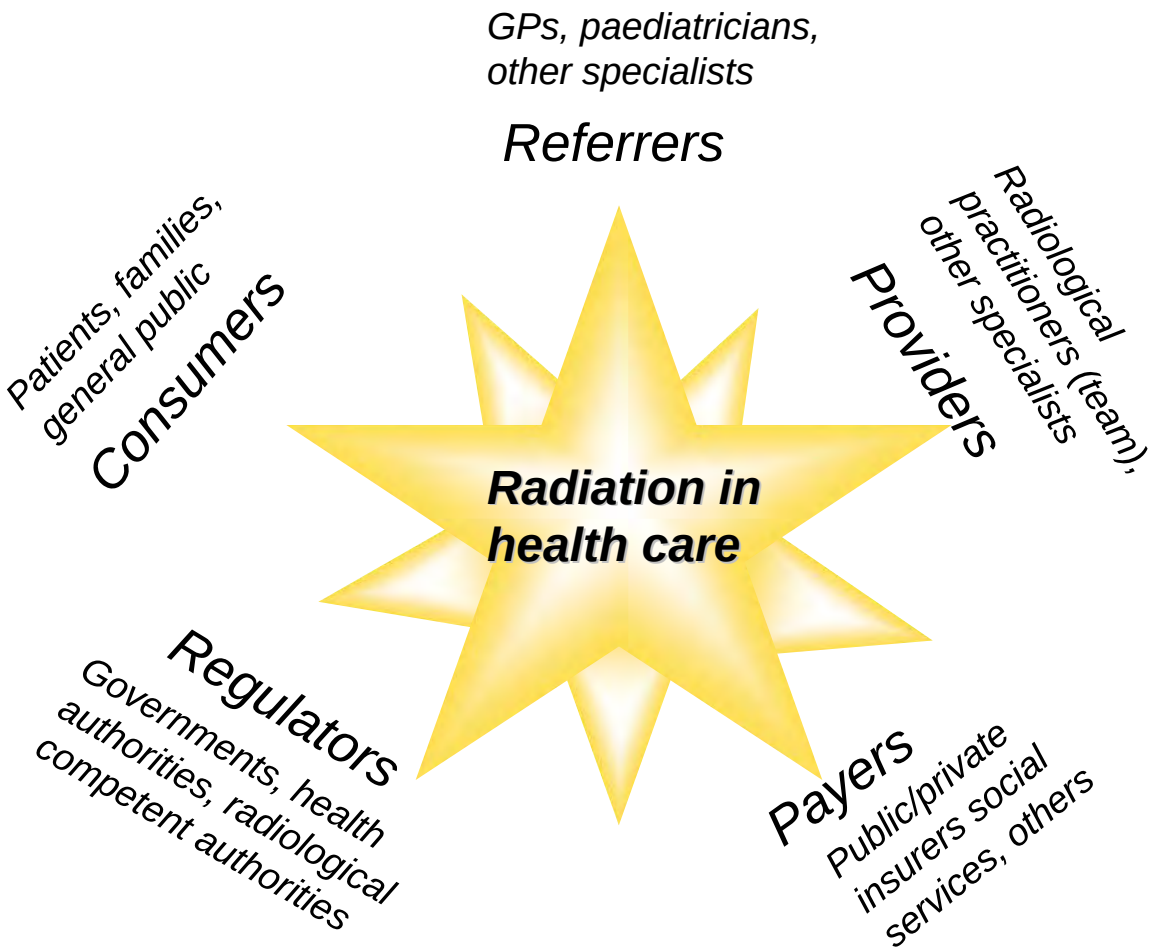
Translate the scientific evidence into policies and programmes



The activities

Risk assessment	• *Collect and share information on the use of radiation in health care, including surveys on population dose distribution .* • *Shape and promote a research agenda on health effects of medical radiation exposure (focusing on children)*
Risk management	• *Reduction on unnecessary radiation exposures: justification of medical procedures (i.e. appropriateness criteria) and optimization of protection (diagnostic reference levels)* • *Advocacy tools and guidance for health authorities and policy makers (including regulatory aspects)* • *Clinical audit and quality improvement* • *Occupational health focused on interventional radiology* • *Education, training, staffing needs (medical physicists, radiographers, radiation technologists)* • *Harmonization of error reporting systems and severity scale grades*
Risk communication	• *Communication strategy for information and awareness raising (including informed consent)*

Stakeholder engagement



Others

……??

Professional, academic & scientific societies

Medical defence organizations

International agencies

Manufacturers

World Health Organization

Global Initiative: work plan and timeline

- *Develop proposal*
- *Internal/external consultation*
- *Identify/consult stakeholders*
- *Build partnership*

Step 1

Outline of the strategy

- *Platform*
- *Terms of reference*
- *Projects/activities*
- *Working groups*
- *Task Coord. Team*
- *Budget, fundraising*

Step 2

Development of the work plan

- *Priorities*
- *Pilot experience*
- *Task execution*
- *Working groups operating*

Step 3

Implementation of the GI

- *Monitor implementation*
- *Evaluate the impact*
- *Feedback and results communication*

Step 4

Monitoring, evaluation

Dec. 2008 → *June 2009* → *June 2011* → *Dec. 2011*

Thank you very much

http://www.who.int/ionizing_radiation/about/med_exposure/en/index.html

perezm@who.int

NCRP
National Council on Radiation Protection & Measurements

Computed Tomography in Emergency Medicine — Ensuring Appropriate Use

Bethesda, Maryland
September 23-24, 2009

Today's Presentation:

Emergency Radiology — Legal/Regulatory Challenges

Overview of Today's Talk

1) Ordering Diagnostic Tests
2) Anti-Markup Rule
3) International Teleradiology
4) Medicare Reimbursement for Emergency Radiology Services – Current Status
5) New Medicare HOPPS supervision "clarification"
6) Joint Commission Standards on Credentialing and Privileging

Ordering Diagnostic Tests

- 42 C.F.R. 410.32
- Medicare Benefit Policy Manual, Chapter 15, Section 80.6
- General rule, only treating physician may order
- Does not apply to hospitals

Ordering Tests Rule

- What is the rule for tests ordered in hospitals?
- Medicare Conditions of Participation 42 C.F.R. 482.26(b)(4)

Ordering Diagnostic Tests

- Prior authorization
- Radiology Benefit Managers
- Appropriations criteria
- Computerize Order Entity Processes

Anti-Markup Rule

- 42 C.F.R. 414.50
- TC and PC Billing

International Teleradiology

SSA § 1862(a)(4). Prohibits Medicare payment for items and services furnished outside the U.S., except for certain limited services in Canada or Mexico.

International Teleradiology

On Feb. 23, 2007 CMS issued transmittal (R66BP) on "Services Not Provided Within United States" The transmittal states:

"Payment may not be made for a medical service (or a portion of it) that was subcontracted to another provider or supplier located outside the United States. For example, if a radiologist who practices in India analyzes imaging tests that were performed on a beneficiary in the United States, Medicare would not pay the radiologist or the U.S. facility that performed the imaging test for any of the services that were performed by the radiologist in India."

International Teleradiology

Transmittal reflects **no change** in CMS policy.

CMS has not indicated that a preliminary interpretation cannot be followed by an official interpretation by the local radiologist.

The official interpretation by the local radiologist is payable by Medicare – **must be real!**

Letter from CMS…

December 4, 2007 Letter from CMS Director of Technical Payment Policy, Donald H. Romano:

"…the radiologist in the United States must actually perform the entire service and not simply rely on or 'rubber stamp' the interpretation of the radiologist in India."

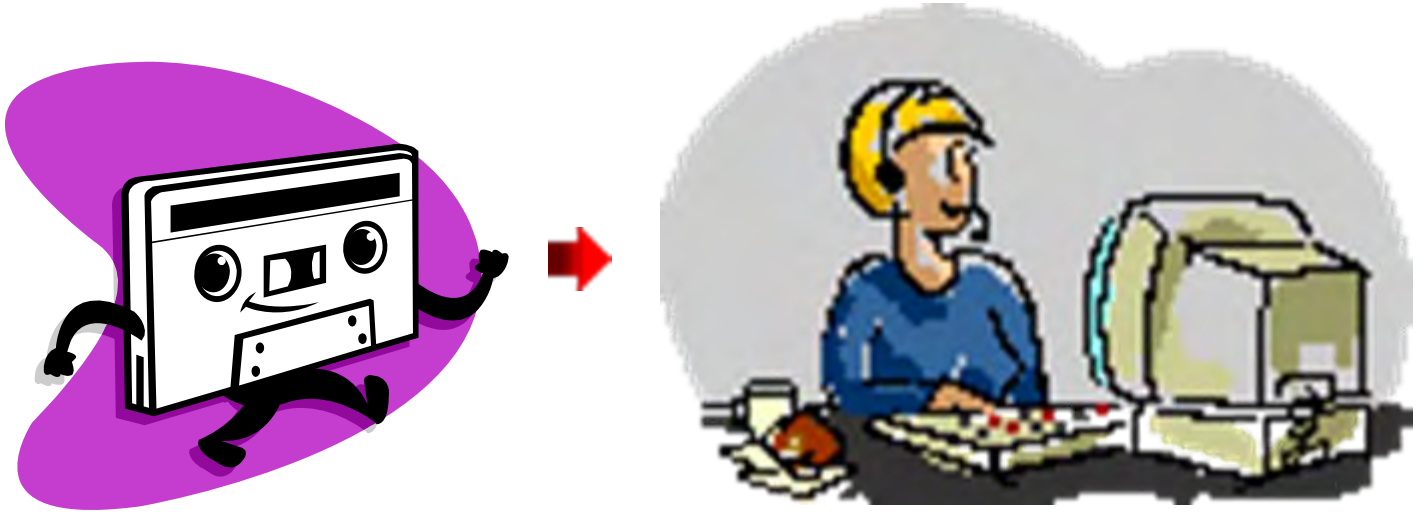
OIG 2009 Fiscal Year Work Plan

Payments for Diagnostic X-Rays in Hospital Emergency Departments

"We will review a sample of Medicare Part B paid claims and medical records for diagnostic x-rays performed in hospital emergency departments to determine the appropriateness of payments. Radiology services furnished by a physician are reimbursed by the Medicare Physician Fee Schedule provided the conditions for payment for radiology services at 42 CFR § 415.102(a) and 42 CFR § 120 are met. The Medicare Payment Advisory Commission (MedPAC), in its March 2005 testimony before Congress, reported concerns regarding the increasing cost of imaging services for Medicare beneficiaries and potential overuse of diagnostic imaging services. In 2004, approximately 4.7 million diagnostic x-rays were performed in Medicare-certified hospitals with emergency departments, a 9.6-percent increase since 2001. Medicare spent approximately $48.3 million for these services in 2004. We will determine the appropriateness of payments for diagnostic x-rays and interpretations."
(OEI; 00-00-00000; expected issue date: FY 2009; new start)

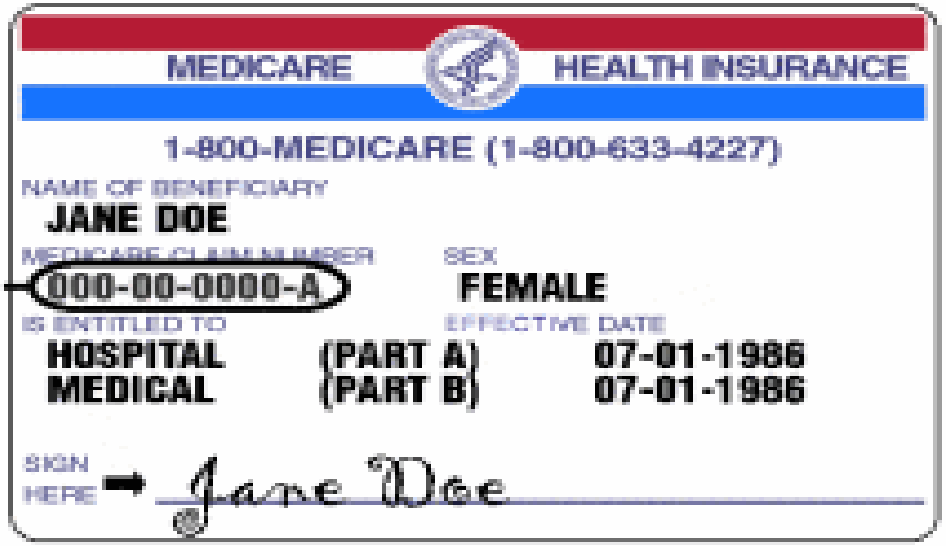
Medicare Rule

Professional component of radiology service requires written report of findings. *See* 42 CFR 415.120.



Medicare Reimbursement Issue

Issue is whether the Medicare carrier will reimburse radiologist or emergency physician for physician service.



Medicare Reimbursement Issue

Currently, Medicare billing policy allows carrier to reimburse radiologist for a physician service. But also possible that carrier reimburse emergency physician for physician service, precluding reimbursement to radiologist.

OIG Concern

OIG has, in the past, raised the question whether interpretations of emergency department diagnostic tests produced after an emergency physician has made treatment decisions are appropriately payable by Medicare as physician services.

OIG Concern

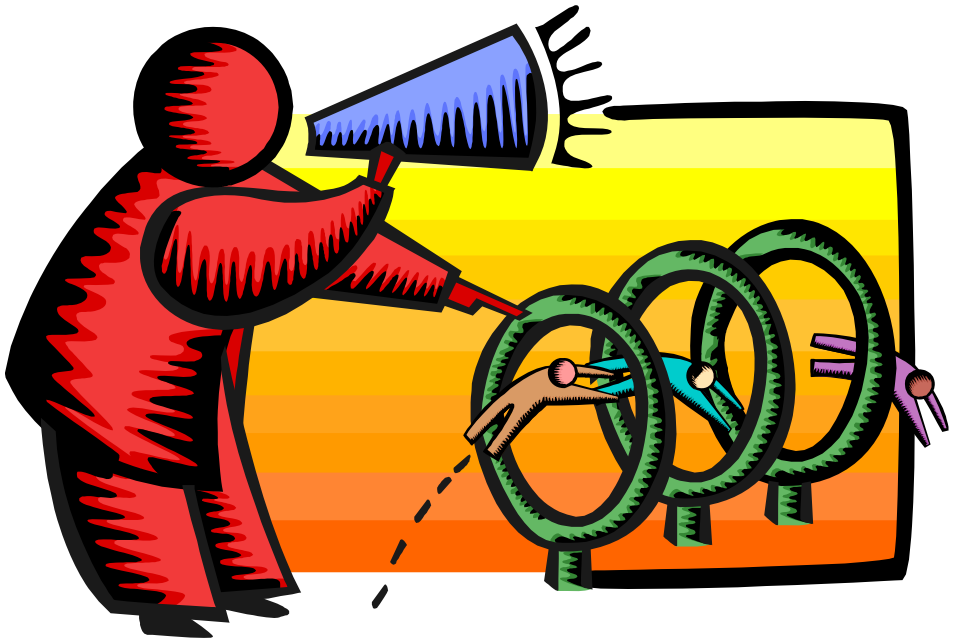
- Office of Evaluation and Inspection study entitled "Diagnostic Testing in Emergency Rooms."
- Work plan for 2009.

OIG Recommendations

1993 OIG Report "Medicare's Reimbursement for Interpretations of Hospital Emergency Room X- rays." OIG Report No. OEI-02-89-01490 (July 1993).

OIG Recommendations

1993 report criticized then-current Medicare payment policy for x-rays in hospital emergency rooms.



OIG Recommendations

Then CMS Policy:

Medicare's 1993 policy:

Section 2020G of the Medicare Carriers Manual, when a hospital radiologist interpreted an x-ray that had already been interpreted by another physician, the service of the radiologist almost always constituted a physician service and was payable by the Medicare carrier. (cont'd)

OIG Recommendations

CMS 1993 Policy:

...In those situations where the radiologist's interpretation was for quality control purposes, the service was to be considered a hospital service instead of a physician service and was to be reimbursed to the hospital by a fiscal intermediary under Medicare Part A.

OIG Recommendations

CMS 1993 Policy:

Policy based on three assumptions:

(1) reinterpretations almost always constituted patient care.

OIG Recommendations

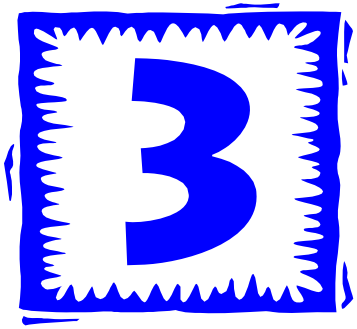
CMS 1993 Policy:

(2) Radiologists are recognized experts, therefore, x-rays should be read by them.

OIG Recommendations

CMS 1993 Policy:

(3) The qualifications of the interpreting physician are more important than the exact timing of the interpretation in determining whether a substantive physician service had been provided.



OIG Recommendations

OIG stated in 1993 report that when patients discharged before, or on the same day as, radiologist's final interpretation did not constitute patient care because no effect on the treatments provided by emergency physicians.

OIG Recommendations

OIG recommended in 1993 Medicare pay for reinterpretations of x-rays only when attending physicians specifically requested a second physician's interpretation in order to render appropriate medical care before patient discharged.

OIG Recommendations

OIG also recommended any other reinterpretation of attending physician's original interpretation should be treated and reimbursed under Part A as hospital quality assurance program.

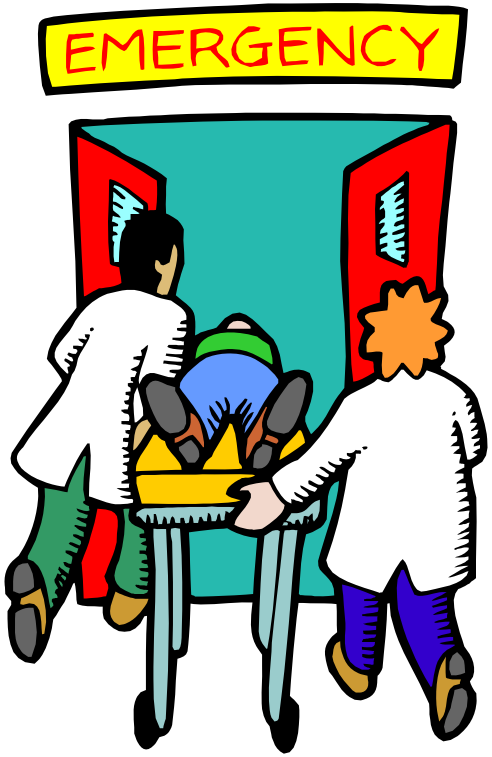
OIG Recommendations

HCFA (now CMS) responded to OIG recommendations. Their response is current Medicare payment policy.

Current CMS Policy

Medicare Claims Processing Manual; Chapter 13; Section 100.1, *et seq*.

Carrier pays for only one interpretation and report of x-ray procedure furnished to emergency patient.

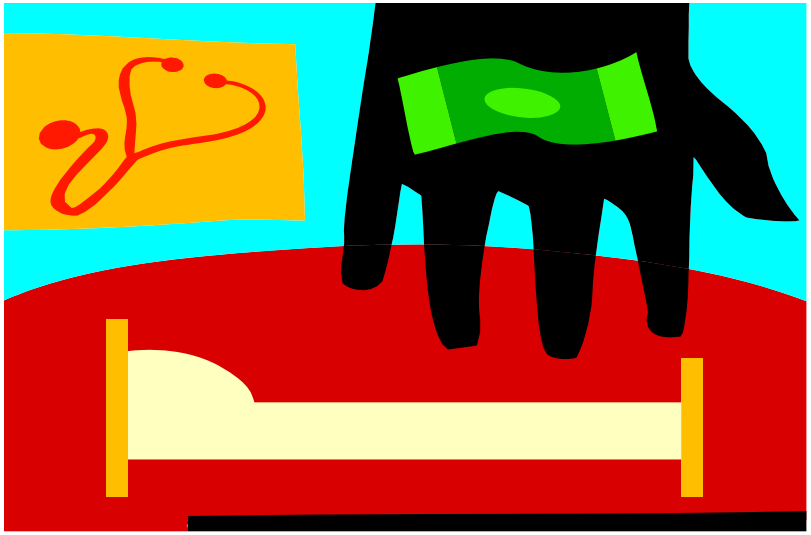


Current CMS Policy

Note that carrier will pay for interpretations of radiology examinations only if there is written report prepared for inclusion in patient's medical record. *See* 42 CFR 415.120. *See* also Medicare Claims Processing Manual Ch. 13, Section 20.1.

Current CMS Policy

<u>If multiple claims submitted</u> for payment for interpretations of same diagnostic test, policy is to pay only for interpretation and report that directly contributed to diagnosis and treatment of patient.



Current CMS Policy

In practice, default assumption for carrier is that the first claim received should be paid.

Current CMS Policy

Hospitals are also required by Medicare's Conditions of Participation for Hospitals to maintain reports signed by the interpreting physician. See 42 CFR 482.26.

Value of Teleradiology

Availability to teleradiology services has enhanced the availability of "contemporaneous" interpretations – even if "preliminary" and "non-official."

Preliminary Interpretations

Q: Can local radiologist simply sign-off on Preliminary Interpretation?

A: “No.” The interpretation must be “real.”

Medicare New HOPPS Supervision Rule “Clarification”

- General
- Direct
- Personal

Long applied only to physician offices, IDTFs and **off-campus** provider-based entities.

Medicare New HOPPS Supervision Rule “Clarification”

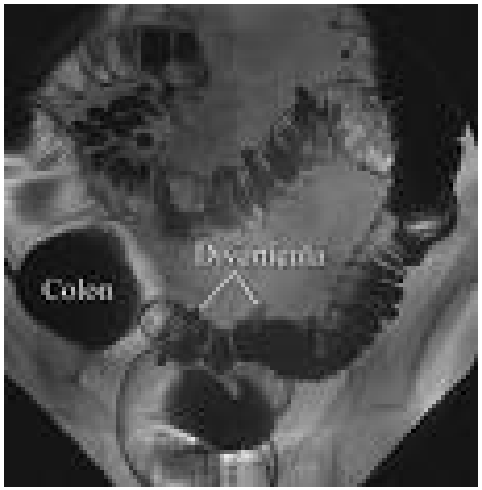
- General
- Direct
- Personal

Now applies to all Medicare outpatient tests – **off-campus** AND **on-campus**.

Medicare New HOPPS Supervision Rule “Clarification”

Impact:

1) Contrast studies
2) Fluoroscopy



Joint Commission Standards

Leadership Standard LD 3.50

- Permits proxy credentialing and privileging when hospital contracts for interpretation services with Joint Commission accredited organization.

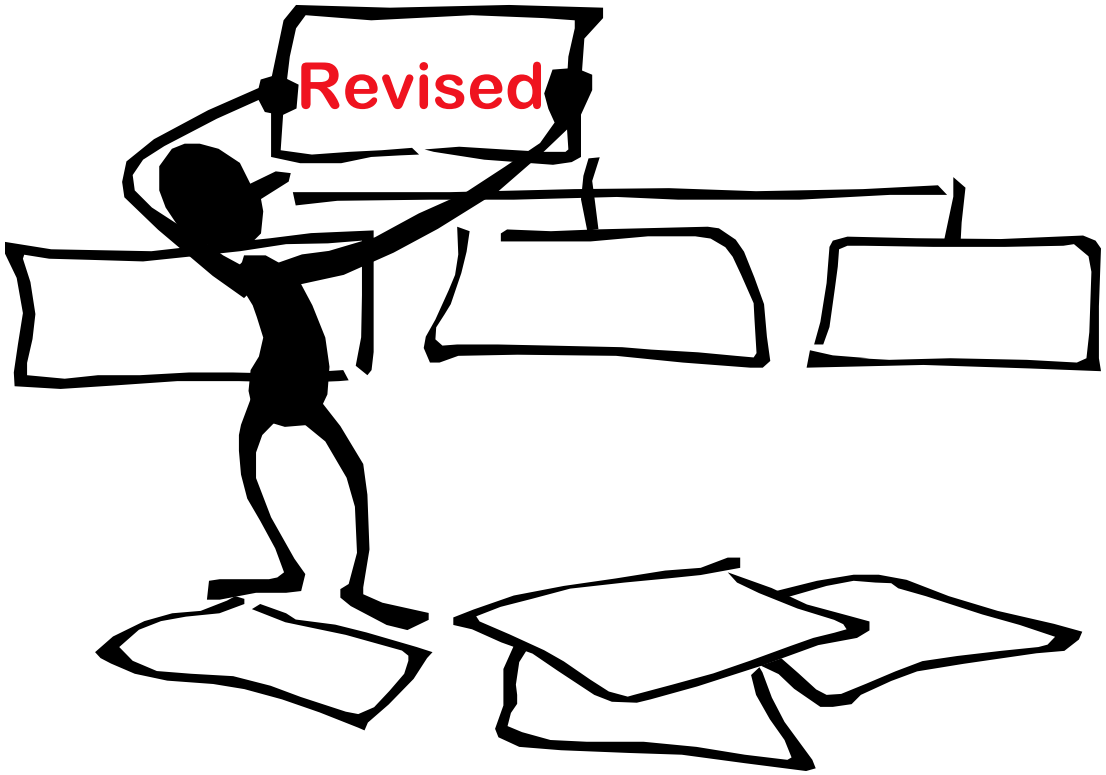
Joint Commission Standards

CMS (unofficially) takes a different view.

- CMS opposes proxy credentialing.
- Believes Medicare Conditions of Participation (42 C.F.R. 482.22) require medical staff to examine credentialing of all staff members.

Joint Commission Standards

LD 3.50 revised effective January, 2008. Hospital may continue to relay on proxy credentials.



Joint Commission Standards

Revised LD 3.50

Hospital that contracts with Joint Commission accredited organization should:

- Determine that the care, treatment, or services are included in the scope of the accreditation or certification of contracting entity; and
- Ensure that contracted entity policies and practices meet hospital's requirements for staff qualifications and competence and for providing care, treatment, and services.

Joint Commission vs. CMS

- An open issue
- Things could change when Joint Commission files its "Deemed Status" application in January with CMS

VS

In sum…

Radiologist's official interpretation following preliminary interpretation by teleradiology company:

- Must be standard report documenting all findings!
- *Not* an overread.
- *Not* a confirmation
- It is a ***real*** interpretation.

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NCRP Workshop on
Computed Tomography in Emergency Medicine – Ensuring Appropriate Use

Section 5: Clinical Decision Making and Implications for Reducing or Eliminating Imaging Done

Clinical Decisions: Radiology Perspective

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Director of Emergency Radiology, Massachusetts General Hospital
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CT of Emergency Department Patients Goals of Radiologist for Reducing Radiation

1. Perform CT scans only on ED patients in whom a CT scan is truly indicated
2. Utilize precise knowledge of clinical presentation to plan the optimal CT protocol for resolving the clinical question
3. Perform the CT scan with the minimum radiation exposure for obtaining a diagnostic quality examination

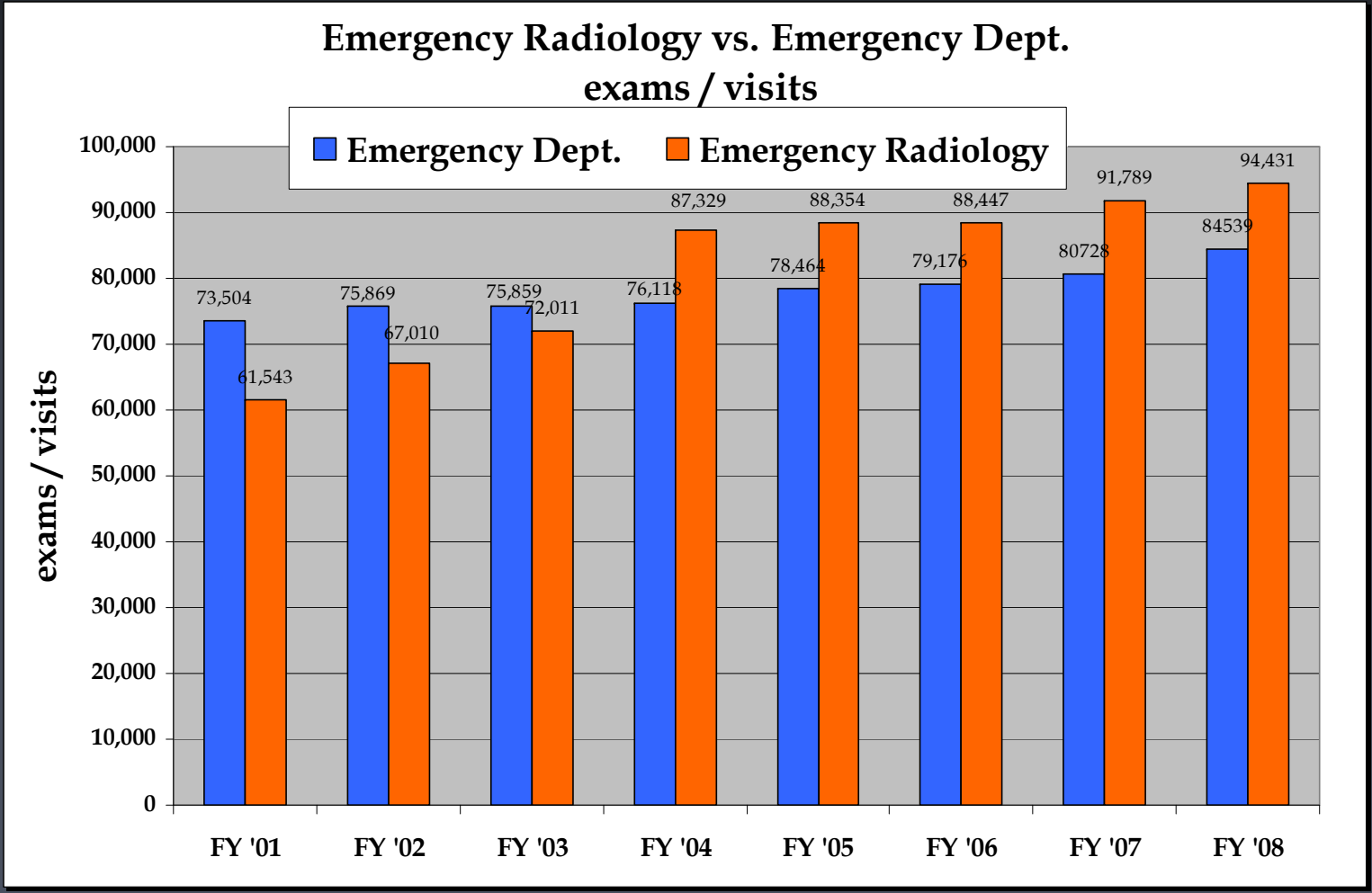
How Common are CT Examinations on ED Patients at the Massachusetts General Hospital?

2008 Statistics
MGH Emergency Radiology Division

- Fiscal year 2008:
  - 94,431 imaging exams on 84,539 ED patients
  - 34,121 (36%) imaging exams were CT scans
- CT volume on ED patients has been increasing by more than 5% annually
- Current ED CT volume is >100 scans/day

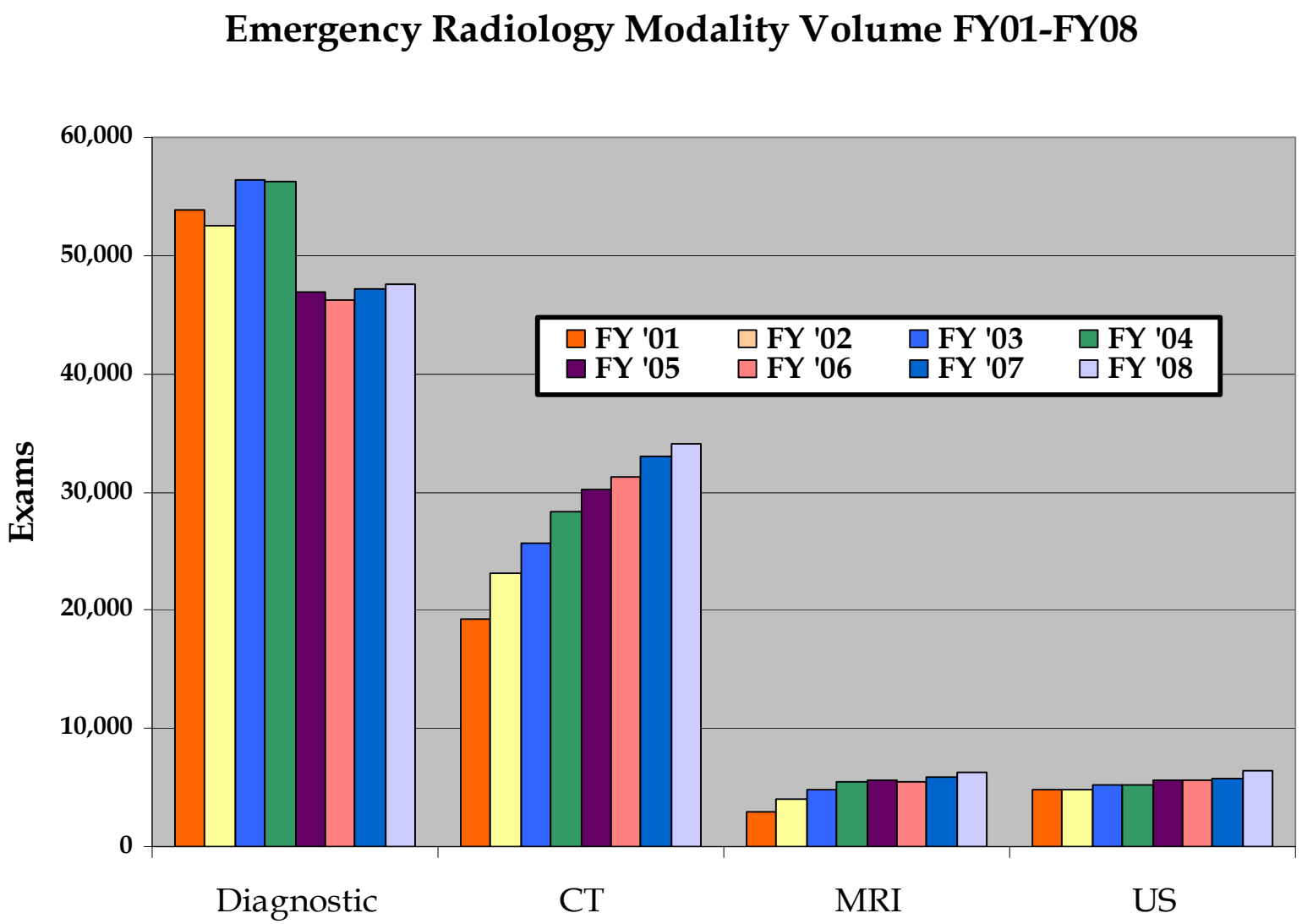
Number of imaging exams now exceeds the number of ED patients visits

Massachusetts General Hospital



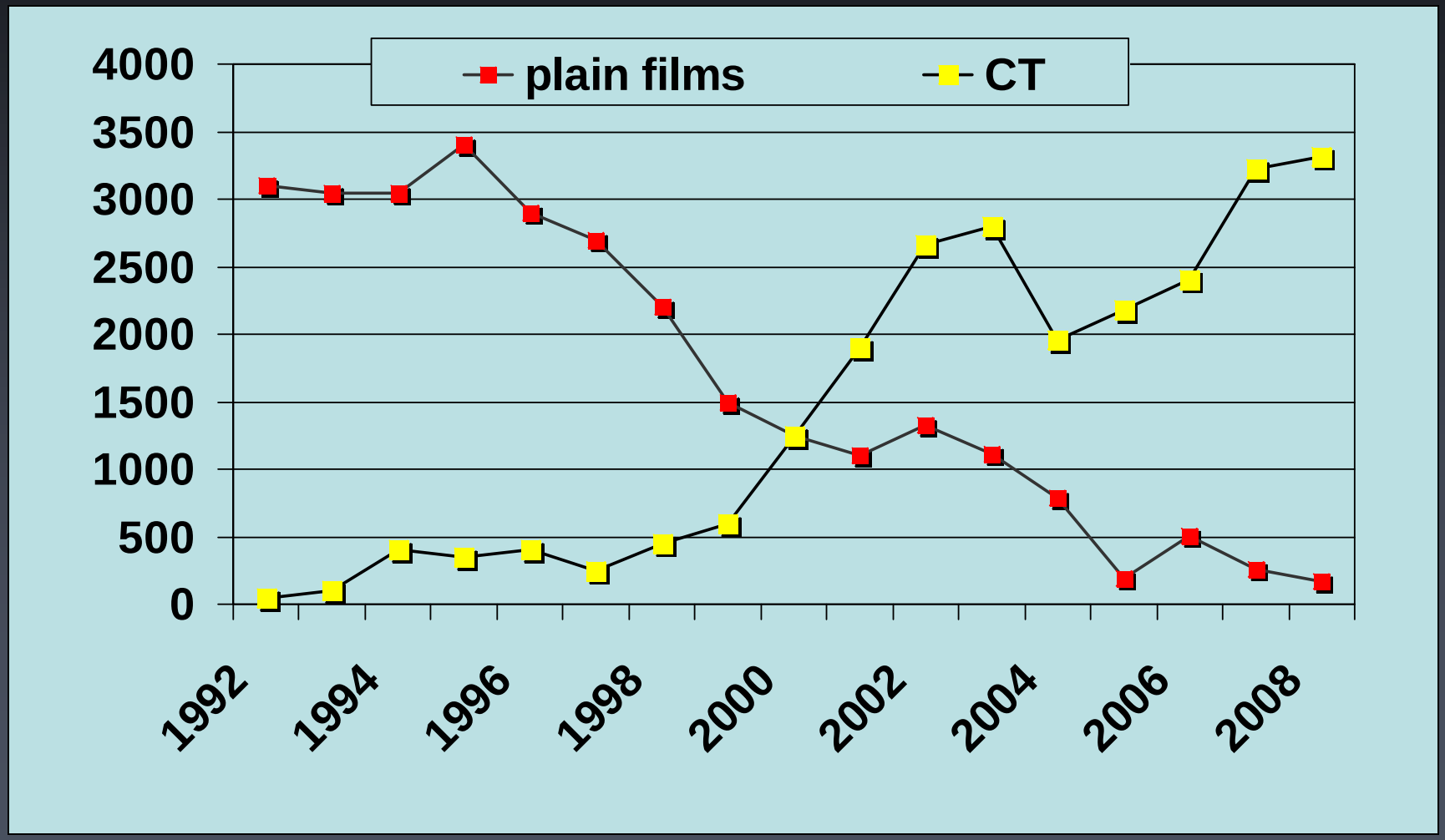
CT has been increasing >5% per year

Massachusetts General Hospital



Radiography Volume Decreasing as Radiographic Exams Replaced with CT

Cervical Spine Radiographs Vs CT



Decreasing ED CT Radiation Exposure by Optimizing Clinical Decision Making

Causes of Unnecessary CT Radiation Exposure in ED Patients

1. Repeating CT scans which have already been performed
2. Performing CT when the results are unlikely to affect patient management
3. Investigating with CT too frequently
4. Performing the wrong imaging exam
5. Performing incorrect CT protocol from communication failure of true clinical presentation, resulting in repeat CT
6. Over-investigating

Causes of Unnecessary CT Radiation Exposure in ED Patients

1. Repeating CT scans which have already been performed:
   - Outside CT scan from referring hospital not sent with the patient
   - Outside CT satisfactory, but referring physician requests repeat to get patient's CT scan on PACS

Repeating outside CT may be indicated for problems with scan or clinical changes in patient

- Cannot view outside scan; software problem
- No IV contrast
- Wrong contrast timing
- Wrong slice thickness
- No multiplanar or volumetric reformations

Causes of Unnecessary CT Radiation Exposure in ED Patients

2. Performing CT scans when the results are unlikely to affect patient management
   - Venous CT requested with a PECT in patient with a positive venous US for DVT
   - Extremity CT requested for a shaft fracture of a long bone
   - Chest CT requested for confirmation of a pneumothorax shown on a chest radiograph

Causes of Unnecessary CT Radiation Exposure in ED Patients

3. Investigating with CT too frequently
   - Serial CT scans over several days or weeks to follow the progress of a ureteral stone
   - Thoracolumbar spine CT requested every time a patient with a chronic back condition comes to ED with back pain
   - Chest CT requested for suspected pneumonia every time a patient with cystic fibrosis comes to ED with cough or fever
   - Abdominal CT requested every time a patient with Crohn’s Disease comes to ED with abdominal pain

Causes of Unnecessary CT Radiation Exposure in ED Patients

4. Performing the wrong imaging exam
   - Abdominal CT requested for a gynecological problem rather than pelvic US
   - CT requested for suspected avascular necrosis of hip rather than an MR scan
   - Abdominal CT requested for RUQ pain (suspected cholecystitis) rather than US

Causes of Unnecessary CT Radiation Exposure in ED Patients

5. Performing incorrect CT protocol from communication failure of true clinical presentation, resulting in a repeat CT scan
   - Non-contrast chest CT requested in patient with chest pain in whom the real concern was suspected PE
   - Non-contrast abdominal CT requested in patient in whom the real concern was trauma, not ureteral stone
   - Non-contrast cervical spine CT requested when real concern was neck abscess

Causes of Unnecessary CT Radiation Exposure in ED Patients

6. Over-investigating
   - Performing unnecessary pre-contrast and delayed scans of the abdomen and chest
   - Performing a “total body” trauma CT scan (Pan-Scan) of head, face, cervical spine, chest, abdomen and pelvis when on clinical exam the patient only needs scans of the head and abdomen
   - CT scan of the entire abdomen rather than only peri-appendiceal area in young male with acute RLQ pain

Faulty equipment and poorly trained technologists can also contribute to repeat CT scanning of ED patients

Guidelines for the CT Imaging of Emergency Department Patients:

Trauma Rules
ACR Appropriateness Criteria
European Referral Guidelines

Judicious Use of CT in Trauma
Is the CT exam indicated?

- Head CT
  - Canadian Head CT Rule for minor head injuries
- Face CT
  - Cosmetic deformity, functional impairment
- Cervical Spine CT
  - Canadian Spine Rules
  - NEXUS Criteria
- Chest CT
  - Major trauma history
  - Abnormal chest film
  - Abnormal clinical examination
- Abdomen/Pelvis CT
  - Major trauma history
  - Abnormal ultrasound/pelvis film
  - Abnormal clinical examination

Canadian Head CT Rule for Minor Head Injuries

Panel 1: **Canadian CT Head Rule**

CT Head Rule is only required for patients with minor head injuries with any one of the following:

High risk (for neurological intervention)

- GCS score <15 at 2 h after injury
- Suspected open or depressed skull fracture
- Any sign of basal skull fracture (haemotympanum, 'racoon' eyes, cerebrospinal fluid otorrhoea/rhinorrhoea, Battle's sign)
- Vomiting ⩾two episodes
- Age ⩾65 years

Medium risk (for brain injury on CT)

- Amnesia before impact >30 min
- Dangerous mechanism (pedestrian struck by motor vehicle, occupant ejected from motor vehicle, fall from height >3 feet or five stairs)

Minor head injury is defined as witnessed loss of consciousness, definite amnesia, or witnessed disorientation in a patients with a GCS score of 13–15.

**Steill IG, PI, The Ottawa Health Research Institute*

Cervical Spine CT for Trauma
*Nexus Low Risk Criteria (NLC)

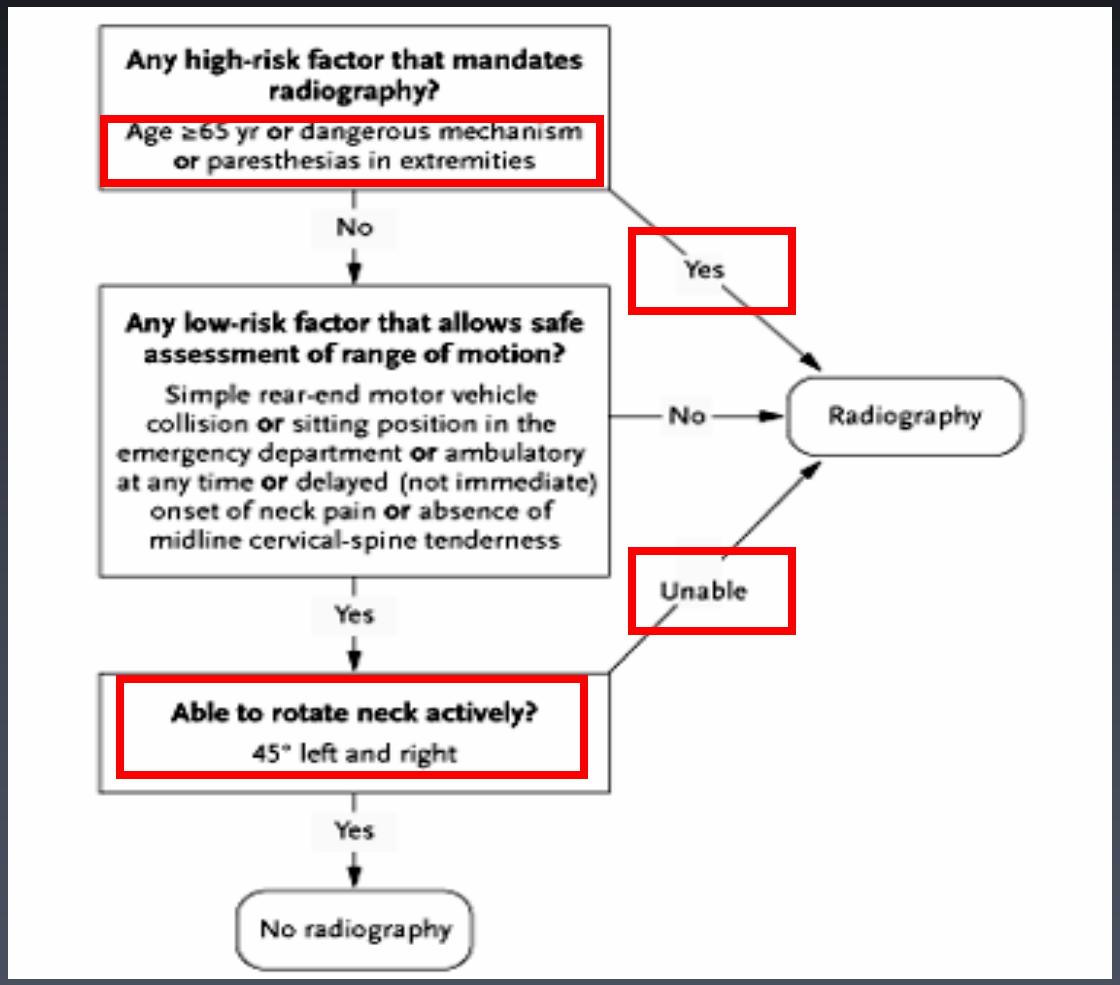
Table 1. The NEXUS Low-Risk Criteria.*

Cervical-spine radiography is indicated for patients with trauma unless they meet all of the following criteria:

- No posterior midline cervical-spine tenderness,†
- No evidence of intoxication,‡
- A normal level of alertness,§
- No focal neurologic deficit,¶ and
- No painful distracting injuries.‖

**National Emergency X-Radiography Utilization Study (NEXUS)*

Cervical Spine CT for Trauma
*Canadian C-Spine Rule



** Steill IG, PI, The Ottawa Health Research Institute*

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- ACR Appropriateness Criteria® are evidence-based guidelines to assist referring physicians and other providers in making the most appropriate imaging or treatment decision.
- By employing these guidelines, providers enhance quality of care and contribute to the most efficacious use of radiology.
- The guidelines are developed by expert panels in diagnostic imaging, interventional radiology, and radiation oncology.
- Each panel includes leaders in radiology and other specialties.

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ACR Appropriateness Criteria
Suspected Spine Trauma Under MSK

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- Chronic Foot Pain*
- Chronic Hip Pain (Revised)
- Chronic Neck Pain* (Revised)
- Chronic Wrist Pain
- Follow-up of Malignant or Aggressive Musculoskeletal Tumors (Revised)
- Imaging after Total Hip Arthroplasty
- Imaging after Total Knee Arthroplasty
- Metastatic Bone Disease
- Nontraumatic Knee Pain* (Revised)
- Osteoporosis and Bone Mineral Density*

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Musculoskeletal Imaging

*This topic also includes pediatric imaging recommendations

- Acute Hand and Wrist Trauma (Revised)
- Acute Trauma to the Knee*
- Avascular Necrosis of the Hip
- Bone Tumors
- Chronic Ankle Pain
- Chronic Elbow Pain (Revised)
- Chronic Foot Pain*
- Chronic Hip Pain (Revised)
- Chronic Neck Pain* (Revised)
- Chronic Wrist Pain
- Follow-up of Malignant or Aggressive Musculoskeletal Tumors (Revised)
- Imaging after Total Hip Arthroplasty
- Imaging after Total Knee Arthroplasty
- Metastatic Bone Disease
- Nontraumatic Knee Pain* (Revised)
- Osteoporosis and Bone Mineral Density*
- Shoulder Trauma
- Soft Tissue Masses
- Stress/Insufficiency Fractures, Including Sacrum, Excluding Other Vertebrae (Revised)
- Suspected Ankle Fractures
- Suspected Osteomyelitis in Patients with Diabetes Mellitus (Revised)
- Suspected Spine Trauma*

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ACR Appropriateness Criteria

Exams Scored in Appropriateness from 1-10

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http://www.acr.org/SecondaryMainMenuCategories/quality_safety/app_criteria/pdf/ExpertPanelonMusculoskeletalImaging/SuspectedCervicalSpineTraumaDoc22.aspx

Variant 1: **Cervical spine imaging not indicated by NEXUS or CCR clinical criteria. Patient meets low-risk criteria.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray cervical spine lateral only	1		Min
X-ray cervical spine AP lateral open mouth	1		Low
X-ray cervical spine AP lateral open mouth obliques	1		Low
X-ray cervical spine AP lateral open mouth obliques flexion/extension	1		Low
CT cervical spine with sagittal and coronal reformat	1		Med
CT myelography cervical spine	1		Med
CTA head and neck	1		Med
MRI cervical spine	1		None
MRA neck	1		None
INV arteriography cervicocerebral	1		Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Done

Unknown Zone

ACR Appropriateness Criteria

CT Highest if no Neurological Deficits

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Variant 2: **Suspected acute cervical spine trauma. Imaging indicated by clinical criteria (NEXUS or CCR). Not otherwise specified.**

Radiologic Procedure	Rating	Comments	RRL*
CT cervical spine with sagittal and coronal reformat	9		Med
X-ray cervical spine lateral only	6	Useful if CT reconstructions are not optimal.	Min
X-ray cervical spine AP lateral open mouth	2	Might be appropriate in addition to CT, but not instead of CT.	Low
X-ray cervical spine AP lateral open mouth obliques	2	Might be appropriate in addition to CT, but not instead of CT.	Low
X-ray cervical spine AP lateral open mouth obliques flexion/extension	1	Flexion/extension contraindicated until other imaging studies are performed.	Low
CT myelography cervical spine	1		Med
CTA head and neck	1	See variant 6.	Med
MRI cervical spine	1	See variant 3.	None
MRA neck	1	See variant 6.	None
INV arteriography cervicocerebral	1	See variant 6.	Med

Rating Scale: 1=Least appropriate, 9=Most appropriate *Relative

ACR Appropriateness Criteria
MR Scored High with Myelopathy

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Clinical Condition: Suspected Spine Trauma

Variant 3: Suspected acute cervical spine trauma. Imaging indicated by clinical criteria (NEXUS or CCR). Myelopathy.

Radiologic Procedure	Rating	Comments	RRL*
CT cervical spine with sagittal and coronal reformat	9	MRI and CT provide complementary information. It is appropriate to perform both exams.	Med
MRI cervical spine	9	MRI and CT provide complementary information. It is appropriate to perform both exams. See comments regarding contrast in text under "Anticipated Expectations."	None
X-ray cervical spine lateral only	6	Useful if CT reconstructions are not optimal.	Min
CT myelography cervical spine	5	If MRI is contraindicated or inconclusive.	Med
X-ray cervical spine AP lateral open mouth	1		Low
X-ray cervical spine AP lateral open mouth obliques	1		Low
X-ray cervical spine AP lateral open mouth obliques flexion/extension	1	Flexion/extension contraindicated.	Low

Problems with Cervical Spine Radiographic Exams; More than 30% of Cervical Spine Injuries Missed by Radiography

*NEXUS Data:

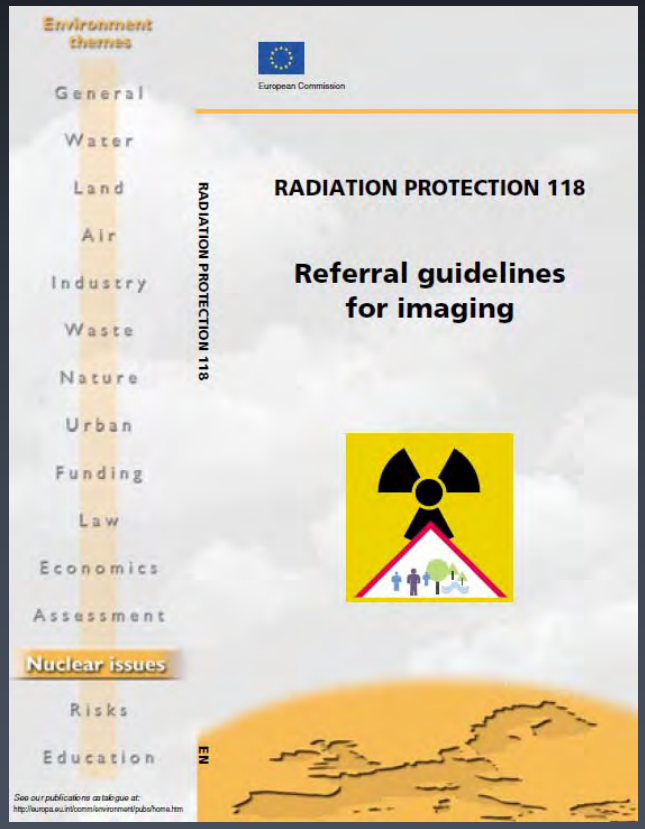
- 34,069 patients with suspected c-spine injury:
  - 1,496 had c-spine injury:
    - 932 (62%) identified by radiography
    - 564 (38%) were missed by radiography

**Meta-analysis of 7 reports by Holmes:

- Pooled sensitivity for detecting c-spine injury:
  - 52% for radiography
  - 98% for CT

**National Emergency X-Radiography Utilization Study (NEXUS)*
***Holmes JF et al. J Trauma 2005; 58(5): 902-905*

European Union Referral Guidelines for Imaging



Published in 2001

"Booklet of referral guidelines for health professionals qualified to refer patients for imaging, in order to ensure that all examinations are well justified and optimized"

"Adapted by experts representing European radiology and nuclear medicine, in conjunction with the UK College of Radiologists"

European Union Referral Guidelines for Imaging

- A useful imaging examination is one in which the result, positive of negative, will alter the management of the patient and add confidence to the clinician diagnosis
- Imaging exams that do not fulfill these aims should not be performed and may add unnecessary radiation to the patient

European Guidelines Table of Contents

European Guidelines Suspected Cervical Spine Injury

CLINICAL PROBLEM	INVESTIGATION (DOSE)	RECOMMENDATION (GRADE)	COMMENT
Cervical spine			
Conscious patient with head and/or face injury only **K10**	*XR C spine (I)*	Not indicated routinely (B)	In those who meet all of the following criteria: (1) Fully conscious. (2) Not intoxicated. (3) No abnormal neurological findings. (4) No neck pain or tenderness.
Unconscious head injury (see K3/4) **K11**	*XR C spine (I)*	Indicated (B)	Must be of good quality to allow accurate evaluation. But radiography may be very difficult in the severely traumatised patient and must avoid manipulation (see also K12).
Neck injury: with pain	*XR C spine (I)*	Indicated (B)	Cervical spine XRs can be very difficult to evaluate. Radiography also difficult and: 1. Must show C7/T1. 2. Should show odontoid peg (not always possible at time of initial study). 3. May need special views, CT or MRI especially when XR equivocal or complex lesions.
K12	*CT (II) or MRI (0)*	Specialised investigation (B)	Discuss with department of clinical radiology.

European Guidelines Suspected Cervical Spine Injury

Neck injury: with neurological deficit **K13**	*XR (I)*	Indicated (B)	For orthopaedic assessment.
	MRI (0)	Indicated (B)	Some constraints with life support systems. MRI best and safest method of demonstrating intrinsic cord damage, cord compression, ligamentous injuries and vertebral fractures at multiple levels. CT myelography may be considered if MRI not available.
Neck injury: with pain but XR initially normal; suspected ligamentous injury **K14**	*XR C spine; flexion and extension (I)*	Specialised investigation (B)	Views taken in flexion and extension (consider fluoroscopy) as achieved by the patient with no assistance and under medical supervision. MRI may be helpful here.
Thoracic and lumbar spine			
Trauma: no pain, no neurological deficit **K15**	*XR (II)*	Not indicated routinely (B)	Physical examination is reliable in this region. When the patient is awake, alert and asymptomatic, the probability of injury is low.
Trauma: with pain, no neurological deficit or patient not able to be evaluated **K16**	*XR painful area (II)*	Indicated (B)	A low threshold to XR when there is pain/tenderness, a significant fall, a high impact RTA, other spinal fracture present or it is not possible to clinically evaluate the patient. Increasing use of CT and MRI here.

European Guidelines Suspected Cervical Spine Injury

CLINICAL PROBLEM	INVESTIGATION (DOSE)	RECOMMENDATION (GRADE)	COMMENT
Trauma: with neurological deficit — pain **K17**	*XR (II)*	Indicated (B)	
	MRI (0)	Indicated (B)	Where technically possible. CT often used as patient undergoing CT for other reasons. But MRI best method of demonstrating intrinsic cord damage, cord compression and vertebral fractures at multiple levels.
Pelvis and sacrum			
Fall with inability to bear weight **K18**	*XR pelvis (I) plus lateral XR hip (I)*	Indicated (C)	Physical examination may be unreliable. Check for femoral neck fractures, which may not show on initial XR, even with good lateral views. In selected cases NM or MRI or CT can be useful when XR normal or equivocal.
Urethral bleeding and pelvic injury **K19**	*Retrograde urethrogram (II)*	Indicated (C)	To show urethral integrity, leak, rupture. Consider cystogram if urethra normal and suspicion of bladder leak.
Trauma to coccyx or coccydynia **K20**	*XR coccyx (I)*	Not indicated routinely (C)	Normal appearances often misleading and findings do not alter management.

MGH Decision Support

Physician Dialogue for ED CT

Computerized for Outpatient CT

Decision Support with Conversation CT Scheduling in MGH ED

- E.D. physician initiates CT request on computer
- Computer requesting program solicits clinical information and initiates examination scheduling
- Discussion with radiologist for CT protocol selection

Decision Support with Conversation CT Scheduling in MGH ED

Requests for CT require discussion with the on-duty Emergency Radiology staff or resident

- Communication of clinical presentation, physical exam and labs permits confirmation of exam appropriateness and selection of optimum exam protocol
- Confirms responsible referring physician
- Permits inquiry regarding possible pregnancy, contrast allergy, renal function
- Permits inquiry about special post-processing: 3D, CTA
- Finalized CT protocols are entered on a QuickBase computer log which is available for viewing by radiologists and technologists

CT Protocols Entered on a QuickBase: Dashboard

Customize Share Recent Find Help Signed in as Mary-Theresa Shore MY QUICKBASE

Copy of Emergency Radiology Whiteboard | EMERGENCY RADIOLOGY LOG

Resident Dashboard

Add a New Message | Add a New Record | Customize this Page

TO BE PROTOCOLLED -----> Displays any exam that has been scheduled by the RSR but still needs to be protocolled...

FULL REPORT | EMAIL | PRINT | OTHER ▾ No results

Neuro Exam? ▲	Time	Patient Name	MRN	Exam Type	Exam Description	History	Ordering Physician
No records found							

ED EXAM LIST -----> Displays any scheduled exam that has yet to be marked as "Dictated"...

FULL REPORT | EMAIL | PRINT | OTHER ▾ No results

Neuro Exam? ▲	Date	Time	Patient Name	MRN	History	Exam Description	Ordering Physician	Cleared for OOC?	Protocol	Physician Consulted	Pager#
No records found											

MESSAGES -----> Displays any outstanding request for a Consult, Exam Approval or Wet Read...

FULL REPORT | EMAIL | PRINT | OTHER ▾ No results

Time ▲	Patient Name	MRN	Exam Description	Type of Request
No records found				

QuickBase: Protocol a Case

Copy of Emergency Radiology Whiteboard | EMERGENCY RADIOLOGY LOG

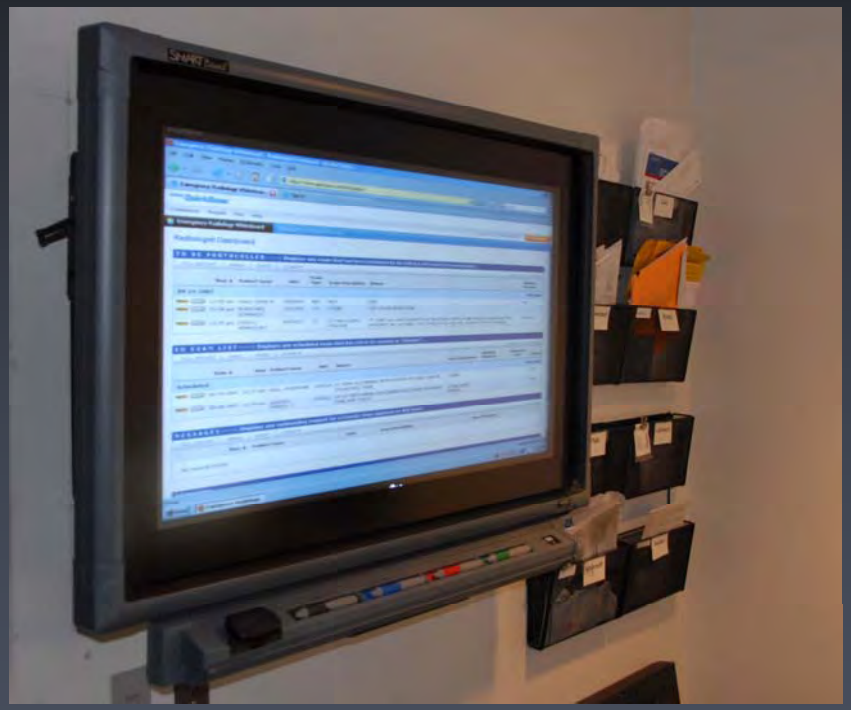
Request Specifics

Date	09-27-2007
Time	9:00 am
Origin of Request	Order Entry
Needs Protocol?	YES
* Current Status	Scheduled

Patient and Exam Specifics

Patient Name	Smith, John
MRN	1111
History	s/p MVA Neck Pain`
Accession Number	1111111
* Ordering Physician	Dr. Jones
* Ordering Physician's Pager#	1-2345
* Exam Type	CT
Is this a CT of the C-Spine?	YES
* Exam Description	CTSPN-
* Protocol	I-
* Protocolled By	JOJ
Comments	

QuickBase Patient Queue with CT Protocols Displayed for Physicians and Technologists



Consultation Room

CT Control Room

MGH Computerized Decision Support Radiology Order Entry (ROE) for Outpatients Provides Feedback for Physician Requests

MGH Radiology Order Entry - Microsoft Internet Explorer provided by Partners HealthCare System

MASSACHUSETTS GENERAL HOSPITAL

RADIOLOGY

ROE
Radiology Order Entry

Home | Insurance Info | My Preferences | Help

User: DIR

Home | View Reports

Select a Physician and Enter a Patient MRN:

Physician: Rosenthal, Daniel Ira --- Radiology Service

MRN:

Next >>

For assistance try Help, or contact:

Bill Barron
(617)-643-2198
Page (617)-724-5700 pin# 22172

Michelle Dean
(617)-643-2494
Page (617)-724-5700 pin# 22082

Request for a Spine MR Exam

EXAM REQUESTED Pick only ONE of the Following

◉ Muscoskeletal Interpretation ○ Neuroradiology Interpretation

At least one box MUST be selected from either of the following groups

LOW BACK SIGNS / SYMPTOMS

- ☑ Back Pain
- ☐ Back pain improved with exercise
- ☐ Sciatic leg pain (sciatica)
- ☐ Radiculopathy (such as pain,numbness, abnormal reflexes)
- ☐ Pain in the legs relieved when sitting
- ☐ Neurogenic Claudication
- ☐ Symptoms of Cauda Equina syndrome such as: Urinary retention, Fecal incontinence, Saddle anesthesia
- ☐ Lower extremity weakness (hemiparesis)

KNOWN DIAGNOSES (NOT Rule/out!)

- ☐ Cauda Equina syndrome
- ☐ Demyelinating disease with spinal cord syx (type) _____
- ☐ Disc disease
- ☐ Kyphosis
- ☑ Osteoporosis
- ☐ Scoliosis
- ☐ Spinal Stenosis
- ☐ Spine fracture (Traumatic) specify location _____
- ☐ Spondylolisthesis
- ☐ Congenital spine malformation (specify) _____
- ☐ Demyelinating disease without spinal cord syx
- ☐ Known primary tumor (specify) _____
- ☐ Metastases to spine
- ☐ Primary spine tumor
- ☐ Spinal cord Injury
- ☐ Spine fracture (pathological) (specify cause) _____
- ☐ Spine infection (specify) _____

ABNORMAL PREVIOUS EXAMINATIONS

- ☐ Abnormal bone scan
- ☐ Abnormal x-ray bone destruction
- ☐ Abnormal x-ray DJD

“Appropriateness” Values

1-3
Low Utility

4-6
Intermediate

7-9
High Utility

Decision Support

MGH Radiology Order Entry - Microsoft Internet Explorer provided by Partners HealthCare System

Patient Name: **ROSENTHAL, DANIEL** MRN: **2219795** Ordering Physician: **Rose**

Proceed with Order | Cancel Exam

Lumbar Spine MRI has low utility for the clinical indications provided

9	8	7	6	5	4	3	2	1
Indicated 7-9			Marginal 4-6			Low Utility 1-3		

Alternate procedures to consider:

X_Ray	CT
7	2

Additional Information:

When imaging is helpful for Back Pain

Patient Information on Back Pain

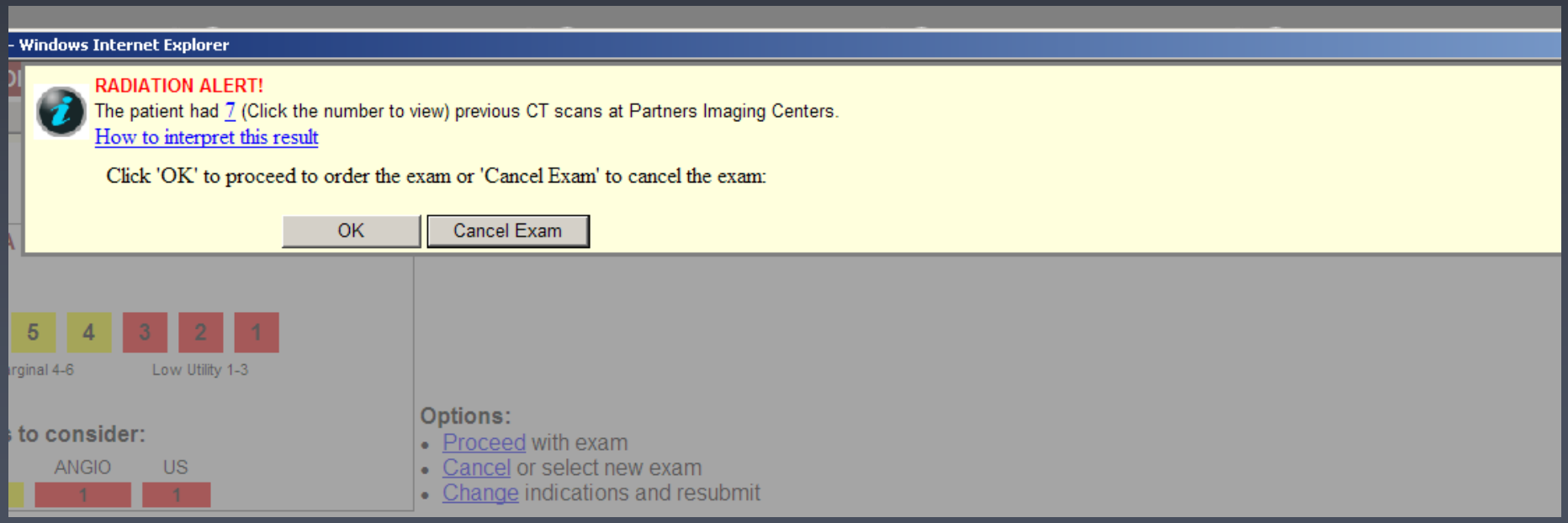
Vertebroplasty

Options:

- Proceed with exam
- Cancel or select new exam
- Change indications and resubmit

“Radiation Alert”

- Notifies ordering physician of ALL CT scans that the patient has had at ALL Partners facilities



Clinical Decision Making for ED CT *Conclusions and Recommendations*

Precise communication of clinical presentation and a dialogue between emergency physicians and radiologists can help ensure that ED CT scans are:

1. Performed only on those ED patients in whom a CT scan is truly indicated
2. Performed utilizing the optimal CT protocol for diagnosing the patient's clinical condition
3. Performed with the minimum radiation exposure for obtaining a diagnostic quality examination

Clinical Decision Making for ED CT
Role of the Emergency Physician

- Provide the radiologist with relevant clinical information to assist in the selection of optimal imaging procedure, and when CT is indicated, the optimal CT protocol
- Utilize evidence-based imaging guidelines
- Be willing to communicate in conversation with the radiologist
- Be willing to participate in decision support

MGH EDIS

Global - Microsoft Internet Explorer provided by Partners HealthCare System

MASSACHUSETTS GENERAL HOSPITAL | Emergency Department - EDIS

Carignan, Sarah Phone | Feedback | Help

Areas | Lists | Admin/Reports | Referrals | Find

ED Resources

Global | START | Acute | Urgent A | Urgent B | Pedi | Fast Track | APS | ED Obs | Other

Global

Total Number of Active Patients: 86

ED Critical - 26 (0:02)

START Patients:19

START (19)

Pre-Screen:6

Post Screen:10

Pedi Waiting:3

Acute (14)

5a 5b 6

4 7

3 Arrival:0 8

2 Hall:4 9

1 10

Urgent A (20)

21 22 23 24 25

20 26

19 27

18 Arrival:0 28

Hall:3 29

SR 16 15 14 30

Urgent B (7)

D E

C F

B Arrival:0 G

A Hall:0

Pedi (5)

P1

P2 Arrival:0

P3 Hall:0

P4 Guppy:1

Fast Track (9)

36 37 38 39

35 Arrival:0

34 Hall:1

33 Orth

APS (6)

A 42

B Arrival:0 41

C In Prog:1 40

SW1 SW2

ED Obs (6)

38b 38a 36a 34a 32a

40a 30a 30b

42b 42a

44b 44a

46b 46a

Expects: 4

Arrival:0

Other (0)

In Prog:0

Legend

Inpt Bed | ED Obs Bed | Requested | Assigned | Cleaning | Ready

1 patient in bed | 2 patients in bed | DC Note Complete | Bed Occupied

Last Updated On: Fri Feb 13 16:55:59 2009

Local intranet

Clinical Decision Making for ED CT
Role of the Radiologist

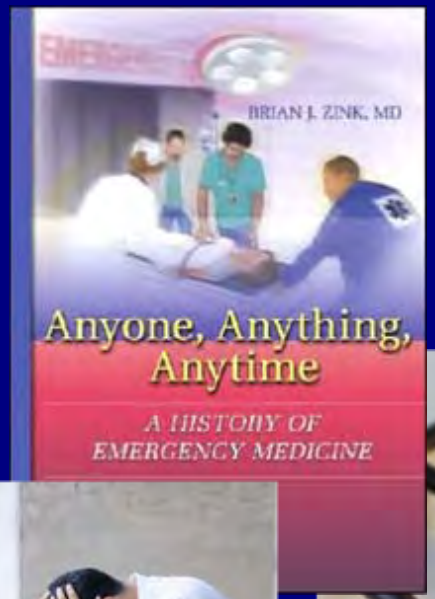
- Take advantage of all patient care information resources as well as communications with referring physicians to obtain the relevant clinical information to provide optimal advise on emergency imaging procedures, and when CT is indicated, to advise on the most optimal CT protocol
- Utilize evidence based imaging guidelines
- Consider instituting decision support

Thank You!

Robert A. Novelline, MD
Professor of Radiology, Harvard Medical School
Director of Emergency Radiology, Massachusetts General Hospital
novelline.robert@mgh.harvard.edu

Clinical Decisions:
The Emergency Physician Perspective

Paul R. Sierzenski, MD, RDMS, FACEP
Chief, Emergency Ultrasound Section
Director, EM, Trauma & Critical Care Ultrasound
Christiana Care Health System
Newark Delaware



A Unique Environment

Our two hospital ED system sees 160,000 ED patients per year with 3,500 level one traumas. That's over 400 patients per day!

Paul R. Sierzenski, MD, RDMS, FACEP. Sept 2009

Emergency Medicine

- "Emergency medicine is the medical specialty dedicated to the diagnosis and treatment of unforeseen illness or injury."
- EM is the safety net
- EM physicians hold the net
- The ED is the most federally regulated department within any hospital by EMTALA (speaks to our duty public health duty)

Paul R. Sierzenski, MD, RDMS, FACEP. Sept 2009

“EMTALA”: The Facts

- Emergency Medical Treatment & Active Labor Act
- Enacted by Congress in 1986
- Address “patient dumping” by emergency departments.
- EMTALA has two principal categories:

  1) ensure an appropriate medical screening

  2) require stabilization before transfer or discharge

“EMTALA”- ED Issue # 1

- The impact of EMTALA is real and applies to all Medicare accepting hospitals with EDs
  - Ensure an “appropriate medical screening”
  - “an appropriate medical screening exam” is still ill defined by EMTALA

“EMTALA”: ED Issue # 2

- **Require “stabilization” before transfer / discharge**
- Unlike the screening requirement, the language of the stabilization requirement does not qualify the care to be given as “appropriate.”
- **No “improper motive” need be alleged to show a violation of EMTALA’s stabilization provisions.**
- Places a federal mandate on our level of care

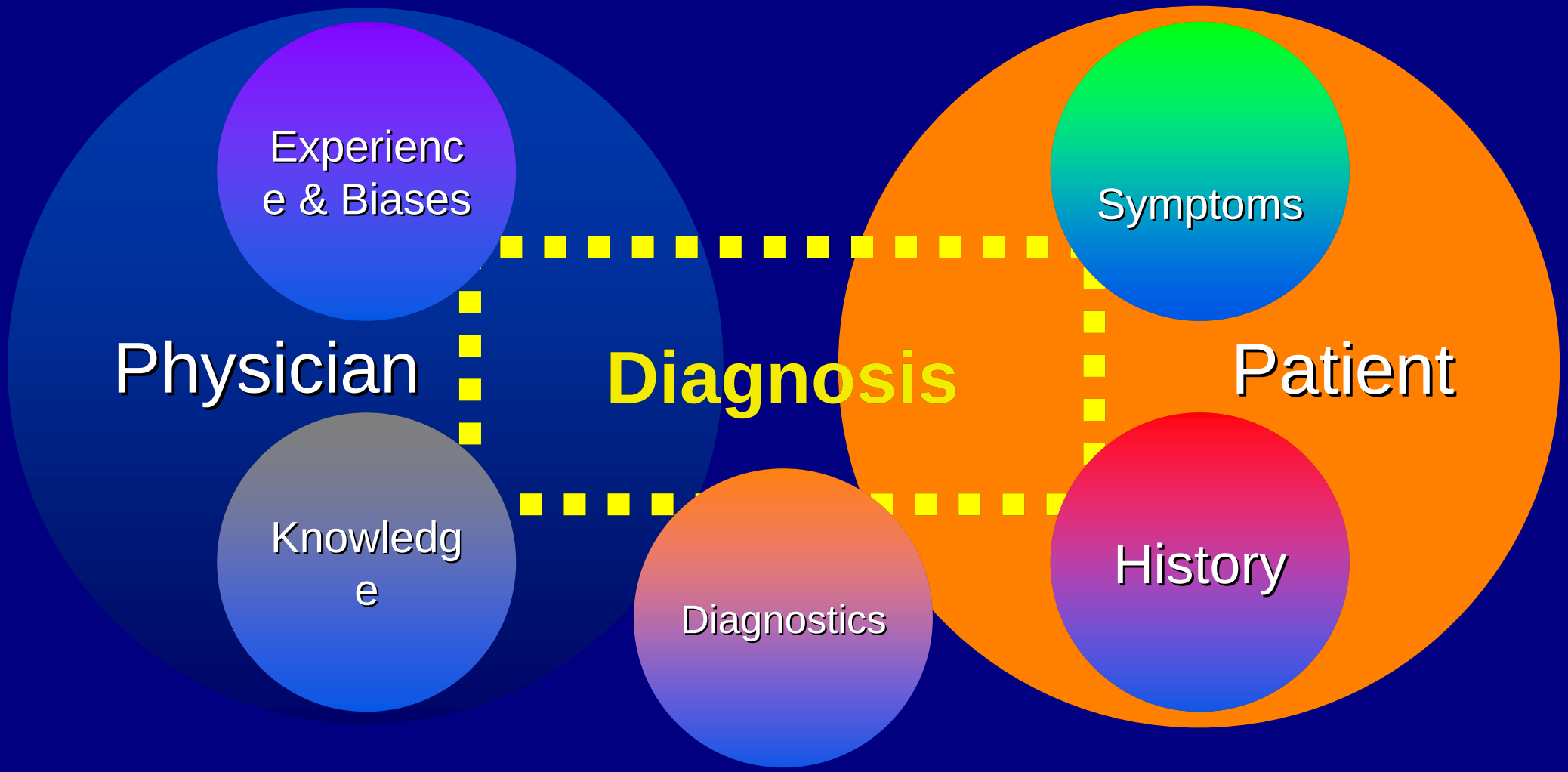
“EMTALA”: The Concern

- Stabilization has occurred when there is a **“reasonable assurance”** that no material deterioration would result from that individual’s transfer or discharge from the hospital
- *CT is often the most effective & efficient means to accurately and rapidly “assure” that deterioration will not occur. (excellent negative predictive value)*
- **To realistically affect CT usage, EMTALA scope and impact must be addressed, and potentially narrowed respective to stabilization in the ED** (this was discussed by the EMTALA-TAG in April 2009)

“EMTALA”: So What?

- Based on the Supreme Court, if there is a deterioration of a patient, emergency physicians ***MAY*** be open to EMTALA violations
- These fines ($ 50,000.00 per violation) would not be covered by medical malpractice insurance!
- So would you order the CT?

Clinical Decisions Making



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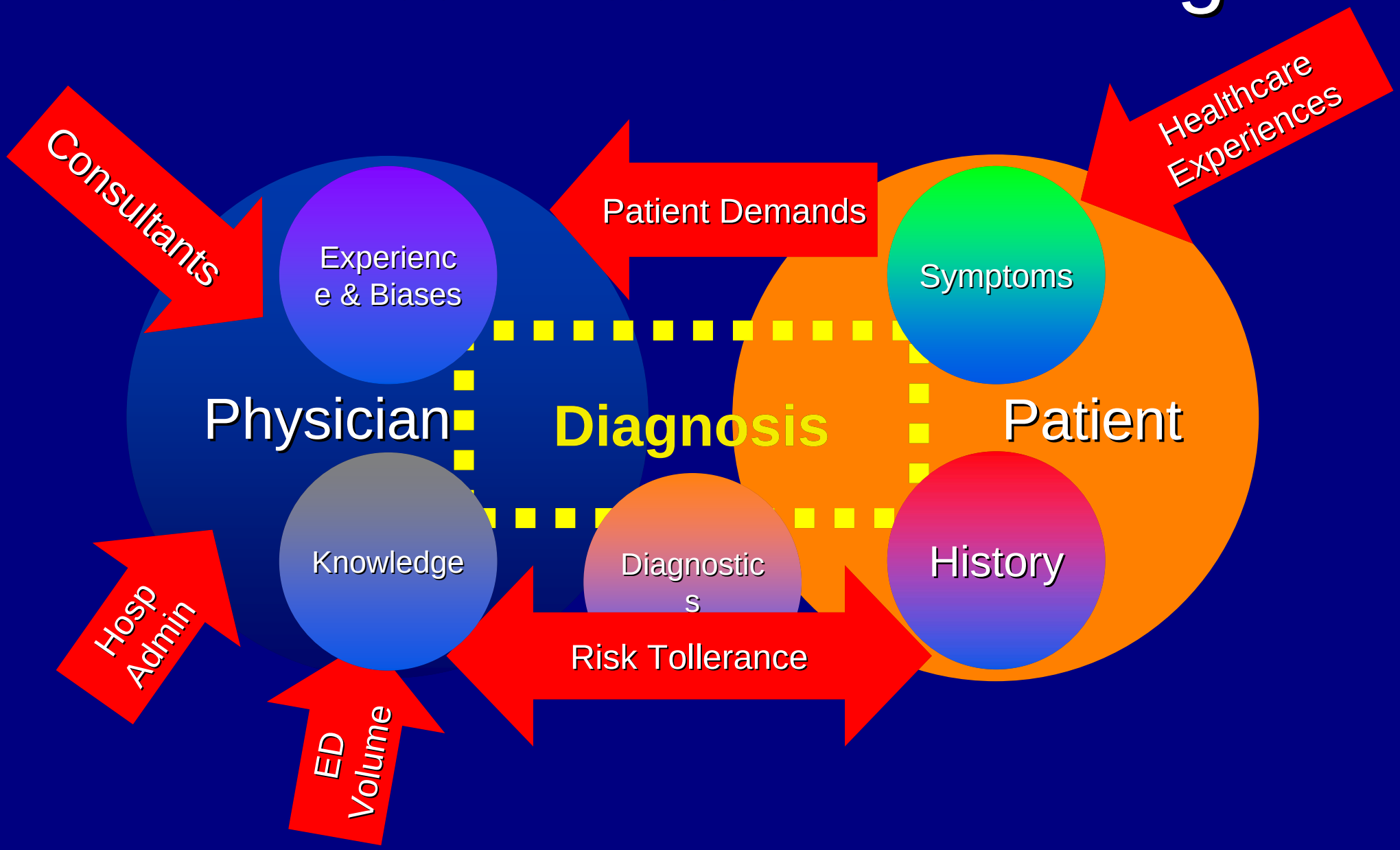
Clinical Decisions Making



Paul R. Sierzenski, MD, RDMS, FACEP. Sept 2009

Clinical Decision Making

TABLE 2. Strategies in Decision Making

Pattern recognition
Rule out worst-case scenario (ROWS)
Exhaustive method
Hypothetico-deductive method
Heuristics
Cognitive disposition to respond (CDR)

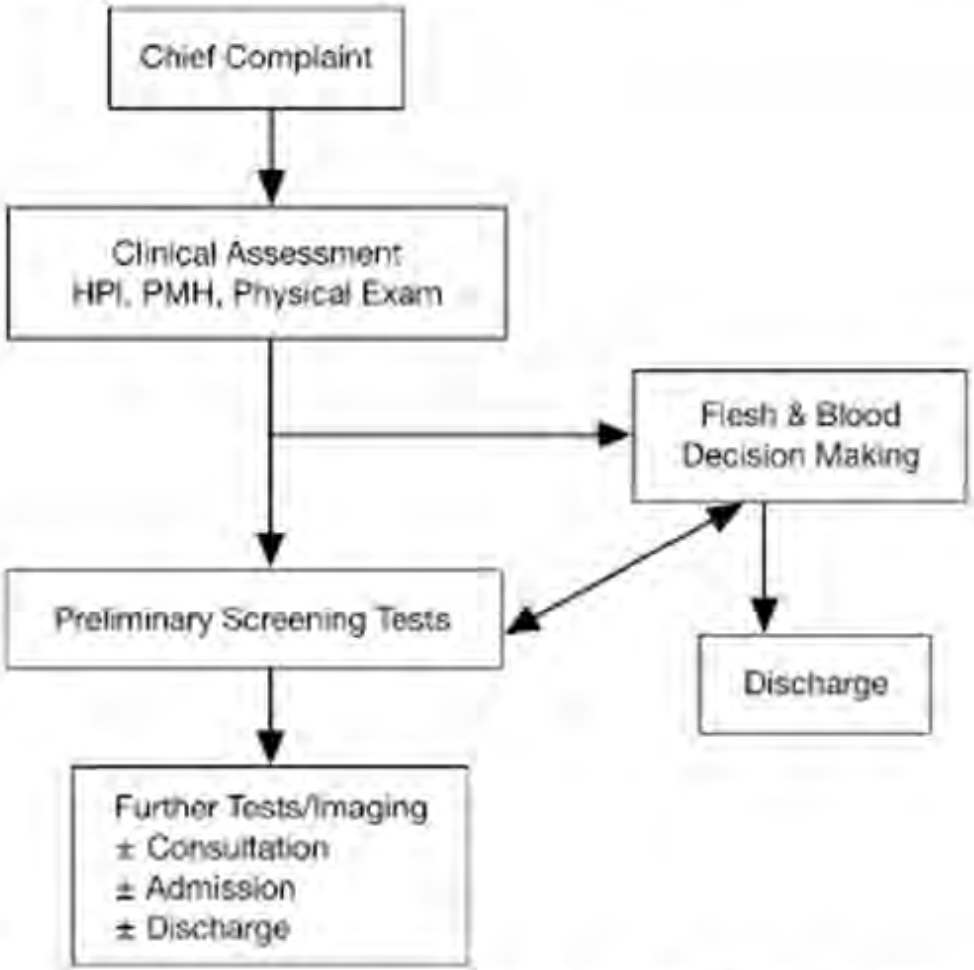


Figure 1. Overview of clinical decision making in the emergency department. HPI = history of present illness; PMH = past medical history.

"Above all else, emergency physicians must not miss critical diagnoses"

Achieving Quality in Clinical Decision Making: Cognitive Strategies and Detection of Bias. ACAD EMERG MED • November 2002, Vol. 9, No.

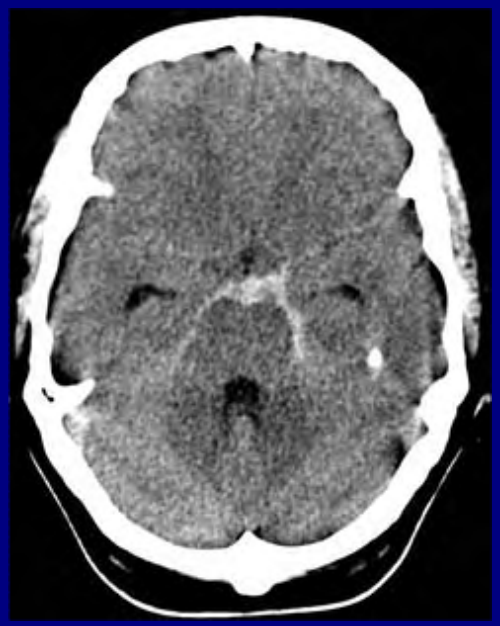
Paul R. Sierzenski, MD, RDMS, FACEP. Sept 2009

Clinical Decision Making

- Multiple factors to be discussed by Drs. Blaivas, Melanson and McCarthy
- Hypothetical-Deductive Model
  - Hypothesis Generation
  - Clinical presentation, Prevalence of Disease, experience/knowledge, acuity
  - Hypothesis Evaluation: for the EP this is the “elimination” not the hypothesis confirmation.
  - EP’s goal is to identify, treat or exclude life or limb threatening conditions

Retrospective Reviews: Flawed

- 29 yo patient with HTN, Migraines c/o HA with vomiting
- Lights out, states acute “thunder clap”, “worst every”. HO HTN
- Based on **prevalence** migraine is most likely
- Based on **symptoms** “worse ever” “thunderclap”, Subarachnoid Hemorrhage should be excluded...CT head...lumbar puncture
- **If the work up is negative that does not mean the work up was not needed.**



Paul R. Sierzenski, MD, RDMS, FACEP. Sept 2009

American College of Emergency Physicians®
ADVANCING EMERGENCY CARE

PAIN MANAGEMENT/CLINICAL POLICY

Clinical Policy: Critical Issues in the Evaluation and Management of Adult Patients Presenting to the Emergency Department With Acute Headache

From the American College of Emergency Physicians Clinical Policies Subcommittee (Writing Committee) on Critical Issues in the Evaluation and Management of Adult Patients Presenting to the Emergency Department with Acute Headache:

Jonathan A. Edlow, MD (Chair)
Peter D. Panagos, MD
Steven A. Godwin, MD
Tamara L. Thomas, MD
Wyatt W. Decker, MD

Members of the American College of Emergency Physicians Clinical Policies Committee (Oversight Committee):

The Paradox: Emergency Care

- "One of the important features of the availability heuristic (pattern recognition) is its dependence on personal experience...***applications of Rule Out Worse Case Scenerio may lead to over utilization of resources."***

- ***However this is the ethical, legal (EMTALA) obligation of EM and a societal expectation***

Achieving Quality in Clinical Decision Making: Cognitive Strategies and Detection of Bias. ACAD EMERG MED • November 2002, Vol. 9, No. 11 •www.aemj.org

CDM Errors Do Occur

- Errors often are the result as an act of omission
- Negative reinforcement increased utilization as a result

TABLE 3. Failed Heuristics, Biases, and Cognitive Dispositions to Respond

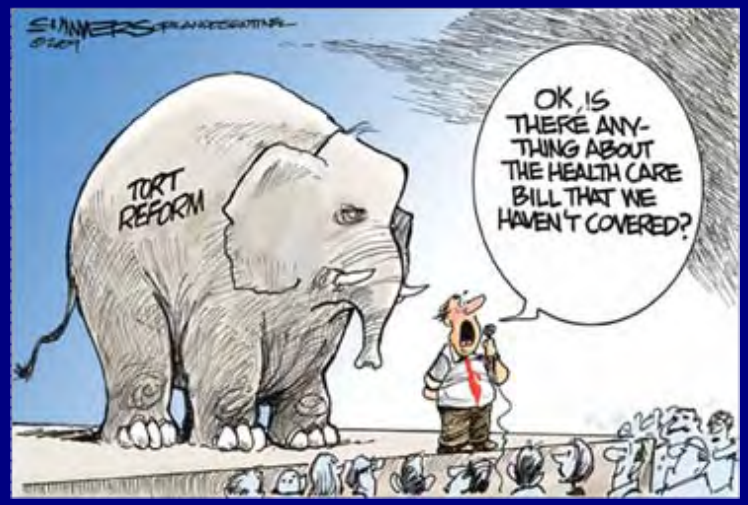
Aggregate bias	Confirmation bias	Multiple alternatives bias	Posterior probability error	Sutton's slip
Anchoring	Diagnosis momentum	Omission bias	Premature closure	Triage-cueing
Ascertainment bias	Fundamental attribution error	Order effects	Psych-out error	Unpacking principle
Availability and non-availability	Gambler's fallacy	Outcome bias	Representativeness restraint	Vertical line failure
Base-rate neglect	Gender bias	Overconfidence bias	Search satisfying	Visceral bias
Commission bias	Hindsight bias	Playing the odds		Yin–yang out
				Zebra retreat

Noncontroversial Solutions

- Electronic medical records
- Medical homes without boarders
- Increased communication with consultants
- Improved communication with patients
- Staged Imaging (US before CT, etc.)
- Multi-specialty guideline development

Controversial Solutions

- Medical liability reform
- Patient expectations
- EMTALA modifications
- Increased error transparency
- Clinical decision support systems



Clinical Decision Support Systems: State of the Art

Prepared for:

Agency for Healthcare Research and Quality
U.S. Department of Health and Human Services
540 Gaither Road
Rockville, MD 20850
www.ahrq.gov

Prepared by:

Eta S. Berner, Ed.D.
Department of Health Services Administration
University of Alabama at Birmingham

AHRQ Publication No. 09-0069-EF
June 2009

The Paradox: Emergency Care

- Computerized clinical decision support systems (CDS) have shown promise in reducing variance in care and resource utilization
- Most of these scenarios are limited to care "post diagnosis" care (e.g. diabetes, not in a diagnostic algorithm)
- Emergency medicine often cares for the acutely "undiagnosed patient"
- However small changes can have significant positive impact (renal colic, suspected appendicitis)

Conclusions

- As the emergency physician who is treating the patient we are ultimately responsible
- Our specialty was designed to be a safety net
- The environment and external factors affecting EP CDM are real and significant and affect CT usage
- Real solutions will need to address transformation of legal, regulatory, communication and medical care issues.

EM Physicians are Learning

How Much Is Too Much? The REAL Risks of X-Rays and CTs (WE-227) Wednesday, October 7 , 3:00 PM - 3:50 PM

“How much radiation is my baby going to get?”

“Will this CT scan give me brain cancer?”

These questions and more will be answered during this lecture.

Objectives:

Total RAD dosages of imaging radiography to CT scanning.

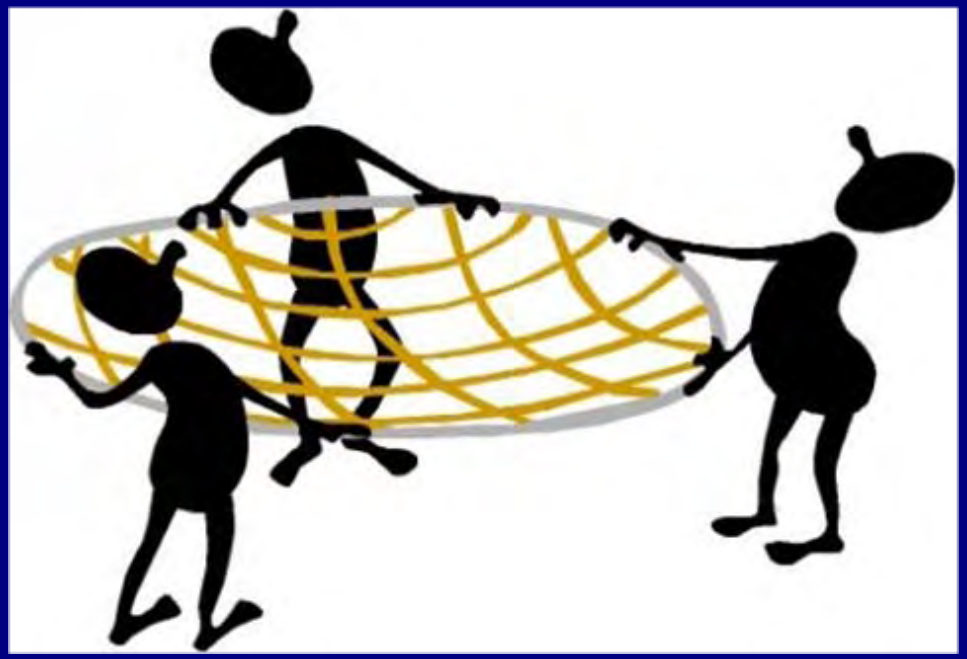
Discuss risks of renal failure associated with contrast imaging

Explain ways to avoid certain high RAD imaging studies.

Paul R. Sierzenski, MD, RDMS, FACEP. Sept 2009

Questions?

Since 8 am today nearly 100,000 patients have been treated by emergency physicians throughout the USA



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- Trott AT, Greenberg R. Acute abdominal pain. In: Rosen P, Barkin RM (eds). Emergency Medicine, Concepts and Clinical Practice. St. Louis: Mosby–Year Book, 1992.
- Final Report of The Emergency Medical Treatment and Labor Act Technical Advisory Group To the Secretary U.S. Department of Health and Human Services
- Croskerry P. Achieving Quality in Clinical Decision Making: Cognitive Strategies and Detection of Bias. ACAD EMERG MED • November 2002, Vol. 9, No. 11

CT Basic Physics, Equipment Operations and Dose Optimization

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Associate Professor of Radiology & Cardiology

Chief Physicist - Johns Hopkins Hospital

The Russell H. Morgan Department of Radiology and Radiological Science

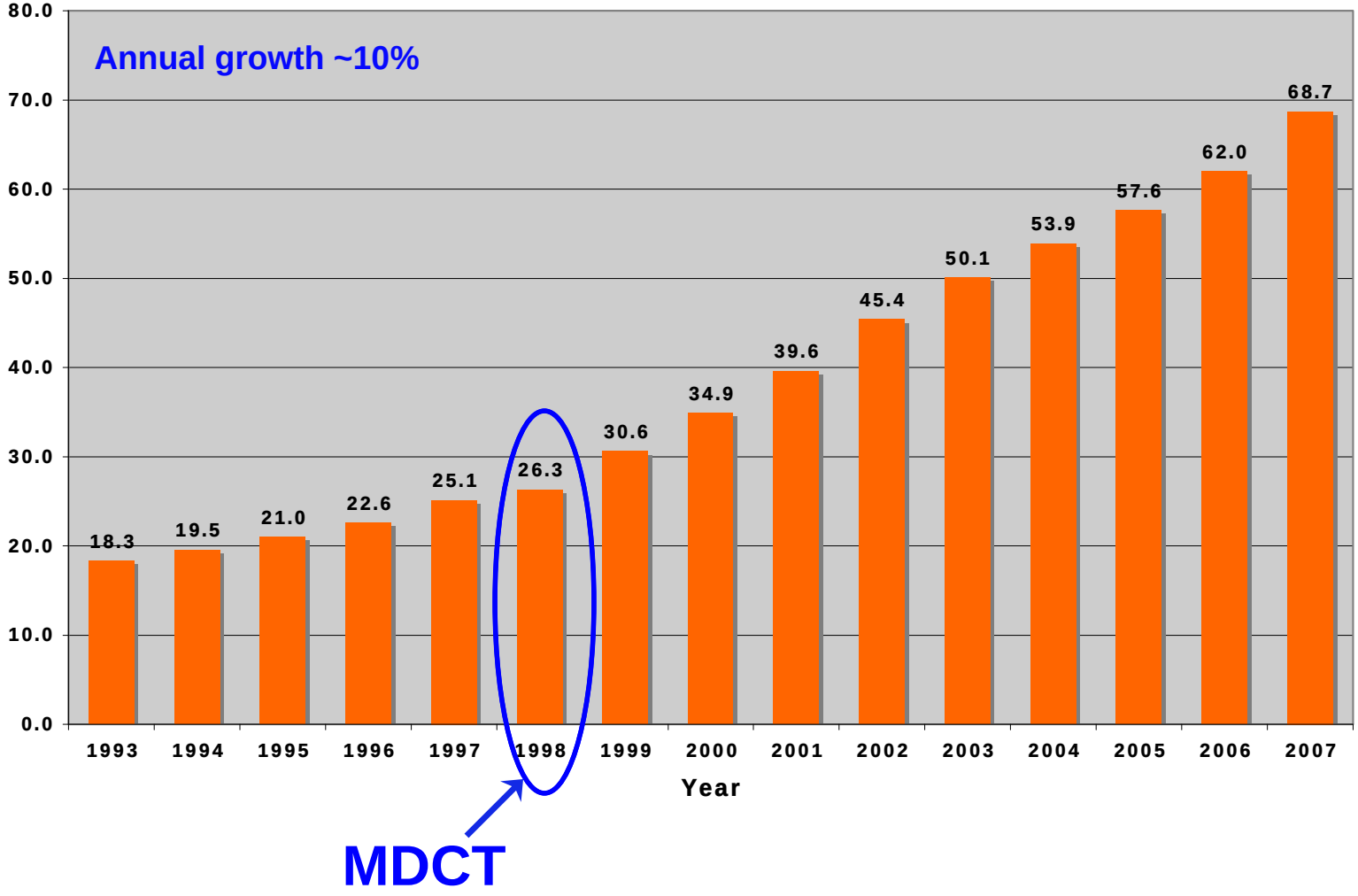
Johns Hopkins University, Baltimore, MD

CT in Emergency Medicine – Ensuring Appropriate Use
NCRP Meeting, Washington DC, September 23-24, 2009

Computed Tomography (CT)

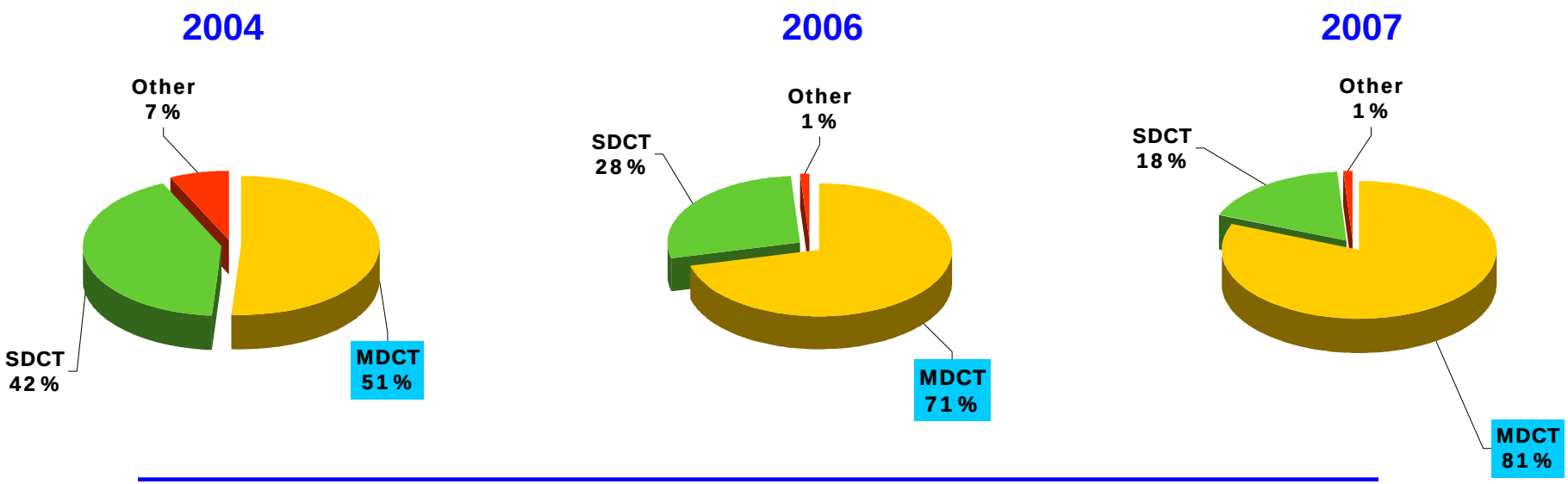
- Method for acquiring and reconstructing an image of a thin cross-section of an object
- Based on measurements of x-ray attenuation through section plane from many projections
- Achieved by rotating both x-ray tube and detectors around the patient
- CT is consistently rated in the top 5 medical innovations over the past 35 years

Number of CT procedures in US



IMV Benchmark Report on CT, 2008

MDCT growth in US as percent CT scanner



Survey Year	2004	2006	2007
Total CT installed in US	9,380	10,110	10,300
MDCT	51%	71%	81%
SDCT	42%	28%	18%
Other	7%	1%	1 %

MDCT Physics: The Basics…, Lippincott, 2009

Basic Principles

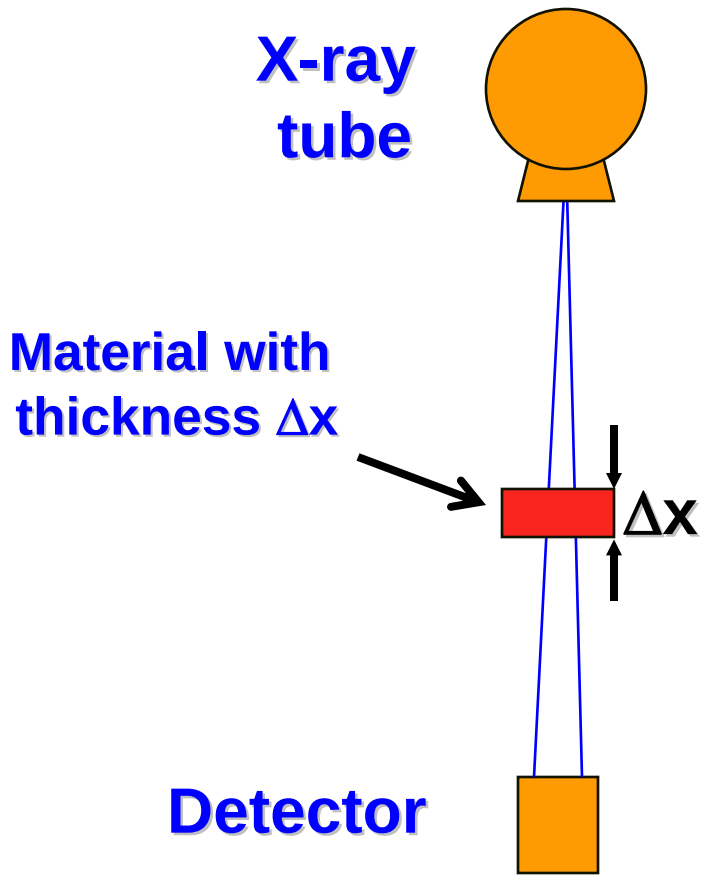
The Physics: X-ray Attenuation

- When an x-ray beam passes through an object, photons are removed by:
  - Photoelectric Effect
  - Compton Scattering
  - Coherent Scattering

The CT Signal

- **Tissue discrimination due to *variations in attenuation* between voxels depends on differences in:**
  - **Density**
  - **Atomic number of elements present**
  - **Influenced by detected mean photon energy**

Fundamental Measurement of Attenuation



$$I_t = I_o e^{-\mu \Delta x}$$

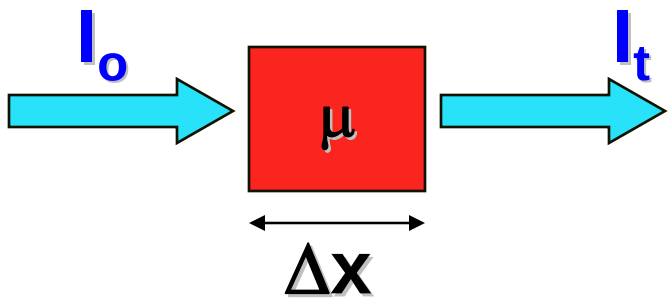
$$H = \ln\left(\frac{I_o}{I_t}\right) = \mu \Delta x$$

I_o = Input x-ray intensity

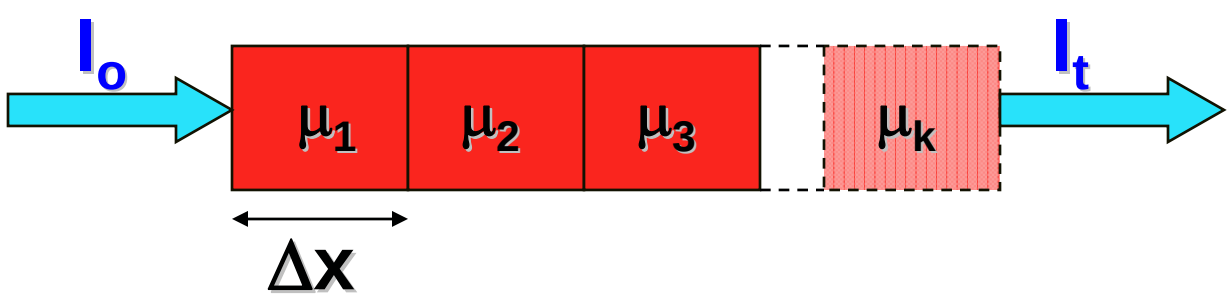
I_t = Transmitted x-ray intensity

μ = Linear attenuation coefficient

Ray Sum of X-Ray Attenuation



$$I_t = I_o e^{-\mu \Delta x}$$



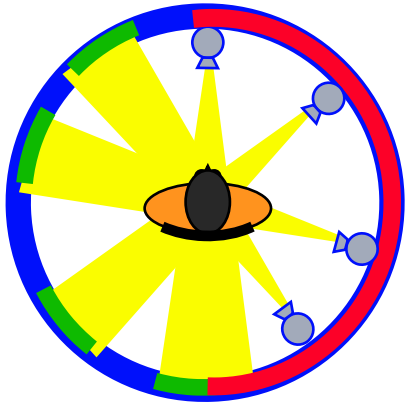
$$I_t = I_o e^{-\sum_{i=1}^{k} \mu_i \Delta x}$$

$$\sum_{i=1}^{k} \mu_i \Delta x = \ln\left[\frac{I_o}{I_t}\right]$$

Ray sum

CT Image Reconstruction

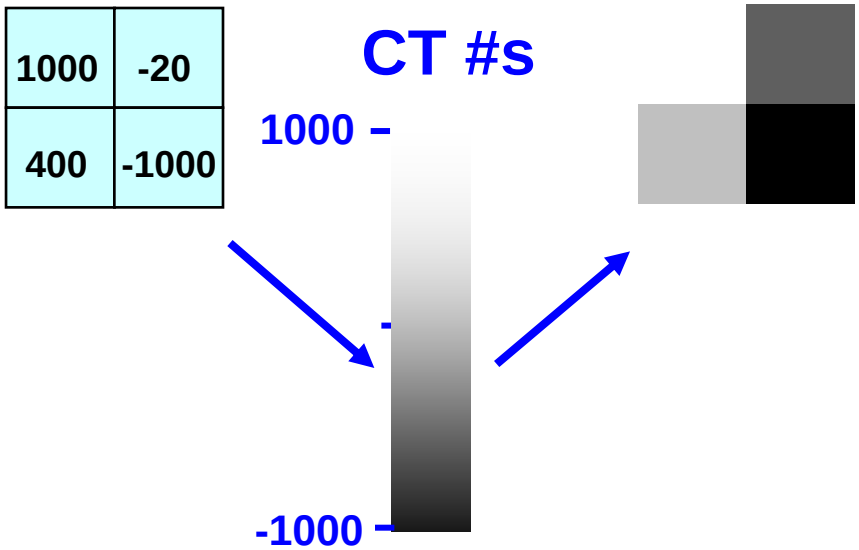
- **Process of deriving average attenuation coefficient (μ) values for each voxel in the cross section using many rays from many different projections**



CT Numbers in Hounsfield Units Normalized to Voxel containing Water

$$CT\ \# = k\left(\frac{\mu - \mu_w}{\mu_w}\right)$$

k = Scaling factor = 1000

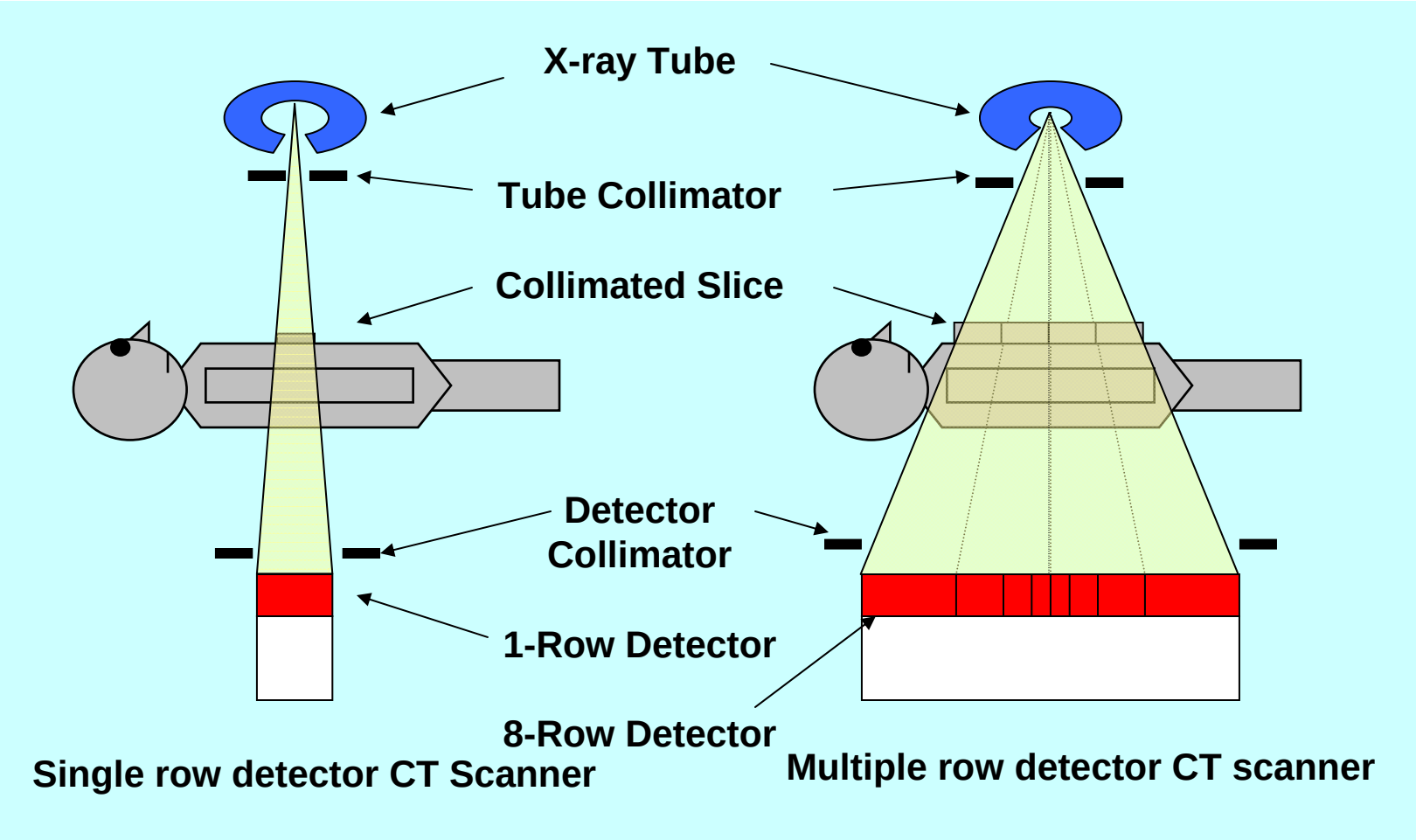


By definition CT # of water = 0, CT # of air = -1000

Tissues: Denser than water → positive CT #s

Less dense than water → negative CT #s

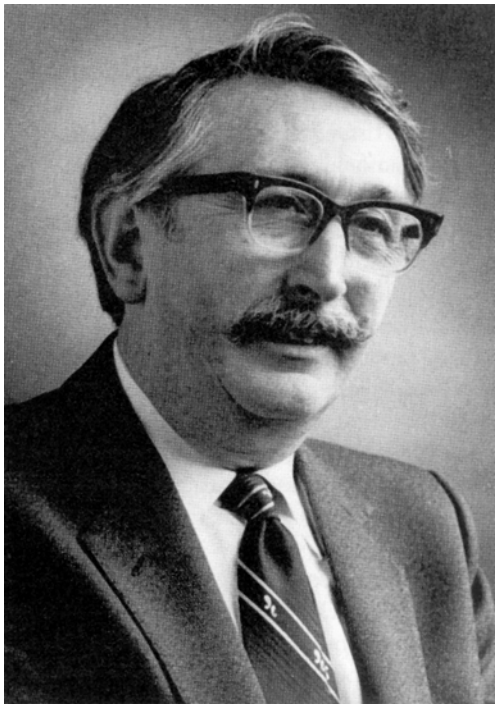
Single-row vs Multiple-row Detector CT



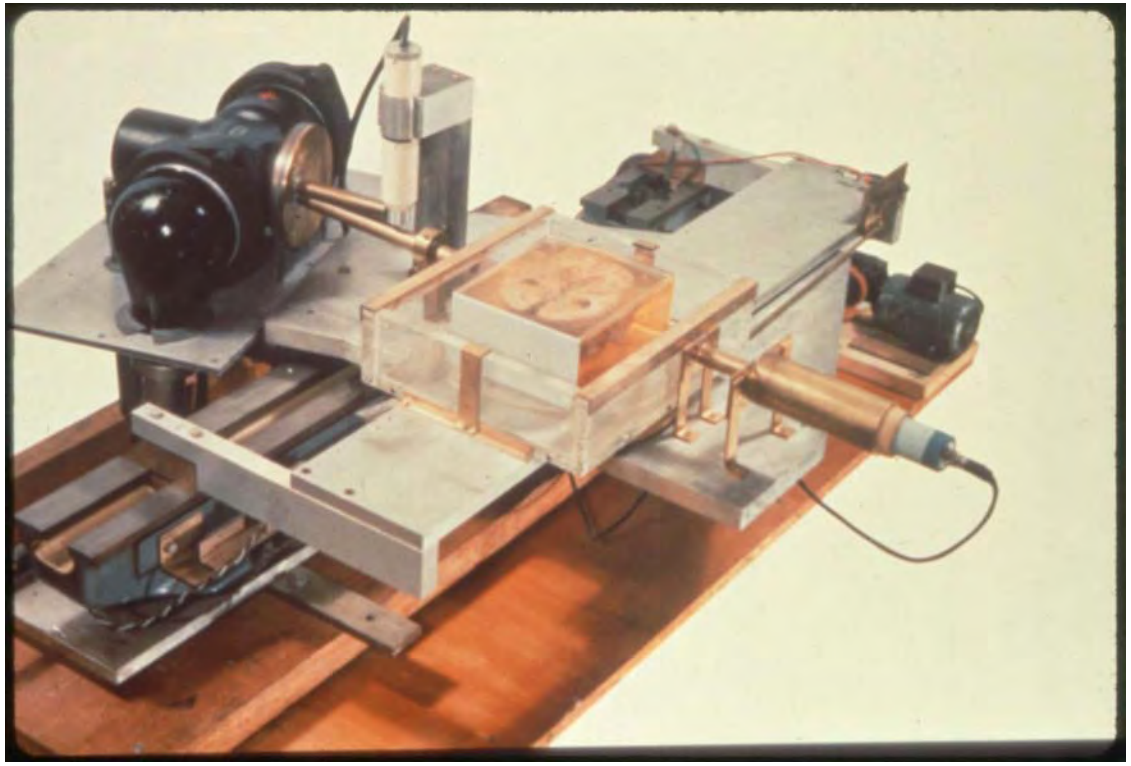
Mahesh M. MDCT Physics: The Basics…, Lippincott, 2009

CT Equipment Operations

Early Experiments



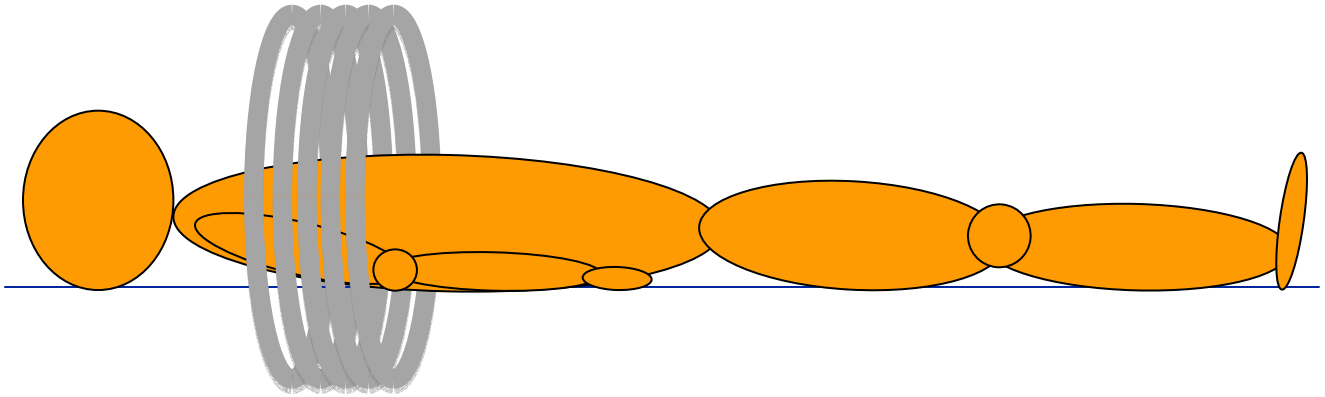
Sir Godfrey N. Hounsfield*



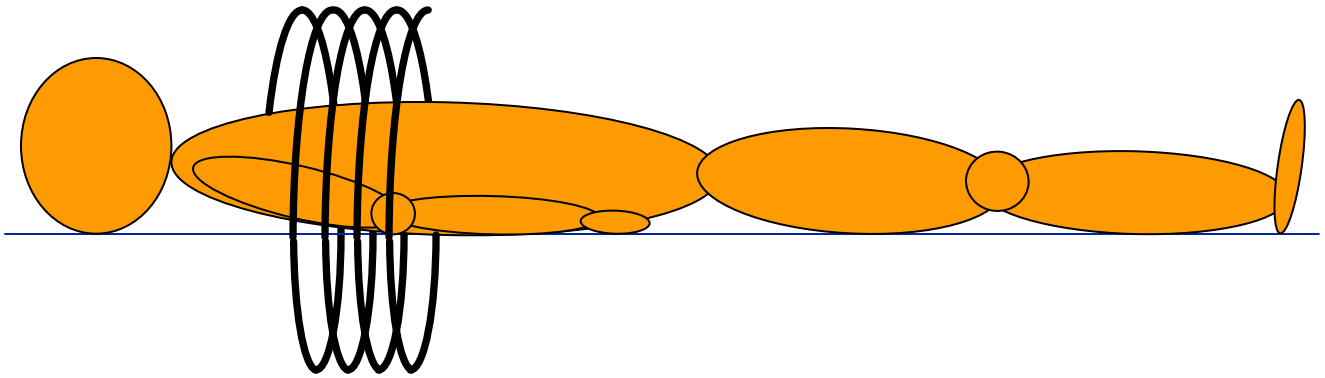
Original lathe bed scanner used in early CT experiments

* 1979 Nobel Prize in Medicine

Scan Types: Sequential and Helical



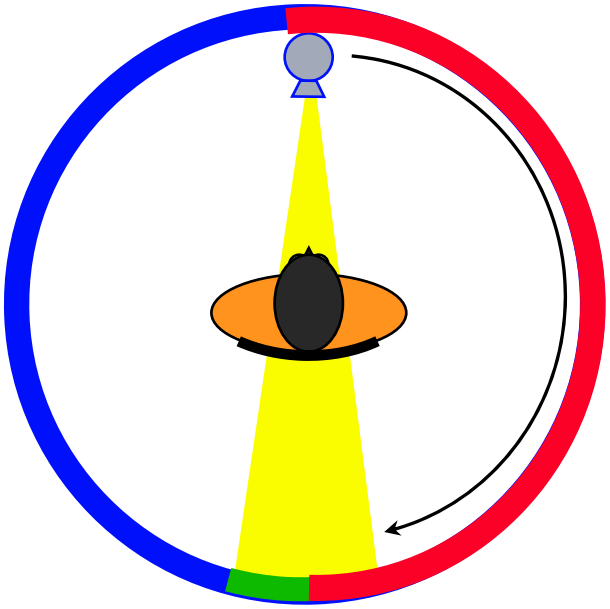
Sequential or 'Step and Shoot' scan



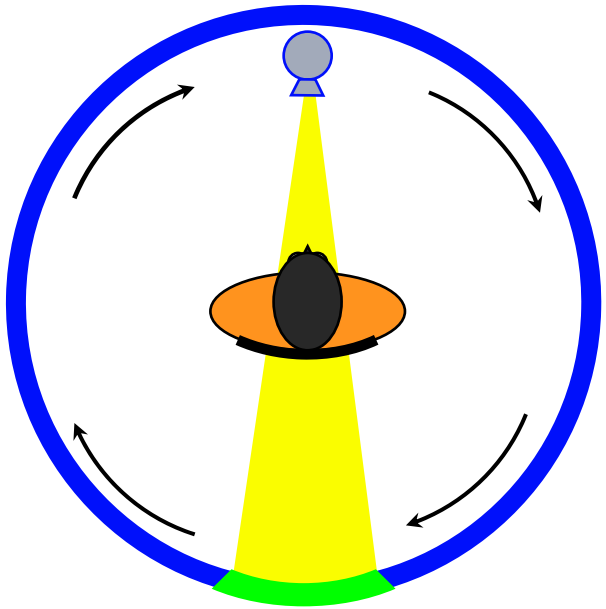
Helical or Spiral scan

Mahesh M. MDCT Physics: The Basics…, Lippincott, 2009

Scan Modes: Partial and Dynamic



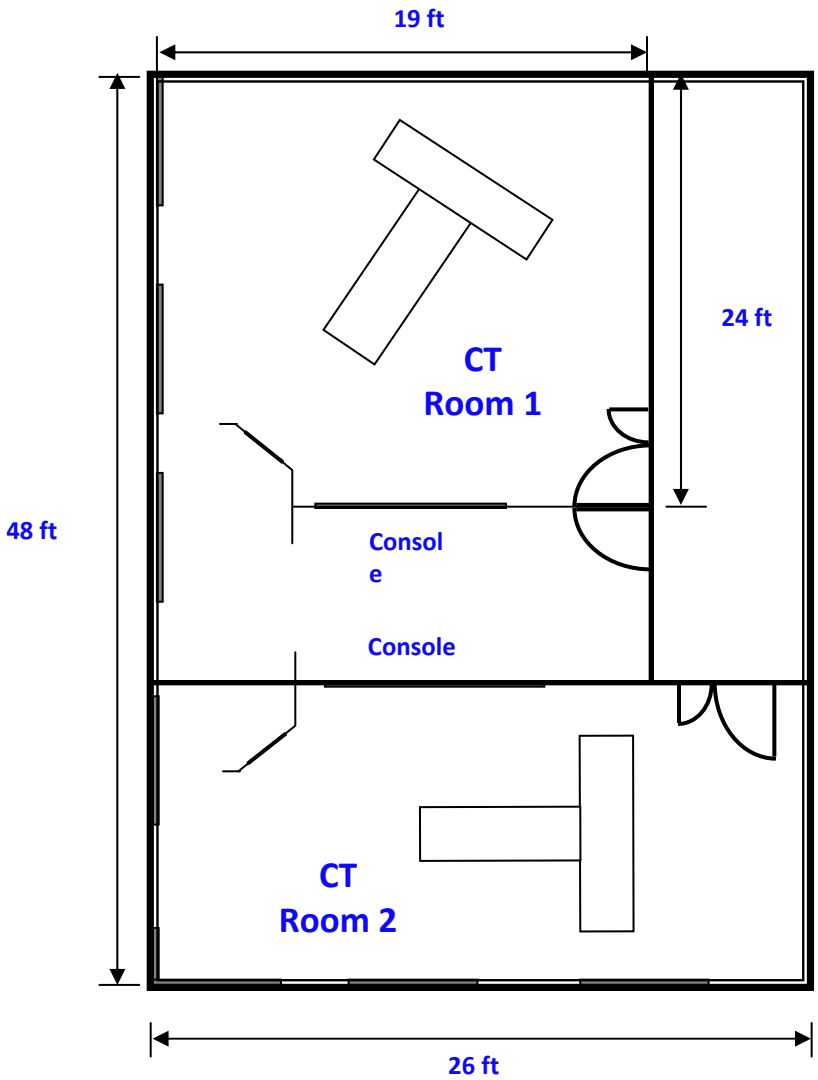
Partial scan mode – Half-scan plus fan angle



Dynamic scan mode – Multiple continuous rotation of x-ray tube at same table position

Mahesh M. MDCT Physics: The Basics…, Lippincott, 2009

Typical CT scanner layout

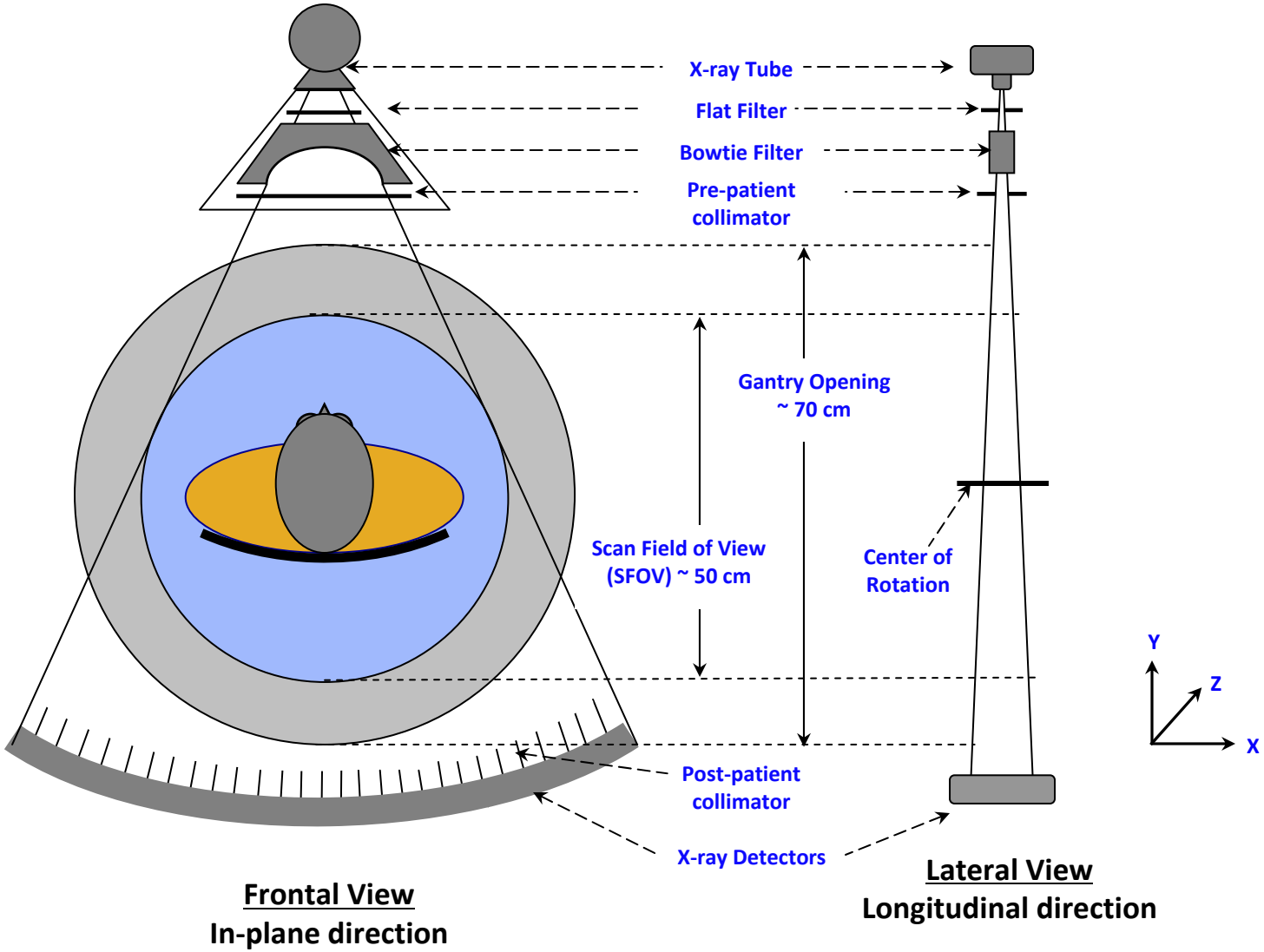


Typical CT suite with control booth

Typical CT room

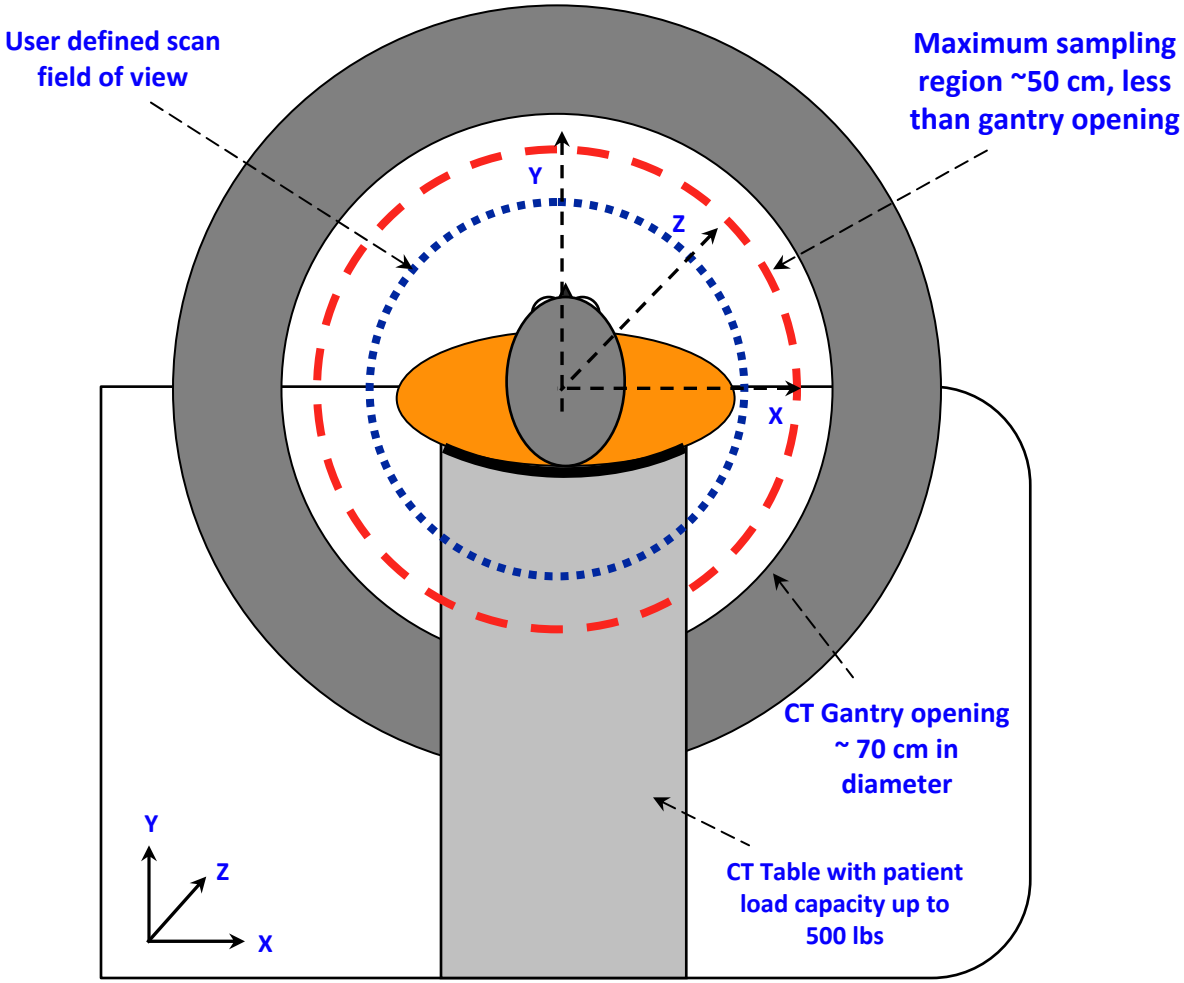
MDCT Physics: The Basics…, Lippincott, 2009

CT Gantry with major components



Mahesh M. MDCT Physics: The Basics…, Lippincott, 2009

CT Gantry



MDCT Physics: The Basics…, Lippincott, 2009

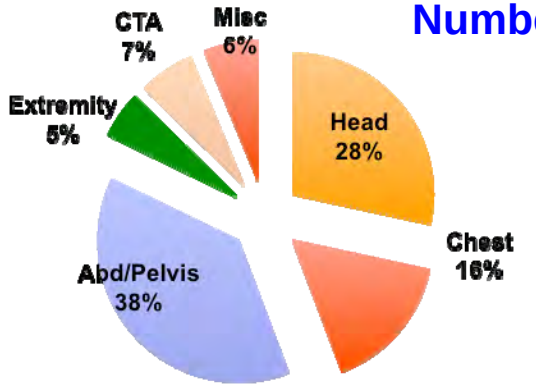
CT Dose Optimization

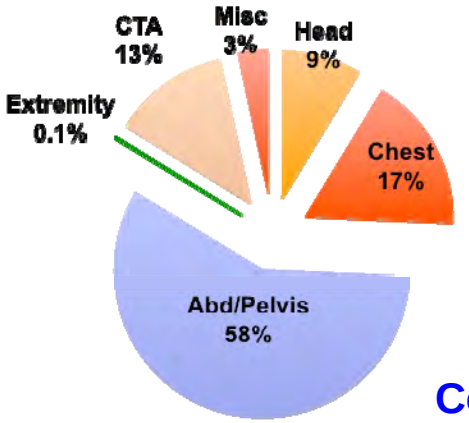
CT: Numbers vs Collective Dose

	Number (millions)	%	Collective dose (person Sv)	%
Head	19.0	28	38,000	8.7
Chest	10.6	16	74,000	17.0
Abd/Pelvis	25.4	39	254,000	58.0
Extremity	3.5	5	500	0.1
CT Angiography	4.3	6	56,000	12.8
Miscellaneous	4.2	6	15,000	3.4
TOTAL	67		438,000	

84%

Numbers



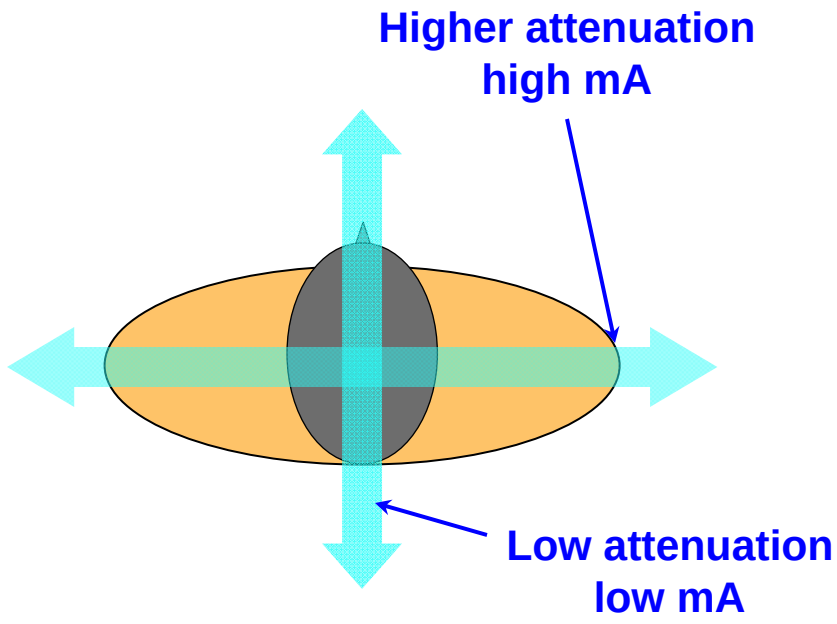


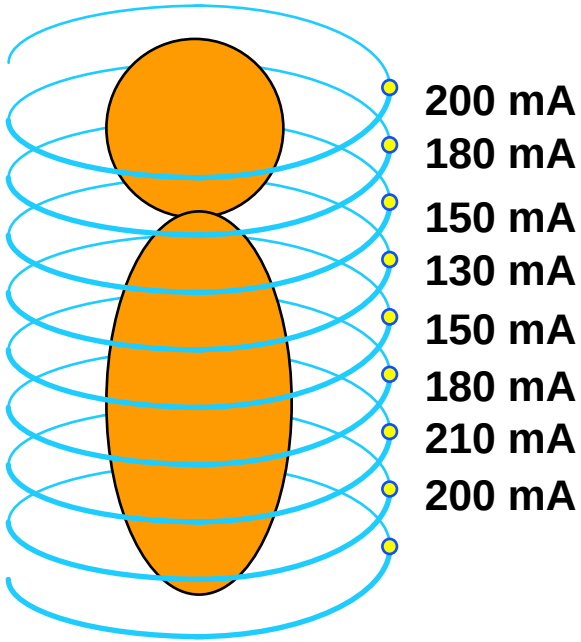
Collective Dose

NCRP Report 160

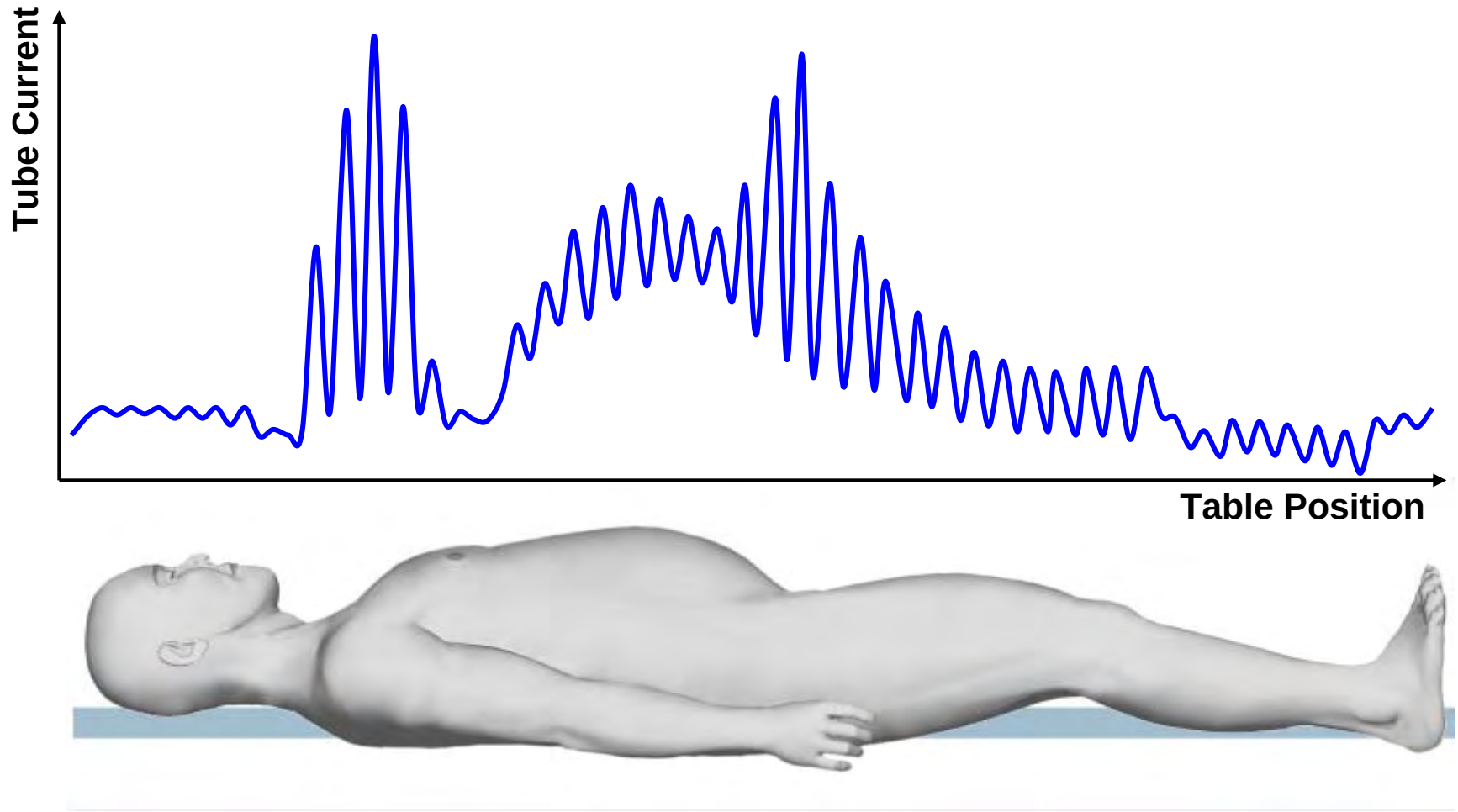
CT Dose Modulation

- X-ray attenuation lower in AP and higher in lateral projection
- Dose reduction based on patient anatomy
- Lower mA in AP, higher mA in lateral directions





CT Dose Modulation



MDCT Physics: The Basics…, Lippincott, 2009

Typical Effective Dose Values

CT Protocol	Effective dose (mSv)
Head CT	1 - 2
Chest CT	5 - 7
Abdomen & Pelvis CT	8 - 11
Calcium Scoring	1 - 6
Cardiac CT Angiography (helical)	10 – 20
Cardiac CT Angiography*	2 - 7
Typical Chest x-ray	0.1 – 0.2
Average US natural background radiation per year ~3.0 mSv	

* Prospectively triggered, DSCT, 320 MDCT

Adult Effective Doses for Various CT Procedures

Examination	Effective dose (mSv)	Range in literature (mSv)
Head	2	0.9 – 4.0
Neck	3	…
Chest	7	4.0 – 18.0
Chest for Pulmonary Embolism	15	13 – 40
Abdomen	8	3.5 – 25
Pelvis	6	3.3 – 10
Three-phase liver study	15	…
Spine	6	1.5 – 10
Coronary angiography	16	5.0 – 32
Calcium scoring	3	1.0 – 12
Virtual colonoscopy	10	4.0 – 13.2

Mettler FA, et al., Radiology, 248(1), 254-263, 2008

Topics of Concern in CT

- Multiple CT scans within a CT exam
- Radiation dose per CT scan
- Repeat CT exams

CT exam of abdomen and pelvis: Sample dose reports

Arterial and Venous scan series

Total mAs 20002 Total DLP 2736

	Scan	kV	mAs / ref.	CTDIvol	DLP	TI	cSL
Patient Position H-SP							
Topogram	1	120				7.8	0.6
ARTERIAL	2	120	450	32.31	1053	0.33	0.6
VENOUS	3	120	450	32.24	1683	0.33	0.6

52 mSv

Arterial, Venous and Delay scan series

Total mAs 28164 Total DLP 3873

	Scan	kV	mAs / ref.	CTDIvol	DLP	TI	cSL
Patient Position H-SP							
Topogram	1	120				7.8	0.6
ARTERIAL	2	120	534	38.34	1212	0.5	0.6
VENOUS	3	120	530	38.02	1437	0.5	0.6
DELAY	4	120	500	35.96	1224	0.5	0.6

74 mSv

Radiation Dose Report - CT Angiography Exam

25-Jan-2007 11:45

Ward: 231I
Physician:
Operator:

Total mAs 9313 Total DLP 1266

	Scan	kV	mAs / ref.	CTDIvol	DLP	TI	cSL
Patient Position H-SP							
Topogram	1	80				5.3	0.6
CaScSeq	2	120	135	9.73	140	0.24	0.6
TestBolus	10	120	40	26.62	27	0.5	10.0
TestBolus-use	21	120	40	24.20	24	0.5	10.0
CorCTA	31	120	850	65.78	1075	0.33	0.6

Effective dose (mSv)

2.4 mSv

1.0 mSv

18.3 mSv

Total effective dose (mSv) 21.7 mSv

CT Dose Optimization

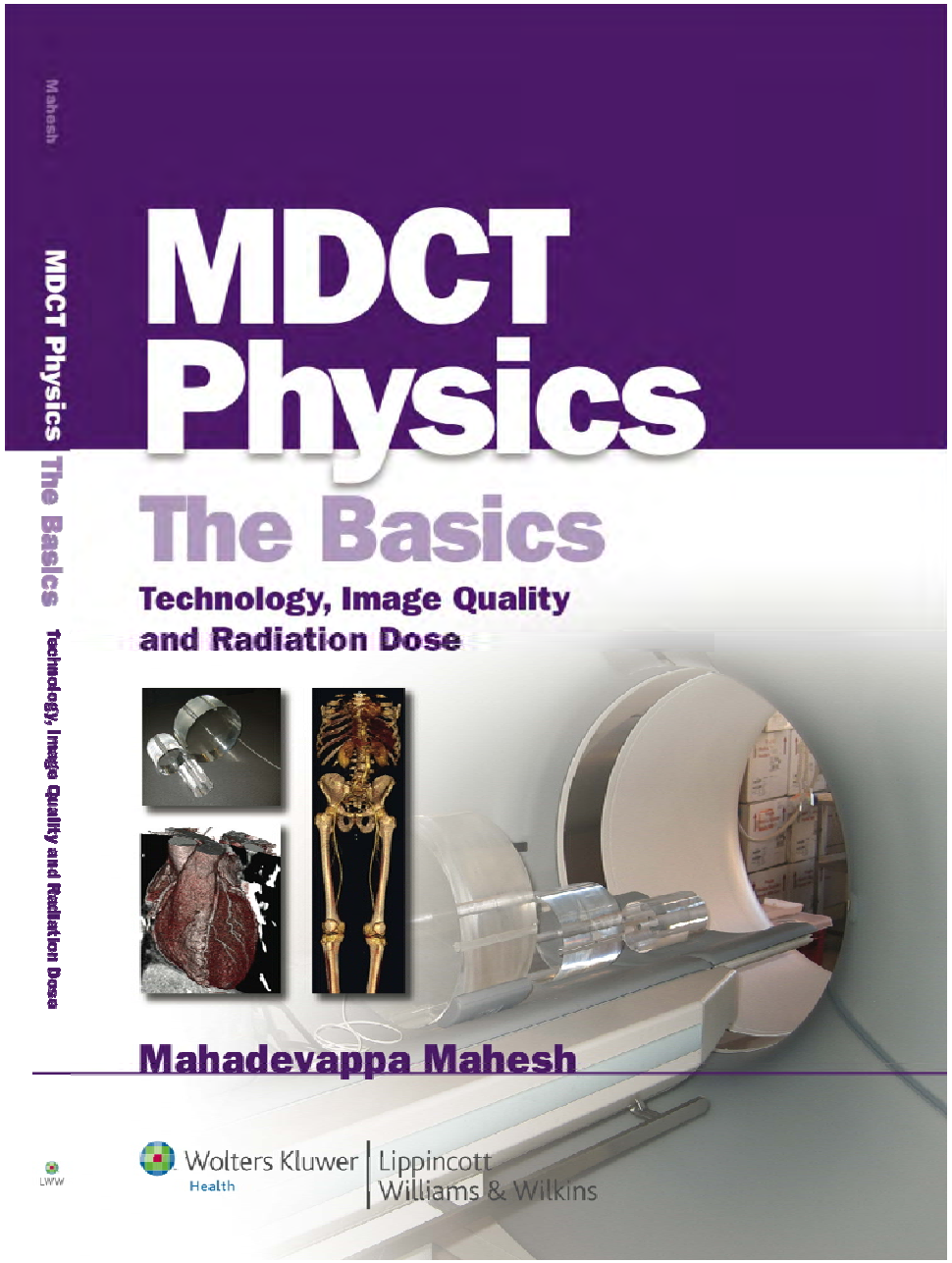
- Alter CT scan parameters based on patient size, weight and type
- Adopt CT dose modulation techniques
  - Variation during routine scans
  - ECG dose modulation during cardiac scans
- Increased awareness about CT dose
- Apply *'Image Gently'* campaign advice

CT Dose Optimization

- ***'Image Gently'*** **campaign advice**
  - **Child-size the amount of radiation used**
  - **Scan only when needed**
  - **Scan only indicated region**
  - **Scan once – avoid multi-phase scanning**
- **Avoid unnecessary CT scans**
  - **Especially scans performed due to insufficient image quality or due to difficulty in timely access of images**

Conclusions

- **Understanding CT physics basics benefits efforts in dose optimization and reducing overall CT dose**
- **Justifying appropriateness of CT exam is critical!**



Contents

Radiation Doses and Risks from Medical Imaging of Trauma Patients

Walter Huda PhD, Tyler Scimeca MD
William Conway MD, Eugene Mah MS

Radiology and Radiological Science
Medical University of South Carolina

PURPOSE

Determine patient effective doses (and carcinogenic risks) to trauma patients

METHOD

26 consecutive patients treated in MUSC ED

Injury Severity Score > 15

Medical records

$\rightarrow$

Number/Type of examinations

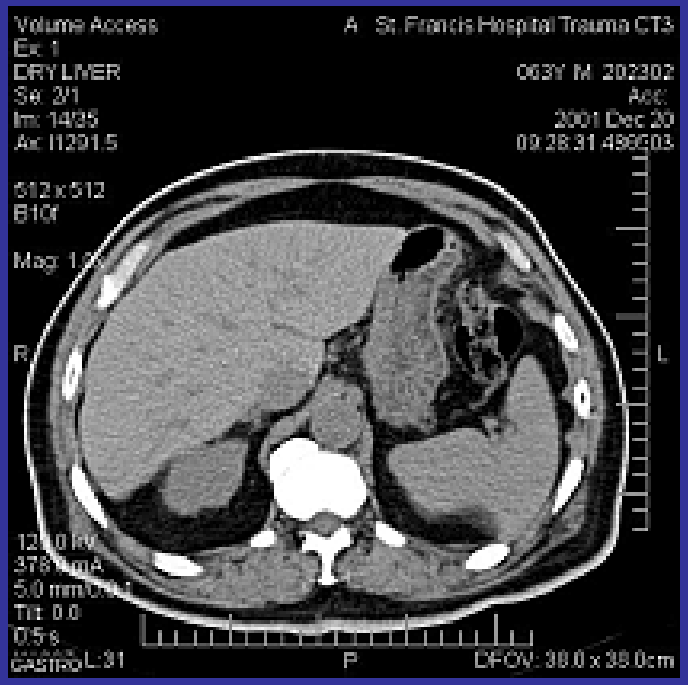
$\rightarrow$

Cumulative Effective Dose

Radiography
Dose Conversion Factors

~ 0.036 μSv/cm^2

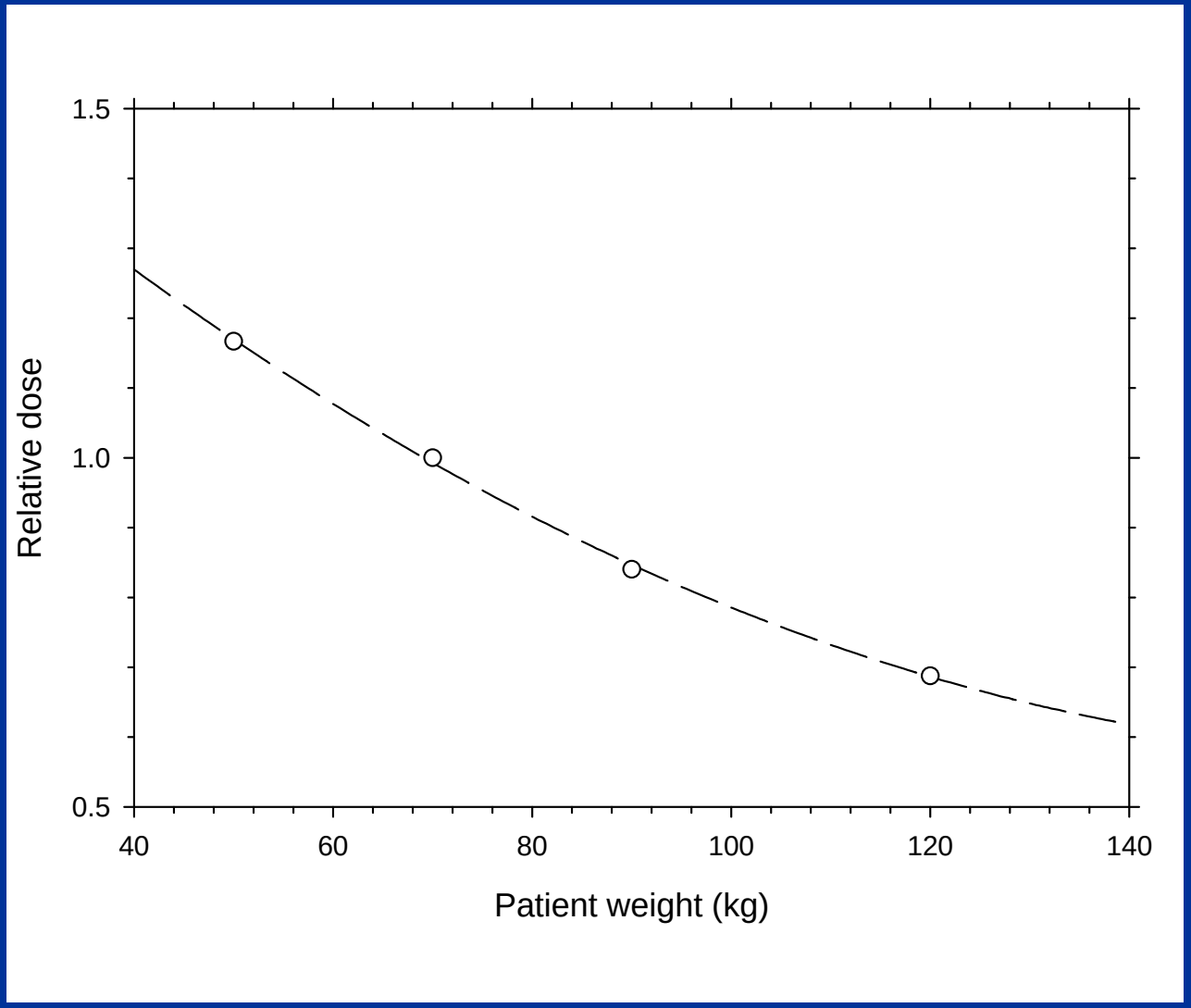
CT
Dose Conversion Factors



~ 18 μSv/mGy-cm

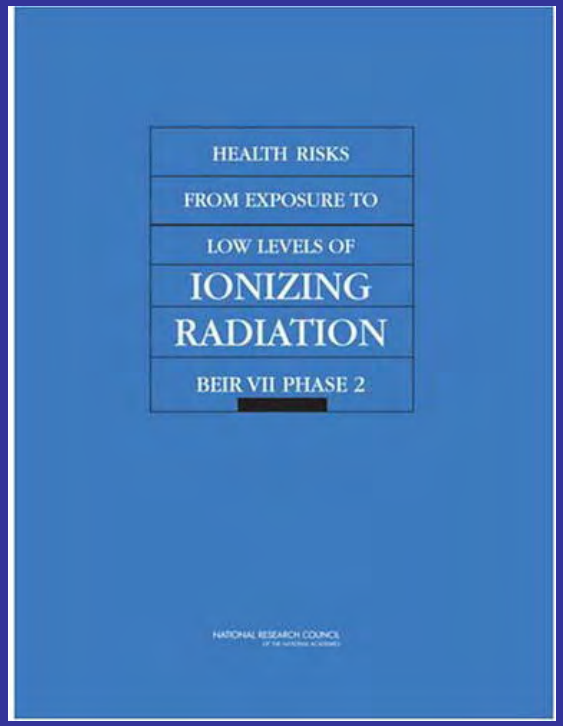
Radiology ***248*** (2008) 995-1003

Doses corrected for patient weight

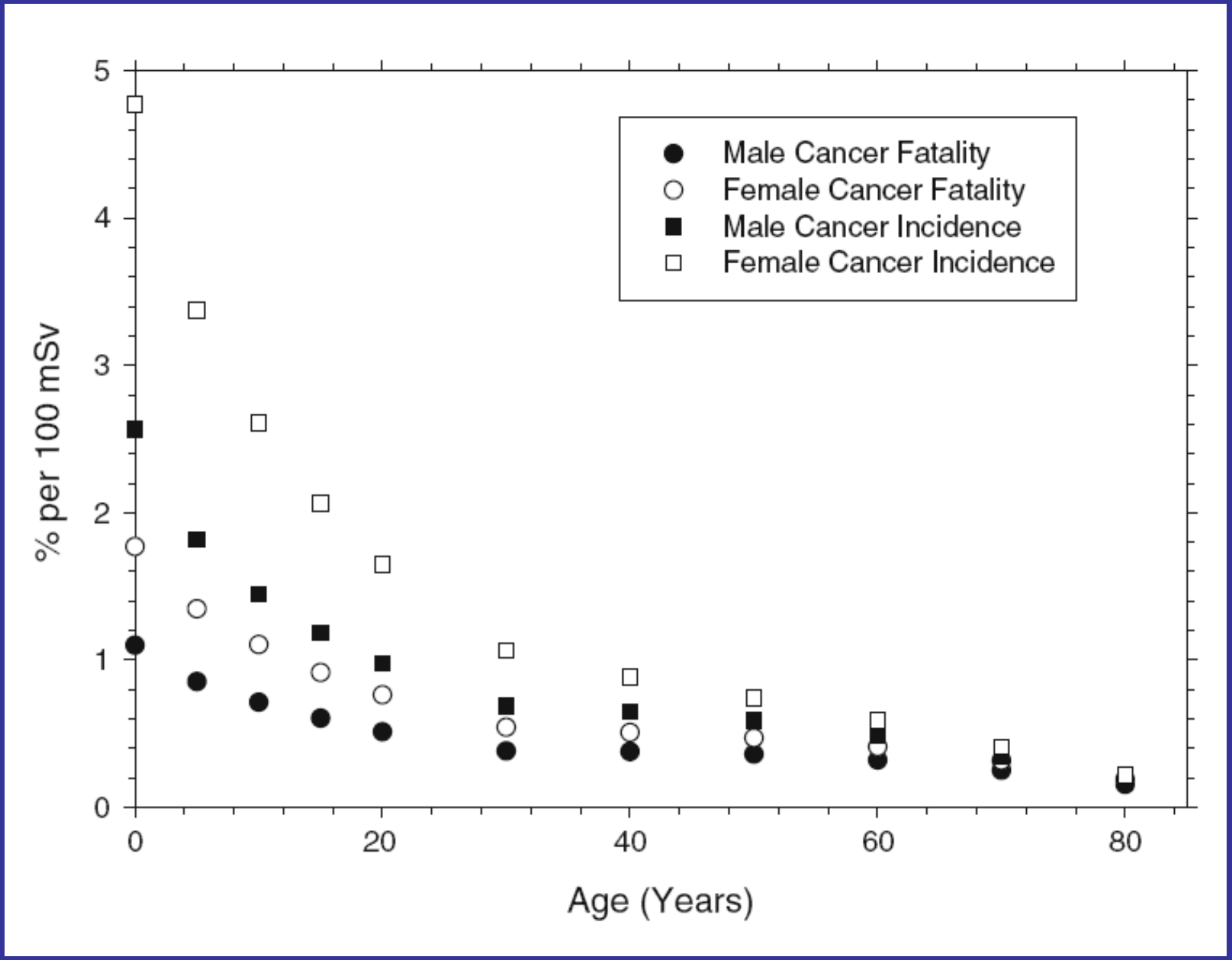


Huda/McCollough; Cardiac CT Dosimetry CT of the Heart (UJ Schoepf) 2nd Edition

Effective dose quantify the patient risk of cancer



Accounting for patient age and sex



Emergency Radiology **16** (2009) 335–341

RESULTS

Average age 41 ± 16

9/26 (35%) females

During ED visit, on average

4.9 radiographic images

4.1 CT scans

Average Effective Dose

68 ± 29 mSv

~ 98% from CT

Average Risk of Cancer

Males ~ 0.47%

Females ~ 0.54%

US Cancer Incidence ~ 42%

American Cancer Society

CONCLUSIONS

Trauma Patients in ED (MUSC)

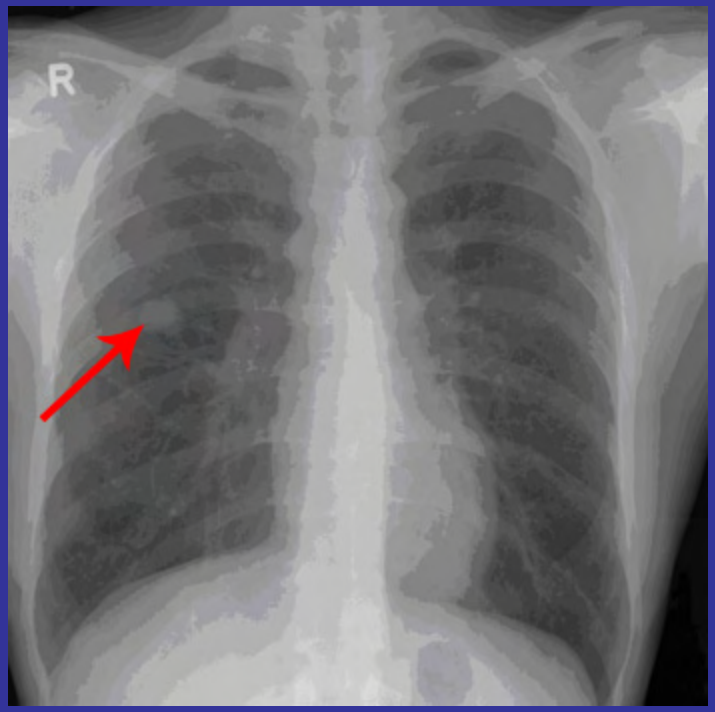
Relatively Young

Receive ~ 70 mSv
from medical imaging (ISS > 15)

(~100% from CT)

Radiation Risks from Medical Imaging Need to be Justified By a Corresponding Patient Benefit

CT Protocols
Ensure Patient Exposures
As Low As Reasonably Achievable
(ALARA)



Thank You

huda@musc.edu

Conduct of CT:

Techniques and Tactics for Dose Management

Donald P. Frush, MD

Division of Pediatric Radiology
Department of Radiology
Duke University Medical Center

I consider the radiologist's responsibility with (radiation) dose to be the same as any physician's with (medication) dose.

Over (or under) dosing is a medical error.

"This is the city. Los Angeles, California. I work here... I'm a radiologist.“

“The story you are about to hear…”

Conduct of CT Outline

- Background
- Justification
- Optimization
  - dose reduction strategies

Radiation Dose Reduction Strategies for CT

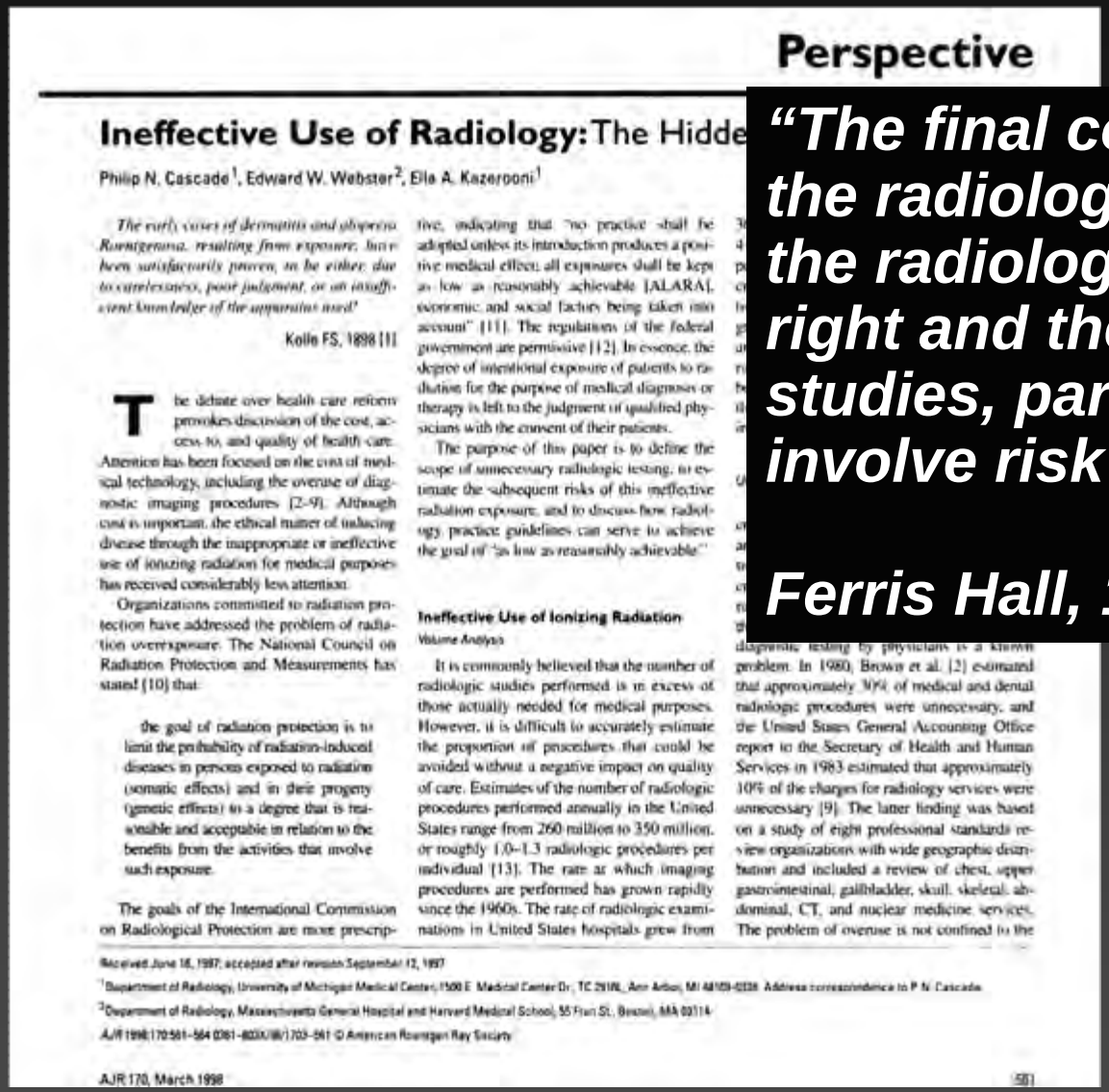
- Judicious use of CT
- Adjusted techniques
- Other

Background

PEM Malpractice Lawsuits: Most Common Diagnoses

- Meningitis
- Appendicitis
- Fractures
- Testicular torsion


Isn't it easier just to get a CT?



Perspective

Ineffective Use of Radiology: The Hidde

Philip N. Cascade[1], Edward W. Webster[2], Ella A. Kazerooni[1]

The early cases of dermatitis and alopecia Roentgenana, resulting from exposure, have been satisfactorily proven, to be either due to carelessness, poor judgment, or an insufficient knowledge of the apparatus used.

Kolle FS, 1898 [1]

The debate over health care reform provokes discussion of the cost, access to, and quality of health care. Attention has been focused on the cost of medical technology, including the overuse of diagnostic imaging procedures [2–9]. Although cost is important, the ethical matter of inducing disease through the inappropriate or ineffective use of ionizing radiation for medical purposes has received considerably less attention.

Organizations committed to radiation protection have addressed the problem of radiation overexposure. The National Council on Radiation Protection and Measurements has stated [10] that:

> the goal of radiation protection is to limit the probability of radiation-induced diseases in persons exposed to radiation (somatic effects) and in their progeny (genetic effects) to a degree that is reasonable and acceptable in relation to the benefits from the activities that involve such exposure.

The goals of the International Commission on Radiological Protection are more prescriptive, indicating that "no practice shall be adopted unless its introduction produces a positive medical effect; all exposures shall be kept as low as reasonably achievable [ALARA], economic and social factors being taken into account" [11]. The regulations of the federal government are permissive [12]. In essence, the degree of intentional exposure of patients to radiation for the purpose of medical diagnosis or therapy is left to the judgment of qualified physicians with the consent of their patients.

The purpose of this paper is to define the scope of unnecessary radiologic testing, to estimate the subsequent risks of this ineffective radiation exposure, and to discuss how radiology practice guidelines can serve to achieve the goal of "as low as reasonably achievable."

Ineffective Use of Ionizing Radiation

Volume Analysis

It is commonly believed that the number of radiologic studies performed is in excess of those actually needed for medical purposes. However, it is difficult to accurately estimate the proportion of procedures that could be avoided without a negative impact on quality of care. Estimates of the number of radiologic procedures performed annually in the United States range from 260 million to 350 million, or roughly 1.0–1.3 radiologic procedures per individual [13]. The rate at which imaging procedures are performed has grown rapidly since the 1960s. The rate of radiologic examinations in United States hospitals grew from

diagnostic testing by physicians is a known problem. In 1980, Brown et al. [2] estimated that approximately 30% of medical and dental radiologic procedures were unnecessary, and the United States General Accounting Office report to the Secretary of Health and Human Services in 1983 estimated that approximately 10% of the charges for radiology services were unnecessary [9]. The latter finding was based on a study of eight professional standards review organizations with wide geographic distribution and included a review of chest, upper gastrointestinal, gallbladder, skull, skeletal, abdominal, CT, and nuclear medicine services. The problem of overuse is not confined to the

Received June 16, 1997; accepted after revision September 12, 1997

[1]Department of Radiology, University of Michigan Medical Center, 1500 E. Medical Center Dr., TC 2910L, Ann Arbor, MI 48109-0328. Address correspondence to P. N. Cascade.

[2]Department of Radiology, Massachusetts General Hospital and Harvard Medical School, 55 Fruit St., Boston, MA 02114.

AJR 1998;170:581–584 0361–803X/98/1703–581

"The final common pathway of the radiological examination is the radiologist, who has the right and the duty to refuse studies, particularly when they involve risk to the patient"

Ferris Hall, 1976

AJR:170, March 1998

Radiology

Recurrent CT, Cumulative Radiation Exposure, and Associated Radiation-induced Cancer Risks from CT of Adults[1]

Aaron Sodickson, MD, PhD
Pieter F. Baeyens, MD
Katherine P. Andriole, PhD
Luciano M. Prevedello, MD
Richard D. Nawfel, MS
Richard Hanson
Ramin Khorasani, MD, MPH

Purpose: To estimate cumulative radiation exposure and lifetime attributable risk (LAR) of radiation-induced cancer from computed tomographic (CT) scanning of adult patients at a tertiary care academic medical center.

Materials and Methods: This HIPAA-compliant study was approved by the institutional review board with waiver of informed consent. The cohort comprised 31 462 patients who underwent diagnostic CT in 2007 and had undergone 190 712 CT examinations over the prior 22 years. Each patient's cumulative CT radiation exposure was estimated by summing typical CT effective doses, and the Biological Effects of Ionizing Radiation (BEIR) VII methodology was used to estimate LAR on the basis of sex and age at each exposure. Billing ICD9 codes and electronic order entry information were used to stratify patients with LAR greater than 1%.

Results: Thirty-three percent of patients underwent five or more lifetime CT examinations, and 5% underwent between 22 and 132 examinations. Fifteen percent received estimated cumulative effective doses of more than 100 mSv, and 4% received between 250 and 1375 mSv. Associated LAR had mean and maximum values of 0.3% and 12% for cancer incidence and 0.2% and 6.8% for cancer mortality, respectively. CT exposures were estimated to produce 0.7% of total expected baseline cancer incidence and 1% of total cancer mortality. Seven percent of the cohort had estimated LAR greater than 1%, of which 40% had either no malignancy history or a cancer history without evidence of residual disease.

Conclusion: Cumulative CT radiation exposure added incrementally to baseline cancer risk in the cohort. While most patients accrue low radiation-induced cancer risks, a subgroup is potentially at higher risk due to recurrent CT imaging.

[1] From the Department of Radiology and Center for Evidence Based Imaging (A.S., P.F.B., K.P.A., L.M.P., R.N., R.H.), Brigham and Women's Hospital, 75 Francis St, Boston, MA 02115; and Harvard Medical School, Boston, Mass (A.S., P.F.B., K.P.A., L.M.P., R.D.N., R.K.). From the 2008 RSNA Annual Meeting. Received July 28, 2008; revision requested August 28; revision received September 30; accepted October 24; final version accepted November 3. Address correspondence to A.S. (e-mail: asodickson@partners.org).

Number of CT Examinations

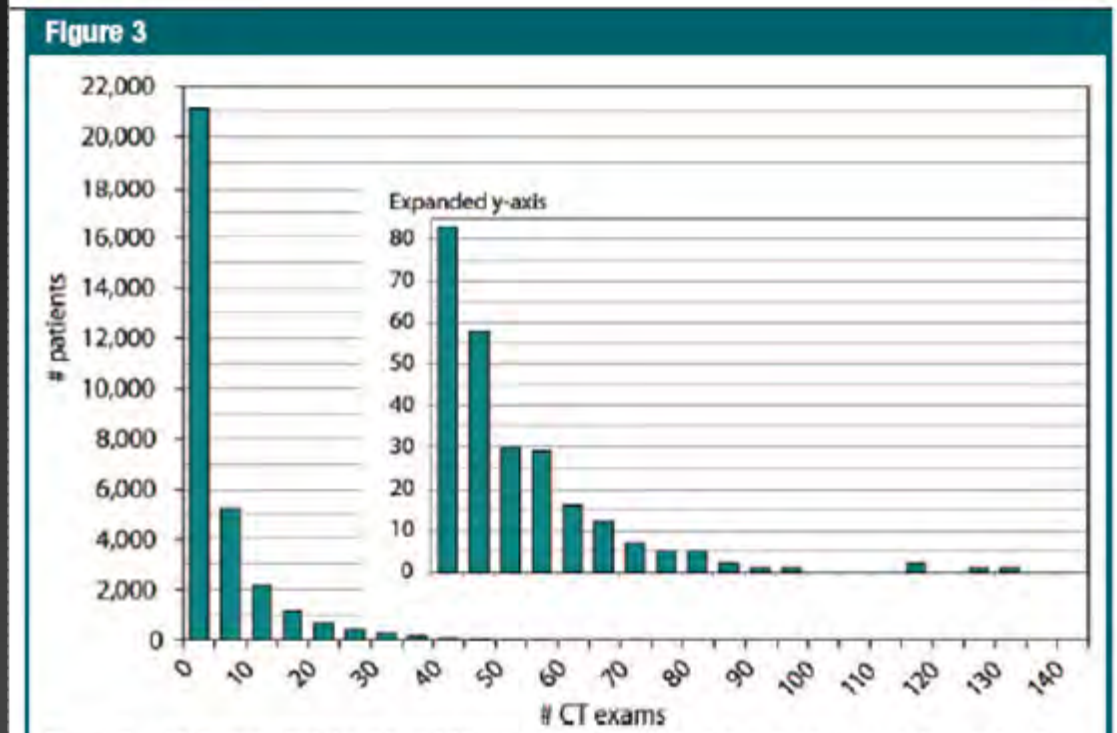


Figure 3: Histogram of total number of CT examinations per patient, over the 22-year study period in the cohort of 31 463 patients. The inset includes an expanded y-axis to display the right tail and contains the top percentile of per-patient examination counts; 33% of patients underwent more than five lifetime CT scans, 5% underwent more than 22 scans, and 1% underwent more than 38 scans.

- **33% ≥ 5 CTs**
- **5% 22-132**

Estimated Cumulative Dose

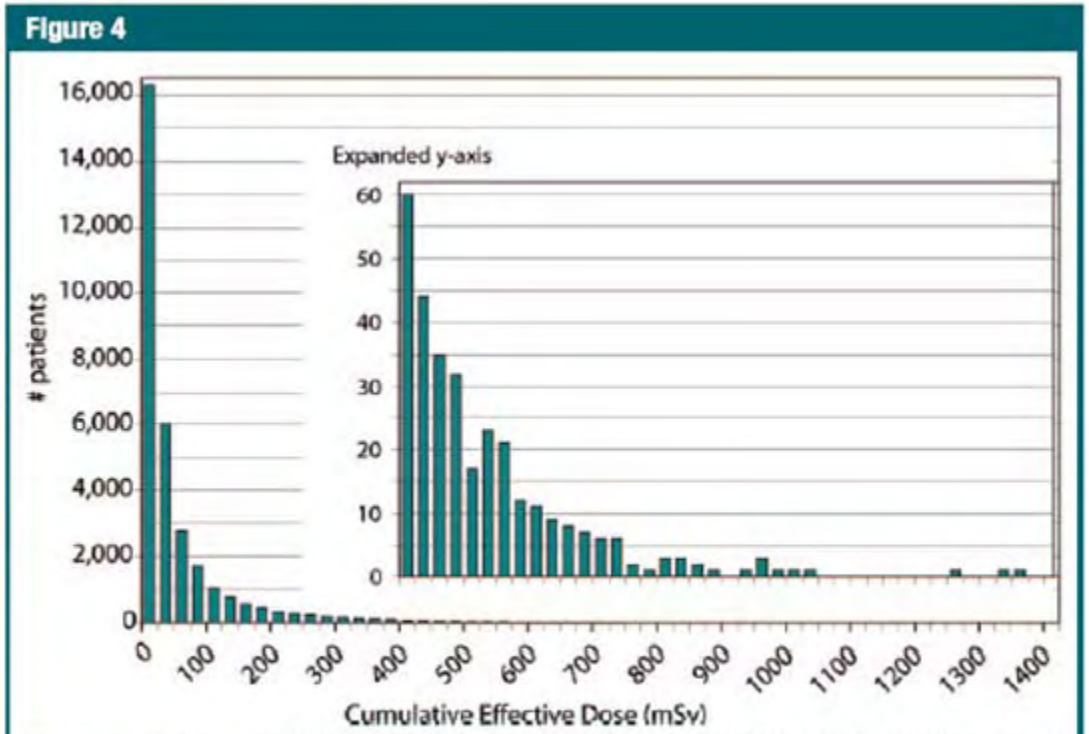
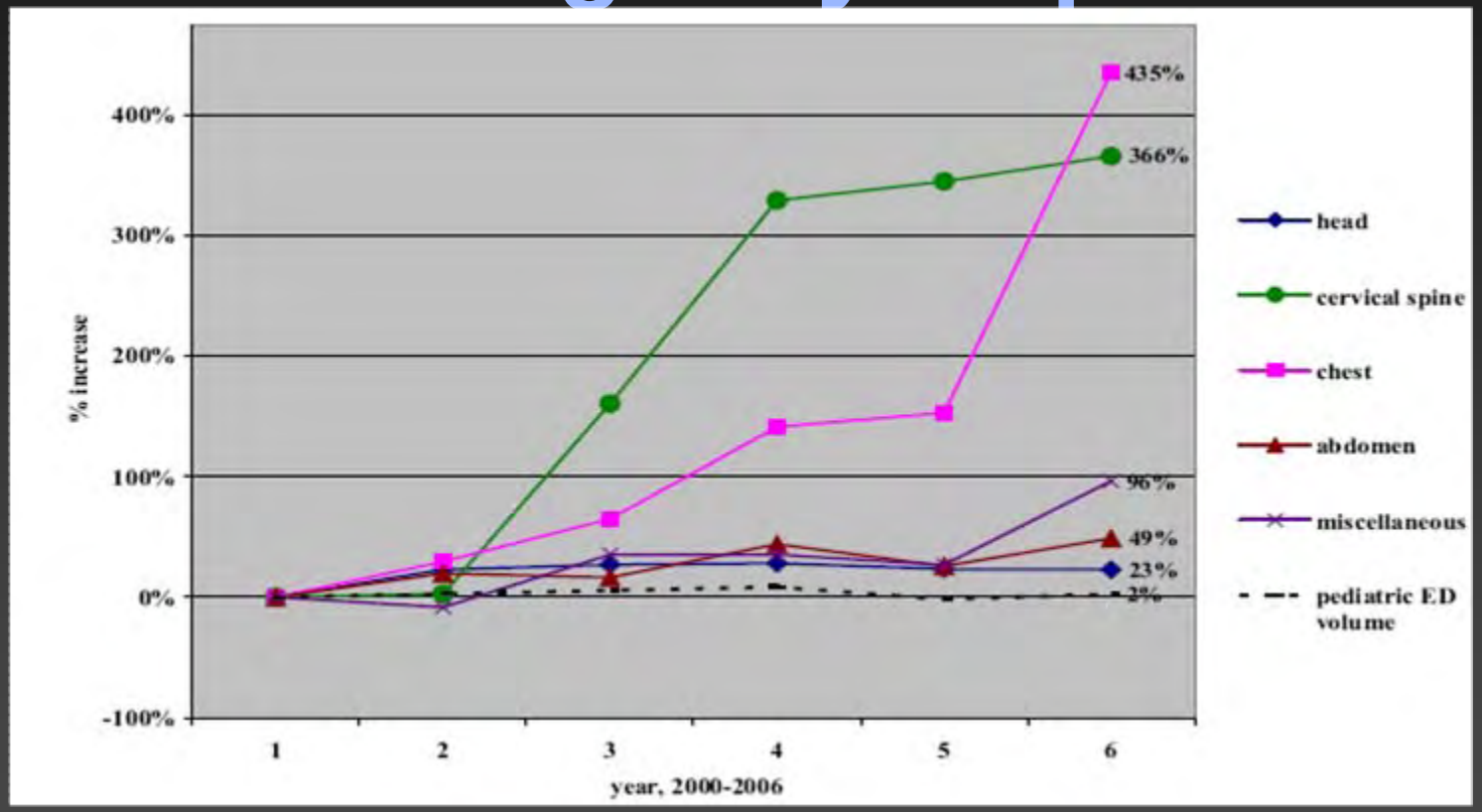


Figure 4: Histogram of cumulative CT effective dose per patient, over the 22-year study period in the cohort of 31 463 patients. The inset includes an expanded y-axis to display the right tail and contains the top percentile of cumulative exposures; 15% of patients received over 100 mSv, 4% over 250 mSv, 1% over 399 mSv.

- 15% ED > 100 mSv
- 4% 250 -1375 mSv
- 1% >399 mSv

Increased Pediatric CT in the Emergency Department



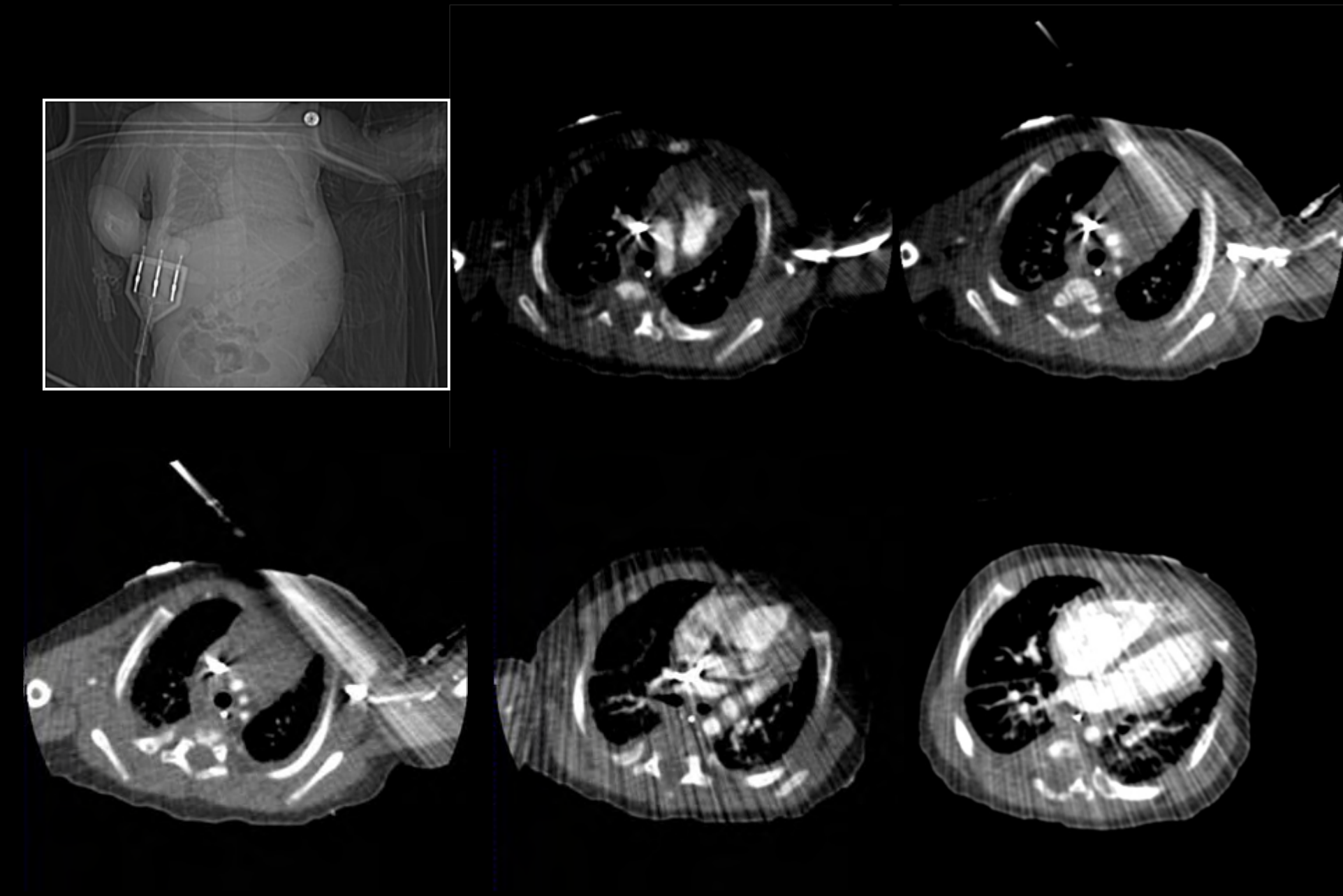
Broder et al. Emerg Radiol 2007; 14:227-32

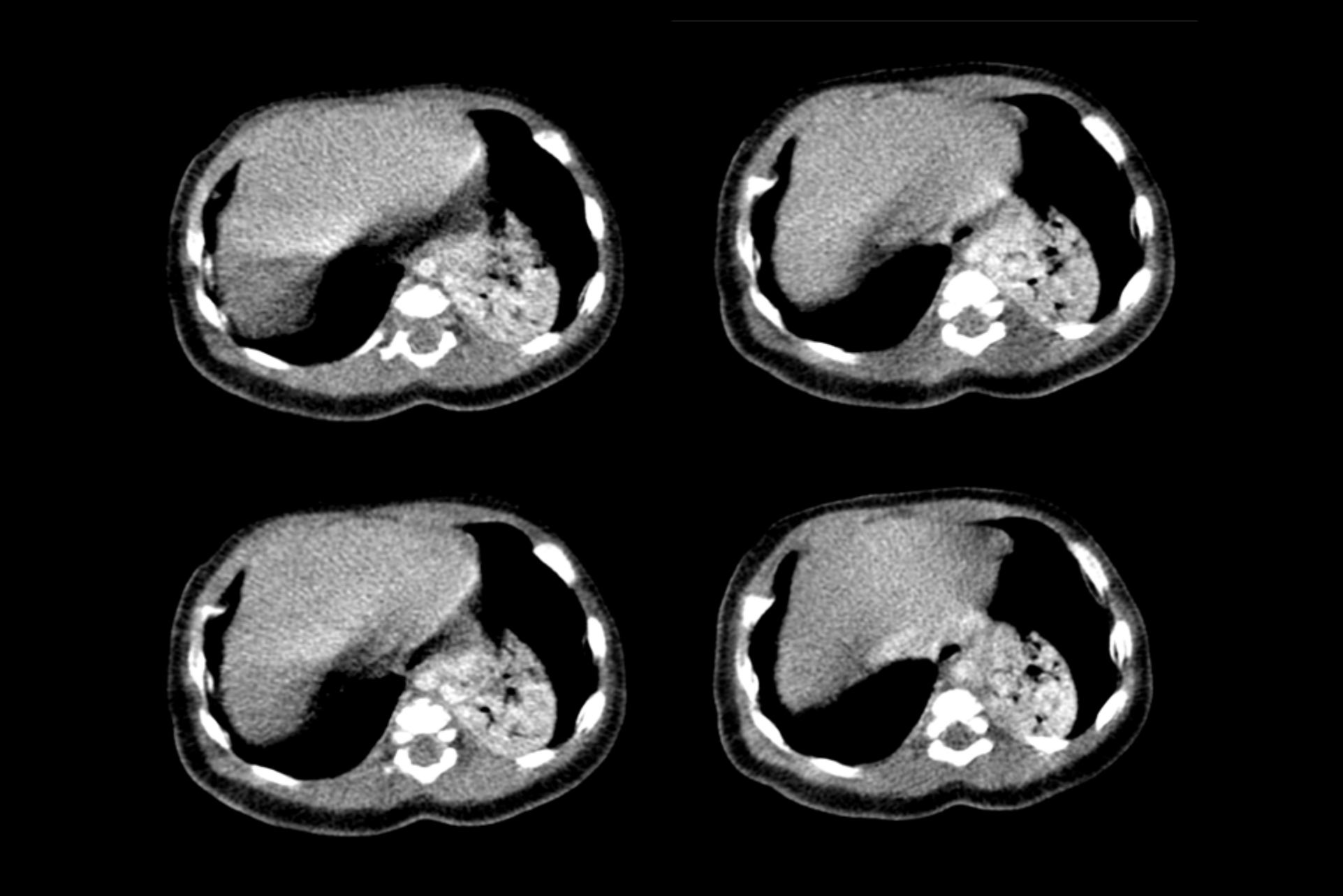
Radiation Dose Reduction Strategies for CT

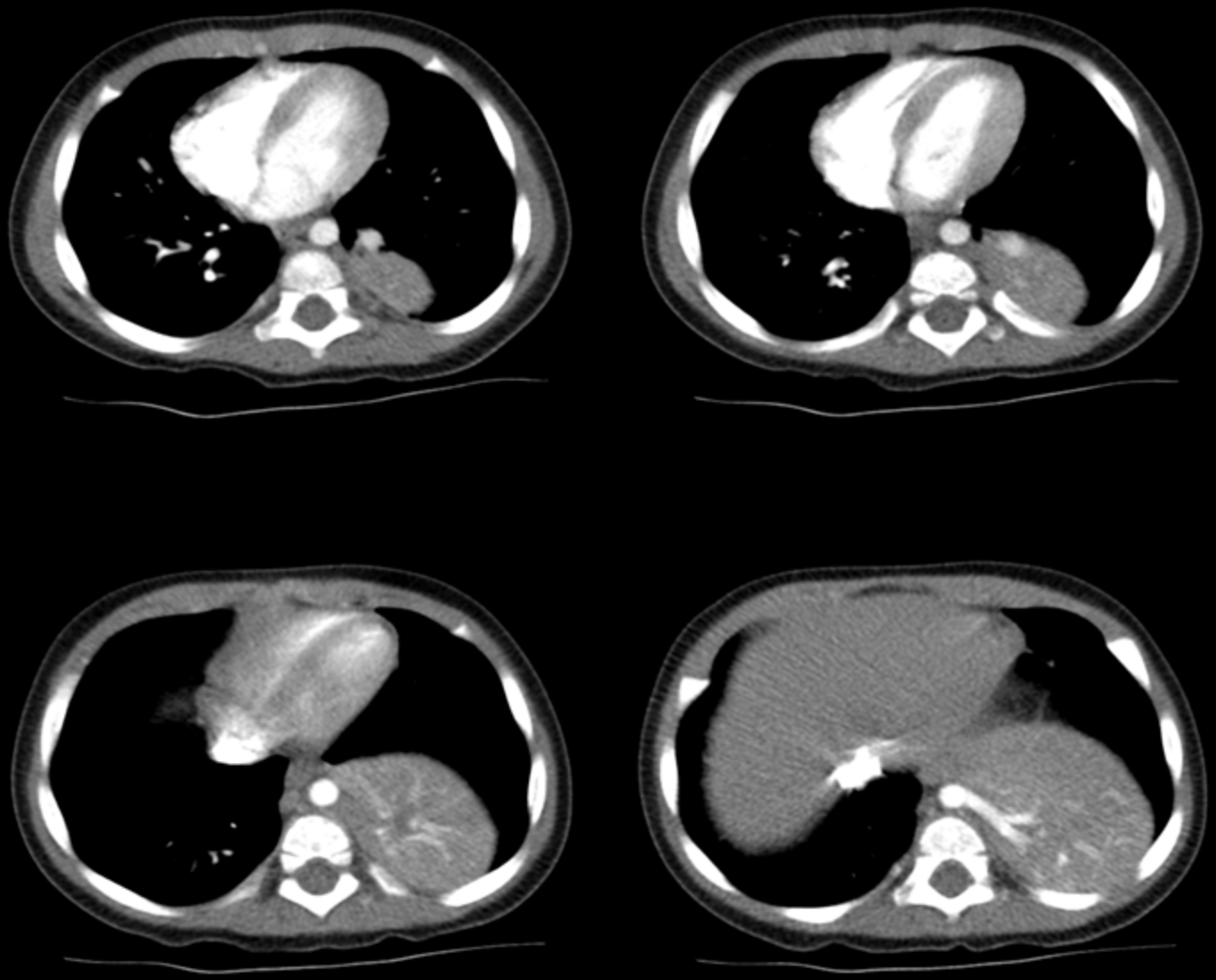
- Judicious use of CT
- Adjusted techniques
- Other

Must not forget the basics!!!

e.g., positioning, external material, immobilization, contrast

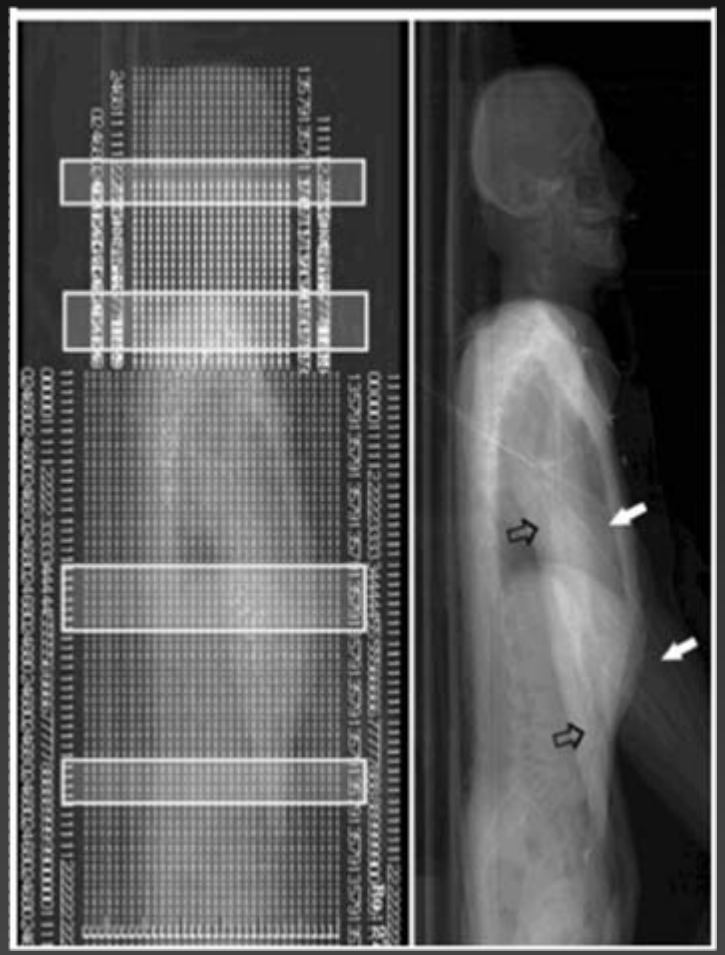






Radiation Dose Reduction Strategies for CT

- Adjust scanning by:
  - appropriate coverage
  - minimizing overlap
  - indication
  - region/organ system
  - size
  - CT scanner technology



“Single pass”

17% decreased dose

Ptak T, Rhea J, Novelline R. Radiation Dose is Reduced with a Single-Pass Whole-Body Multi-Detector Row CT Trauma Protocol compared with a Conventional Segmented Method: Initial Experience. Radiology 2003; 229:903-905

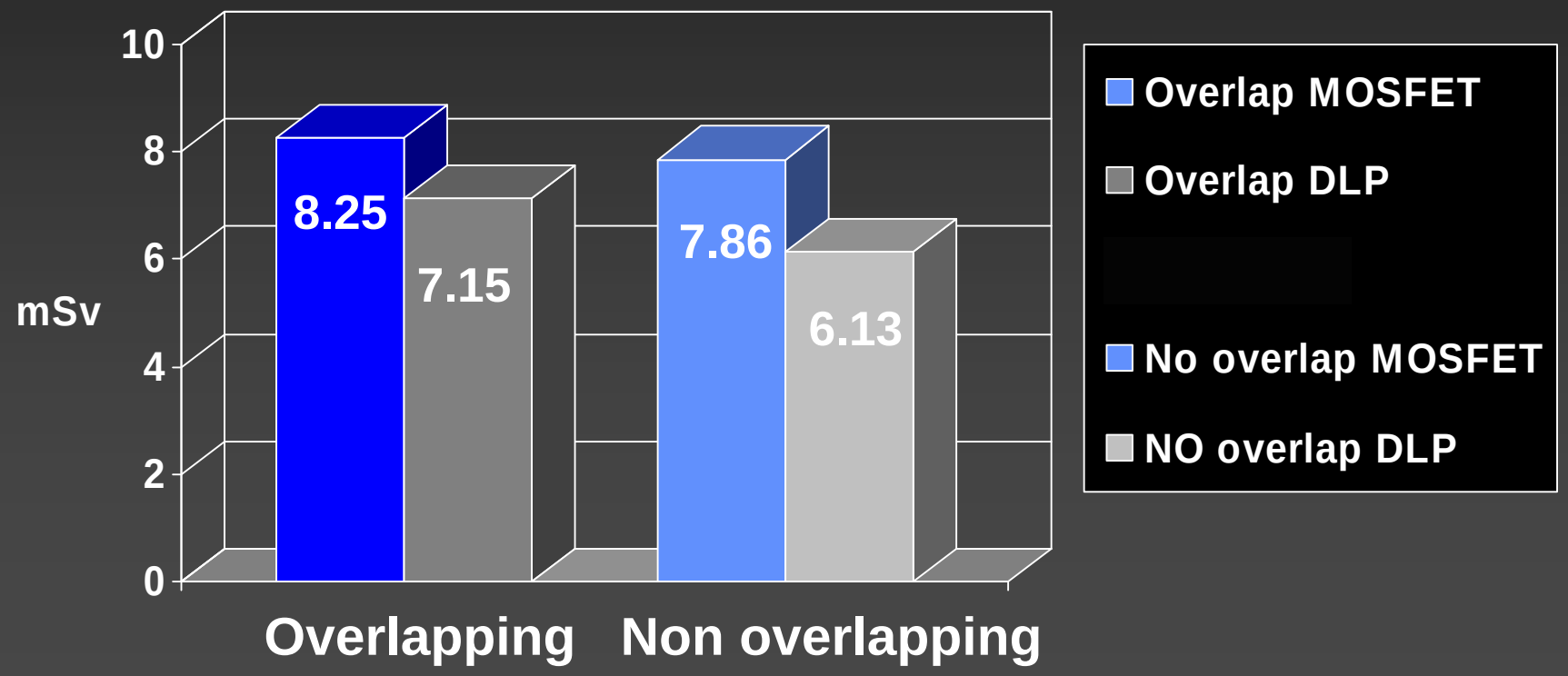

ightSpeed
VCT

Methods

	BRAIN	CSPINE	CHEST	ABDOMEN/ PELVIS
TYPE	Axial Full 1 sec	Helical Full 0.5 sec	Helical Full 0.4 sec	Helical Full 0.4 sec
mA	220	230	80	100
kVp	120	120	120	120
PITCH	-	0.969:1	1.375:1	1.375:1
SFOV	Small	Small	Medium	Medium

Results

Effective Dose



Radiation Dose Reduction Strategies for CT

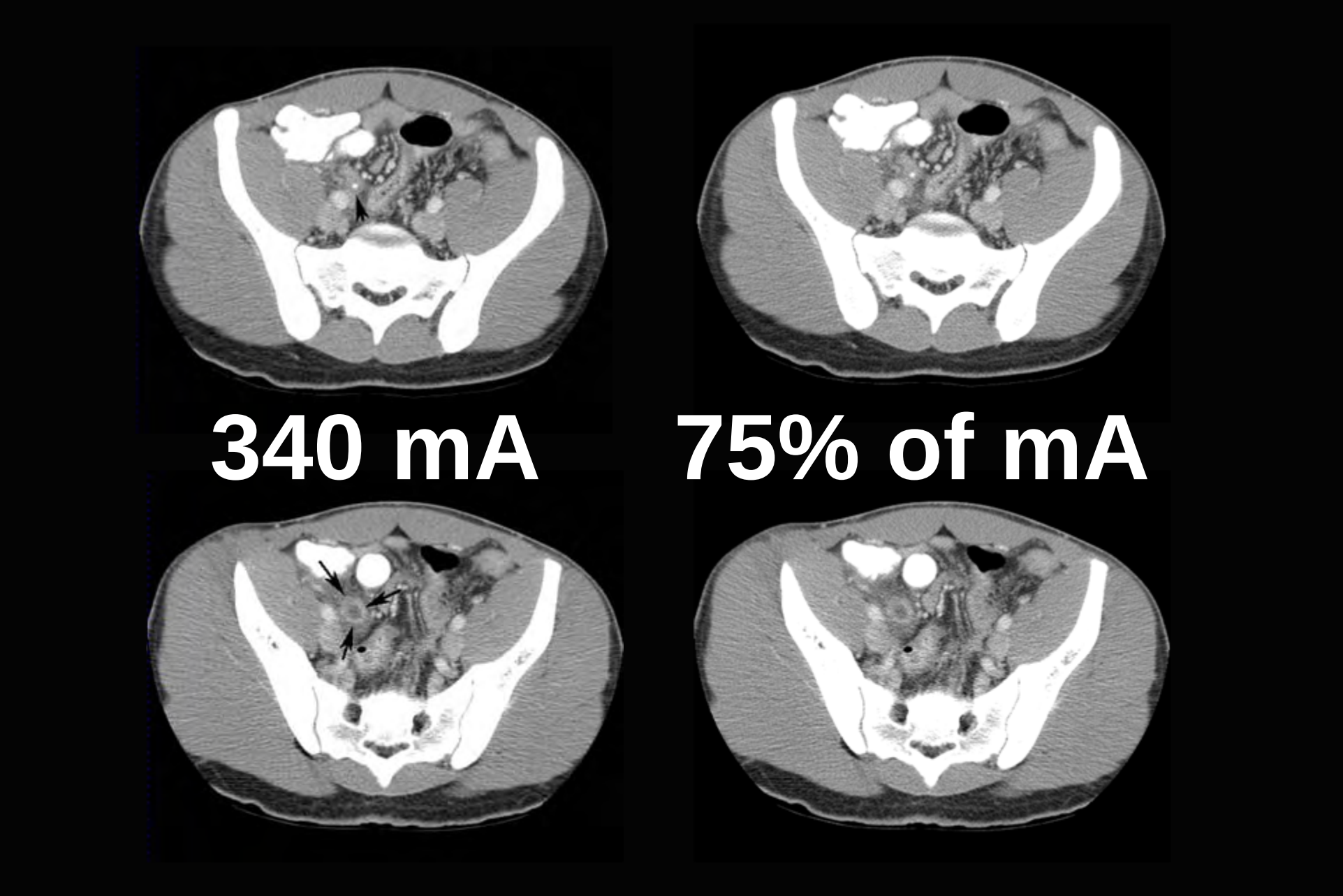
- Adjust scanning by:
  - appropriate coverage
  - minimizing overlap
  - indication
  - region/organ system
  - size
  - CT scanner technology

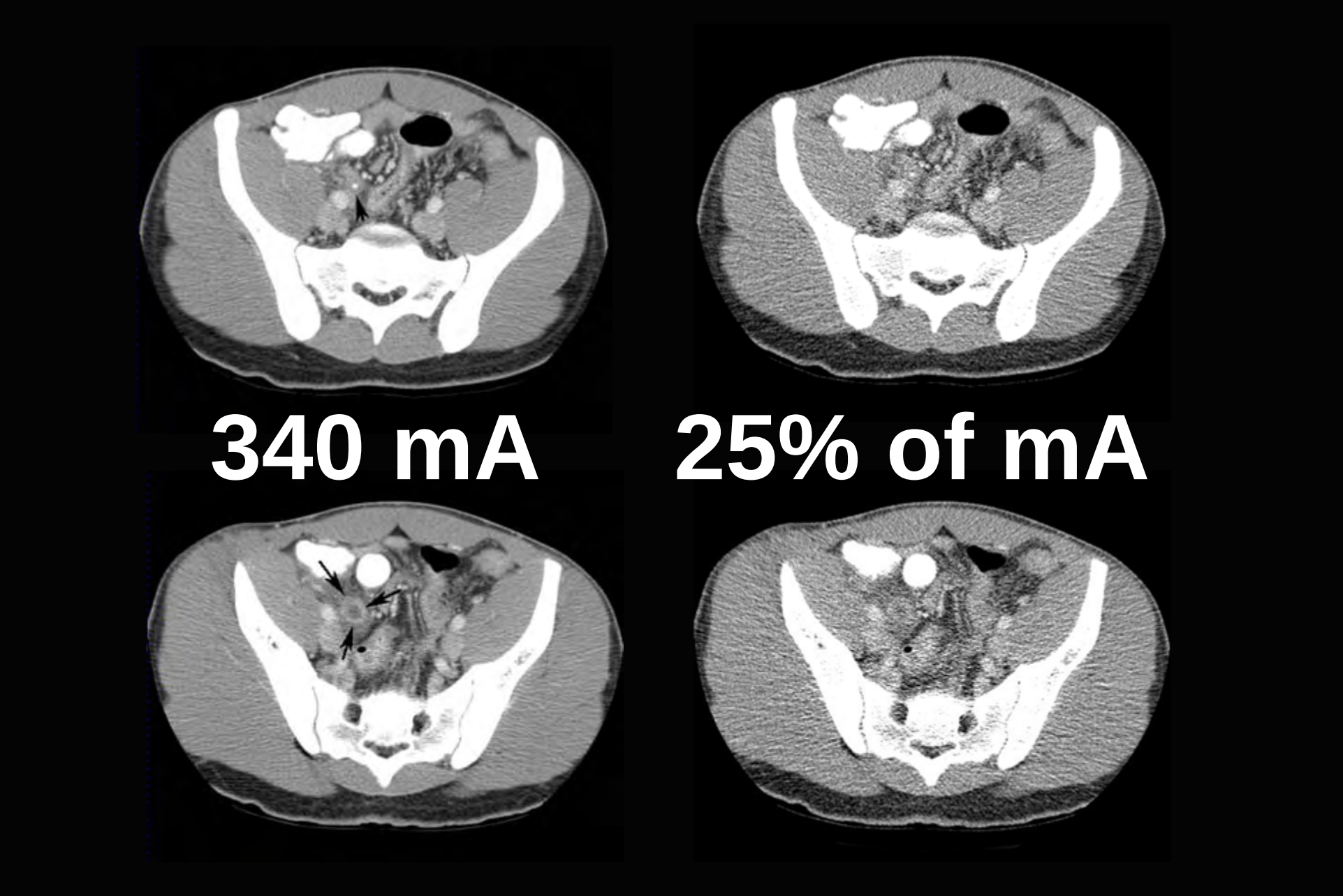
Radiation Control: Adjustable CT Parameters

- Tube Current (mA)
- Gantry cycle time (0.5 –1.0 seconds)
- Kilovoltage (kVp)
- Pitch

340 mA

80 mA


340 mA
75% of mA


340 mA
25% of mA

Conventional and Reduced Radiation Dose of 16-MDCT for Detection of Nephrolithiasis and Ureterolithiasis

Erik K. Paulson[1]
Carolyn Weaver[1,2]
Lisa M. Ho[1]
Lucie Martin[1,3]
Jianying Li[1]
James Darsie[1]
Donald P. Frush[1]

OBJECTIVE. Our purpose was to prospectively compare the reader compatibility and acceptability of a range of reduced-dose 16-MDCT images with standard-dose 16-MDCT images for the detection of nephroureterolithiasis using a dose reduction simulation technique.

SUBJECTS AND METHODS. The study was HIPAA compliant and institutional review board approved. Fifty consecutive patients with suspected nephrolithiasis were recruited to undergo conventional renal stone unenhanced 16-MDCT with at least 160 mA. Noise was then artificially introduced to simulate levels of 70, 100, and 130 mA. Three blinded independent readers interpreted the original and simulated-dose scans for the location and number of renal and ureteral calculi and secondary signs of obstruction using a 5-point confidence scale.

RESULTS. Reader acceptability of scans was inversely related to noise. There was no significant reduction in readers' confidence in detection or exclusion of renal collecting system calculi with simulated reduction of mA of 70, 100, and 130 compared with the standard-dose study. However, for ureteral calcifications, there was a decrease in confidence for the detection or exclusion of ureterolithiasis at an mA of 70 (35 mAs).

CONCLUSION. An mA as low as 70 (35 mAs) is acceptable for evaluation of nephrolithiasis. However, the evaluation of ureterolithiasis is compromised with an mA of 70.

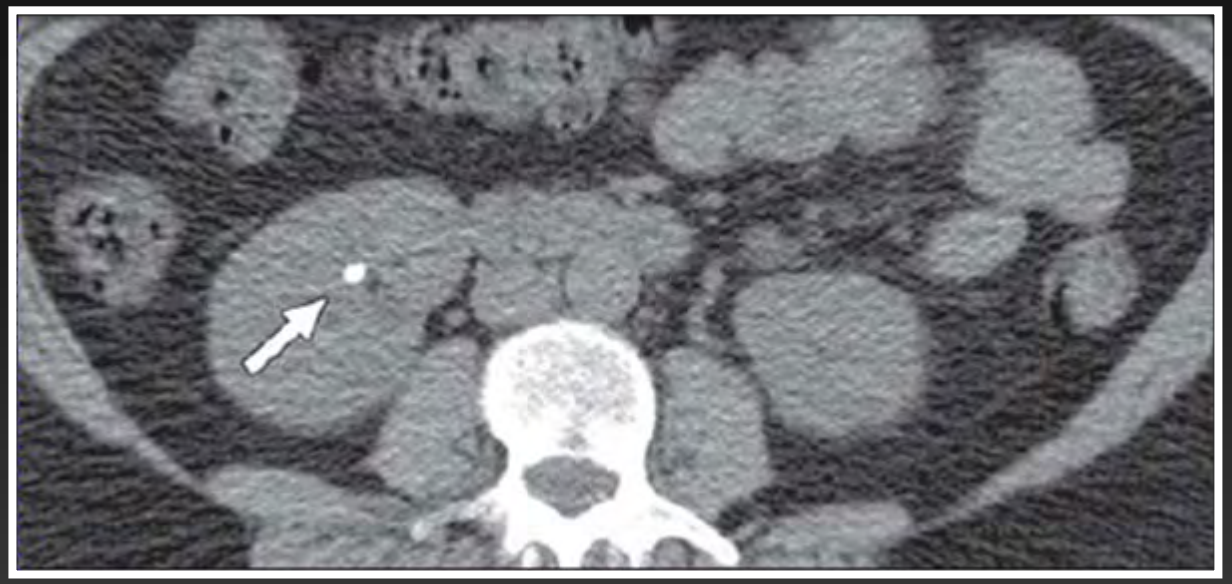
Keywords: helical CT, nephrolithiasis, radiation dose, ureterolithiasis

CT has been used extensively for the examination of patients with suspected urinary obstruction from ureterolithiasis and for the detection of nephrolithiasis. In many practices, CT has virtually replaced conventional radiography for these indications [1–4]. For [8, 9]. However, to our knowledge, it is not known what minimum dose is required for adequate stone detection using 16-MDCT.

Our purpose was to prospectively compare the reader acceptability and confidence of a range of reduced-dose 16-MDCT images with standard-dose 16-MDCT images for

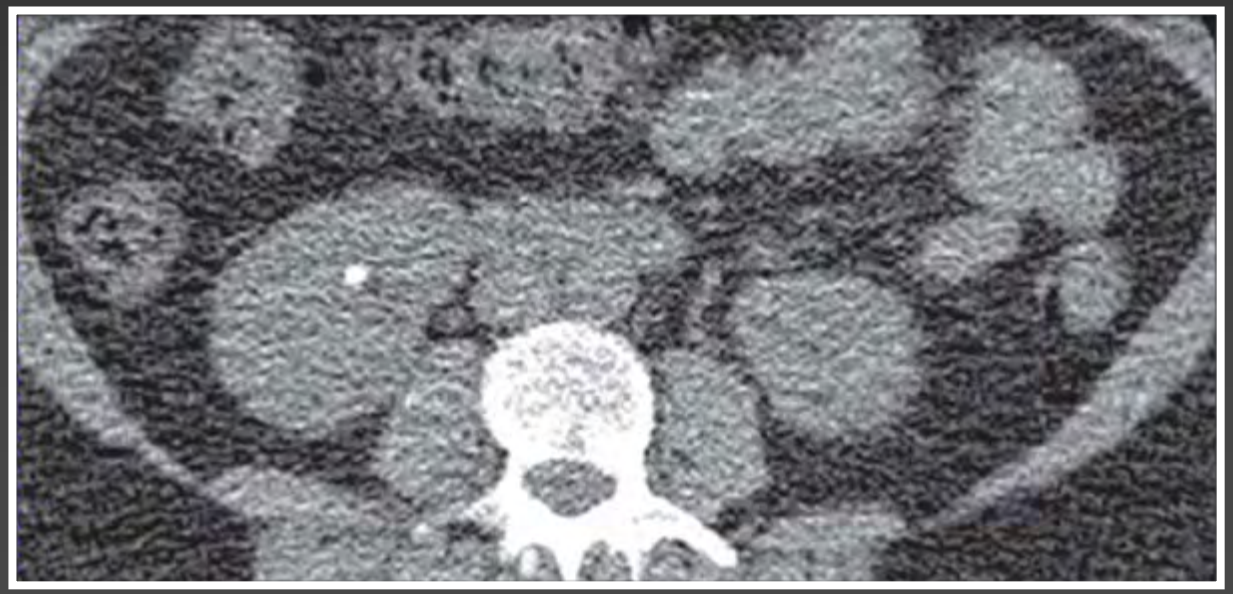
AJR January 2008: 190

Original:
380 mA

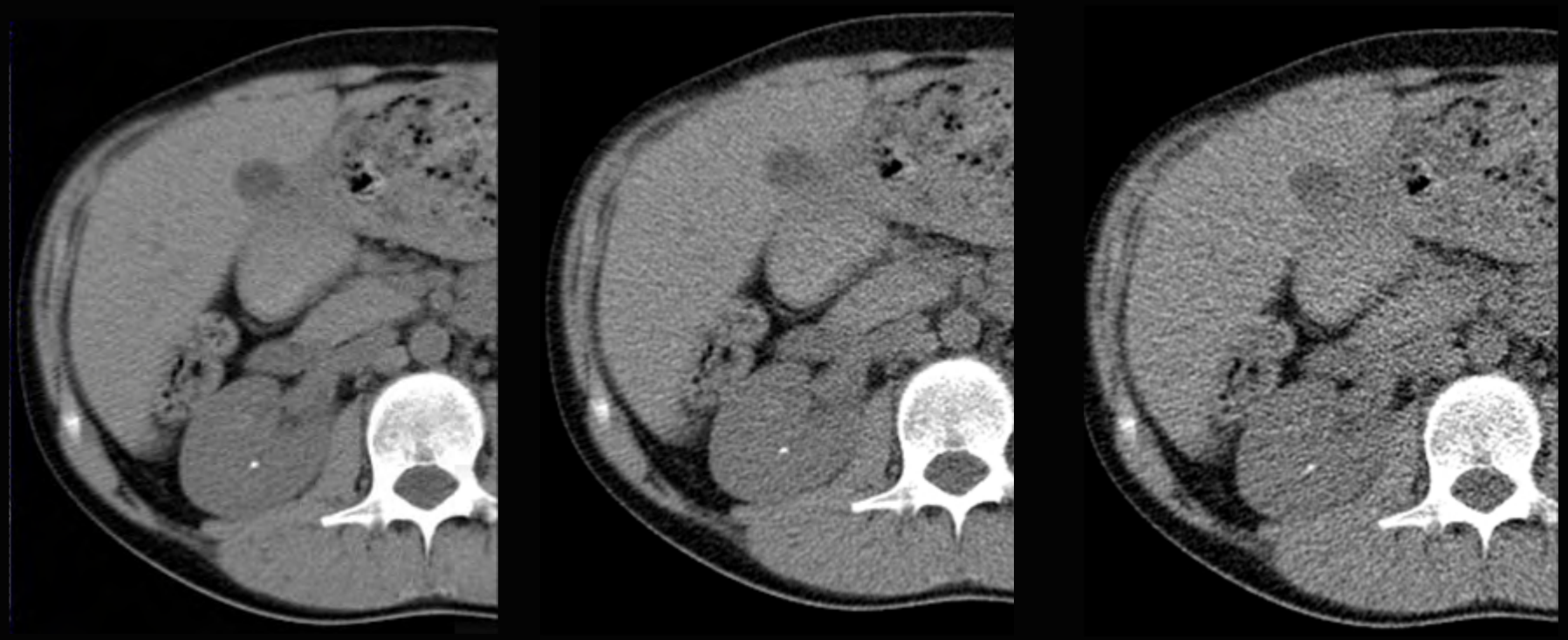


Simulated:
70 mA

18% of dose!



AJR January 2008: 190



130 mAs 40 mAs* 20 mAs*

*** Simulated, by adding noise**

Karmazyn, B et al. AJR January 2009

Radiation Dose Reduction Strategies for CT

- Adjust scanning by:
  - appropriate coverage
  - minimizing overlap
  - indication
  - region/organ system
  - size
  - CT scanner technology

ORIGINAL RESEARCH ■ PEDIATRIC IMAGING

Dose Redu
with Pedia
Adapted t
Indication
Studies[1]

Sandeep Singh, MBBS
Manudeep K. Kalra, MD
Michael A. Moore, MD
Raudhee Shailam, MD
Bob Liu, PhD
Thomas L. Toth, BS
Ellen Grant, MD
Synk J. Westra, MD

Purpose:

Materials and Methods:

Results:

Conclusions:

[1] From the Department of Radiology, Massachusetts General Hospital, 55 New Chardon St, 4th Floor, Boston, MA 02114 [U.S.]; M.K.K., M.A.M., R.S., B.L., E.G., S.J.W.; and GE Healthcare, Waukesha, Wis [T.L.T.]. From the 2007 RSNA Annual Meeting. Received August 29, 2008; revision requested October 20; revision received December 8; accepted January 29, 2009; final revision accepted February 19. S.J.W. supported in part by a grant from the Society for Pediatric Radiology Research and Education Foundation. Address correspondence to S.J. (e-mail: sdsingh@partners.org).

Figure 1

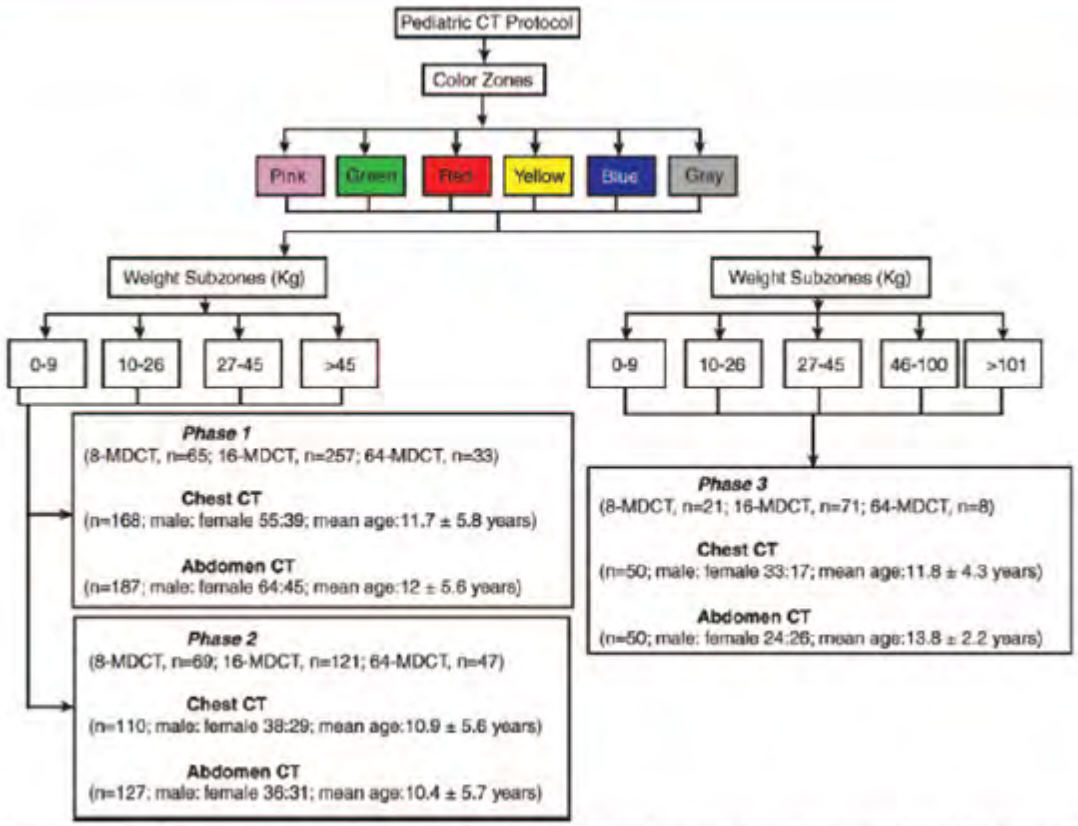


Figure 1: Flowchart depicts patient demographics in the three phases of incremental dose reduction for implementation of new pediatric CT protocols. *MDCT* = multidetector CT scanner, *n* = number of CT examinations.

Radiation Dose Reduction Strategies for CT

- Adjust scanning by:
  - appropriate coverage
  - minimizing overlap
  - indication
  - region/organ system
    bones, lungs, CT angiography

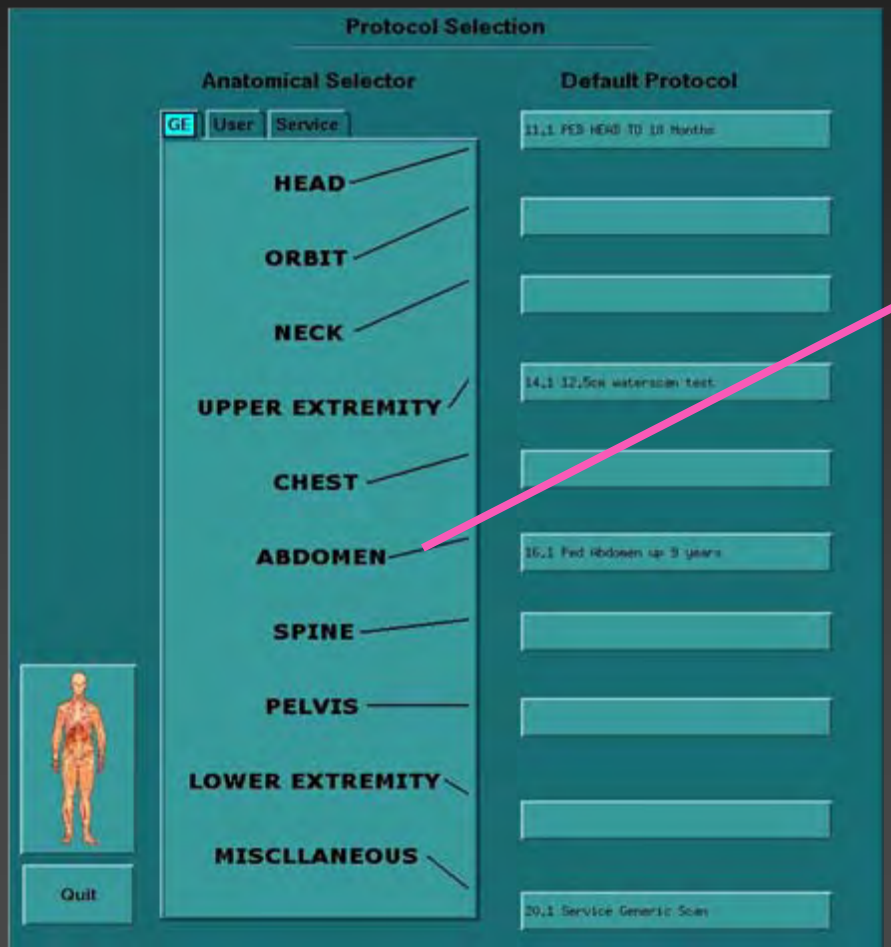
100 kVp
60 mAs
1.375; 0.625 x 16

Radiation Dose Reduction Strategies for CT

- Adjust scanning by:
  - appropriate coverage
  - minimizing overlap
  - indication
  - region/organ system
  - size
  - CT scanner technology

Color Coding for KIDS

Weight-Based Pediatric Protocols



Selecting a Pediatric

AEC Guidelines for Pediatric MDCT

Zone	Wt	Length	Age	Noise Index Chest	Noise Index Abd Pelvis
PINK	5.5 – 7.4 kg	60-67 cm	2.5 – 5.5 mo	9.5	6.5
RED	7.5 – 9.4 kg	67-75 cm	5.5 – 11.5 mo	10.0	7.5
PURPLE	9.5 – 11.4 kg	75-85 cm	11.5 – 22 mo	10.5	8.5
YELLOW	11.5 – 14.4 kg	85-97 cm	22 mo – 3yr, 2 mo	11	9.5
WHITE	14.5 – 18.4 kg	97-109 cm	3 ys, 2 mo – 5 yr, 2 mo	12	10.5
BLUE	18.5 – 23.4 kg	109-121 cm	5 yr, 2 mo – 7 yr, 4 mo	13	11.5
ORANGE	23.5 – 29.4 kg	121-133 cm	7 yr, 4 mo – 9 yr, 2 mo	14	12.5
GREEN	29.5 – 36.4 kg	133-147 cm	9 yr, 2 mo – 13 yr, 6 mo	15	13.5
BLACK	36.5 – 55 kg	>147 cm	>13 yr, 6 mo	16	14

GE LightSpeed, VCT

Radiation Dose Reduction Strategies for CT

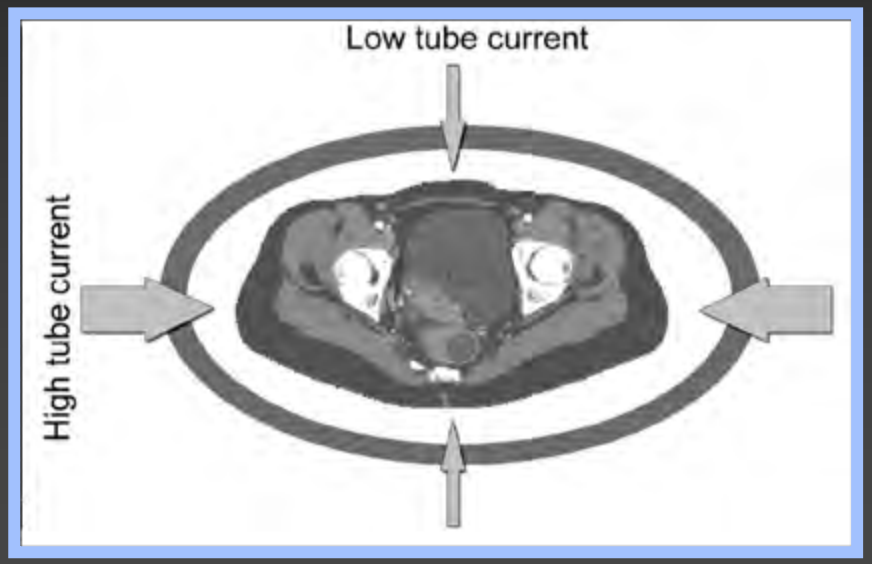
- Adjust scanning by:
  - appropriate coverage
  - minimizing overlap
  - indication
  - region/organ system
  - size
  - CT scanner technology

Dose Reduction Technology

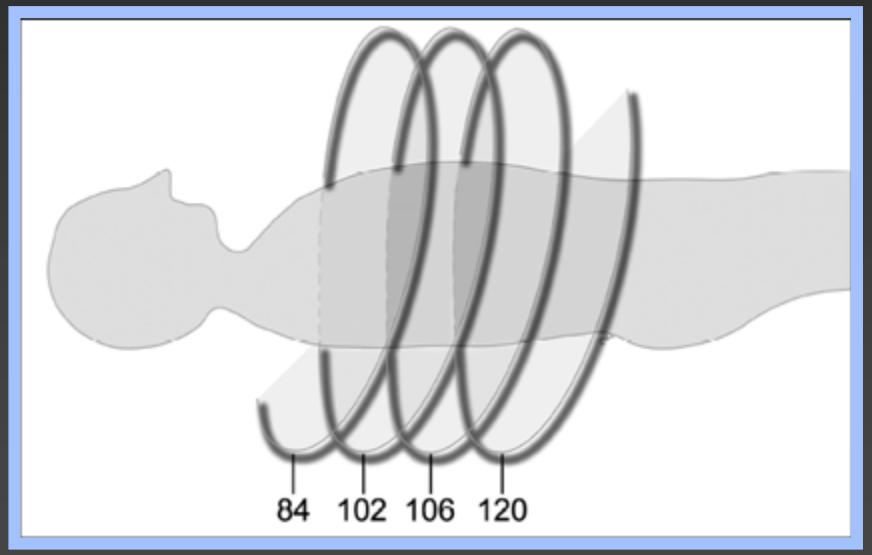
- Tube current modulation
- Iterative reconstruction
- New detector technology
- Adaptive collimation
- Increasing detector rows
- Surface based modulation

Tube Current Modulation (ATCM)

Angular (x, y)

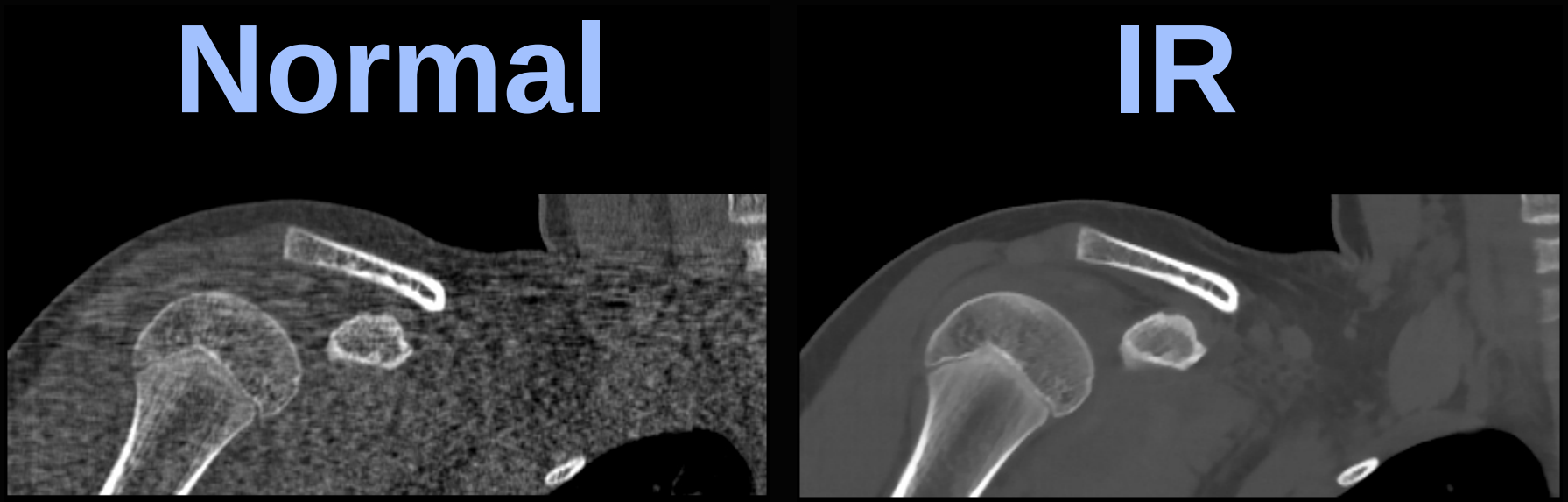


Z-axis



Kalra et al. Radiology 2004; 233:649-657

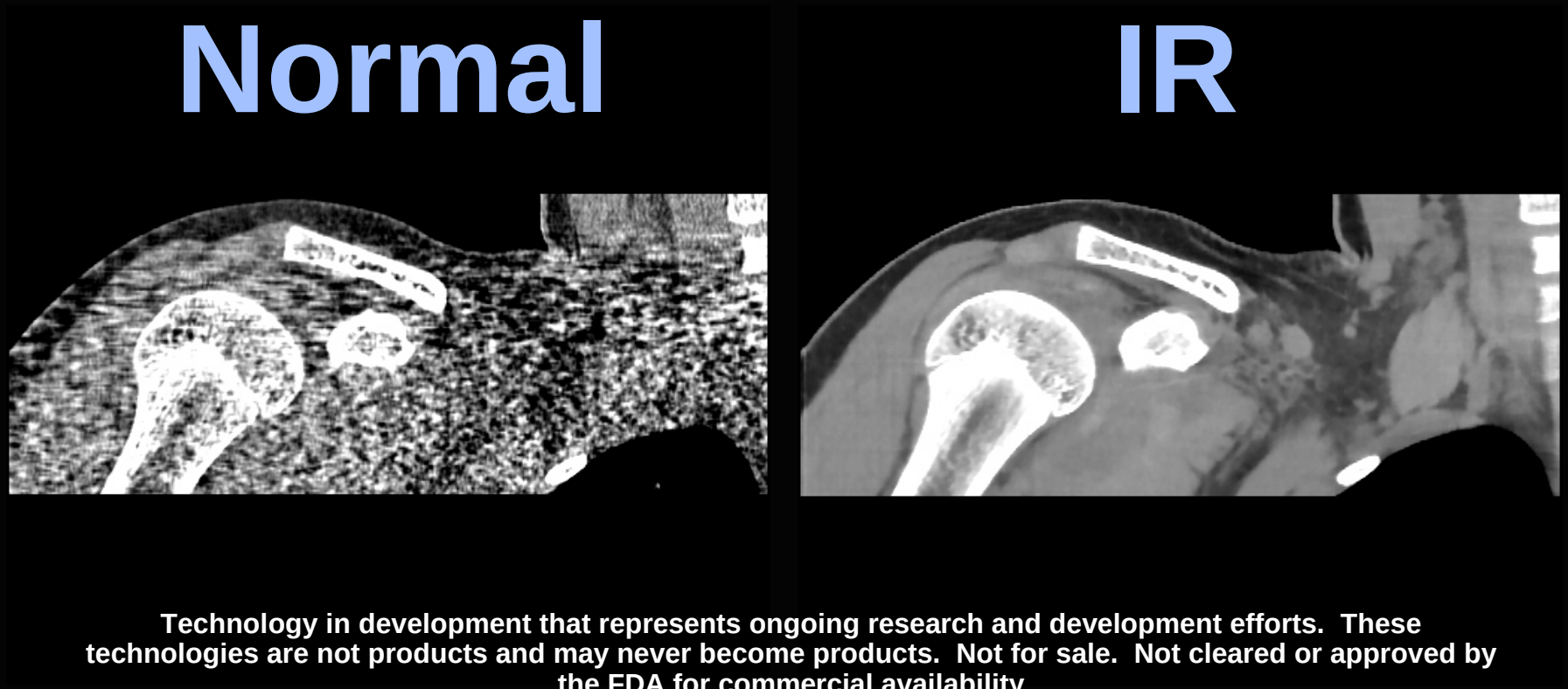
IR Shoulder: Bone Window



Technology in development that represents ongoing research and development efforts. These technologies are not products and may never become products. Not for sale. Not cleared or approved by the FDA for commercial availability

Courtesy GE Healthcare

IR Shoulder: Soft Tissue Window



Technology in development that represents ongoing research and development efforts. These technologies are not products and may never become products. Not for sale. Not cleared or approved by the FDA for commercial availability

Courtesy GE Healthcare

Radiation Dose Reduction Strategies for CT

- Judicious use of CT
- Adjusted techniques
- Other: *education*

“But I thought that the ED was different than the clinic…. and we should order more [CTs]”

resident, June 4th, 2008

The ALARA* Concept in Pediatric Imaging

Building Bridges Between Radiology and Emergency Medicine:

Consensus Conference on Imaging Safety and Quality for Children in the Emergency Setting

**As Low as Reasonably Achievable*

February 23-24, 2008

Hyatt Regency Orlando International Airport

Orlando, Florida

This program endorsed by:

The Society for Pediatric Radiology

American Academy of Pediatrics

American College of Radiology

American College of Emergency Physicians

National Council on Radiation Protection & Measurements

Supporting Organization:

Joint Commission Resources

Jointly sponsored by:

American College of Radiology

Program

FRIDAY, FEBRUARY 22

4:00 - 6:00 pm **Registration**

SATURDAY, FEBRUARY 23

7:30 - 8:30 am **Registration and Continental Breakfast**

8:30 - 8:45 am **Program Introduction, Welcome, and Announcements**
Donald P. Frush, M.D., Karen S. Frush, M.D.

8:45 - 9:45 am **"Sleeping with the Enemy?" Expectations and Reality in Imaging Children in the Emergency Setting**
Donald P. Frush, M.D., Karen S. Frush, M.D.

9:45 - 11:00 am **Standards of Care in the Emergency Setting**

- 9:45 - 10:15 am Standards for Radiology Interpretation and Reporting in the Emergency Setting
  Leonard Berlin, M.D., F.A.C.R.
- 10:15 - 10:30 am Break
- 10:30 - 11:00 am Standards for Clinical Evaluation and Documentation by the EM Provider
  Steven M. Selbst, M.D., F.A.A.P.

11:00 am - 12:00 pm **The Art of Communication: Strategies to Improve Patient and Information Flow**

- 11:00 - 11:30 am Radiology Perspective
  Thomas L. Slovis, M.D.
- 11:30 - 12:00 pm ED Perspective
  Steven E. Krug, M.D., F.A.A.P.

12:00 - 1:15 pm Lunch

1:15 - 3:30 pm **Imaging Utilization**

- 1:15 - 1:40 pm Imaging Utilization: Radiology Perspective
  Martin H. Reed, M.D., F.A.A.P.
- 1:40 - 2:05 pm Imaging Utilization: ED Perspective
  Joshua Broder, M.D.
- 2:05 - 2:30 pm Imaging Utilization: What We Need to Do
  Nathan Kuppermann, M.D., M.P.H., F.A.A.P.
- 2:30 - 3:00 pm Contemporary Imaging: Technology and Controversies
  Carlos J. Sivit, M.D.
- 3:00 - 3:30 pm Bedside Pediatric Emergency Evaluation Through Ultrasonography
  Ann M. Dietrich, M.D., F.A.A.P., F.A.C.E.P.

image gently℠

The Alliance for Radiation Safety in Pediatric Imaging

What Can I Do? | Resources | FAQ

Let's *image gently* when we care for kids! The *image gently* Campaign is an initiative of the Alliance for Radiation Safety in Pediatric Imaging. The campaign goal is to change practice by increasing awareness of the opportunities to lower radiation dose in the imaging of children.

This site offers information for every audience interested in radiation safety in pediatric imaging

- Parents
- Community Radiologists
- Pediatricians
- Radiologic technologists
- Medical Physicists
- Press

Pediatric CT Protocol Guidance and worksheet

Click here to take the image gently pledge

ONE SIZE DOES NOT FIT ALL...

What's Needed … Quality Improvement

- Multidisciplinary collaboration
  - investment and responsibility
- IT!!!
  - EMR
  - Radiology data transfer, storage, reading
- Appropriateness criteria
- Evidence-based research

Cumulative Radiation Exposure and Cancer Risk Estimates in Emergency Department Patie Undergoing Repeat or Multipl

Richard T. Griffey[1]
Aaron Sodickson[2]

OBJECTIVE. The purpose of our study was to define a conservative estir ber of patients undergoing repeat or multiple emergency department CT studi fy their cumulative CT radiation doses and lifetime attributable risk of develo

MATERIALS AND METHODS. We identified all patients at a tertiar demic medical center with at least three emergency department visits withir that included CT of the neck, chest, abdomen, or pelvis. For this cohort, we agnostic CT studies over the previous 7.7 years. We calculated cumulative ra summing typical effective doses of the anatomic regions scanned, and we ca attributable risk using the population-averaged dose-to-risk conversion fact per 1,000 patients receiving a 10-mSv dose, in accordance with the seventh of Ionizing Radiation (BEIR VII) report.

RESULTS. One hundred thirty emergency department patients met the i Over the 7.7-year period, median, mean, and maximum values for the study 13, and 70 with cumulative CT doses of 91, 122, and 579 mSv and lifetime at one in 110, one in 82, and one in 17, respectively. Emergency department st 55% of those captured. Repeat imaging of the same study type represented a imaging for 72% of the cohort and all of the imaging for 12%.

CONCLUSION. A small proportion (1.9%) of emergency department p ing CT of the neck, chest, abdomen, or pelvis have high cumulative rates of r imaging. Collectively, this patient subgroup may have a heightened risk of de from cumulative CT radiation exposure.

Keywords: CT radiation exposure, emergency department, radiation risks, repeat imaging

DOI:10.2214/AJR.08.1351

Received June 4, 2008; accepted after revision August 22, 2008.

In many ways, CT has transformed care for emergency department patients and is the technique of choice for a wide range of indications because of the timely and reliable diagnostic information it provides. The use of CT, particularly in the emergency department, has grown dramatically in the past decade [1–3], spurred by rapid technological

ous patient populations. In 2 [8] found that 30% of all pat CT in their institution had CT studies in their film jacke than five, and 4% had more t et al. [7] found that 79% of p in the emergency department for renal colic underwent two or more CT scans. Jaffe et al. [9] reported that 9% of patients followed

Conclusion

A small cohort of emergency department patients undergoing CT accrue large cumulative radiation doses from frequent or recurrent CT both in the emergency department setting and overall, which may place them at higher risk for subsequent radiation-induced carcinogenesis. Individualized radiation risk assessment to identify and risk stratify such groups on the basis of cumulative dose estimates is one way of informing clinicians at the point of ordering how further imaging impacts the risk-to-benefit equation. At that point, recommendations for imaging with another technique or the use of established institutional protocols for addressing such scenarios may offer options to the clinician faced with the decision of whether to image again.

630 Journal of the American College of Radiology/Vol. 6 No. 9 September 2009

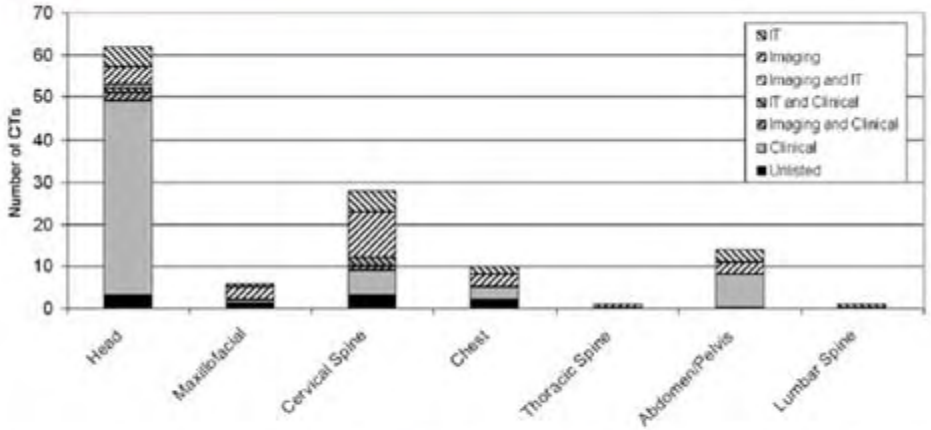


Fig 3. Frequency of and reasons for repeat computed tomographic (CT) examinations from August 2007 to January 2008. Gray-shaded bars represent presumably unavoidable clinical reasons for repeat imaging. Hatched and unshaded components reflect potentially avoidable studies repeated solely for reasons of inadequate outside imaging or information technology (IT); these are represented in the top portions of each bar. Combined indications are illustrated in the legend.

- "Repeat scans might have been avoided in as many as 25% of rescanned patients (35% of repeat examinations) because they were performed solely for imaging or information technology reasons (inadequate imaging, compact disc inoperability, or unavailable images within the hospital's picture archiving and communication system). "

- "Rescanned trauma patients in particular had a high per patient rate (32%) of potentially avoidable reasons, with a lower rate (11%) in nontrauma patients."

Appropriateness Criteria for CT Procedures

Paul A. Larson, MD, FACR
Chair, ACR Commission on Quality and Safety

CT in Emergency Medicine – Ensuring Appropriate Use

Bethesda, MD **September 23, 2009**

Financial Disclosures

- No personal financial disclosures
- Volunteer member American College of Radiology (ACR) Board of Chancellors
- ACR offers various Quality and Safety products for a fee
- ACR licenses its Appropriateness Criteria® for commercial adaptation

Objectives

1) Provide overview of ACR Appropriateness Criteria®
2) Show examples of ACR Appropriateness Criteria®
3) Discuss relevance of ACR Appropriateness Criteria® to Emergency Medicine
4) Discuss possible uses of ACR Appropriateness Criteria® by Emergency Departments and physicians

ACR™
AMERICAN COLLEGE OF RADIOLOGY

ACR Appropriateness Criteria® Overview

- First version released 1995
- Recognized by National Guidelines Clearinghouse
- Used by radiologists and referring clinicians
- Help make well-informed decisions about initial radiologic tests
- Reviewed biennially, updated as needed
- Available on ACR web site
- PDA application coming soon
- Format of AC works from clinical presentation to imaging modalities

ACR™ AMERICAN COLLEGE OF RADIOLOGY

18 Expert Panels

- 10 Diagnostic
- ➢ Breast, Cardiac, Gastrointestinal, Musculoskeletal, Neurological, Pediatric, Thoracic, Urologic, Vascular, Women's Imaging
- 1 interventional Radiology
- 7 Radiation Oncology
- ➢ Brain, Breast, Bone, Hodgkin's, Lung, Prostate, Rectal/Anal

Clinical Conditions

- Criteria developed for more than 160 clinical conditions
  - Over 800 variants (patient presentations)

Selection of Clinical Conditions

- **Disease prevalence**
- **Economic impact of the condition**
- **Potential for morbidity/mortality**
- **Potential for improved care**

Pertinent variations developed to encompass the entire spectrum of each condition

Criteria Development

- Based on principles developed by Institute of Medicine (IOM) and used by Agency for Health Care Research and Quality (AHRQ)
- Panels include Radiologists and other clinical specialists
- Review scientific literature
- Consensus techniques used to complement scientific data (modified Delphi methodology)
- Modalities ranked on a 1-9 scale
  - 9 is most appropriate, 1 is least appropriate

Sample Evidence Table

Left Lower Quadrant Pain

Reference	Type of Study Design	Number of Patients	Study Problem	Study Results	Strength of Evidence
1. Ajaj W, Ruehm SG, Lauenstein T, et al. Dark-lumen magnetic resonance colonography in patients with suspected sigmoid diverticulitis: a feasibility study. *Eur Radiol* 2005; 15(11):2316-2322.	9	40	A prospective study to assess dark-lumen magnetic resonance colonography (MRC) for the evaluation of patients with suspected sigmoid diverticulitis, by comparing the results to conventional colonoscopy (CC).	CC confirmed the presence of light inflammatory signs in 4 patients which were missed in MRC. MRC correctly identified wall thickness and contrast uptake of the sigmoid colon in the patients with diverticulitis. In 3 of these patients false-positive findings were observed, and MRC classified the inflammation of the sigmoid colon as diverticulitis whereas CC and histopathology confirmed invasive carcinoma. MRC detected additionally relevant pathologies of the entire colon and could be performed in cases where CC was incomplete. MRC may be considered a promising alternative to CC for the detection of sigmoid diverticulitis.	3
2. Buckley O, Geoghegan T, McAuley G, Persaud T, Khosa F, Torreggiani WC. Pictorial review: magnetic resonance imaging of colonic diverticulitis. *Eur Radiol* 2007; 17(1):221-227.	12	N/A	To illustrate the emerging role of MRI in the diagnosis and evaluation of colonic diverticulitis.	MRI has a major advantage over CT in that there is no ionizing radiation. In one institution, MRI has increasingly been used as a complimentary imaging modality to CT in the diagnosis and evaluation of diverticulitis and its complications.	4

Total of 25 entries in this table

Relative Radiation Level

Table 1. Relative radiation level designations along with common example examinations for each classification

Relative Radiation Level*	Effective Dose Estimate Range	Example Examinations
None	0	Ultrasound, MRI
Minimal	< 0.1 mSv	Chest radiographs, hand radiographs
Low	0.1 - 1 mSv	Pelvis radiographs, mammography
Medium	1-10 mSv	Abdomen CT, barium enema, nuclear medicine bone scan
High	> 10 mSv	Abdomen CT without and with contrast, whole body PET

*RRL assignments are not included for some examinations. These are designated as IP (in progress) or NS (not specified). The RRL assignments for the IP exams will be available in future releases. The RRL assignments for the NS exams cannot be made because the RRL depends on the region of the body exposed to ionizing radiation, and the body part will vary as a function of the clinical situation.

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AC Relevance in Emergency Medicine

Panel	Topics	ED		Panel	Topics	ED
Breast	4	1		Urologic	19	9
Cardiac	9	7		Vascular	10	7
GI	15	10		Women's Imaging	11	5
Musculoskeletal	22	13		Interventional	4	2
Neurological	14	12		Radiation Oncology	34	0
Pediatric	10	9				
Thoracic	11	5		TOTAL	163	80

As of October 2008 release

ACR™ AMERICAN COLLEGE OF RADIOLOGY

ACR Appropriateness Criteria®
Clinical Condition: Left Lower Quadrant Pain
Variant 1: Older patient with typical clinical presentation for diverticulitis.

Radiologic Procedure	Rating	Comments	RRL
CT abdomen and pelvis with contrast	8	Oral and/or colonic contrast may be helpful for bowel luminal visualization.	High
CT abdomen and pelvis without contrast	6		High
X-ray contrast enema	5		Med
US abdomen transabdominal graded compression	4		None
US abdomen transrectal or transvaginal	4		None
X-ray abdomen and pelvis	4		Med
MRI abdomen and pelvis with or without contrast	4	See comments regarding contrast in text under “Anticipated Exceptions”	None

ACR™ AMERICAN COLLEGE OF RADIOLOGY

ACR Appropriateness Criteria®
Clinical Condition: Left Lower Quadrant Pain
CT abdomen and pelvis with contrast ratings by variant

Variant	CT Appropriateness Rating
1 - **Older patient with typical clinical presentation for diverticulitis.**	8
2 - **Acute, severe, with or without fever.**	9
3 - **Chronic, intermittent, or low grade.**	8
4 - **Woman of childbearing age.**	7
5 - **Obese patient.**	8

ACR™ AMERICAN COLLEGE OF RADIOLOGY

ACR Appropriateness Criteria®
Clinical Condition: Right Lower Quadrant Pain
Highest rated exam by variant

Variant	Exam	Rating
1 - **Fever, leukocytosis, and classic presentation clinically for appendicitis in adults.**	CT abdomen and pelvis with contrast	8
2 - **Fever, leukocytosis; possible appendicitis, atypical presentation, adults and adolescents.**	CT abdomen and pelvis with contrast	8
3 - **Fever, leukocytosis, pregnant woman.**	US abdomen RLQ	8
4 - **Fever, leukocytosis, possible appendicitis, atypical presentation in children (less than 14 years of age).**	US abdomen RLQ	8

Expanding Appropriateness Criteria

- Appropriateness criteria can be used in Computerized Physician Order Entry (CPOE) systems
- ACR has licensed its Appropriateness Criteria
- Companies have expanded the AC for completeness in CPOE
- CPOE systems give the immediate feedback needed in the emergency situation
- Physician is allowed to order exam even if it doesn't "meet criteria"

Uses in Emergency Medicine?

- **Individual case guidance**
- **Protocol development**
- **Education – residents, medical students**
- **Quality review of practitioners**
- **Research**

Conclusions

- Appropriateness criteria can help assure appropriate utilization of imaging in the Emergency Department, including CT
- Eliminating inappropriate use of CT will reduce radiation dose
- Appropriateness criteria and/or computerized physician order entry can be used promptly in the Emergency Department setting.
- Appropriateness criteria are designed to provide educational feedback to the practitioner.

Potential health implications of dose from CT imaging

David J. Brenner
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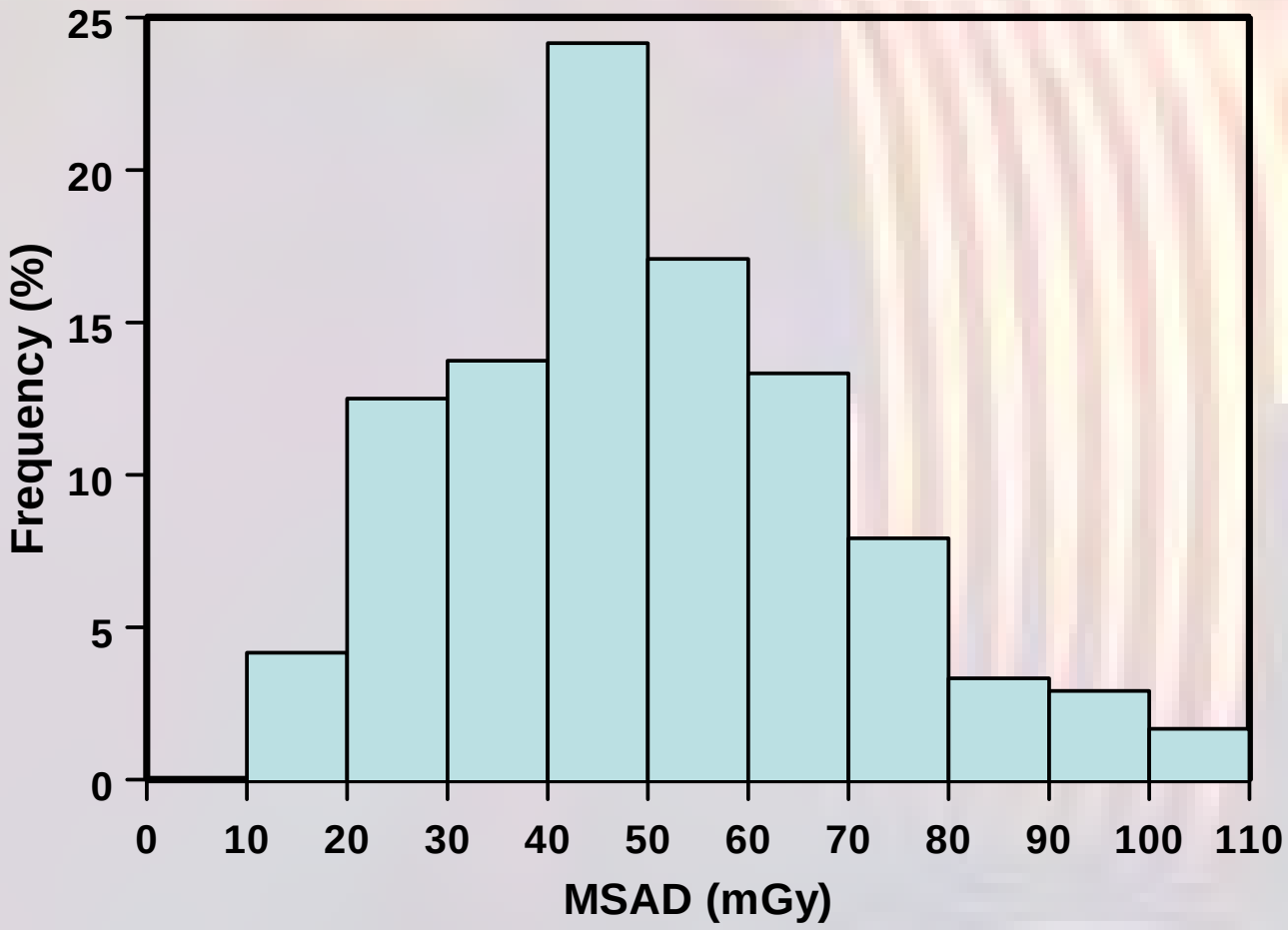
Typical organ doses from single diagnostic x ray examinations

Examination	Relevant organ	Relevant organ dose (mGy)
Dental x ray	Brain	0.005
PA Chest x ray	Lung	0.01
Lateral chest x ray	Lung	0.15
Screening mammogram	Breast	3
Adult abdominal CT (200 mAs)	Stomach	11
Adult head CT (200 mAs)	Brain	13
Child abdominal CT (50 / 200 mAs)	Stomach	8 / 30
Child head CT (100 / 200 mAs)	Brain	18 / 35

There is a considerable variation in CT doses from institution to institution



From the 2000-01 FDA NEXT CT survey

Multiple CT examinations

- 30% of patients who have CT scans have at least 3 scans
- 7% of patients who have CT scans have at least 5 scans
- 4% of patients who have CT scans have at least 9 scans

(Mettler *et al* 2000)

- Median number of CT scans delivered to trauma patients in their initial evaluation: 3

(Winslow *et al* 2008)

Multiple CT examinations (lifetime)

Parameter	Cumulative CT Examination Count	Cumulative Effective Dose (mSv)
Median	3	24
Mean	6.1	54.3
99th Percentile	38	399
Maximum	132	1375

Among patients who had a CT scan in 2007:

- **33% had more than 5 CT scans in the previous 20 yrs**
- **5% had more than 22 CT scans in the previous 20 yrs**
- **1% had more than 38 CT scans in the previous 20 yrs**

(Sodickson *et al* 2009)

So a significant population is being exposed to comparatively high doses from CT

Of the ~25 million people who have CT scans this year in the US, ~250,000 of them will have more than 40 CT scans in their lifetime, with a corresponding total effective dose of >0.4 Sv

(Sodickson *et al* 2009)

The most likely organ dose range for CT

Taking onto account

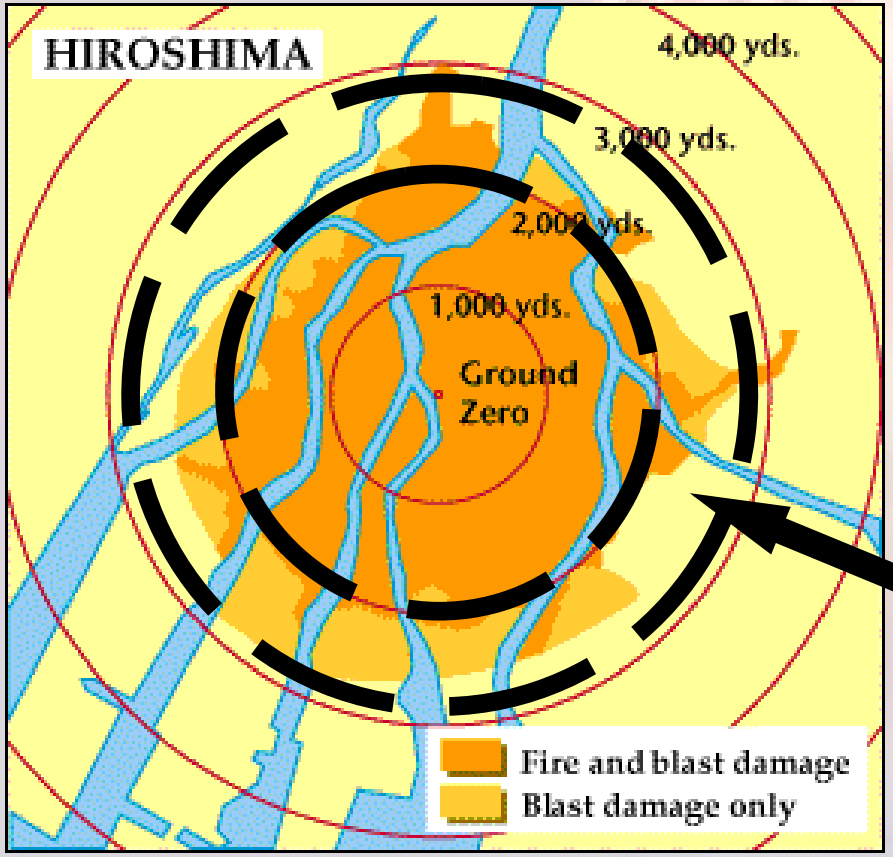
* **Machine variability,**
* **Usage variability,**
* **Age variability,**
* **Multiple scans (median 2-3)**

the most likely organ dose range for CT is

5 - 100 mSv

Low dose radiation risks

Hiroshima and Nagasaki



5-100 mSv

Number of solid cancers in A-bomb survivors exposed to doses from 5-100 mSv

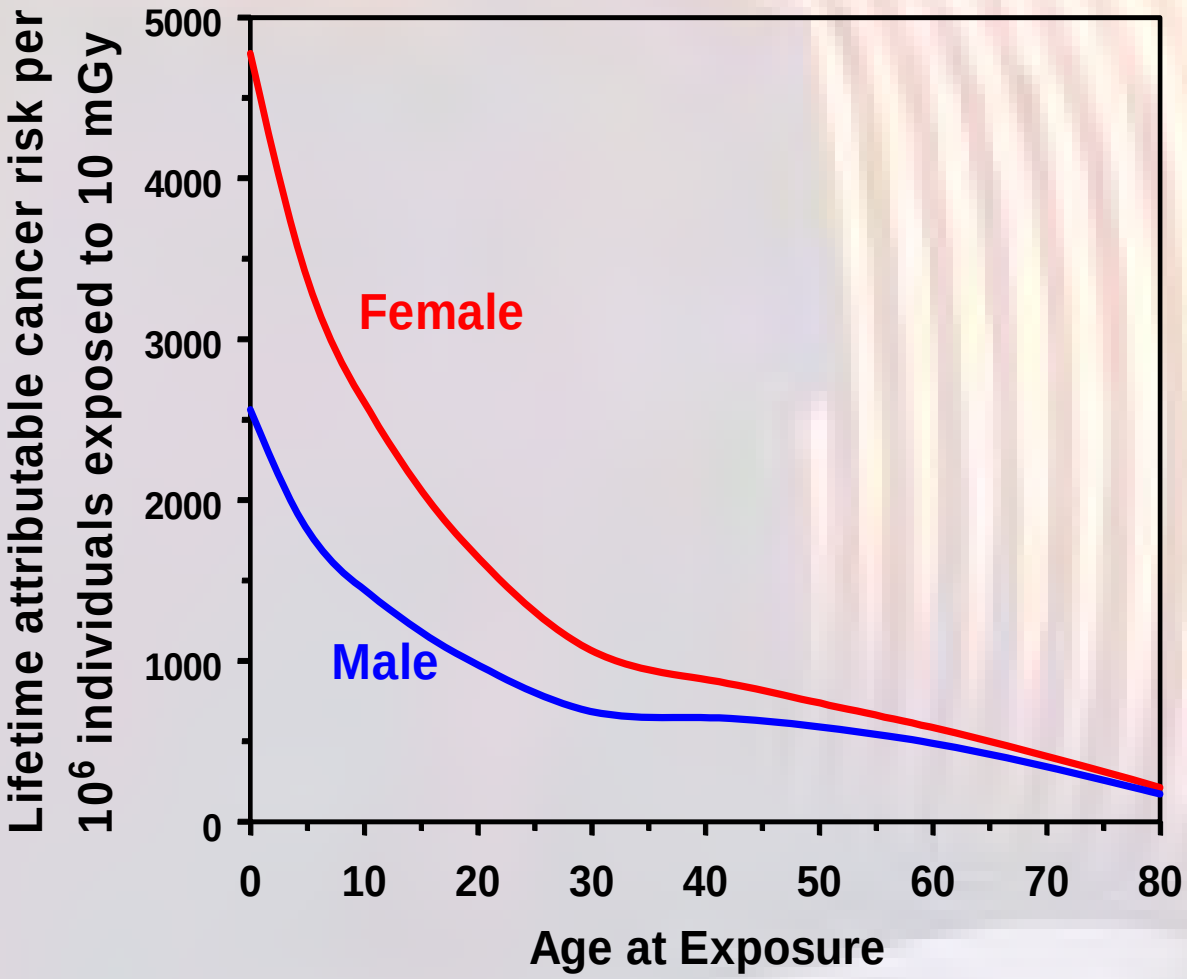
Small but statistically significant increase in risk

	Cancer incidence (1958-98)
Study population (5-100 mSv)	27,789
Total solid cancers observed	4,406
Solid cancers expected (controls)	4,325
Radiation-related excess solid cancers	81

Preston *et al* 2007

The A-bomb data are for individuals of all ages.... what about just children?

Estimated radiation-induced lifetime cancer risks as a function of age at exposure



From BEIR-VII (2006)

Pediatric CT Scans in the USA

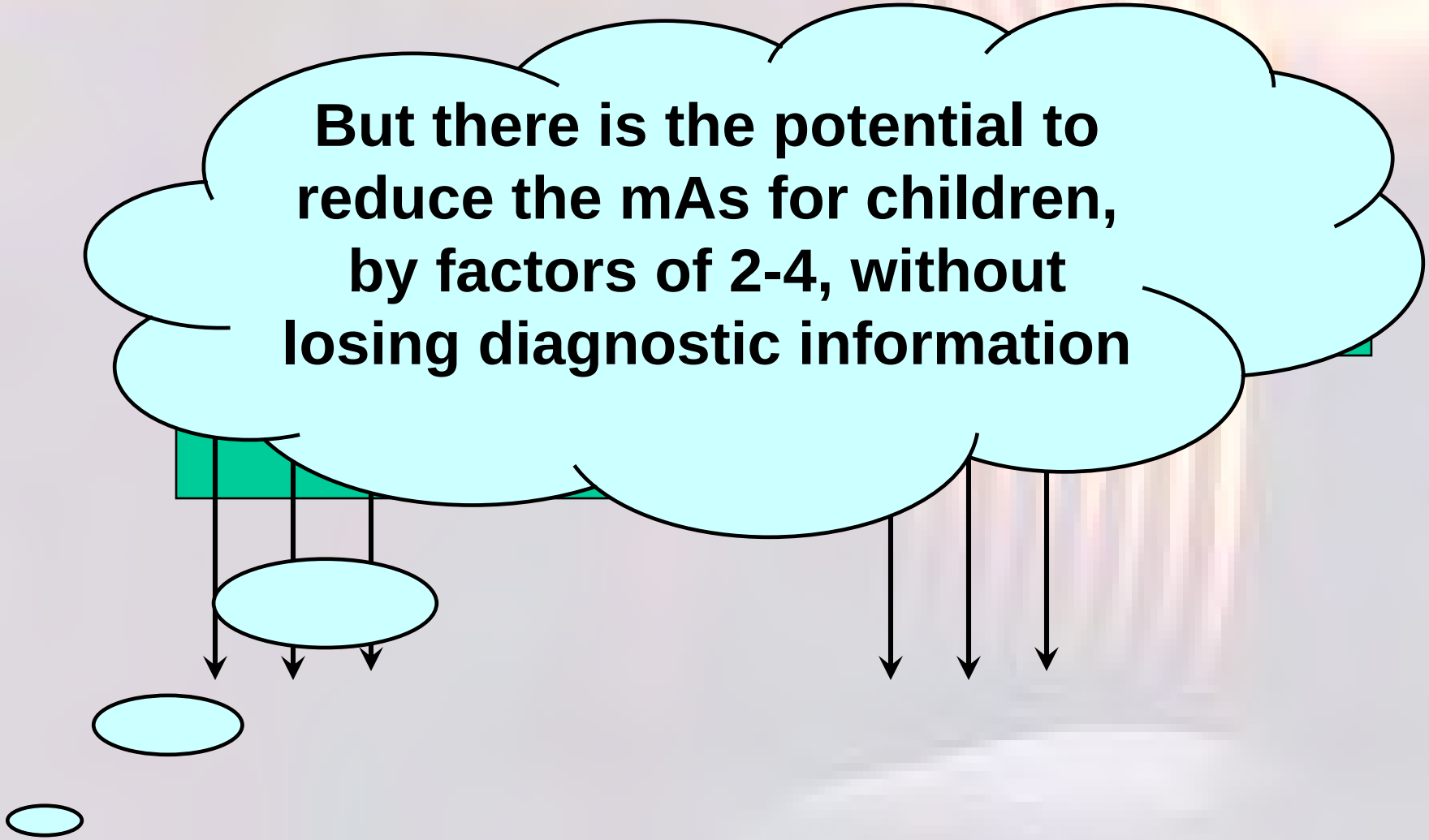
1989: ~½ million

2007: ~3½ to 7 million

(5 to 10% of total number of CTs)

(of these, ~ ¾ to 1.5 million are on children under 5)

For a given mAs, doses from CT are larger for children than for adults



Estimating the radiation-induced cancer risk for a CT exam,

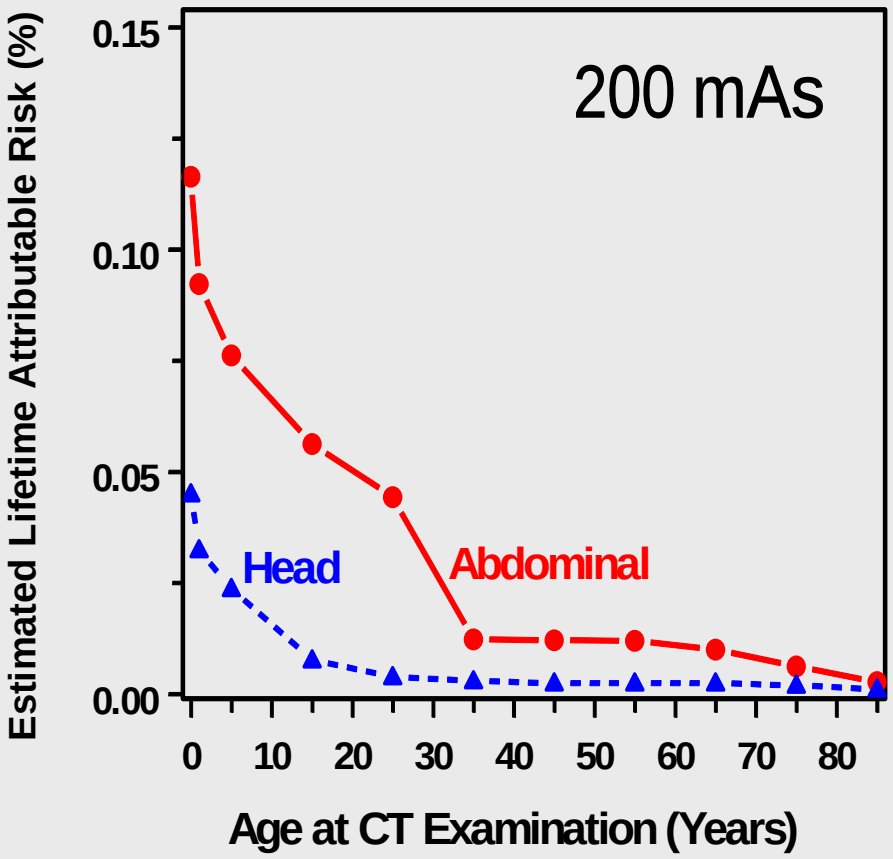
1. Estimate the dose to each organ, as a function of age, gender, and type of CT exam

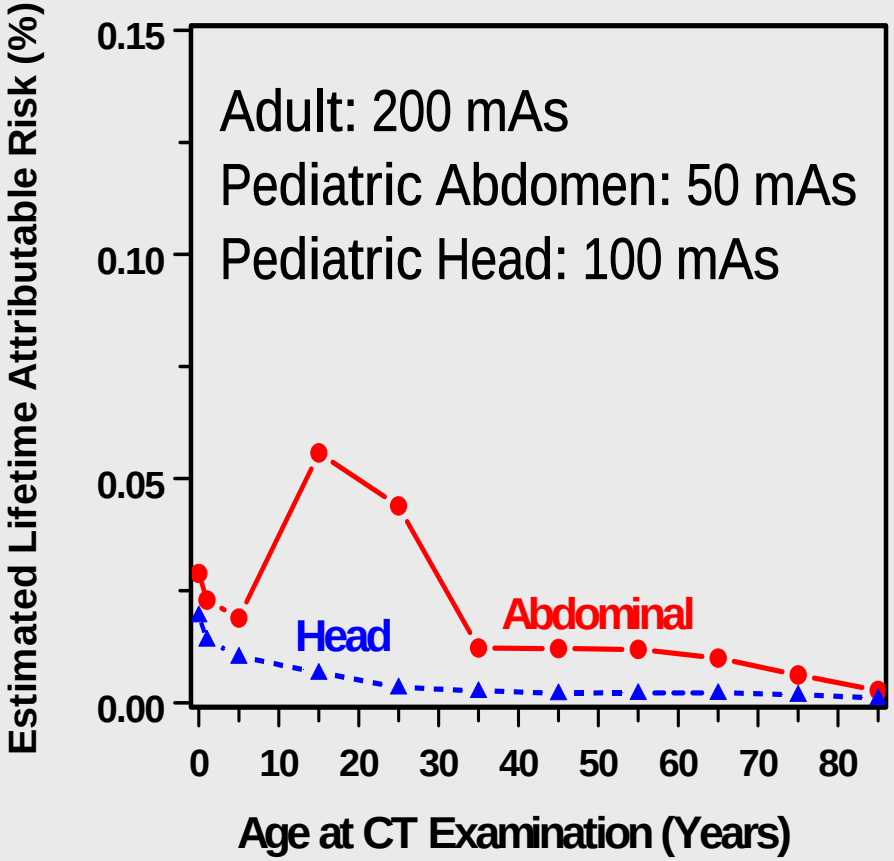
2. Apply estimates of age-, gender-, and organ-specific risks-per-unit dose

   (low-dose risks from A-bomb survivors, "transferred" to a Western population)

3. Sum the estimated risks for all organs

Estimated % lifetime attributable cancer mortality risk, as a function of age at exam, for a single CT exam





What are the uncertainties associated with these risk estimates?

About a factor of 3 in either direction

Epidemiological studies of cohorts of patients who had pediatric CT

- **Ongoing or just starting:**
  - **UK ~200,000 children**
  - **Ontario ~270,000 children**
  - **Israel ~80,000 children**
  - **Australia**

Courtesy, Elizabeth Cardis

Will these studies have enough power?

- The studies are large, but expected numbers of cases is still small
- Power may be sufficient to identify an increased risk of leukemia in young people
- But need larger sample size:
  - ✓ To precisely quantify risk
  - ✓ To evaluate host modifying factors (age, sex, etc)
  - ✓ To study solid tumors in adults

CHILD-MED-RAD – an EC Proposal

	Country
International Agency for Research on Cancer	France
Johannes Gutenberg-Universität Mainz	Germany
Säteilyturvakeskus	Finland
Karolinska Institutet	Sweden
University of Newcastle upon Tyne	UK
Centre de Recerca en Epidemiologia Ambiental	Spain
Institut Gustave Roussy	France
Kraeftens Bekaempelse (Danish Cancer Society)	Denmark
Het Nederlands Kanker Institute	Netherlands

SEVENTH FRAMEWORK PROGRAMME

Courtesy, Elizabeth Cardis

Individual risks *vs* population risks

- The individual risks from CT are small, so the benefit / risk ratio for any indicated study will typically be large

- But the exposed population is large (5 million children, ~65 million adults / yr in the US)

- Even a very small individual radiation risk, when multiplied by a large (and increasing) number of individuals, has the potential to produce a significant long-term public health concern

Are CT risks real?

- **The suggestion that CT doses will produce a small increase in individual cancer risk…**
  - ***Based directly on epidemiological evidence?***
  - ***"Extrapolated from high radiation dose exposures studied in the Atomic Bomb experience"?***
- **The typical organ dose range for CT (5 to 100 mSv) is the same dose range for which there is a statistically significant increase in risk in A-bomb survivors**
- **That being said, we await the results of the epidemiological studies over the next few years….**

Views of Emergency Department Physicians and Staff

Michael Blaivas, MD, FACEP
Professor of Emergency Medicine
Associate Professor of Internal Medicine

President, WINFOCUS
Department of Emergency Medicine
Northside Hospital Forsyth
Atlanta, Georgia

My Perspective

- 15 years of academics
- Now 2.5 years in pure community clinical practice
- Point of care ultrasound is my passion
- Research, education, policy, equipment development…

My Perspective

- Ultrasound anything and everything
- Battle to keep patients away from CT
- Huge cultural shock in private practice
- Dinosaurs still roam freely and rule over the land

Who Cares About Community EDs…

- About 5500 ED in USA
- 200 to 250 are academic in some way
- The rest are all community
- Lots of patients are seen here
- Do community docs care about academicians?

Major Issues For Emergency Departments

- Many patients
- Some hiding deadly problems
- So much to test… So little time…
- Some patients will not have a safety net to fall back on, so no second chance

Is There Any Room for Error?

- Many physicians feel error is not acceptable
- Felt most in ED
- Litigation and tort reform attempt trends suggest this
- "I just cannot afford to make a mistake"

November 1999

INSTITUTE OF MEDICINE

Shaping the Future for Health

TO ERR IS HUMAN:
BUILDING A SAFER HEALTH SYSTEM

Health care in the United States is not as safe as it should be--and can be. At least 44,000 people, and perhaps as many as 98,000 people, die in hospitals each year as a result of medical errors that could have been prevented, according to estimates from two major studies. Even using the lower estimate, preventable medical errors in hospitals exceed attributable deaths to such feared threats as motor-vehicle wrecks, breast cancer, and AIDS.

Medical errors can be defined as the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim. Among the problems that commonly occur during the course of providing health care are adverse drug events and improper transfusions, surgical injuries and wrong-site surgery, suicides, restraint-related injuries or death, falls, burns, pressure ulcers, and mistaken patient identities. High error rates with serious consequences are most likely to occur in intensive care units, operating rooms, and emergency departments.

Beyond their cost in human lives, preventable medical errors exact other significant tolls. They have been estimated to result in total costs (including the expense of additional care necessitated by the errors, lost income and household productivity, and disability) of between $17 billion and $29 billion per year in hospitals nationwide. Errors also are costly in terms of loss of trust in the health care system by patients and diminished satisfaction by both patients and health professionals. Patients who experience a long hospital stay or disability as a result of errors pay with physical and psychological discomfort. Health professionals pay with loss of morale and frustration at not being able to provide the best care possible. Society bears the cost of errors as well, in terms of lost worker productivity, reduced school attendance by children, and lower levels of population health status.

A variety of factors have contributed to the nation's epidemic of medical errors. One oft-cited problem arises from the decentralized and fragmented nature of the health care delivery system--or "nonsystem," to some observers. When patients see multiple providers in different settings, none of whom has access to complete information, it becomes easier for things to go

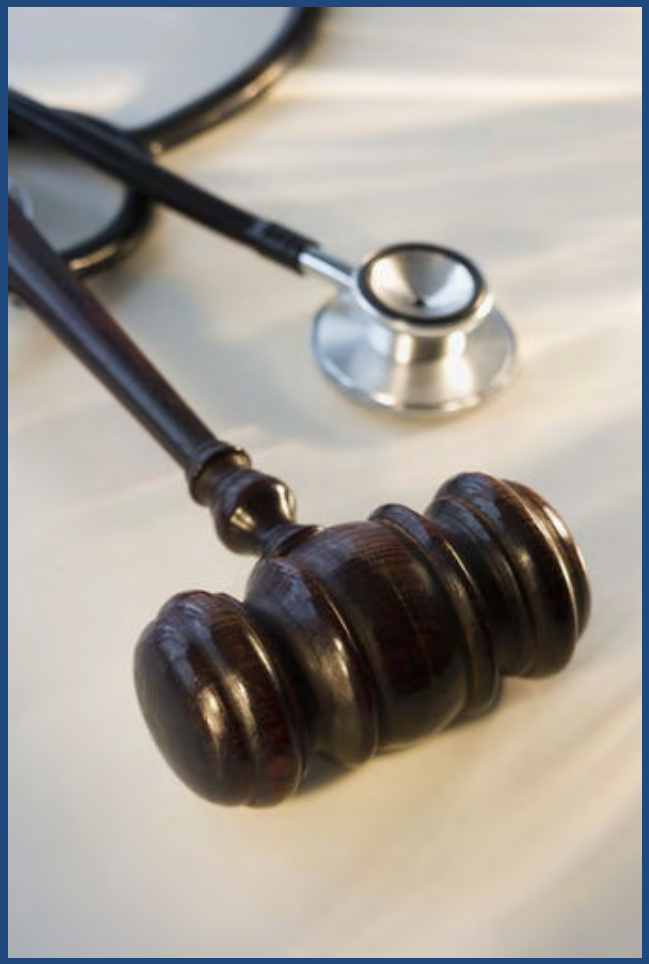
Errors...are costly in terms of loss of trust in the health care system by patients and diminished satisfaction by both patients and health professionals.

Concerns

- Litigation
  - Top 3 source of litigation is ruptured appendicitis
  - No more wait and see
  - Perception is one can acquire definitive answer
  - Patients do not understand nor accept “go home and return if pain is worse”

Concerns

- Litigation
  - Another top 3 source of litigation is chest pain
  - Pulmonary embolism "miss it and people could die"
  - Old rules are gone for PE presentation
  - Dissection: any pain in the chest can be dissection



Taking a Risk?

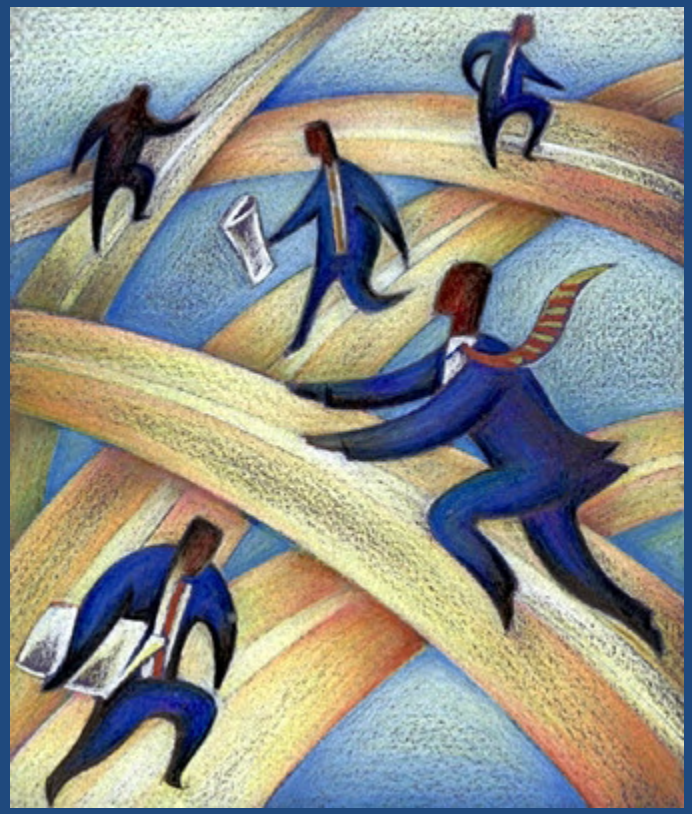
- Pines JM et al., **The association between physician risk tolerance and imaging use in abdominal pain.** *Am J Emerg Med.* 2009; 27:552-7.
  - **Prospective study**
  - **Non-traumatic abdominal pain**
  - **838 patients with abdominal pain**
  - **Analyzed decisions regarding imaging**

Taking a Risk?

- 487 (58%) received imaging studies
- 395 (47%) received CT
- Imaging lower among attendings who were least risk-averse

Other Influences

- Hospital administration
  - Hospitals are focused on patient service when in competitive area
  - People complain ,you lose your contract
  - Everything is a mute point when you are out of a job
  - Well known in EM circles that contracts are lost easily and people are fired easily

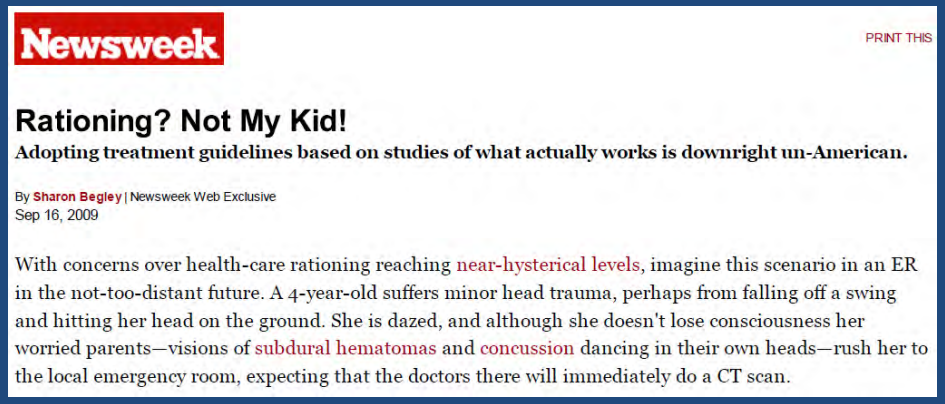


Outside Influences

- Hospital administration
  - Large difference between academic and community setting
  - In community setting administrators will not listen to the latest literature or findings
  - Laws and money are kings
  - Reason and data will not help you

Outside Influences

- Patient complaints
  - Patient frequently insist on studies
  - Use inaccurate information from internet
  - Australian study results
    - Accuracy for major ailments from web is 50%



Newsweek

PRINT THIS

Rationing? Not My Kid!

Adopting treatment guidelines based on studies of what actually works is downright un-American.

By Sharon Begley | Newsweek Web Exclusive
Sep 16, 2009

With concerns over health-care rationing reaching near-hysterical levels, imagine this scenario in an ER in the not-too-distant future. A 4-year-old suffers minor head trauma, perhaps from falling off a swing and hitting her head on the ground. She is dazed, and although she doesn't lose consciousness her worried parents—visions of subdural hematomas and concussion dancing in their own heads—rush her to the local emergency room, expecting that the doctors there will immediately do a CT scan.

Outside Influences

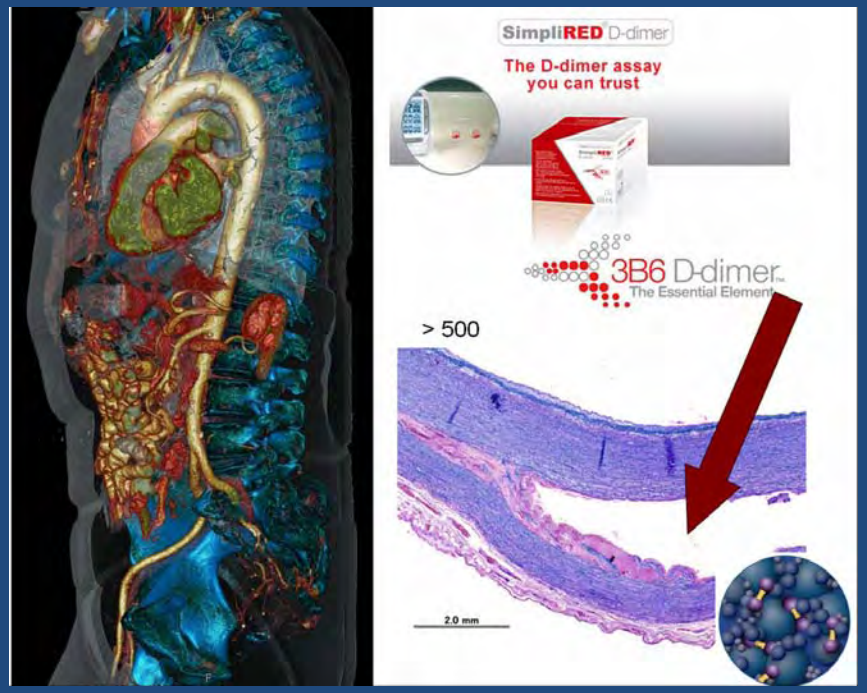
- Primary care complaints
  - No understanding of emergency medicine
  - Call and insist on studies
  - Tell patients to expect to receive certain studies
  - Most of these are CTs
  - Frequently the patient has not even been examined or seen by the PMD

Specialist Issues

- If they are called, best tactic is to stall
  - Order a CT
- There is a practical side to this
  - Avoid false positive trips to ED
- NEXUS is ignored by trauma

Outside Influences

- D-dimer ordered on all chest pain and SOB patients admitted to hospital
- Massive waste
- Large number positive and thus get CTA
- Outside of our control

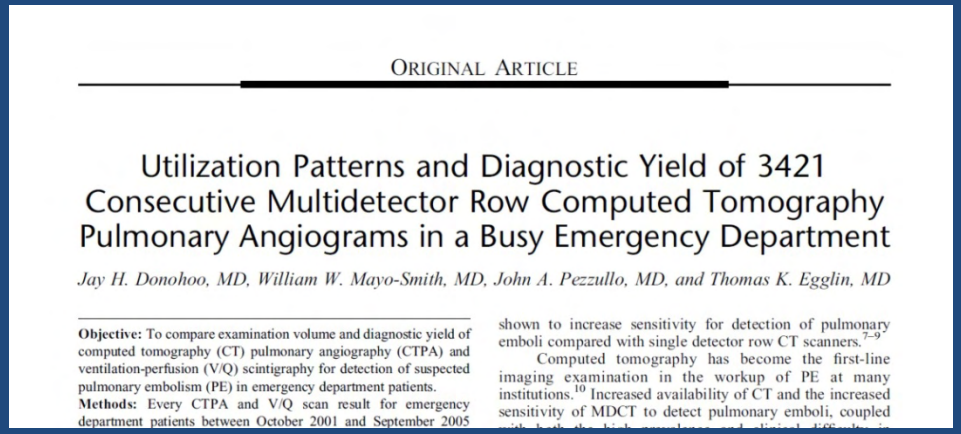


Barriers To Lowering CT Use

- New data does not filter down to community practice quickly
- Institute of Medicine states average of 17 years for new development to get into broad practice
- Things that are old to academics are soon to be new in community

Knowledge In Choosing Tests

- Not always aware of current data
- What did training 20 years ago say about CT for all abdominal pain or every headache?
- New technology means using it?
  - CT increase 227% in 24 months of new CT scanner



ORIGINAL ARTICLE

Utilization Patterns and Diagnostic Yield of 3421 Consecutive Multidetector Row Computed Tomography Pulmonary Angiograms in a Busy Emergency Department

Jay H. Donohoo, MD, William W. Mayo-Smith, MD, John A. Pezzullo, MD, and Thomas K. Egglin, MD

Objective: To compare examination volume and diagnostic yield of computed tomography (CT) pulmonary angiography (CTPA) and ventilation-perfusion (V/Q) scintigraphy for detection of suspected pulmonary embolism (PE) in emergency department patients.
Methods: Every CTPA and V/Q scan result for emergency department patients between October 2001 and September 2005

shown to increase sensitivity for detection of pulmonary emboli compared with single detector row CT scanners.[7–9]

Computed tomography has become the first-line imaging examination in the workup of PE at many institutions.[10] Increased availability of CT and the increased sensitivity of MDCT to detect pulmonary emboli, coupled

Problems With Physical Examination

- Probably never any good for most pathology
- Investigated in 1800s, no way to prove contrary
- Detection of AAA: 50% by PE
- Presence of Becks triad in Tamponade: 15%
- Abscess vs Cellulitis: about 50%
- Pneumonia on PE vs CXR vs US vs CT
- PTA

CT Cervical Spine

- You think there is a spike now after the NEXUS Study?
- Community docs will learn about this over the next 10 years
- Then you will really see a spike!

Test Results

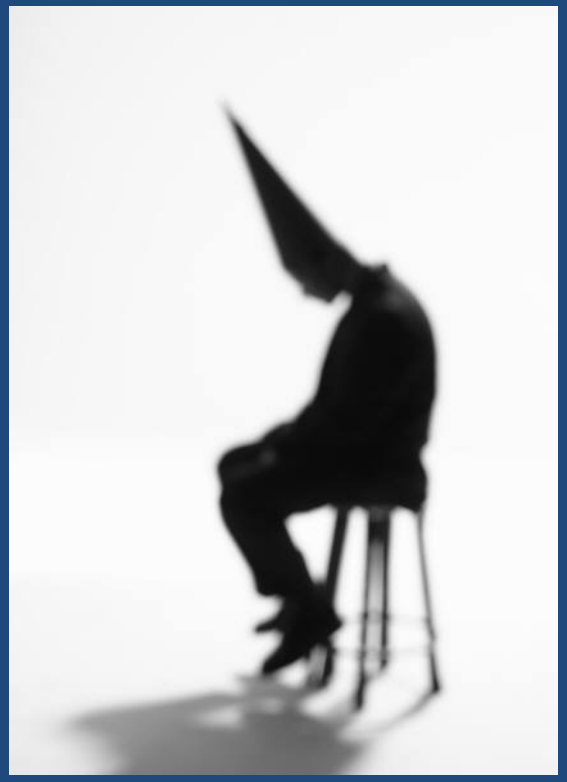
- Clinical relevance of some tests like CTA showing tinny insignificant PEs has hidden value
- This PE may not have hurt him/her, but the next one may kill them
- Work up for serious hypercoagulability syndrome may not be done

Dirty Topic: Drug Seeker

- Don’t really exist according to pain treatment radicals
- Huge number of tests to prove nothing is wrong
- 4 CT in one day?

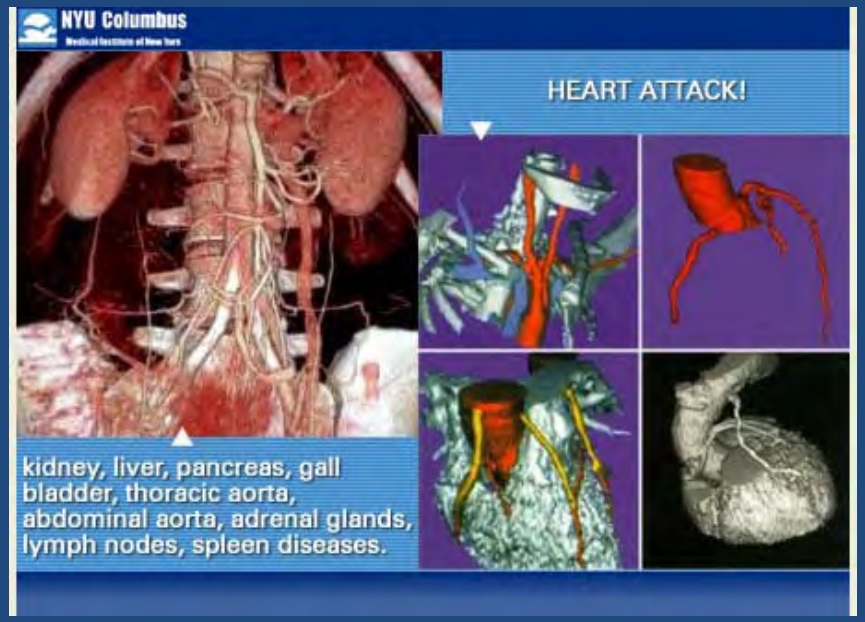
September 20th in my ED

- 5 pm to 1 am shift
- 36 patients
- 12 CT scans
- 3 head, 3 chest, 2 renal colic, 4 abdomen with contrast
- Prior to ordering 3 were justified
- After ordering: same



Total Body Scan

- Some say this as a joke
- Would be very convenient and is highly anticipated by others
- Cardiac CT has real potential
- Order from triage on all CP to rule out triple threat
- Forget d-dimer or MD



Relationship Between Rads and EM

- Right now too adversarial
- Lots of finger pointing
- This is only natural

Relationship Between Rads and EM

- We are in a partnership in patient care and patient safety
- Must look at this issue jointly and in a different way
- Physicians are weakest when they fight among themselves

ACR Appropriateness Criteria and Community EM

- Asked some colleagues
- Variety of responses after topic described
- Impolite to actually mention any of them
- Aerospace engineer and pilot in distress analogy
- Must be a joint effort to have any chance

What Will Effect Use

- Must have teeth
  - Education alone will not effect change fast enough
  - Suggestions don’t help, not fast enough

What Will Effect Use

- Must have teeth
  - Suggestions don't effect patient desires
  - Must make decision "not to CT" defensible
    - Before patient
    - Before lawyer
    - Before hospital
  - Some hoops to jump through may not be all bad

What Will Effect Use

- Army experiment with free ED care delivery
  - Added $.25 co-pay
  - Unneeded visits dropper dramatically
  - Decompressed ED for appropriate visits
- Even a mild computer ordering algorithm might make an impact

"I'll have someone come in and prep you for the bill."

Conclusions

- EPs feel they are in the crosshairs from many angles
- Little room for error
- Advanced imaging seen as protective and is part of an evolution
- Education will not help alone
- Regulation (laws?)

Conclusions

- Go after the low lying fruit
- There is a lot of it and it is safe to reach for
- Almost everyone will agree on this
- Will not impact safety
- Must be joint project

Questions?

- mike@blaivas.org

Benefit-risk analysis and perception and communication of applications of ALARA principles:

Views of Radiologists

Computed Tomography in Emergency Medicine-Radiation, Roles and Responsibility

Bethesda, MD, Sept 23-24, 2009

Fred A. Mettler Jr, MD, MPH.

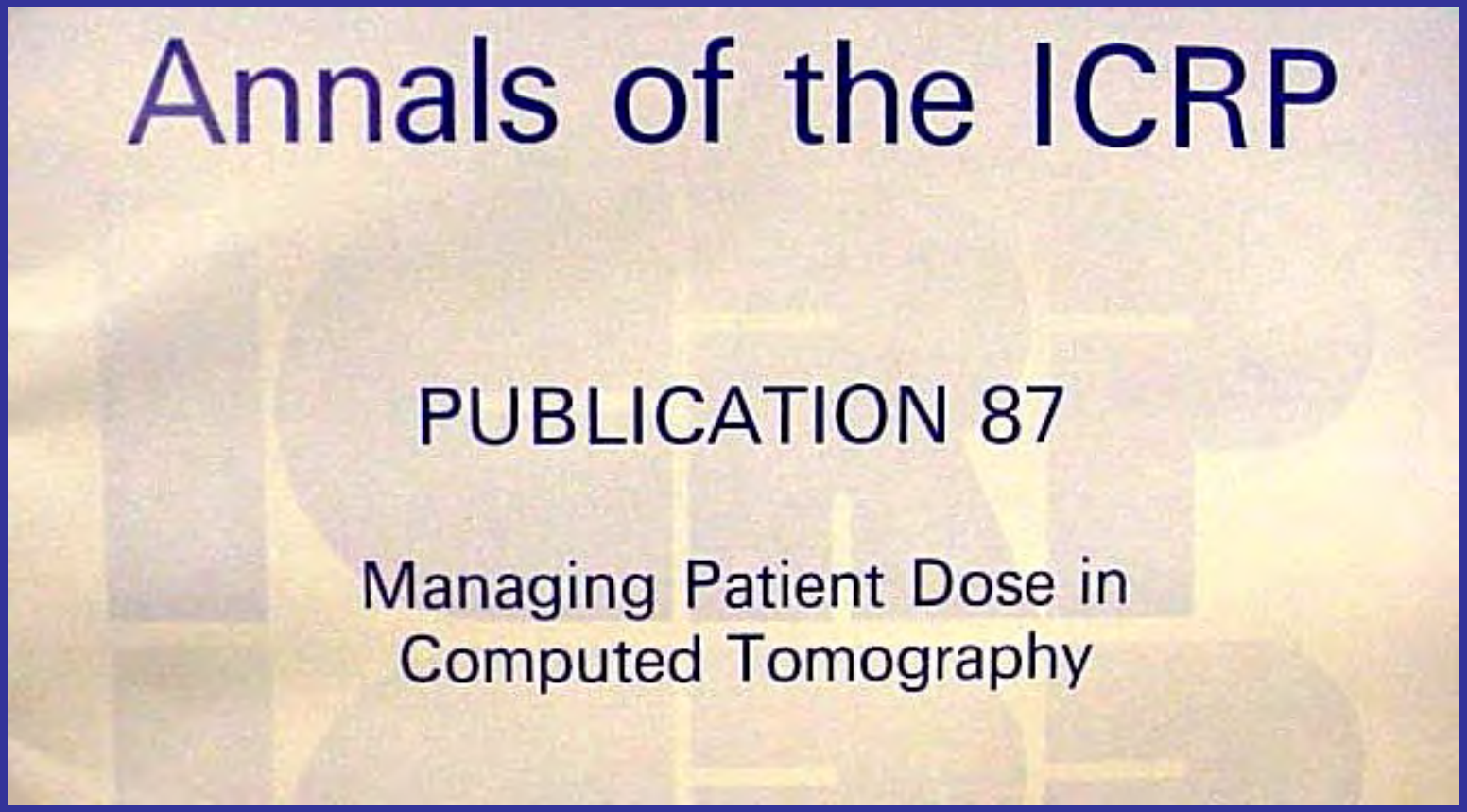
NM VAHCS, Albuquerque, New Mexico

Benefit-risk analysis and

perception and

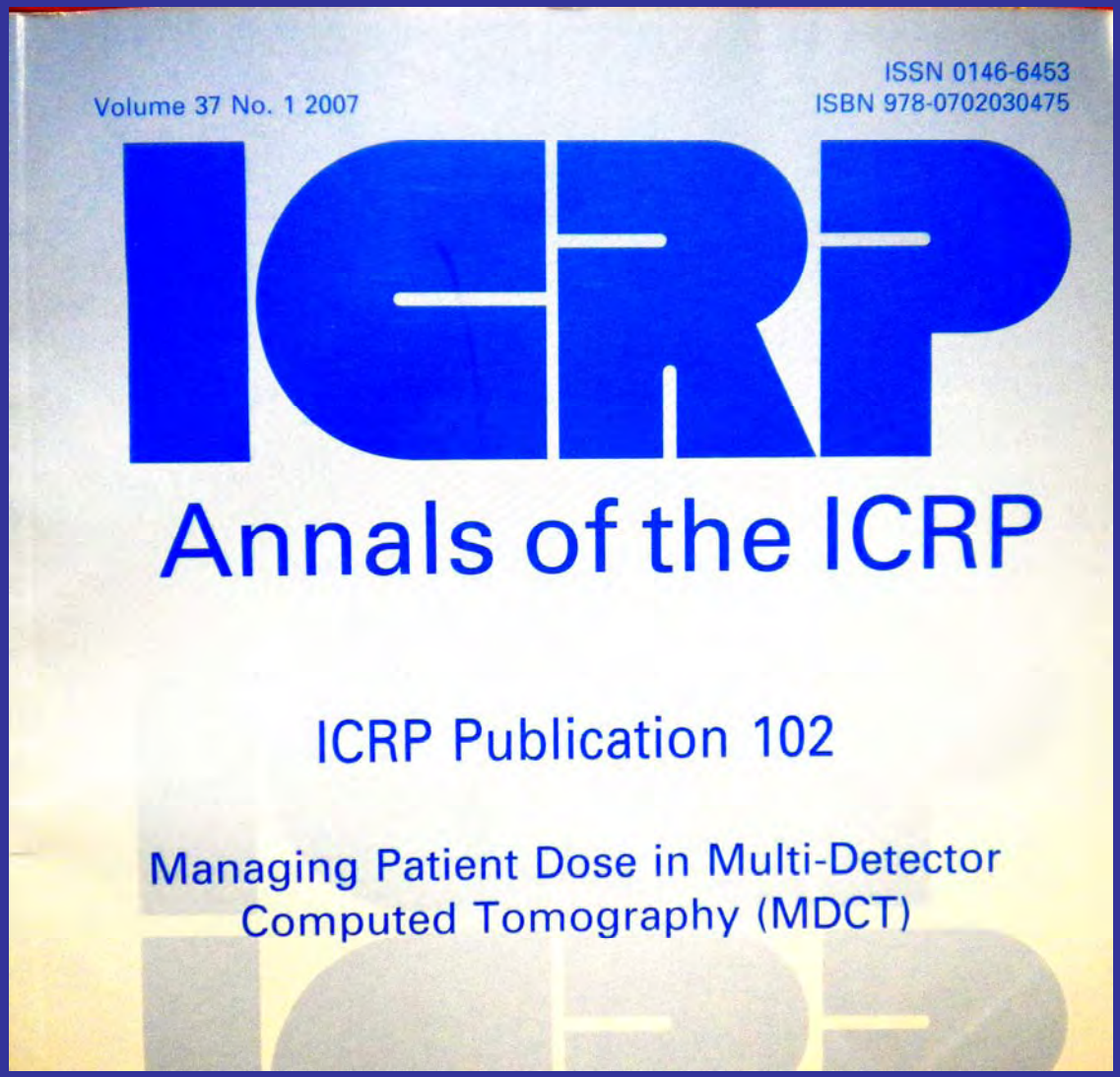
communication of applications of ALARA principles:

2001



“The doses can approach or exceed levels known with certainty to increase the probability of cancer”

2007


Volume 37 No. 1 2007
ISSN 0146-6453
ISBN 978-0702030475
ICRP
Annals of the ICRP
ICRP Publication 102
Managing Patient Dose in Multi-Detector Computed Tomography (MDCT)

- Physicians really do have the patient’s best interests in mind and they have a myriad of factors to balance

- Any proposed radiation protection system must work within existing medical system rather than try to change medical practice

Benefit

- In Emergency Medicine it may be:
- Making an accurate diagnosis
- Selecting the correct therapy
- Leading to improved life span or quality of life
- ***Very difficult to quantitate***

Risk

- “to expose to danger”
- “potential of an undesirable event”
- Can usually be quantitated

- Risks include those from radiation

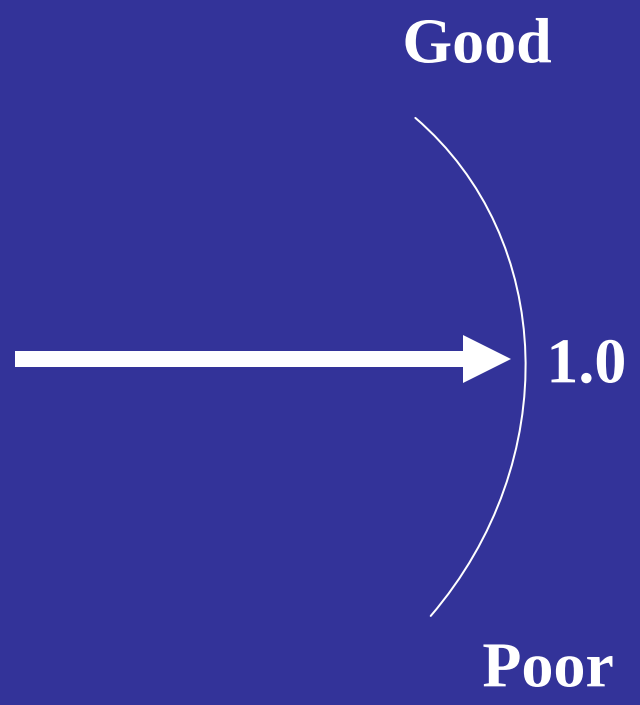
- Risks also include other factors e.g. **not** making the diagnosis or **not** getting the necessary procedure because of radiation fear or lack of resources

Examples of potentially fatal non-radiation risks

Oxygen tank and large 50 kg floor polisher and sucked into magnetic resonance scanner

Benefit/Risk Ratio

- What are the factors that affect this ratio ?



- Benefit/risk ratios are virtually impossible to quantitate and even for a specific procedure there is wide for each individual patient

- There are persistent differences in opinion about such issues as D-dimer and PE where there is no true consensus in practice

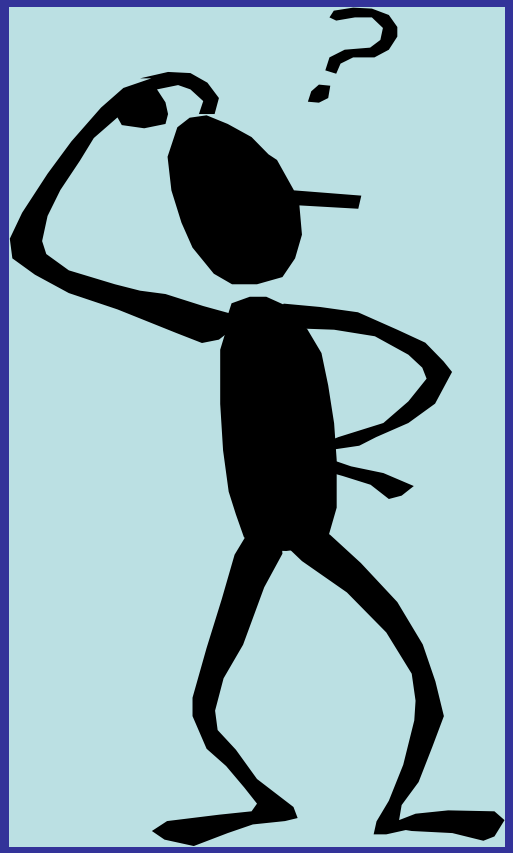
The ideal world (MGH)

- EM physician examines patient
- Confers with radiologist who is there 24 hours

- They consider the benefits and risk
- They actually know the benefit and risk and are NCRP literate
- Order the “appropriate” “justified” exam

- Exam order is entered in computer
- Exam is tailored /optimized to the patient (ALARA), pitch, kVp,contrast, timing etc
- Radiologist interprets exam and communicates results
- Specialist is called as needed depending on the diagnosis

What really happens ??



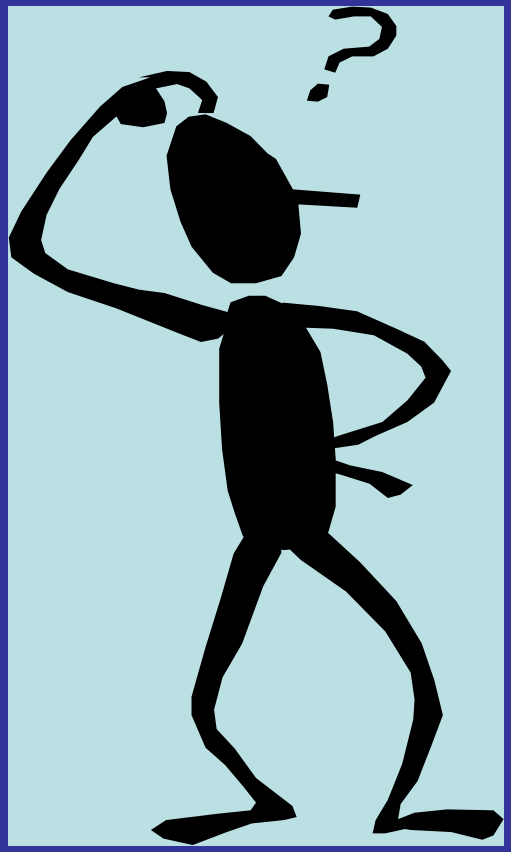
The waiting room is filled with 90 patients who have been there at least 4 hours and who are not happy….

the young, the old and the homeless….

The ambulance and helicopter arrive with “incoming unstable”

The EM physicians here are not too concerned about a stochastic risk of 1/2000 10+ years from now

What does “ABC” stand for

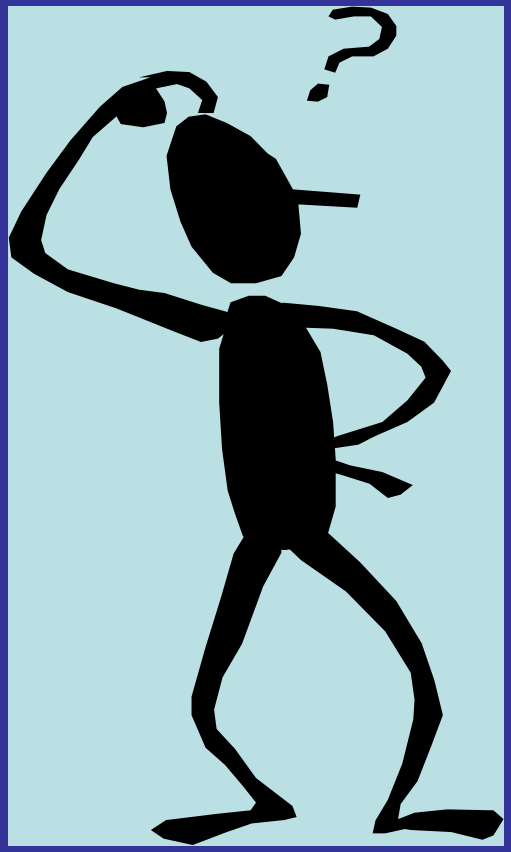


Airway

Breathing

Circulation

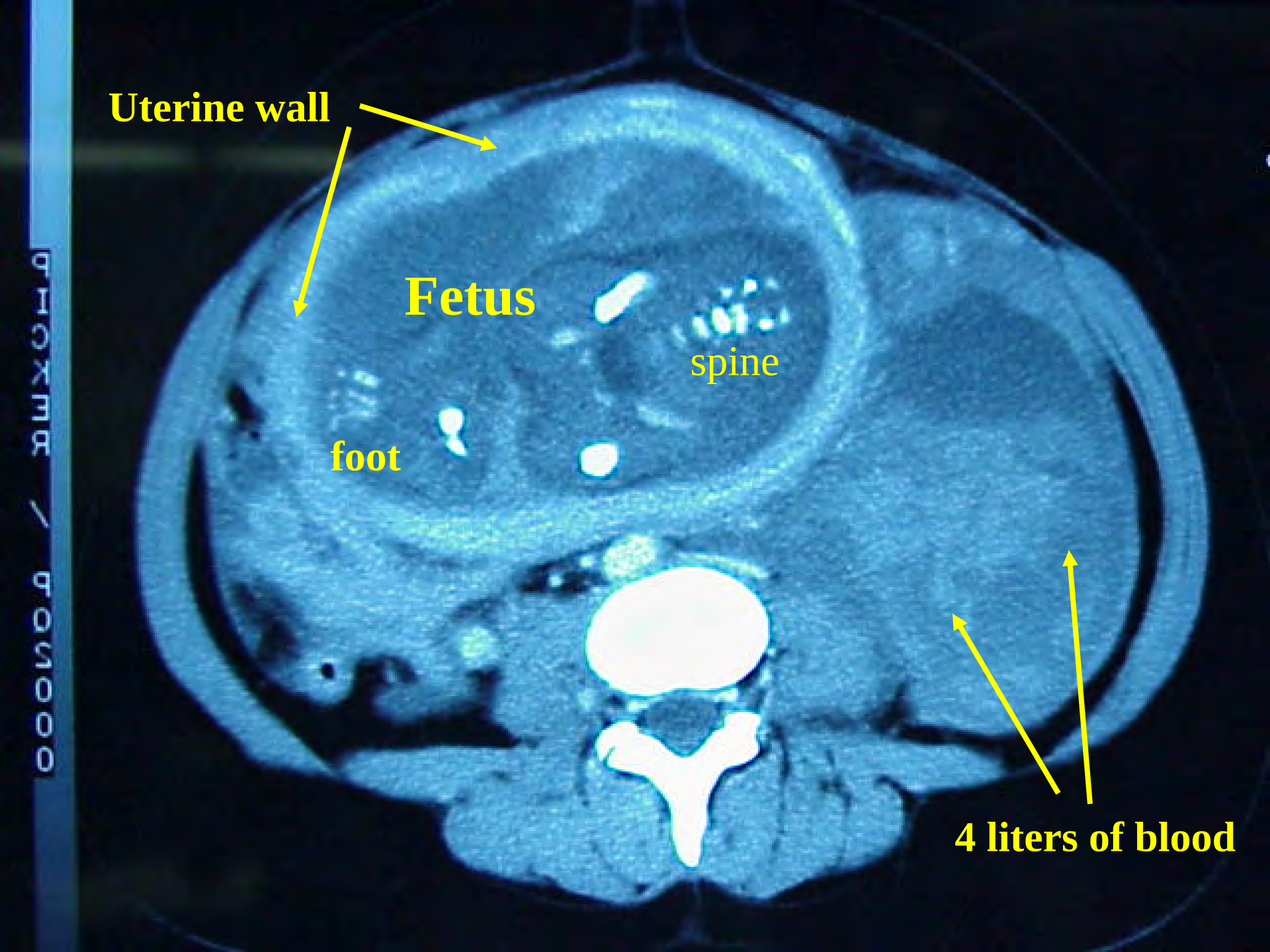
What does “ABC” stand for



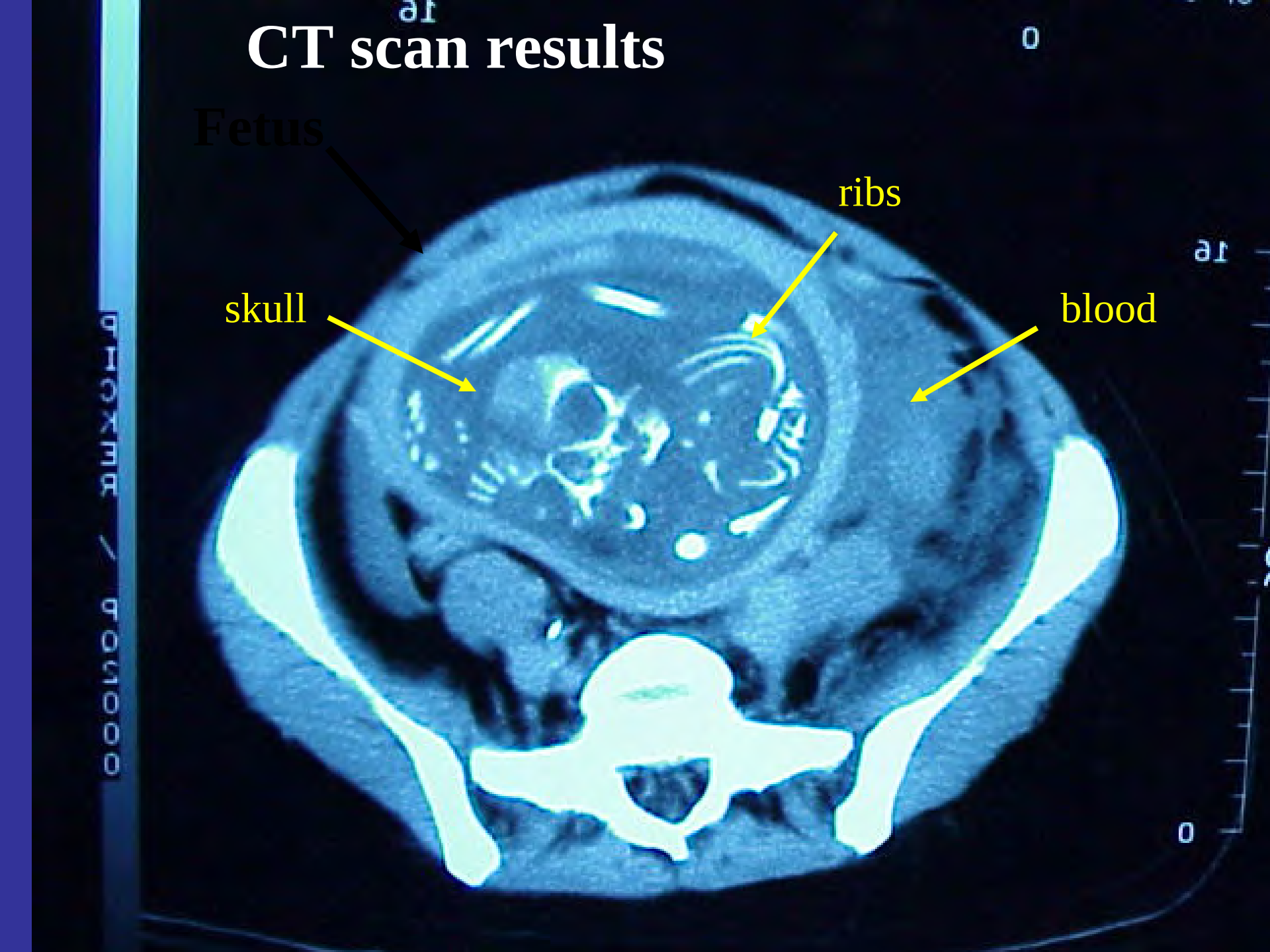
Airway

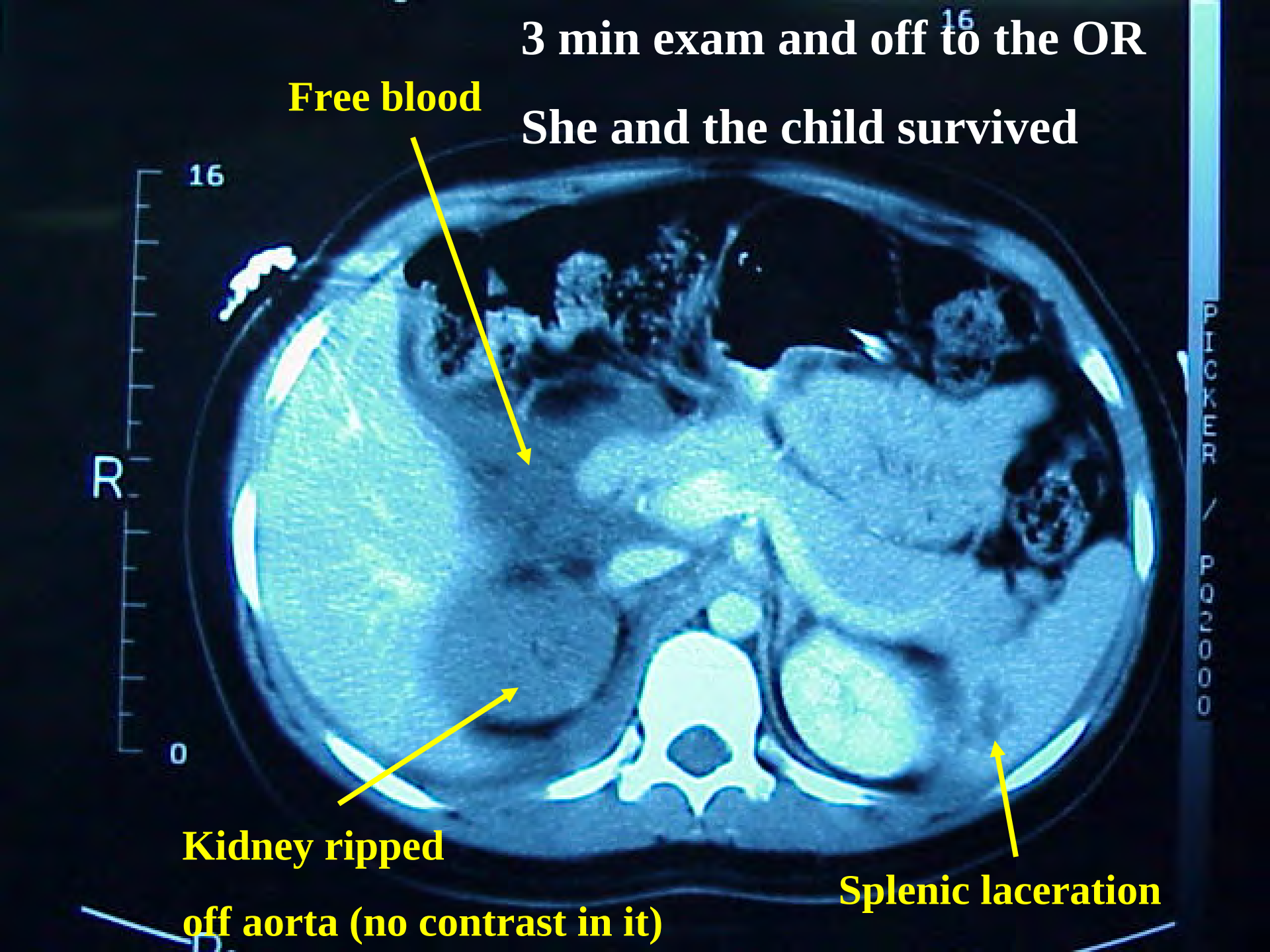
Breathing

CT


Uterine wall
Fetus
spine
foot
4 liters of blood

CT scan results



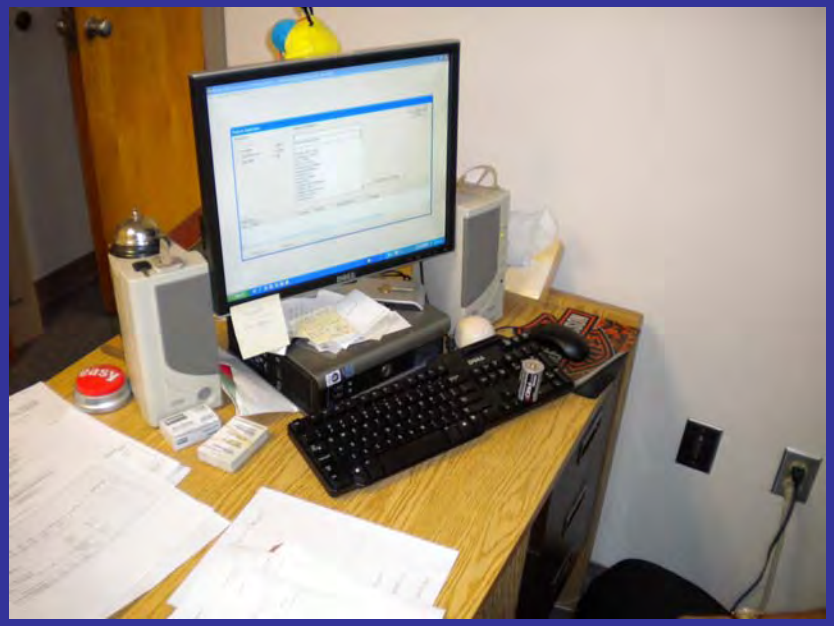

3 min exam and off to the OR
She and the child survived
Free blood
Kidney ripped
off aorta (no contrast in it)
Splenic laceration
16
R
0
PICKER / P02000

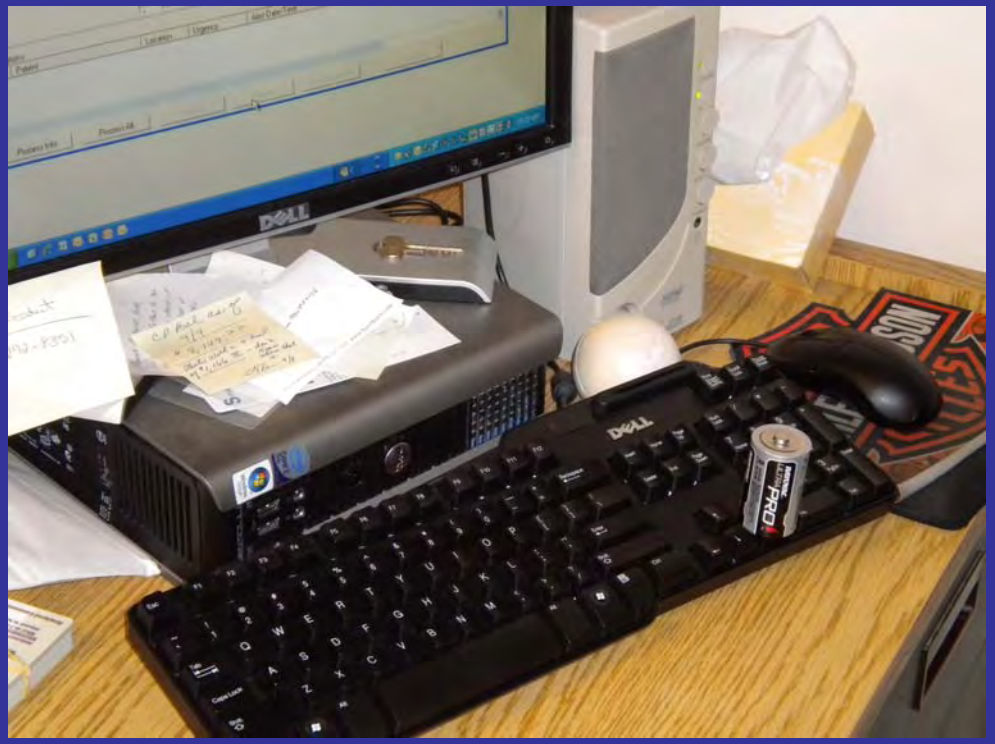
More of the real world

- The urologist refuses to come see the renal stone patient until a CT is ordered

- A nurse tries to triage the other patients before the EM physician sees them and orders a CT scan using a protocol

New computer security of “physician only” order entry and 60 second timeout of computer is solved by the clerks using the “D solution”



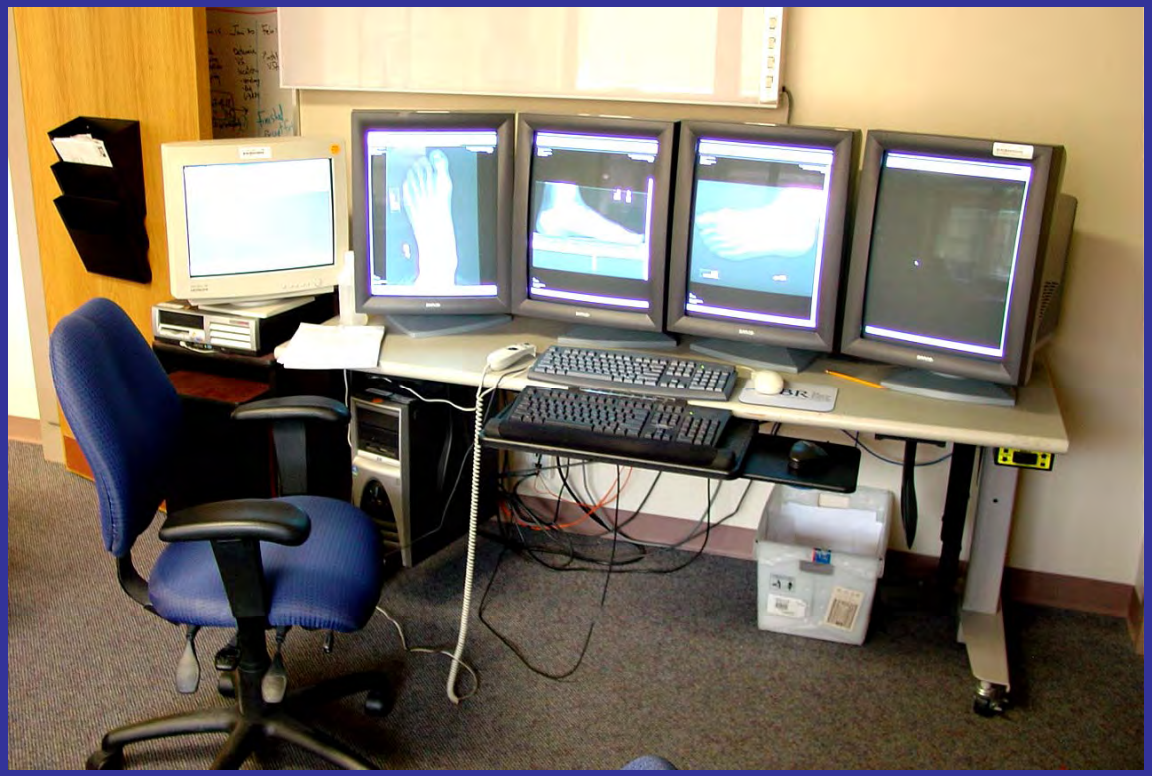


If we say “r/o bleed” for head CT and” r/o appendicitis” for abdominal CT, the computer or radiologist always approves it

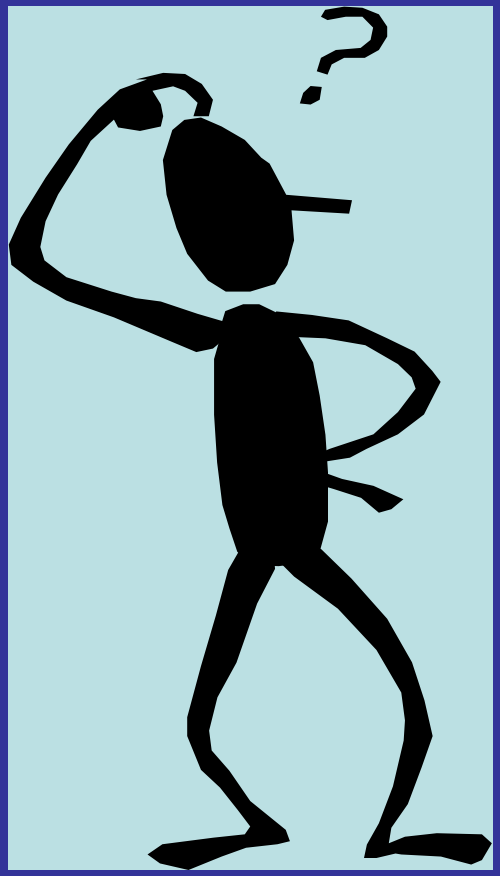
Order is processed by radiology clerks and forwarded to CT technologists

CT technologists are often left holding the bag as to whether things actually make sense and how to tailor the exam

The images are sent to a PACS system and may be read by radiologists who are a 1000 miles away

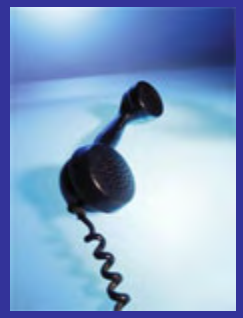


Reality is …..



Risk/benefit analysis is only roughly done, primarily by indication/protocol ordering or by the ordering physician

Communication with the radiologist is rare. Probably less than 5% of the time



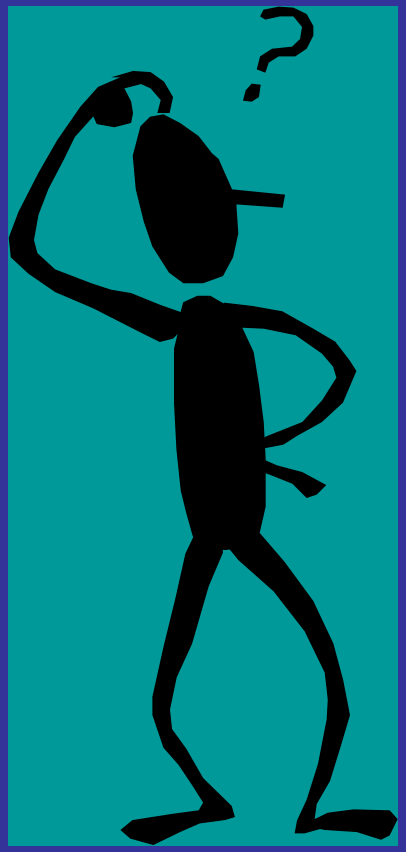
How does an ordering physician really "calculate" the benefits and risks ?

How bad is the patient bleeding ?

Will the test or therapy affect outcome ?

Is it available ?

What is my experience ?



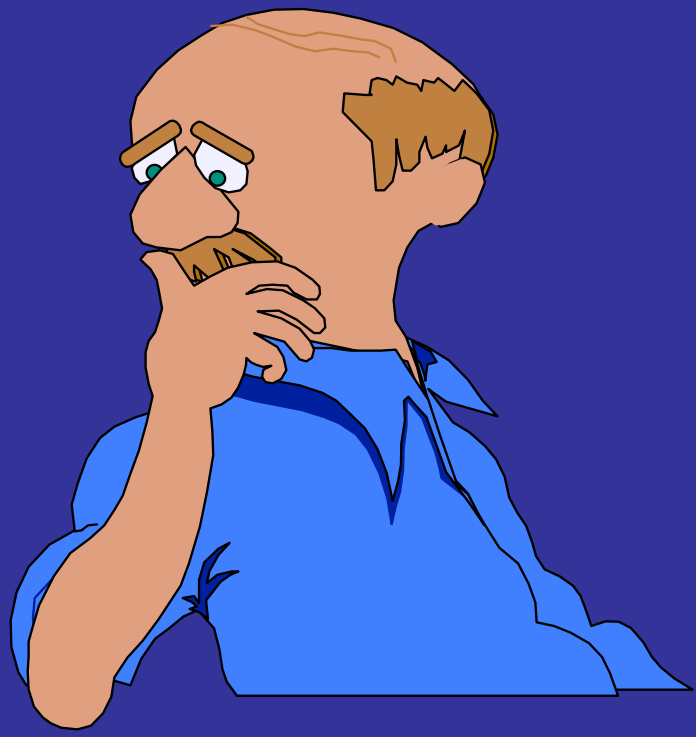
What is the downside if I don't order it ?

Have I seen anything in the literature lately?

What is my gut feeling ?

Radiation risk ?? Is that an issue ??

What are the views of radiologists I surveyed ?



“We don’t have time to discuss all CT scans”

- True - A typical department doing 35,000 CT scans per year = 5-6 phone calls per hour *for CT alone*

- 70 million CT scans annually in the US would mean 70 million phone calls

How about MRI and NM calls ?

“EM physicians don’t usually think radiation is an significant issue and most of the time I suspect they are right”

“More than half the time I call the EM physicians to discuss things, they have not seen the patient and don’t know who I am talking about, but they try to be helpful and at least listen”

- “The EM docs say that it is hard to find a radiologist/resident after hours and it slows up their work. Some view residents as obstructionist and they are sometimes right”

- “All the residents do is listen for the indication and choose a numbered protocol off the menu for the techs based on the symptoms/indication. Why can’t the ER docs do that directly ?”

- “Techs tell me if there is a problem”
- “Never heard of the NCRP”
- “I don’t know where to look up CT risk” …….“ maybe the NRC website ???”

ACR Appropriateness Criteria® October 2008 Version - Microsoft Internet Explorer

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Address http://www.acr.org/ac

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ACR Appropriateness Criteria® October 2008 Version

The ACR Appropriateness Criteria® are evidence-based guidelines to assist referring physicians and other providers in making the most appropriate imaging or treatment decision. By employing these guidelines, providers enhance quality of care and contribute to the most efficacious use of radiology.

The guidelines are developed by expert panels in diagnostic imaging, interventional radiology, and radiation oncology. Each panel includes leaders in radiology and other specialties. There are currently 159 topics with over 800 variants. For more information on the background and development process, click here.

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start | 2:17 - QuickLink Mobile | ACR Appropriateness... | Microsoft PowerPoint... | 9:37 AM

to the higher level. These assignments will be periodically reviewed and updated as practice evolves and further information becomes available.

Table 1. Relative radiation level designations along with common example examinations for each classification

Relative Radiation Level*	Effective Dose Estimate Range	Example Examinations
None	0	Ultrasound, MRI
Minimal	<0.1 mSv	Chest radiographs, hand radiographs
Low	0.1-1 mSv	Pelvis radiographs, mammography
Medium	1-10 mSv	Abdomen CT, barium enema, nuclear medicine bone scan
High	10-100 mSv	Abdomen CT without and with contrast, whole body PET

*RRL assignments are not included for some examinations. These are designated as IP (in progress) or NS (not specified). The RRL assignments for the IP examinations will be available in future releases. The RRL assignments for the NS examinations cannot be made because the RRL depends on the region of the body exposed to ionizing radiation, and the body part will vary as a function of the clinical situation.

The primary risk associated with exposure to ionizing radiation is cancer. Based on the BEIR VII report, it is estimated that approximately 1 in 1,000 individuals will develop cancer from an exposure of 10 mSv. This risk level is relatively small in comparison to approximately 420 out of 1,000 individuals expected to develop cancer from all other causes combined [11]. Keep in mind that cancer, regardless of the etiologic process, has a latent period of 10-20 years. Further, it is important to remember that in addition to radiation exposure from imaging procedures, individuals are exposed to background radiation from natural sources, including radon, cosmic rays, soil, building materials, and food. The average annual amount of natural background radiation for someone living in the United States is approximately 3 mSv [12].

The RRL designations specified in these guidelines assume an average adult patient size (or applicable pediatric size) and

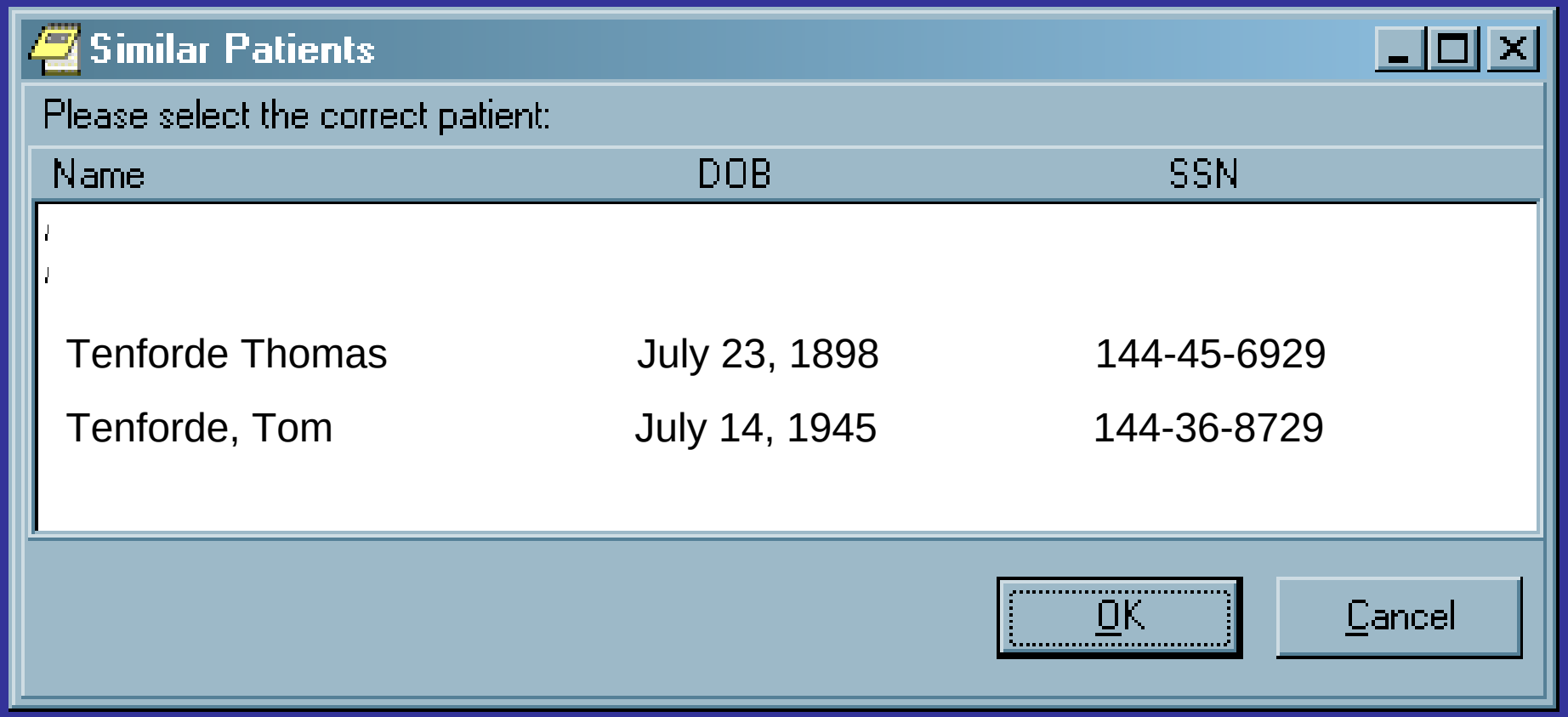
Potential solutions

- Keep the message very simple
- Information technology
- Computer alerts when ordering: May be one of the true viable solution

  Alert by recent similar exam

  Alert by patient age

Warning-Similar Names



Warning-Possible radiation issue

Attention: Possible radiation issue

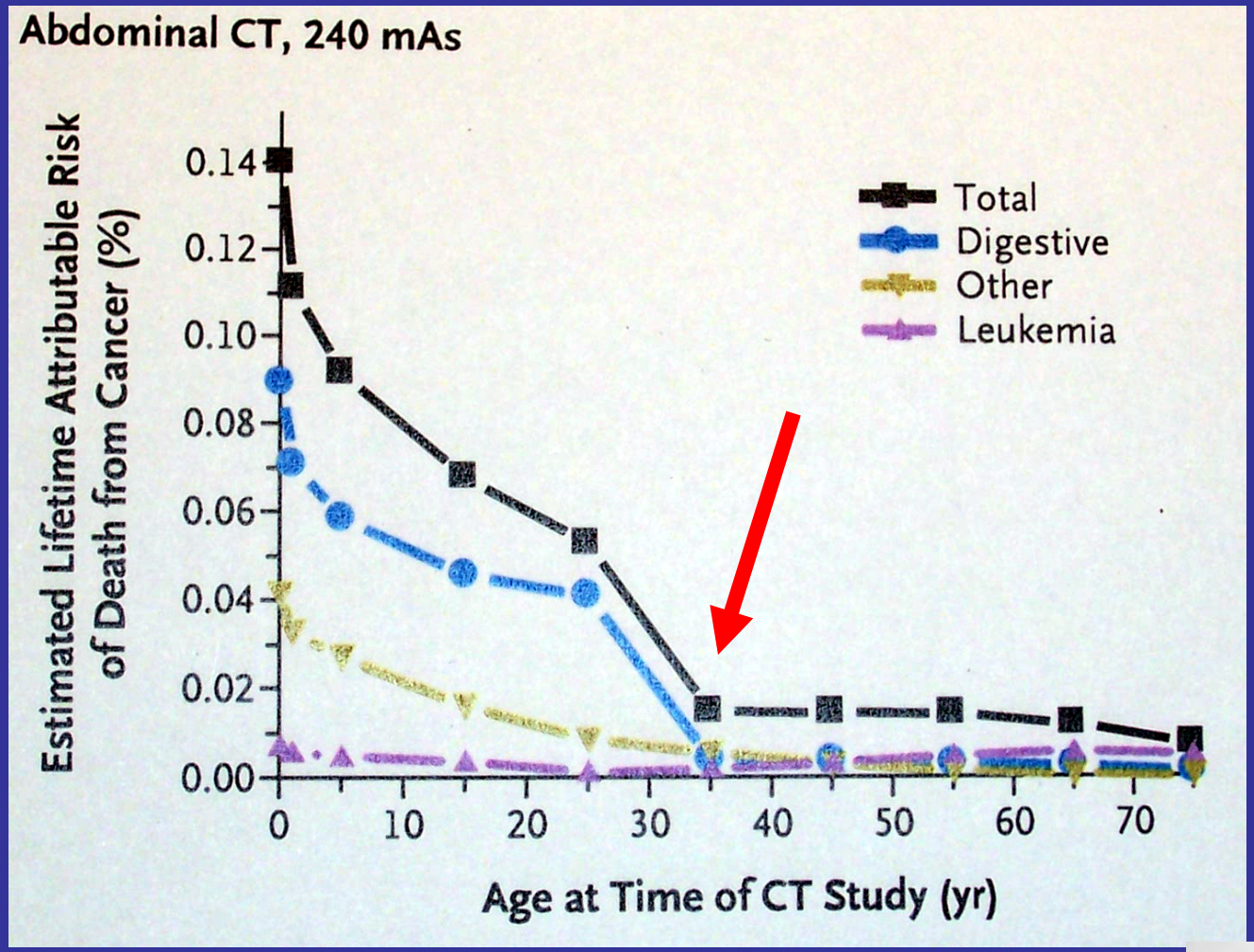
Name	DOB	SSN
Tenforde, Tom	July 14, 2004	144-36-8729

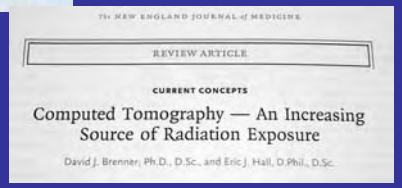
Age 17 6 CT scans done in last 3 months

Continue to order ??

OK Cancel

There is a clear break in the risk




The NEW ENGLAND JOURNAL of MEDICINE

REVIEW ARTICLE

CURRENT CONCEPTS

Computed Tomography — An Increasing Source of Radiation Exposure

David J. Brenner, Ph.D., D.Sc., and Eric J. Hall, D.Phil., D.Sc.

Age discrimination
Breast shields-who gets them?

“If I am 60 and wear a helmet to ski, why don’t I get breast shields for my CT ?”

Hospital specific protocols for ordering and performance

Patient Care / Clinician Toolbox - New Mexico VA Health Care System (U.S. Department of Veteran - Windows Internet Explorer

http://vaww.albuquerque.med.va.gov/Templates/Inner.aspx?pid=109

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U.S. Department of Veteran Affairs – VISN 18

New Mexico VA Health Care System

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- Patient Care / Clinician Toolbox
  - ABCs of Emergency Medicine for Nuclear, Chemical & Biological Agents
  - ACP Pier Plus from STAT! Ref
  - Antibiotic Subcommittee
  - BCMA Coversheet
  - Bi-Directional Health Information Exchange (BHIE)
  - Bylaws
  - CHF – Weight Monitoring
  - Clinical Practice Guidelines
  - Computer Based Training (Clinical)

Patient Care / Clinician Toolbox

Contacts	Antibiotic Subcommittee	Hospitalist On-Call	On Call / POCs	Patient Advocates
Databases	ACP Pier Plus from STAT!Ref	My HealtheVet	Virtual Library	
Guidelines/ Standards	ACR Appropriateness Criteria -Imaging Exams		Bylaws	Clinical Practice Guidelines
	Credentialing & Privileging	Credentialing -Health Care Professionals		Heparin Protocols
	Infection Control	Patient & Nursing Home Resident Rights & Responsibilities		Resident Supervision
Protocols	CT /MRI / NUC MED Ordering	"Ticket to Ride" Transport Procedures		
References	ABCs-Emer. Med for Nuclear, Chemical & Biological Agents		Formularies	Hand Hygiene
	NMVAHCS Staff Privileges	Quality Enhancement Research Initiative (QUERI)		Resident Credentialing (UNM)
	Vaccine Information Statements (CDC)			
Training	BCMA Coversheet	Bidirectional Health Information Exchange (BHIE)		Computer Based Training (Clinical)
	CPRS	CPRS v27 Patient Safety Alerts	Customer Service Toolkit (NMVAHCS)	Customer Service Toolkit (VISN 18)
	Dictation Instructions & Pocket Card	Rapid Response Team	Patient Safety	Scheduling Training (VHA)
	Veterans Health Initiative (VHI)	Vitals Life Training		

MORE LINKS

New Link: **Office of Public Health & Environmental Hazards** - info on chemical, radiation, physical & environmental hazards during military service, possible health problems & related VA programs.

Local intranet 100%

start 2:59 PM

U.S. Department of Veteran Affairs – VISN 18
New Mexico VA Health Care System

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CT/MRI/NUC MED Ordering Protocols

The spreadsheets below show various clinical indications with the accompanying Vista ordering information and necessary patient preparation for ordering CT, MRI and NM studies.

Additional information also includes:

-contraindications for various examinations,
-indications for after-hours urgent and emergent examinations
-patient preparation for contrast allergies is also presented below.

It is also imperative that the ordering clinician assess appropriate laboratory values, allergy history, contraindications and order the necessary prior examination.

After consulting with these spreadsheets, if there remains confusion about which study to order, Radiologists will be available.

Nuclear Medicine Indications & Ordering

MRI Indications & Ordering

CT Indications & Ordering

Reviewed / Updated Date: July 7, 2009

Content Owner: (Michael F. Hartshorne,

Appropriateness criteria are not enough

- Physicians order an “abdominal/pelvic CT”

- There is no such thing anymore
  - Liver 3-phase
  - Pancreas
  - Appendicitis
  - Kidney
  - Aortic aneurysm
  - Aortic stent evaluation in pt with renal failure

Different protocols that are symptom/indication driven

p

Body part and indication	What to order in the computer	Pre-scan requirements and preparation	CT protocol
ABDOMEN AND PELVIS			
Indication - Routine, Abdomen Pain	CT Abdomen w/cont	eGFR 60 or greater OK, 30-60 hydrate, < 30 signif contraindicati	1
also **Default protocol**	CT Pelvis w/cont	NPO 4 hours	
		2 hours Oral Contrast Gastrograffin 30mL in 800 H20, 200mL g30m	
		Peripheral IV	
		Patient alert and oriented or Consent for contrast	
Indication - Acute Abdomen, r/o Appy,	CT Abdomen w/cont	eGFR 60 or greater OK, 30-60 hydrate, < 30 signif contraindicati	2
Abscess, Diverticulitis	CT Pelvis w/cont	NPO 4 hours	
		2 hours Oral Contrast Gastrograffin 30mL in 800 H20, 200mL g30m	
		Peripheral IV	
		Patient alert and oriented or Consent for contrast	
Indication - AAA, Post Graft Placement	CTA Aorta-Iliofemoral Runoff	eGFR 60 or greater OK, 30-60 hydrate, < 30 signif contraindicati	3
	w/o, w contrast	NPO 4 hours	
		18G ANTECUBITAL IV	
		Patient alert and oriented or Consent for contrast	

t

- Diagnostic reference levels (DRL’s)
- Provider Education/Awareness all levels
- Patient education
- Informed consent > Participating in decision
- Certification/Recertification
- Culture changes in institution

Will recording doses in the computer of having a dose card help ?

“There is a patient in the waiting room with an international *‘dose card’*.

“Call radiology and ask what we do with it”

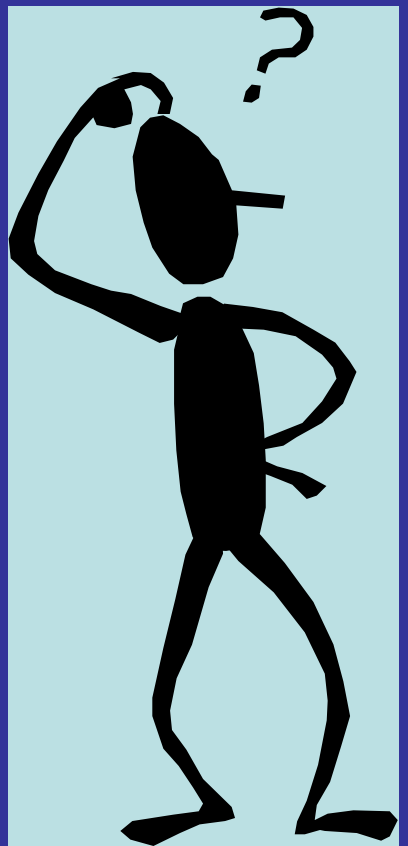
It says 13.2 mSv. Can we order a CT scan ????

? Radioprotectants

- Being seriously looked at for terrorist events
- Would solve a lot of issues if could be given prior to a CT etc.
- Being “promoted” now for Radiology Depts.
- Investigational !Not ready for prime time

Can the government help us ?

Should we ask for a call to action from the policy makers ?

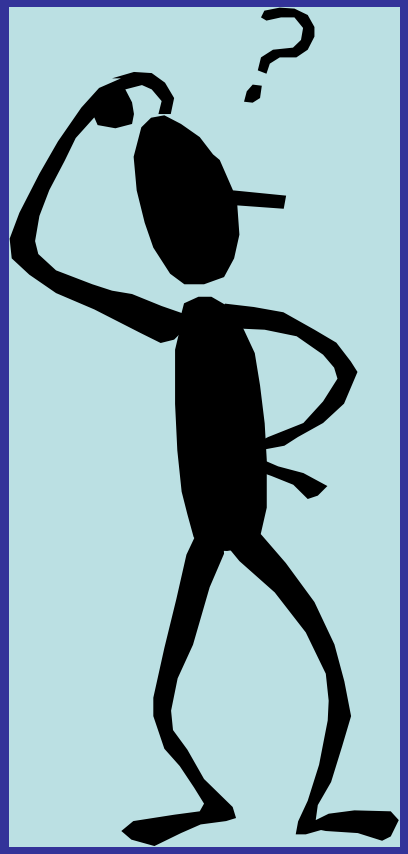


Be careful what you wish for

Cutting reimbursement in half will certainly affect these issues

“The ____ panel has decided that Granny (who is in the ER) does NOT get a CT”

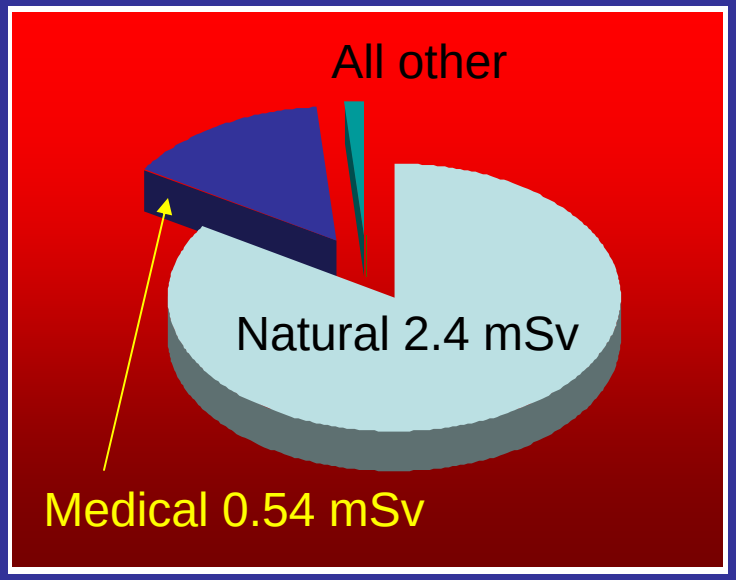
Why are we here ???



What exactly is the basic underlying problem from a radiation protection point of view ?

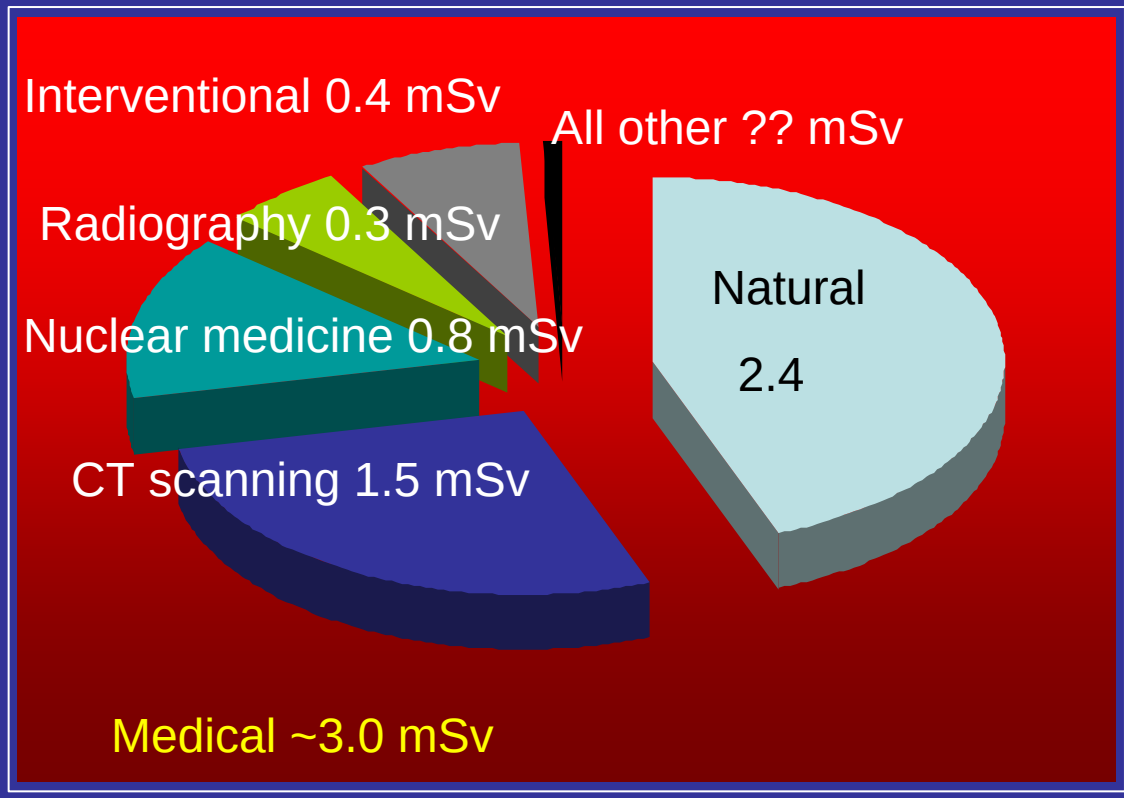
Is this bad ?

U.S. 1980



Total 3.0 mSv per capita

U.S. 2006



Total ~ 5.4

- The problem is that few had any idea that radiation dose was increasing 700%

- (possibly ~15,000 future annual fatal cancer deaths)

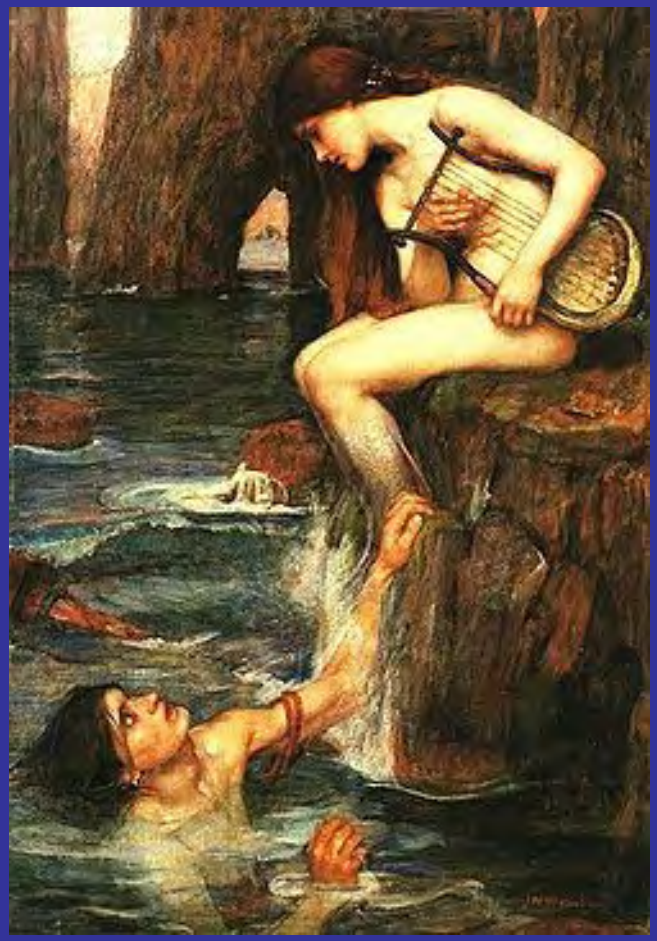
…and

we have little real evidence that this resulted in a significant difference in outcome

- CT technology has moved incredibly fast

- The uses are fantastic

- We were sort of lulled into ignoring the radiation dose increase

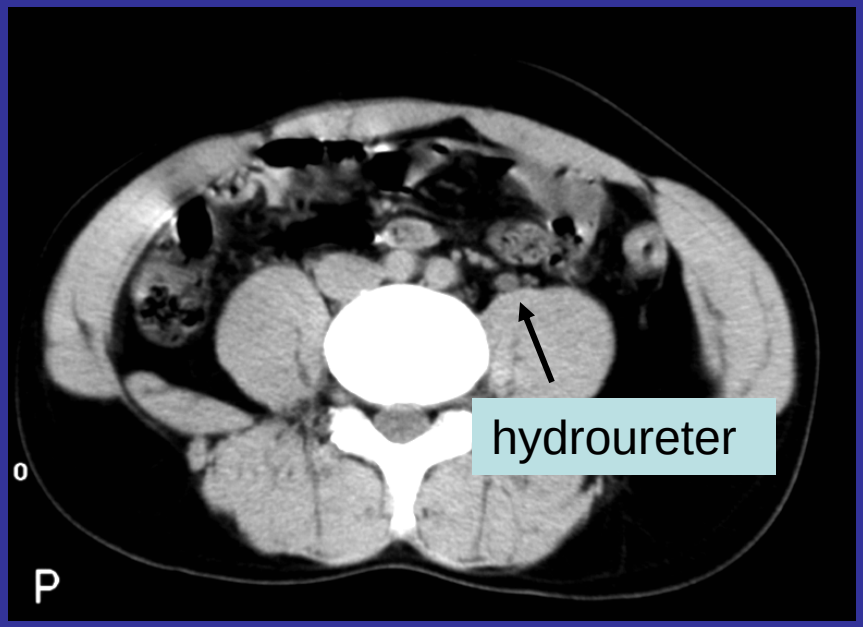


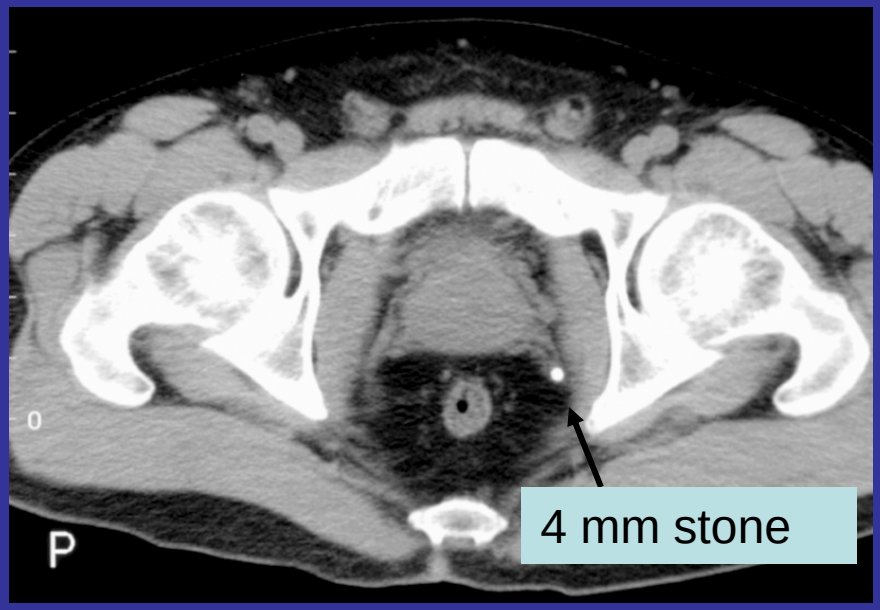
Where do we go ?

- Guidelines ?? EM and radiology

  d-dimer/PE (pulmonologists ??)

  renal stones (urologists ??)

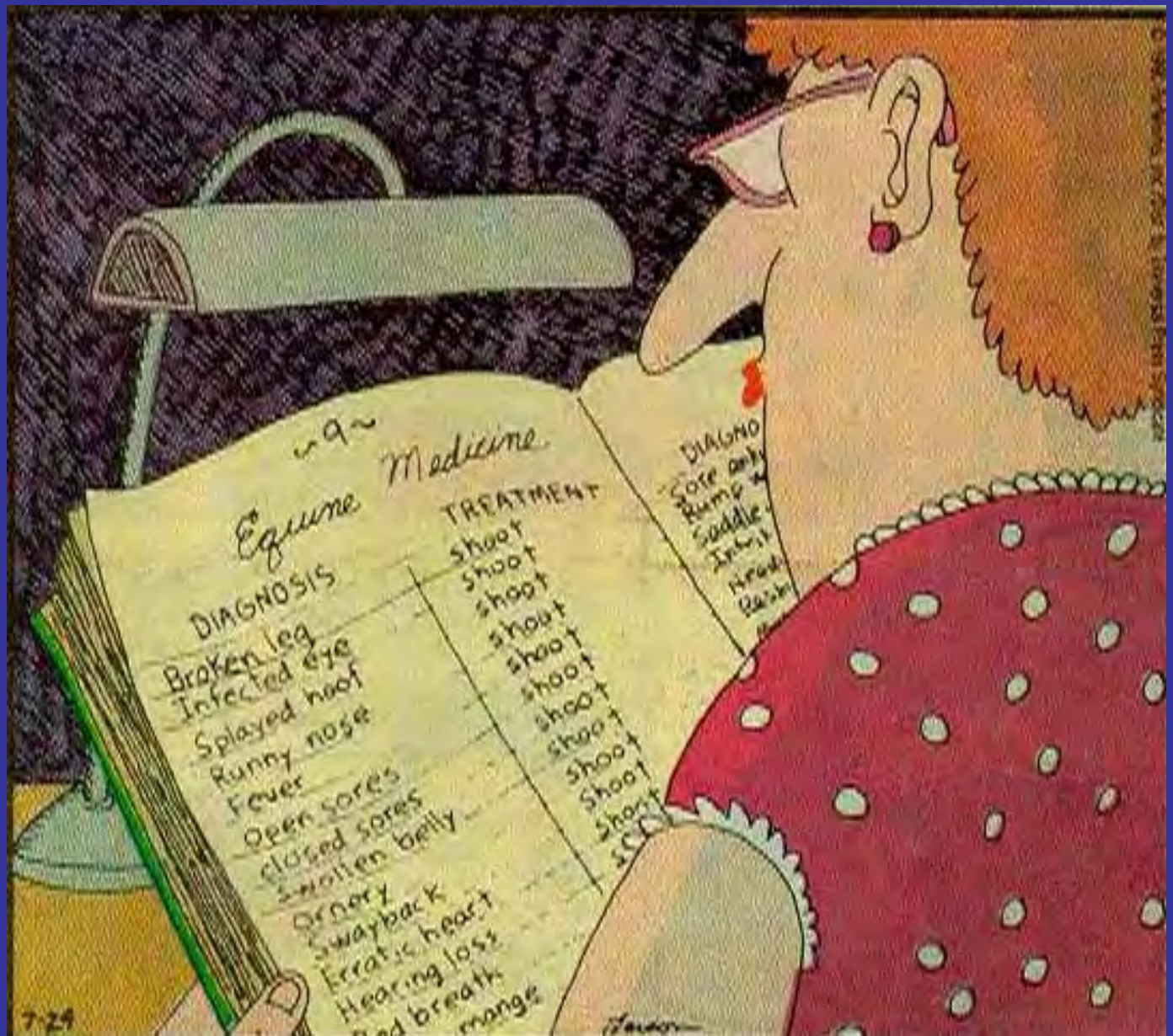




What do we really need to do ?

- "Justify" going forward
  need evidence based data on benefit
  awareness of risk
- "Optimize" ALARA. Push manufacturers
- Regular EM/Rad meetings to keep improving the process. Will be hospital variable
- Not really reduce CT scan frequency unless it comes from the justification process
- Find out if there is a measurable risk from CT

What would we do without CT ?




tube

How did we make clinical decisions?

If the basis wasn't evidence, what was it?

expert recommendations

Perceptions of Patients, Parents, and Pregnant Women

Deborah B. Diercks, MD, MSc
Professor of Emergency Medicine
University of California, Davis
Medical Center

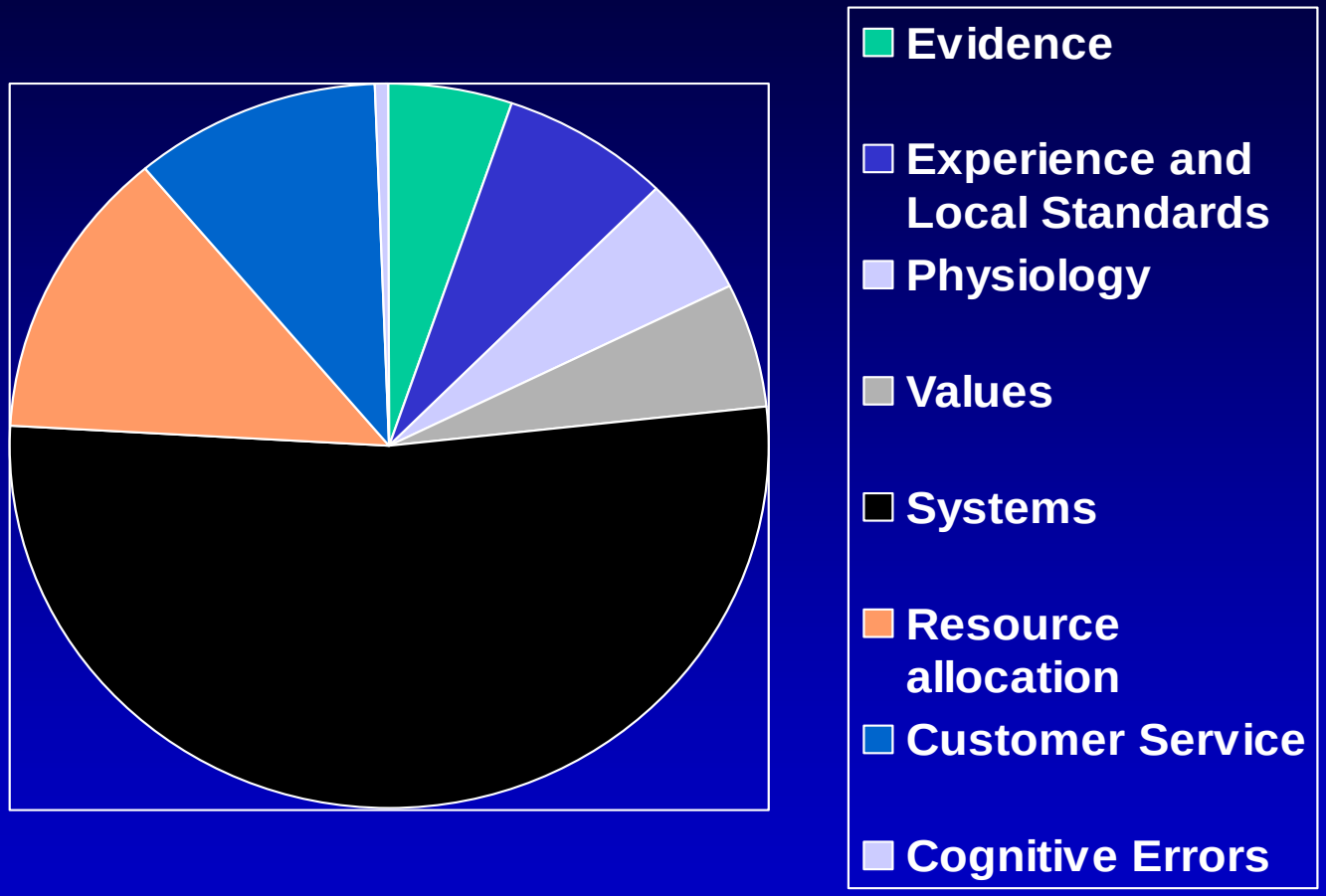
Clinical decision-making

- evidence is never enough
  - values and preferences
- In the clinical setting
  - Multiple factors involved

Factors in Medical Decision Making

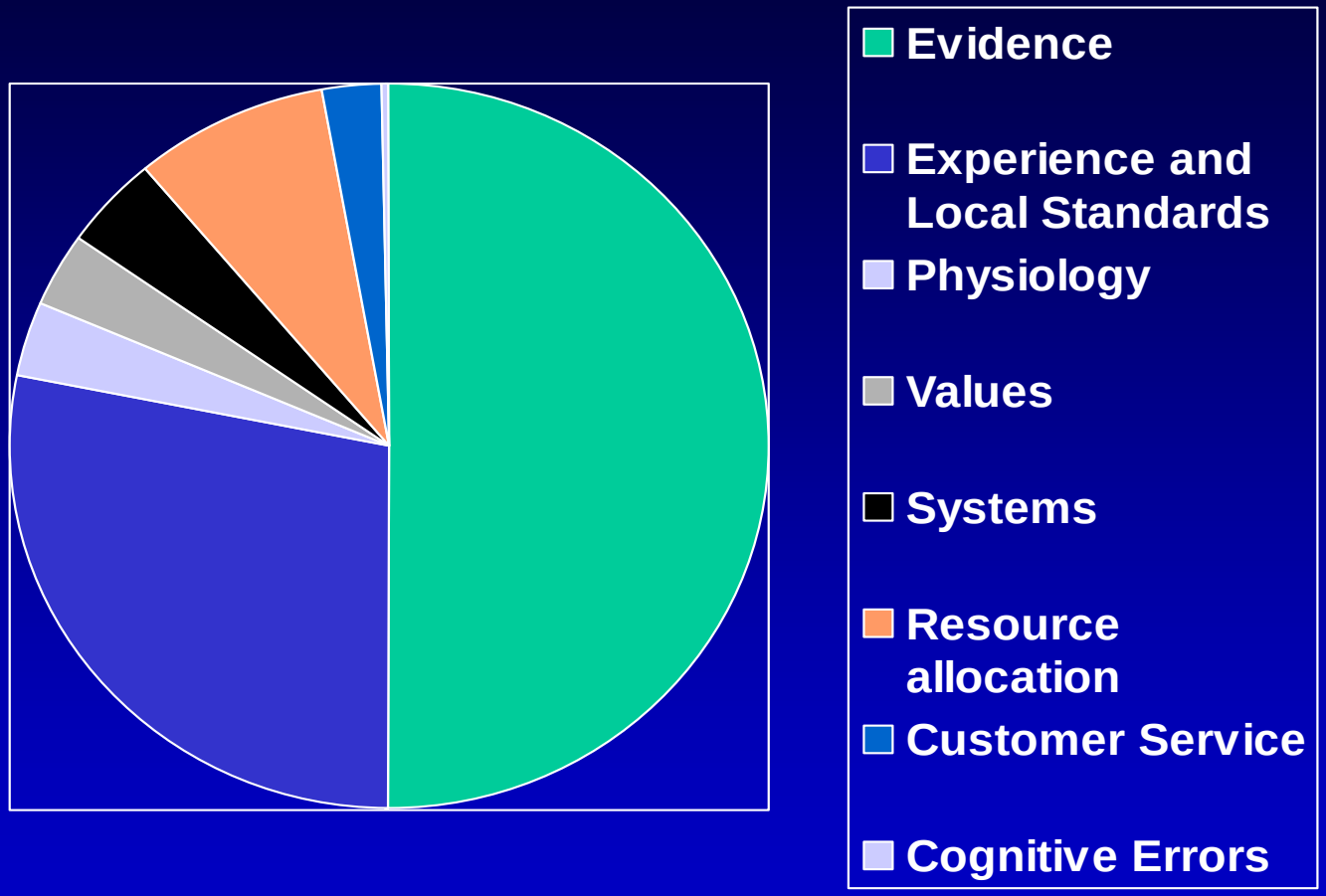
(1) Empirical evidence
(2) Experience and Local Standards
(3) Physiologic principles
(4) Patient and professional values
(5) System features
(6) Resource allocation
(7) ***Customer service***
(8) Cognitive Errors

Factors in Medical Decision Making



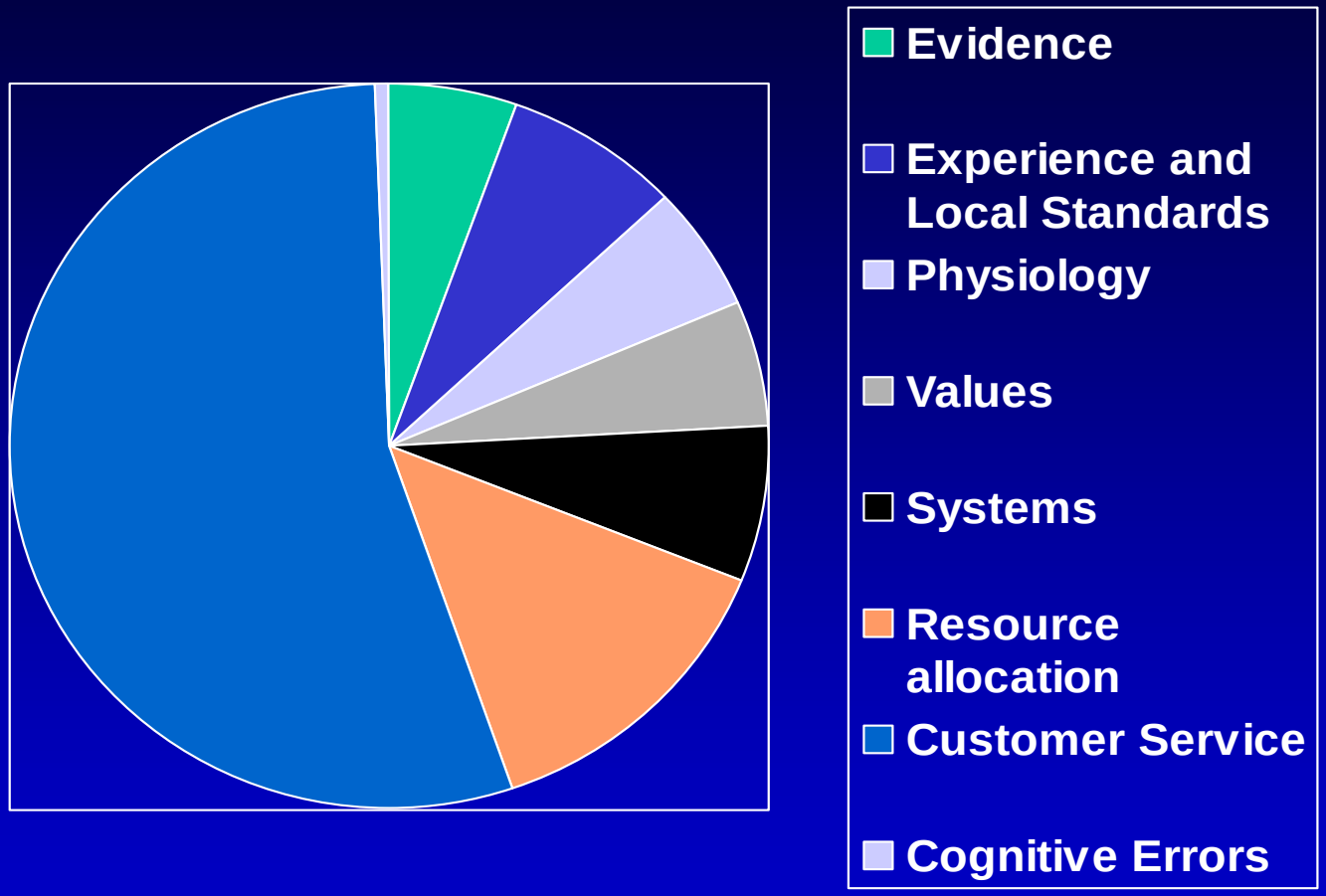
Systems Factor: the CT scanner is broken

Factors in Medical Decision Making



Evidence Factor: Thrombolysis for Acute MI

Factors in Medical Decision Making



Customer Service Factor: “My doctor sent me in for an X-ray.”

Model of evidence based clinical decisions

clinical circumstances

patient preference

research evidence

A patient/parent dilemma

- 3 year old
  - Fell out of shopping cart and hit his head
  - examination frontal contusion in a child acting normal
- which of you:
  - treat kids with head injury?
  - have kids who have had with head injury?
- Does this child need a head CT?

Parent View

- The want to know their child is ok!
- How can we convince them it is ok not to have a CT?
  - Just talk to them?
  - Share data with them?

We have to convince the parent that the risk is greater than the benefit from the CT

Patient Perspective

- Often come with a test in mind
  - Internet
  - Friend
  - Doctor
- Come to different setting with different expectations
  - Pain relief
  - Diagnosis
  - Magic medicine
- May not be concerned about future as they are focused on current issue.

After address acute pain and symptoms may be more willing to listen to risk of certain tests.

Pregnant Patient

- We are concerned about the patient
- She is concerned about the baby
- Different approach
  - May need to convince them to have a test
    - Explain risk of harm for no test
    - Risk of test

Conclusions

- Medical decisions are not only based on evidence
- We have to realize part of clinical practice is addressing patient expectations
- To allow a change we have to be armed with the tools to
  - Change local standards
  - Expand our understanding of the evidence
  - Learn how to communicate risk/benefit evidence to our pateitns

CT in Emergency Medicine: Ensuring Appropriate Use

September 23-24, 2009

Bethesda, MD

Rapporteur Summary

Imaging, especially CT, has revolutionized the practice of medicine

CT is consistently rated in the top 5 medical innovations over the past 35 years

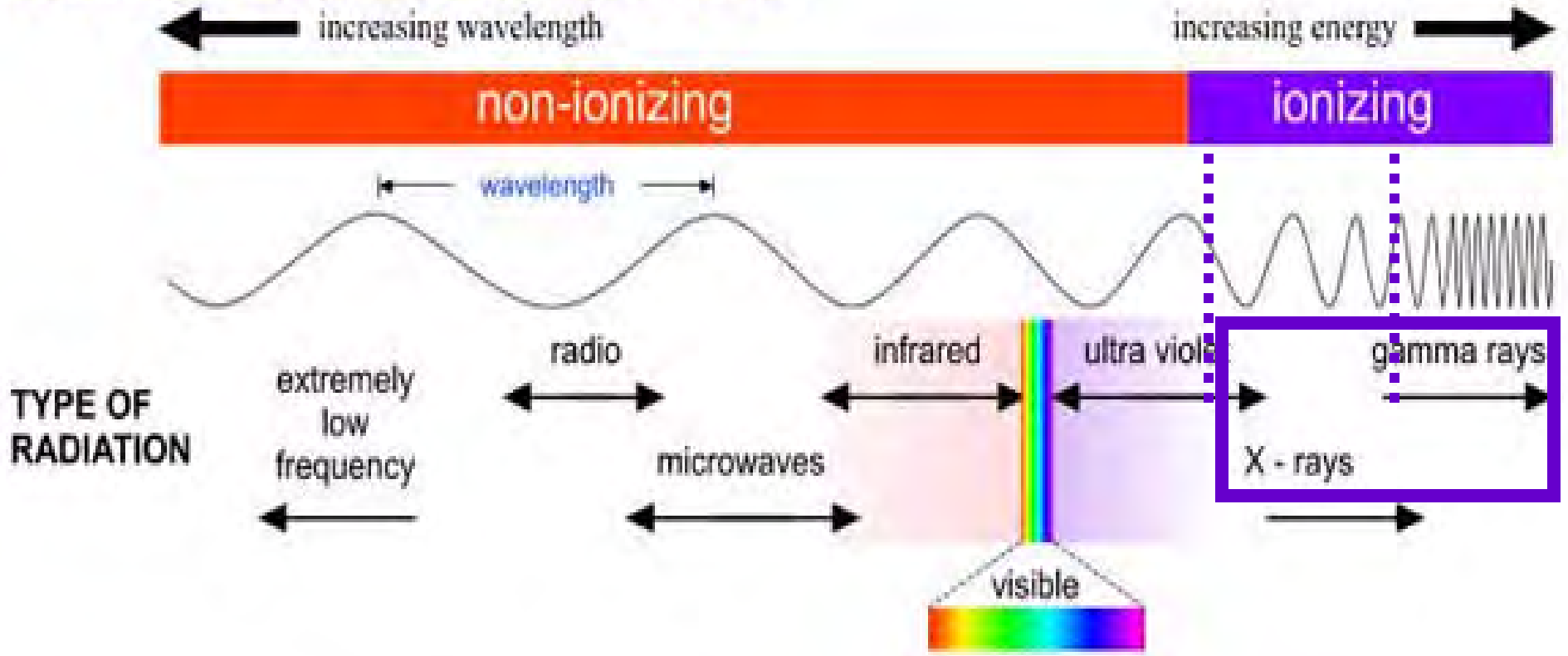
MAHESH

CT Can Provide Quick and Accurate Diagnoses in ED Setting

- Trauma
  - Head or body
- Chest pain
  - Aortic dissection, PE, MI
- Abdominal pain
  - Bowel obstruction, bowel necrosis, ureteral stone, appendicitis, pancreatitis, diverticulitis, pyelonephritis, etc.

That said, X-rays (CT) and gamma rays (nuclear medicine) are ionizing electromagnetic radiation—both are designated as ***carcinogens***

THE ELECTROMAGNETIC SPECTRUM



SOURCES

FDA Oversight of CT (Be careful what you wish for…Mettler)

- ***No ceiling on patient dose***
- However, since Feb. 2009 the following are required:
  - Automatic Exposure Control (AEC)
    - Dose adjusted for patient size
  - Standardization, display and recording of dose indices

- ***However,*** states (via Radiation Control Program Directors) can require CT dose estimates from facilities, and can exercise control over the practice of medicine.

STERN

But, x-rays and gamma rays are ***weak*** carcinogens (low LET or **L**inear **E**nergy **T**ransfer)….

Even so, it is possible to link effective dose with increased cancer risk

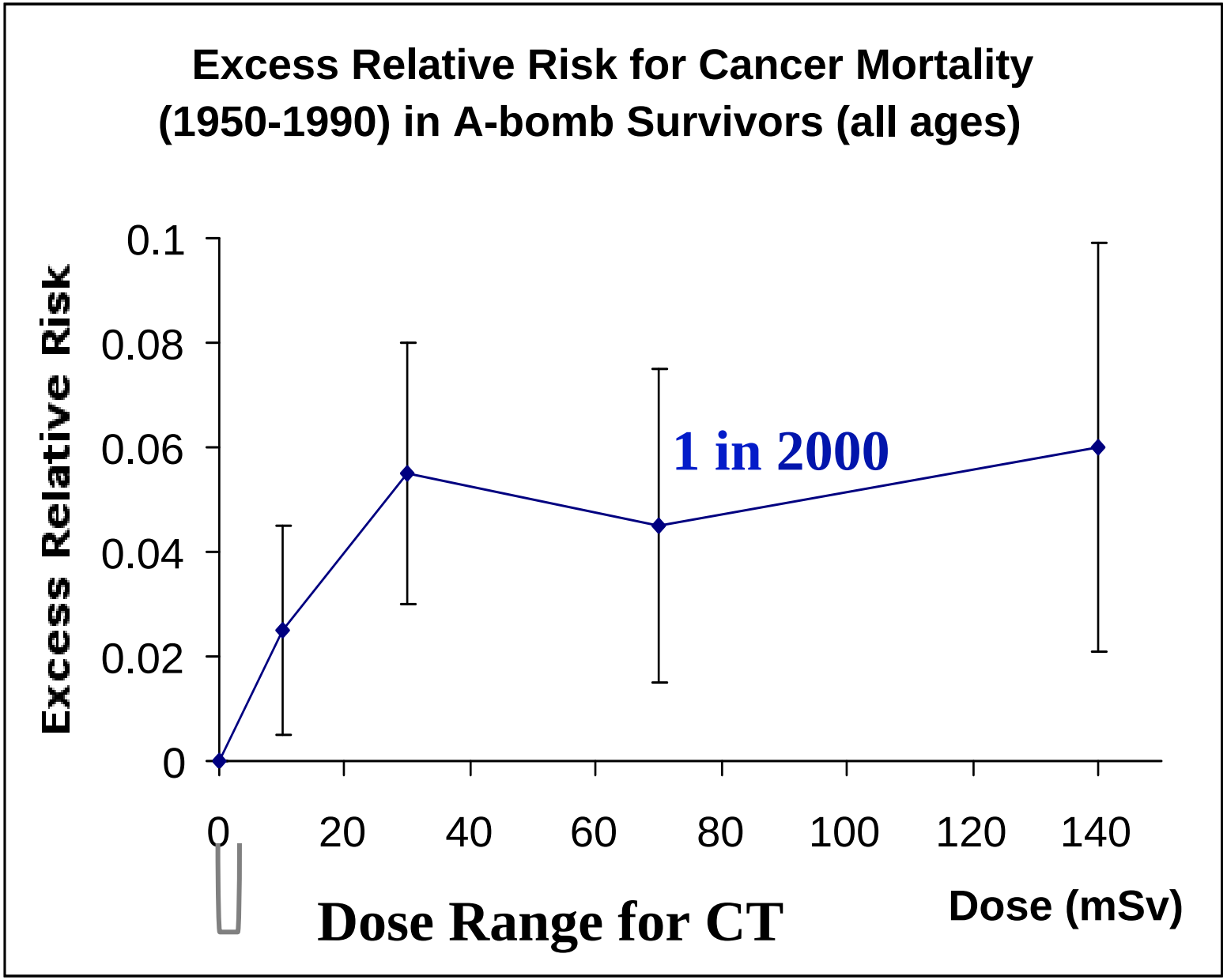
Number of solid cancers in A-bomb survivors exposed to doses from 5-100 mSv

Small but statistically significant increase in risk

	Cancer incidence (1958-98)
Study population (5-100 mSv)	27,789
Total solid cancers observed	4,406
Solid cancers expected (controls)	4,325
Radiation-related excess solid cancers	81

BRENNER

Preston *et al* 2007



Adapted from Pierce, D.A. and Preston, D.L.

Brink

Significant increase in use of CT and cardiac nuclear medicine studies is creating a risk to the U.S. population

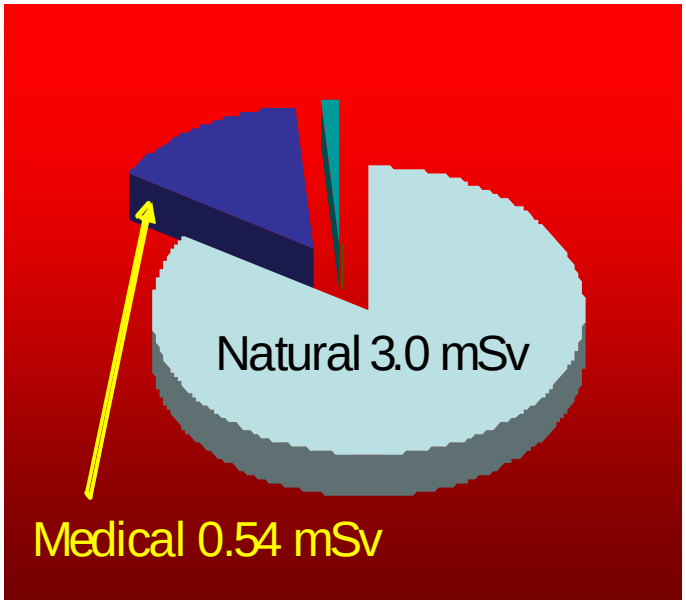
Imaging Growth

	1980	2008
CT	3,000,000	70,000,000*
Nuclear Medicine	7,000,000	20,000,000

*6-10% are in the pediatric age group

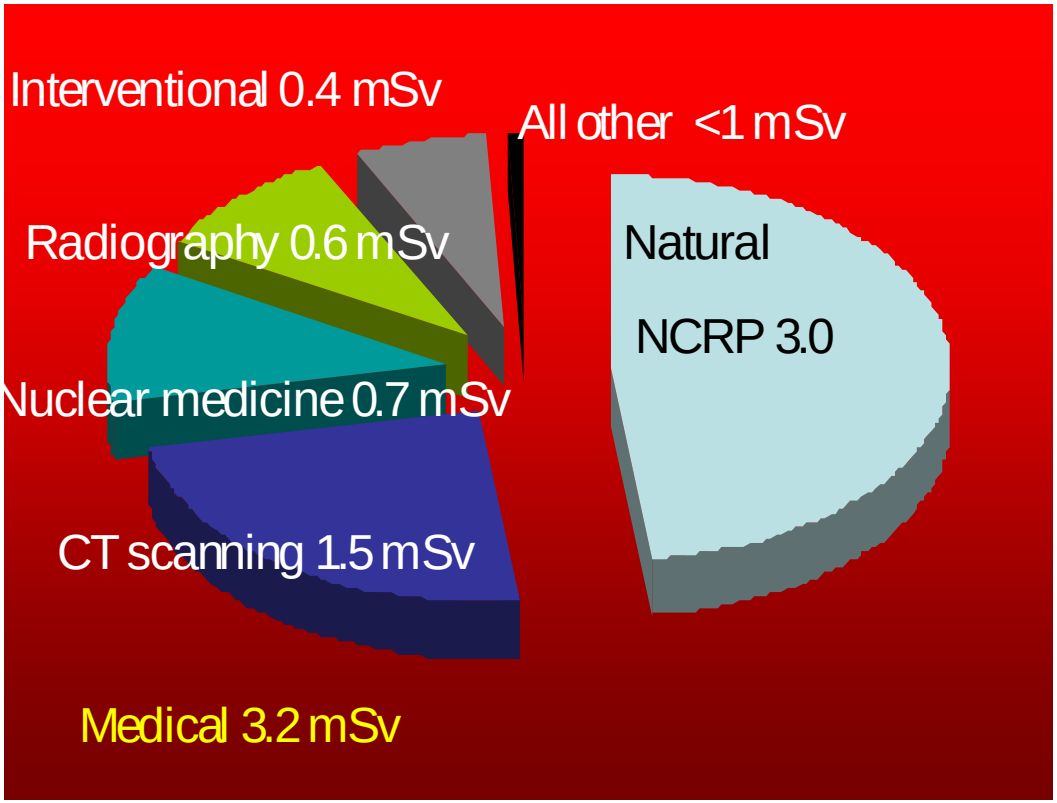
BACKGROUND RADIATION (NCRP Report #160)

U.S. 1980



Total 3.6 mSv per capita

U.S. 2006



Total ~ 6.2 mSv per capita

Medical: 600% increase

Brink

Comparison of Effective Radiation Doses

Event	Mean Effective Dose
1 year background	6.2 mSv
Chest x-ray	0.1 mSv
Mammogram	0.4 mSv
Head CT	2 mSv
Barium Enema	4 mSv
Chest/Abdomen CT	10 mSv

Imaging Procedures using Ionizing Radiation

Procedure	**% of procedures**	**% of collective radiation dose**
Radiography	74	11
CT	17	49
Nuclear Med (cardiac)	5	26

22%

75%

Thomadsen

Individual risks *vs* population risks

- **The individual risks from CT are small, so the benefit / risk ratio for any indicated study will typically be large**

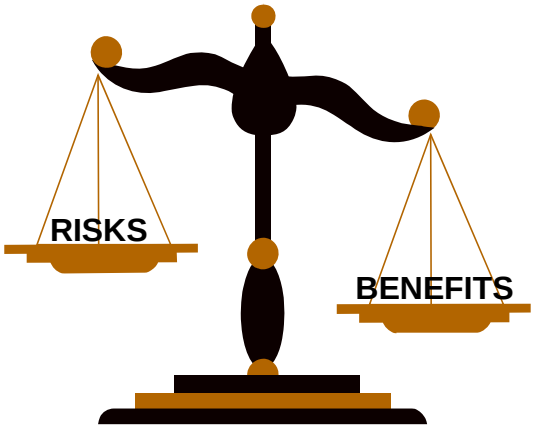
- **But the exposed population is large (5 million children, ~65 million adults / yr in the US)**

- **Even a very small individual radiation risk, when multiplied by a large (and increasing) number of individuals, has the potential to produce a significant long-term public health concern**

BRENNER

The Challenge (WHO)

Although individual risks associated with diagnostic exposures are rather low, the wide use of radiation in medicine calls for a **public health** approach to control and minimize health **risks**, while maximizing the **benefits**



PEREZ

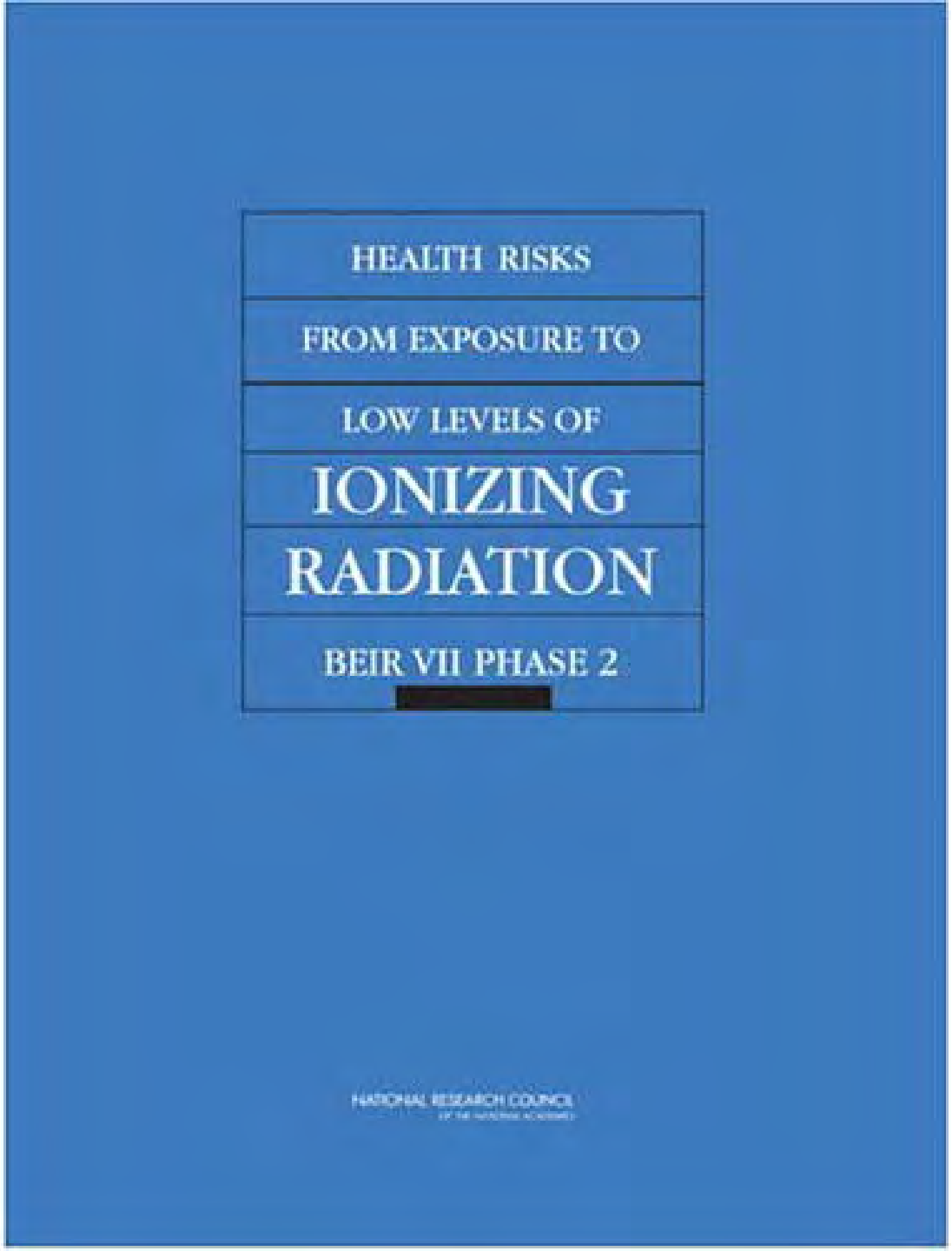
So a significant population is being exposed to comparatively high doses from CT

Of the ~25 million people who have CT scans this year in the US, ~250,000 of them will have more than 40 CT scans in their lifetime, with a corresponding total effective dose of >0.4 Sv

BRENNER

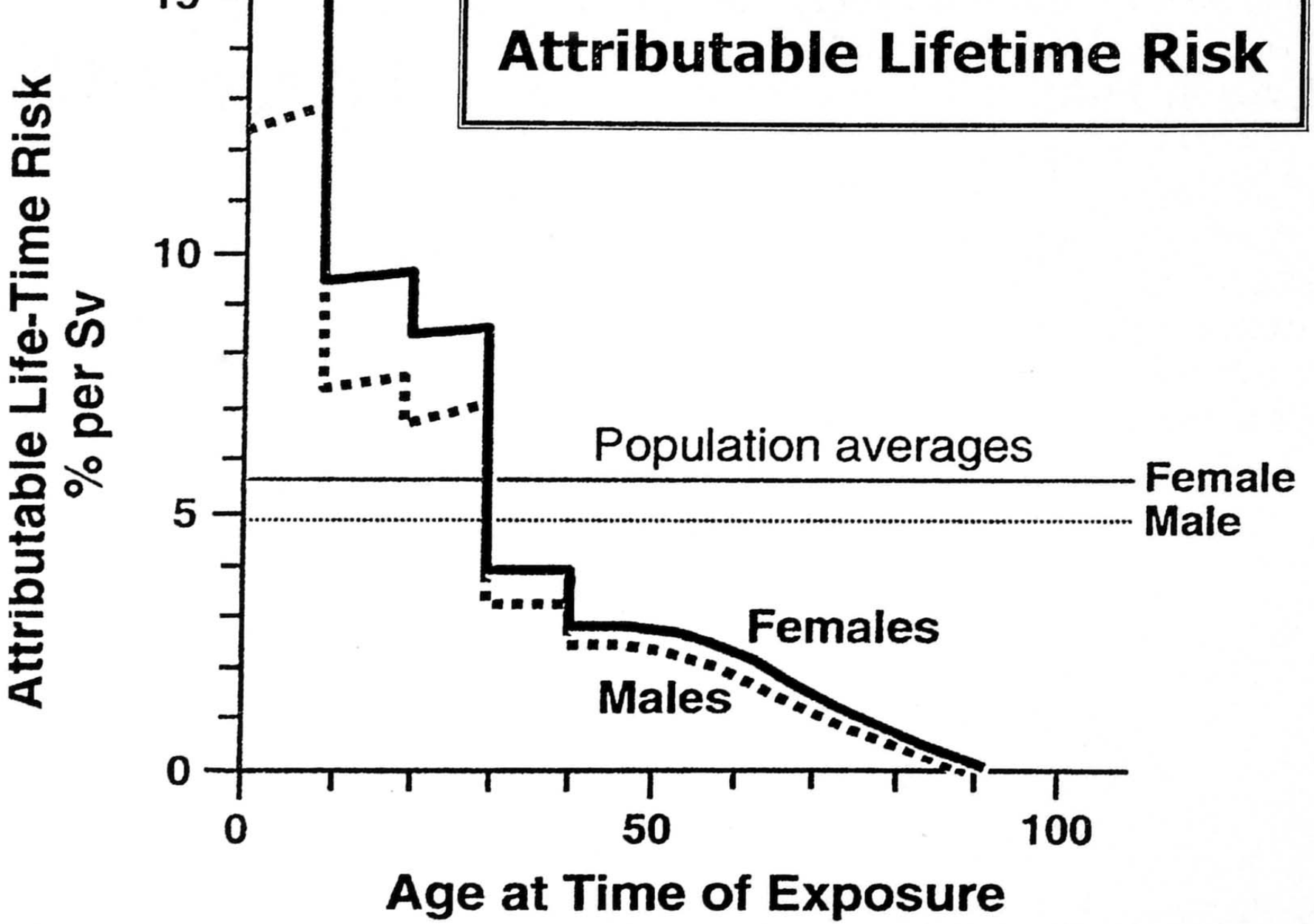
(Sodickson *et al* 2009)

Children and young women have the greatest cancer risk from radiation exposure during imaging (longer life expectancy, tissues more radiation-sensitive)



Bier VII allows quantification of cancer risk based on age and sex of patient

HUDA



Huda et al, Radiology 203: 1997

pg 421

Pediatric CT Scans in the USA

1989: ~½ million

2007: ~3½ to 7 million

(5 to 10% of total number of CTs)

(of these, ~ ¾ to 1.5 million are on children under 5)

BRENNER

Present company excluded, neither clinicians nor radiologists appreciate the radiation dose associated with CT

TABLE 3
Dose Estimates for One CT Scan versus One Chest Radiograph

Respondent Group	CT ≤ CR	CT > CR < 10 × CR	CT ≥ 10 × CR < 100 × CR	CT = 100–250 × CR*	CT ≥ 500 × CR
Patients (n = 67)	19 (28)	43 (64)	5 (7)	0 (0)	0 (0)
ED Physicians (n = 45)	3 (7)	20 (44)	10 (22)	10 (22)	2 (4)
Radiologists (n = 39)	2 (5)	22 (56)	6 (15)	5 (13)	4 (10)

Note.—Data are the number of respondents. Numbers in parentheses are percentages. χ^2 test result, 67.04; $P < .001$. CR = chest radiograph.

* Accurate range.

BRINK

Lee et al. Radiology April 2004

There is ***no*** histologic marker to differentiate radiation-induced malignancies from those that arise de novo

The NEW ENGLAND JOURNAL of MEDICINE

REVIEW ARTICLE

CURRENT CONCEPTS

◄ Previous Volume 357:2277-2284 November 29, 2007 Number 22 Next ►

Computed Tomography — An Increasing Source of Radiation Exposure

David J. Brenner, Ph.D., D.Sc., and Eric J. Hall, D.Phil., D.Sc.

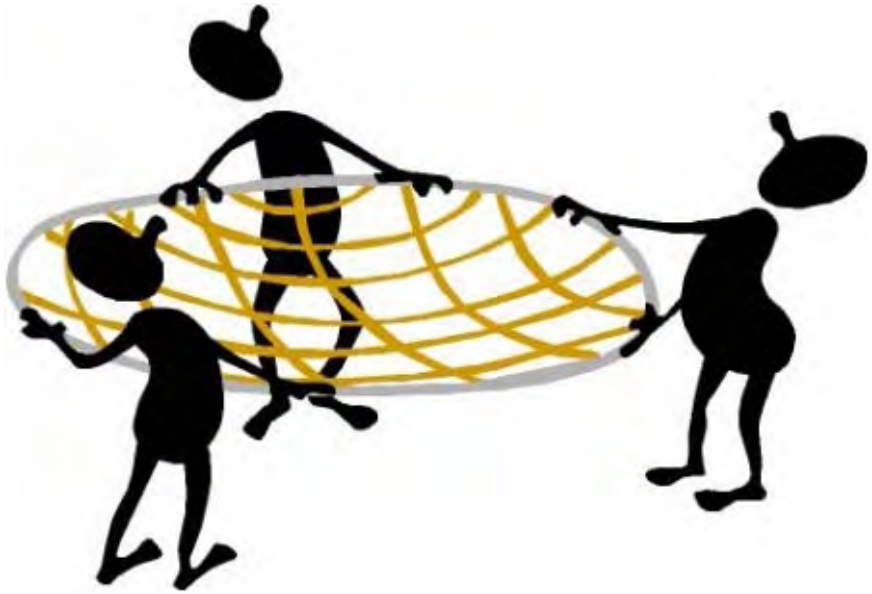
The advent of computed tomography (CT) has revolutionized diagnostic radiology. Since the inception of CT in the 1970s, its use has increased rapidly. It is estimated that more than 62 million CT scans per year are currently obtained in the United States, including at least 4 million for children.[1]

By its nature, CT involves larger radiation doses than the more common, conventional x-ray imaging procedures (Table 1). We briefly review the nature of CT scanning and its main clinical applications, both in symptomatic patients and, in a more recent development, in the screening of asymptomatic patients. We focus on the increasing number of CT scans being obtained, the associated radiation doses, and the consequent cancer risks in adults and particularly in children. Although the risks for any one person are not large, the increasing exposure to radiation in the population may be a public health issue in the future.

1.5-2.0% of new cancers each year in the U.S. may be due to CT
Of 1.4M cases/year in the U.S., perhaps 28,000 due to CT!

This seminar highlighted two points of view, both valid…

Between 8AM and 4PM today, nearly 100,000 patients will have been treated by emergency physicians throughout the USA



Paul R. Sierzenski, MD, RDMS, FACEP. Sept 2009

“EMTALA”- ED Issue # 1

The impact of EMTALA is real and applies to all Medicare accepting hospitals with EDs

Ensure an “appropriate medical screening”

“an appropriate medical screening exam” is still ill defined by EMTALA

Radiologists are ***rarely*** sued for failure to perform additional testing, but no data presented re ED physicians….

BAKER

Given all this, why do we have a disconnect? Perhaps radiologists have been a bit too critical of our colleagues on the front line in the ED?

Use of CT in ED: driving forces

New/sophisticated technology & vendor marketing

Self-referral and other financial incentives

Defensive medicine

High valuation placed on imaging (instead of "*touching/ asking the patient*")

Consumer model (patient's and/or family's expectations)

Lack of awareness about CT radiation doses & associated risks

Insufficient clinical knowledge/expertise in ED referrers

Appropriateness criteria/referral guidelines not available/ignored

Absence of radiologists for consultation during nightshifts

Pressure from other specialists e.g. "*What does the CT shows?*"; "*Repeat the CT scan*"; "*Request a CT scan prior patient release from the ED*" … etc.

What has gone wrong

- Too much reliance on CT and testing displacing clinical acumen / judgement
- Fear of malpractice
- Little appreciation for risks associated with radiation exposure
- Little reliance on clinical verified diagnostic pathways
- Negative feedback for <u>not</u> getting “studies”
- Knee-jerk reaction to uncertainty
- Patient expectations

MIRVIS

ALARA

- "**A**s **L**ow **A**s **R**easonably **A**chievable"
  - ***Controversial*** (sparked a lot of debate)
  - With regard to performing exam, should we use "dose optimization" instead?
  - With regard to justifying performance of an exam, the operational term should be "risk/benefit" analysis for each individual patient

Have to look at ***both*** benefit and risk in our patients…should we consider A**H**ARA as opposed to A**L**ARA?

WAGNER

There is ***likely excess use of CT***, providing an opportunity for optimizing utilization…

"OVERUSE" ?

"Application of an imaging procedure where it is unlikely to improve patient outcome" (unnecessary, unjustified).

The increasing use of radiation in healthcare "per se" cannot be taken as evidence of "OVERUSE"

PEREZ

HOWEVER, Defensive medicine

"Physicians may respond to the perceived threat of litigation by ordering more referrals and more tests, some of which may be recommended by clinical guidelines and beneficial, but others might be wasteful and harmful"

Massachussets Statewide Survey on DM (3650 physicians; 2007-2008

- 83% reported that they practiced DM;
- Plain film X-rays: 22%;
- CT scans: 33% among emergency physicians & obstetrics/gynaecologist and 20% in other specialties;
- Laboratory tests: 18%;
- Hospital admissions: 13%

PEREZ

Causes of Unnecessary CT Radiation Exposure in ED Patients

1. Repeating CT scans which have already been performed
2. Performing CT when the results are unlikely to affect patient management
3. Investigating with CT too frequently
4. Performing the wrong imaging exam
5. Performing incorrect CT protocol from communication failure of true clinical presentation, resulting in repeat CT
6. Over-investigating

NOVELLINE

However, if the work-up is negative, that does **not** mean that the work-up was not needed!

SIERZENSKI

So, where do we go from here?

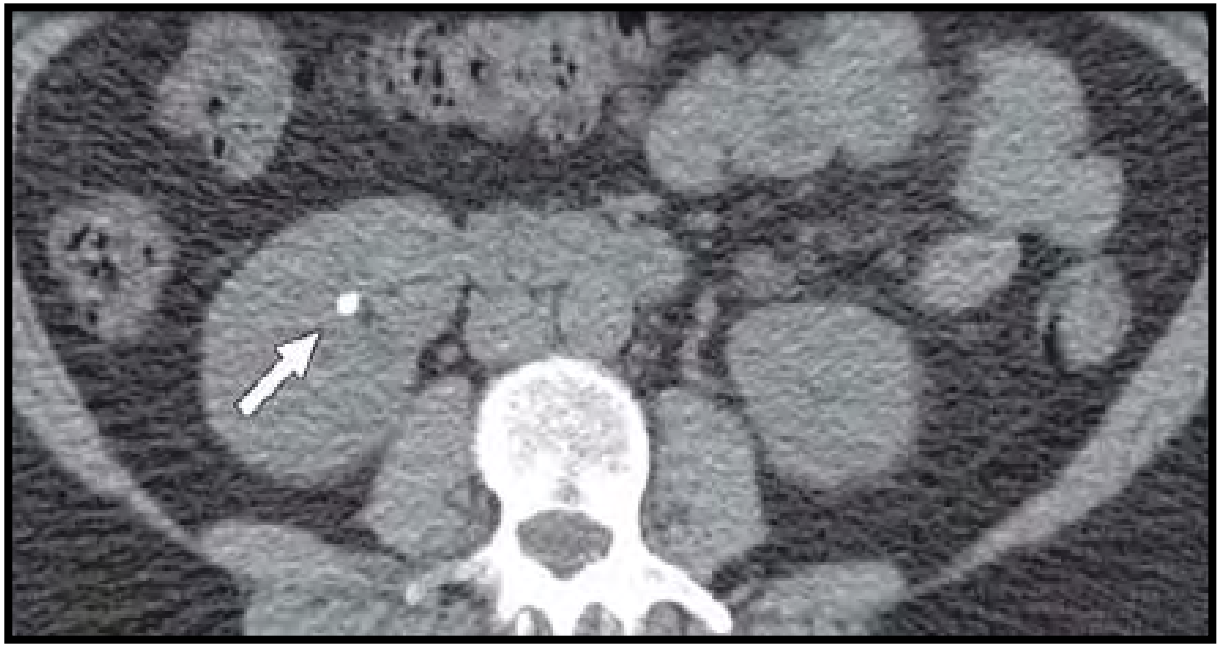
If both radiologists and ED physicians agree we have a problem, both need to step up to the plate…

I consider the radiologist’s responsibility with (radiation) dose to be the same as any physician’s with (medication) dose.

Over (or under) dosing is a medical error.

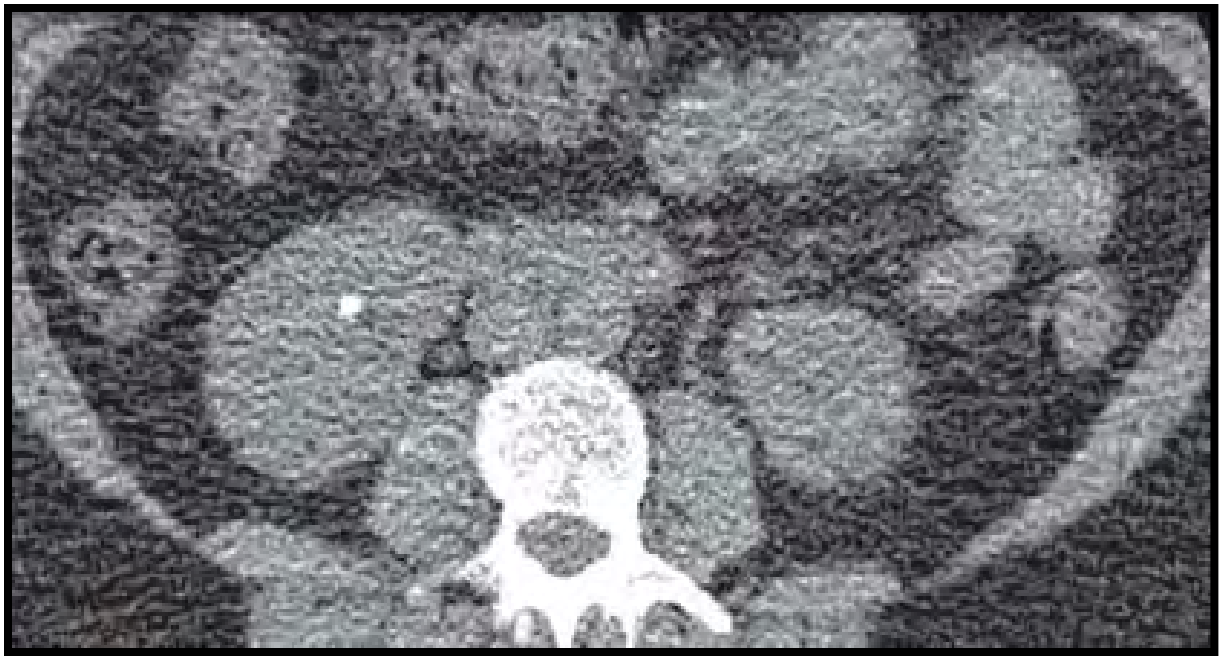
FRUSH

Original:
380 mA



Simulated:
70 mA

18% of dose!



AJR January 2008: 190

FRUSH

Guidelines for the CT Imaging of Emergency Department Patients:

Trauma Rules
ACR Appropriateness Criteria
European Referral Guidelines
Multiple recent publications

NOVELLINE

ACR
AMERICAN COLLEGE OF RADIOLOGY

ACR Appropriateness Criteria®
Clinical Condition: Left Lower Quadrant Pain

Radiologic Procedure	Rating	Comments	RRL
CT abdomen and pelvis with contrast	8	Oral and/or colonic contrast may be helpful for bowel luminal visualization.	High
CT abdomen and pelvis without contrast	6		High
X-ray contrast enema	5		Med
US abdomen transabdominal graded compression	4		None
US abdomen transrectal or transvaginal	4		None
X-ray abdomen and pelvis	4		Med
MRI abdomen and pelvis with or without contrast	4	See comments regarding contrast in text under "Anticipated Exceptions"	None

It’s clear that guidelines already exist for appropriate use of CT in ED setting

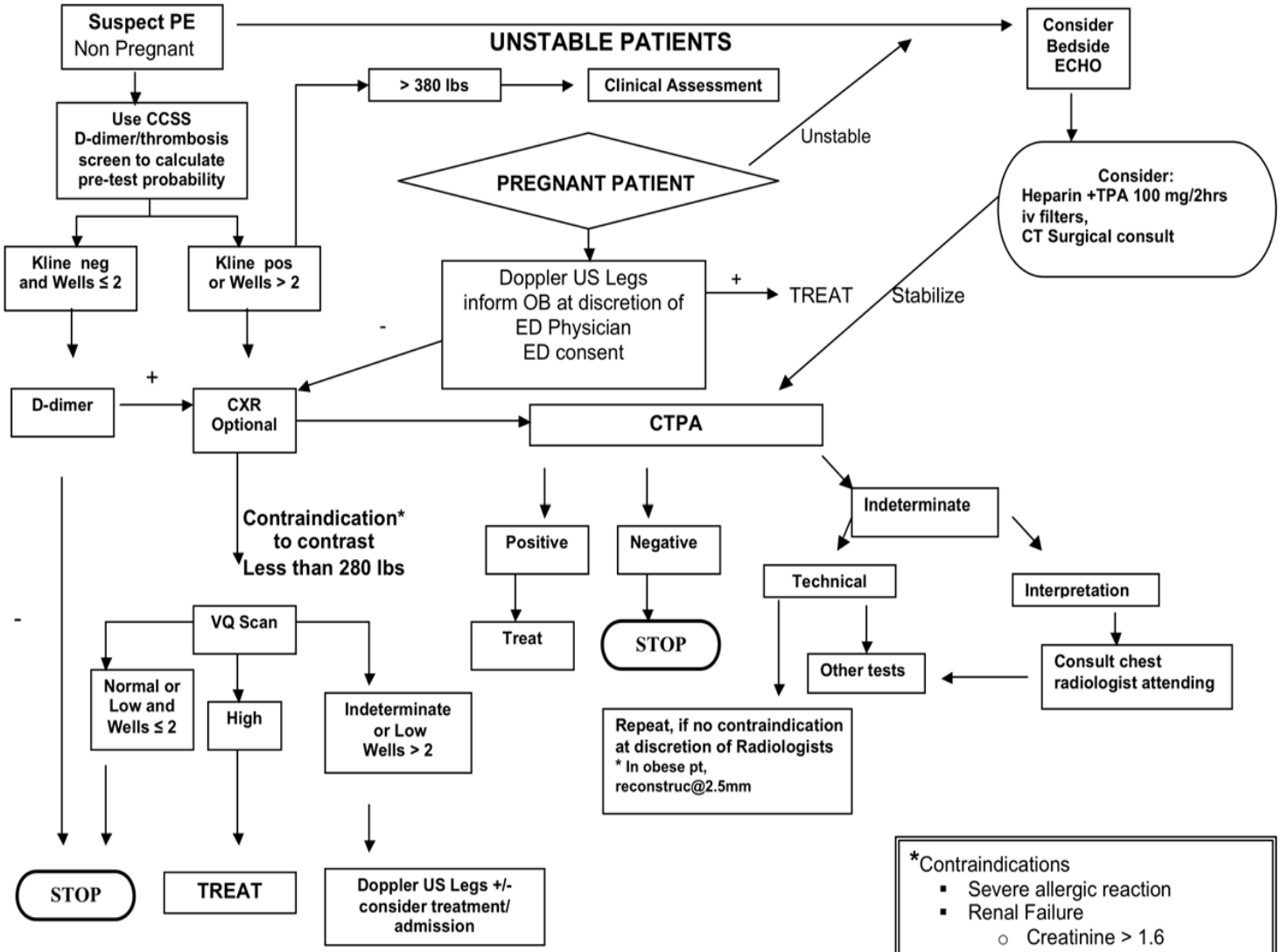
BUT, they are *<u>not consensus</u>* guidelines. We heard loud and clear that ED physicians want ownership in the process

What Will Effect Use

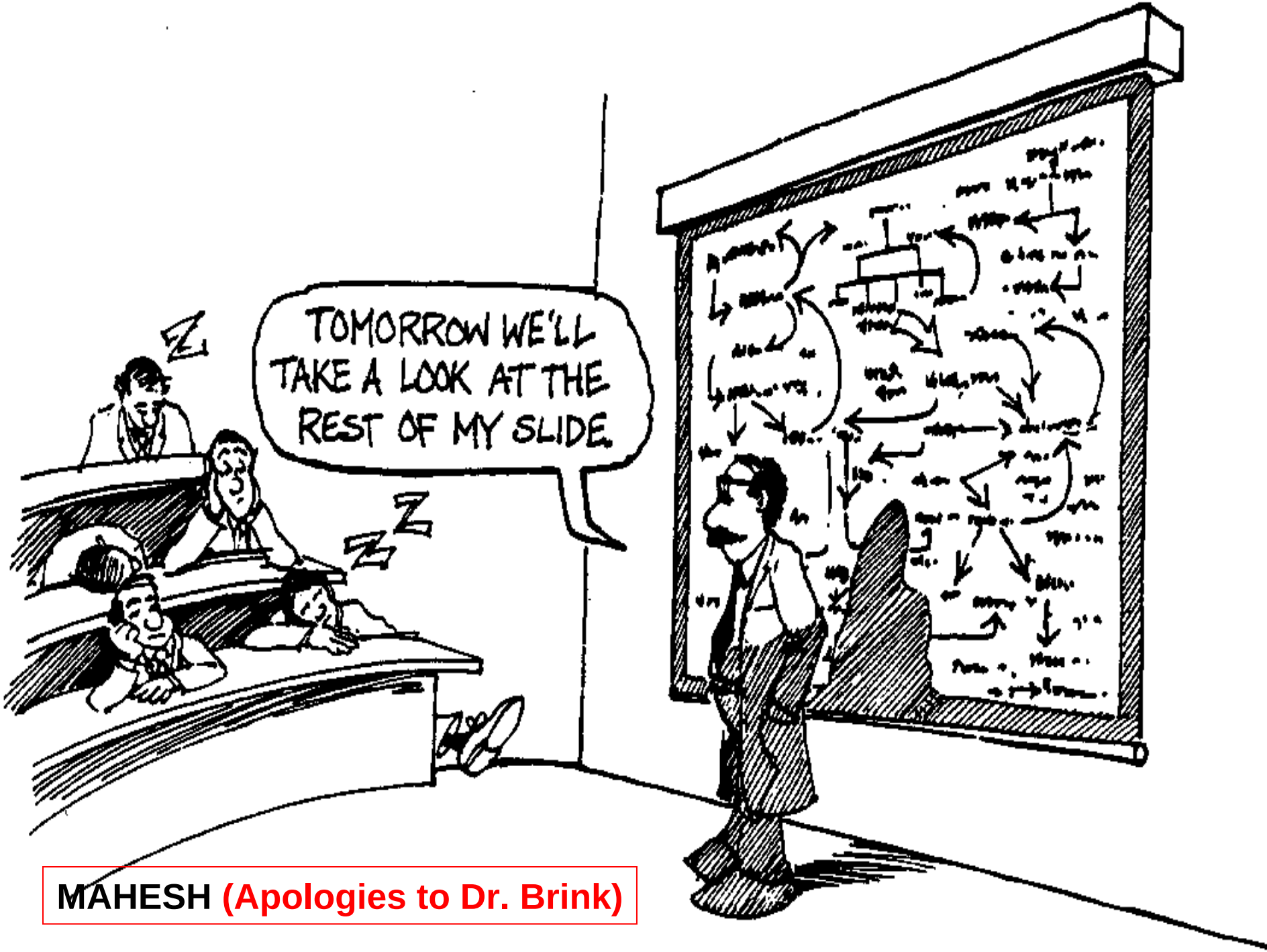
- Must have teeth
  - Suggestions don't help, not fast enough
  - Suggestions don't effect patient desires
  - Must make decision not to CT defensible
    - Before patient
    - Before lawyer
    - Before hospital

BLAIVAS

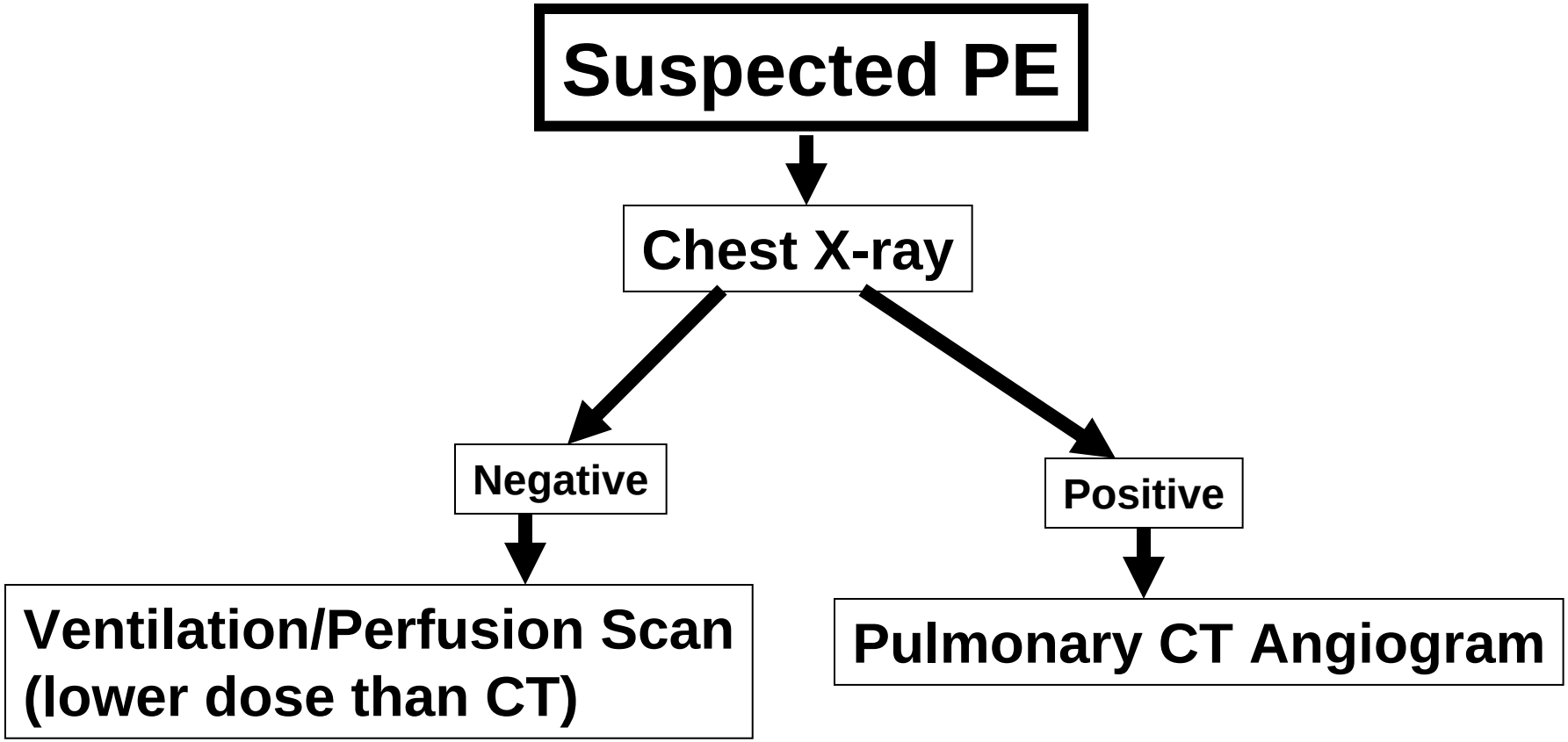
Diagnostic Algorithm for Suspected PE



BRINK



MAHESH (Apologies to Dr. Brink)


Suspected PE
Chest X-ray
Negative
Positive
Ventilation/Perfusion Scan (lower dose than CT)
Pulmonary CT Angiogram

AMIS

Elements of Successful Radiation Protection Program

- Education of both clinicians and radiologists
- Imaging algorithms that emphasize modalities that do not use ionizing radiation
- Protocols that minimize dose when CT necessary
- Identification of patients with elevated dose exposure
- Investigation of extreme dose exposures

BRINK

Education of Physicians

- “image gently”
  - Emphasis on pediatric patients
- ACR/RSNA Joint Task Force on Radiation Exposure in Adults (Brink/Amis)
  - First meeting Nov. 2009
- CMSS (Council of Medical Specialty Societies)
  - Educational session on radiation associated with imaging will occur at fall meeting in Nov. (Chicago)
- More and more articles in medical literature

The ideal world

- EM physician examines patient
- Confers with radiologist

Night coverage by nighthawk radiologists via teleradiology doesn't facilitate consultation…real problem!

- Consider the benefits and risk
- They actually know the benefit and risk and are NCRP literate
- Order the "appropriate" "justified" exam

METTLER

Bottom Line….

- CT employs ionizing radiation (x-rays), a weak carcinogen
- Dramatically increased use of CT will likely increase the incidence of cancer in the U.S. and individual patients will also be at risk
- Many physicians don’t understand radiation risk
- ED physicians function in a high pressure, highly regulated environment and need clinical answers that CT can quickly and accurately provide
- Given the best intent of the ED physicians, there is likely overuse of CT for several reasons (Novelline)
- Diverse guidelines for CT use exist, but there is the need for a set of ED/Radiology ***consensus*** guidelines

Summary and Conclusions

From the NCRP Medical Radiation and CT Utilization in the ED Conference

Paul R. Sierzenski, MD, RDMS, FACEP
Member, CMS MEDCAC
Chief, Emergency Ultrasound Section
Director, EM, Trauma & Critical Care Ultrasound
Christiana Care Health System
Newark Delaware

Issues

- Imaging is an effective and critical tool for risk stratification and patient care in the Emergency Department
- Medical radiation exposure has increased over the last decade
- CT utilization in the ED has increased above other modalities
- Multiple factors impact CT ordering
- Variance is physician CT utilization and clinical decision making exists

The ED is Different

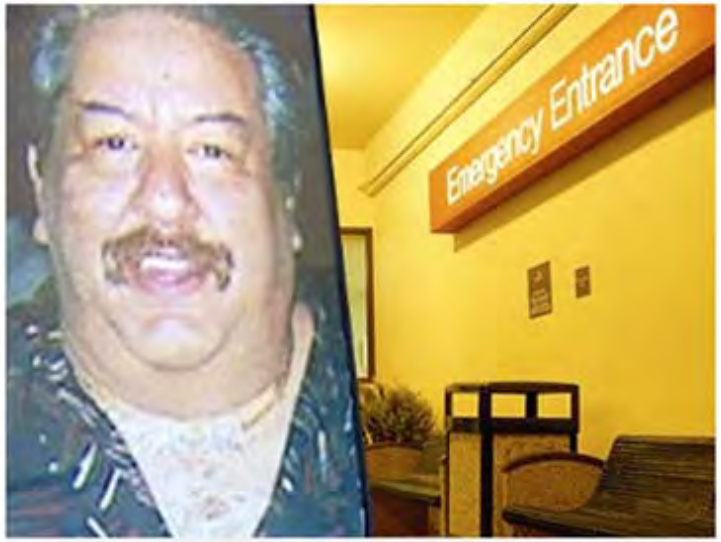
Small Changes can make big impact

Paul R. Sierzenski, MD, RDMS, FACEP. Sept 2009

Experiences Easily Affect Behavior

ER Death Points to Growing Wait-Time Problem

Family, Doctors Say Deadly 19-hour Wait Is an Example of a Nationwide Problem

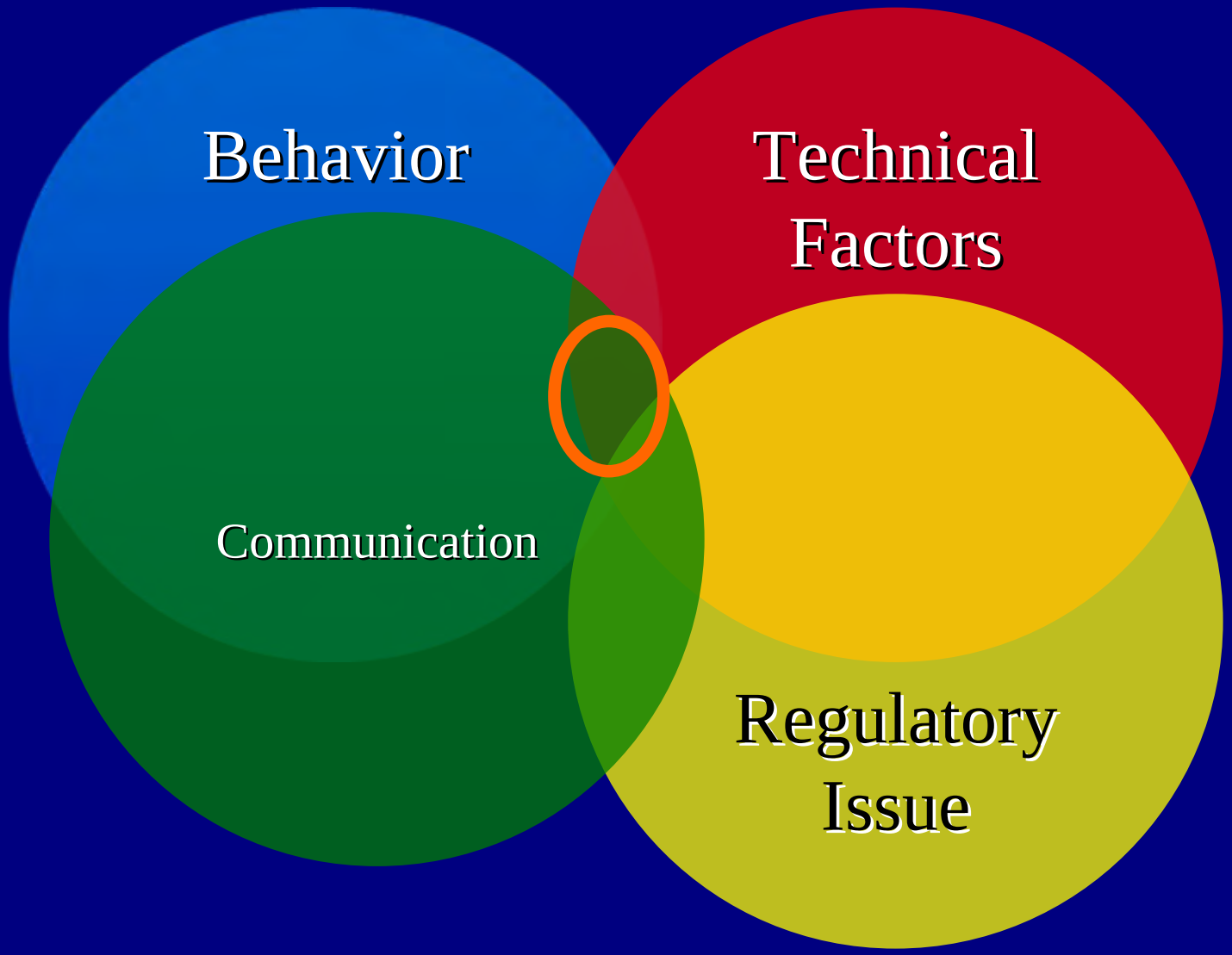


Michael Herrera, left, died after waiting 19 hours to see a doctor in a Dallas Hospital emergency room. His family and emergency physicians say the wait in U.S. emergency rooms is a dangerous problem.
(WFAA News)

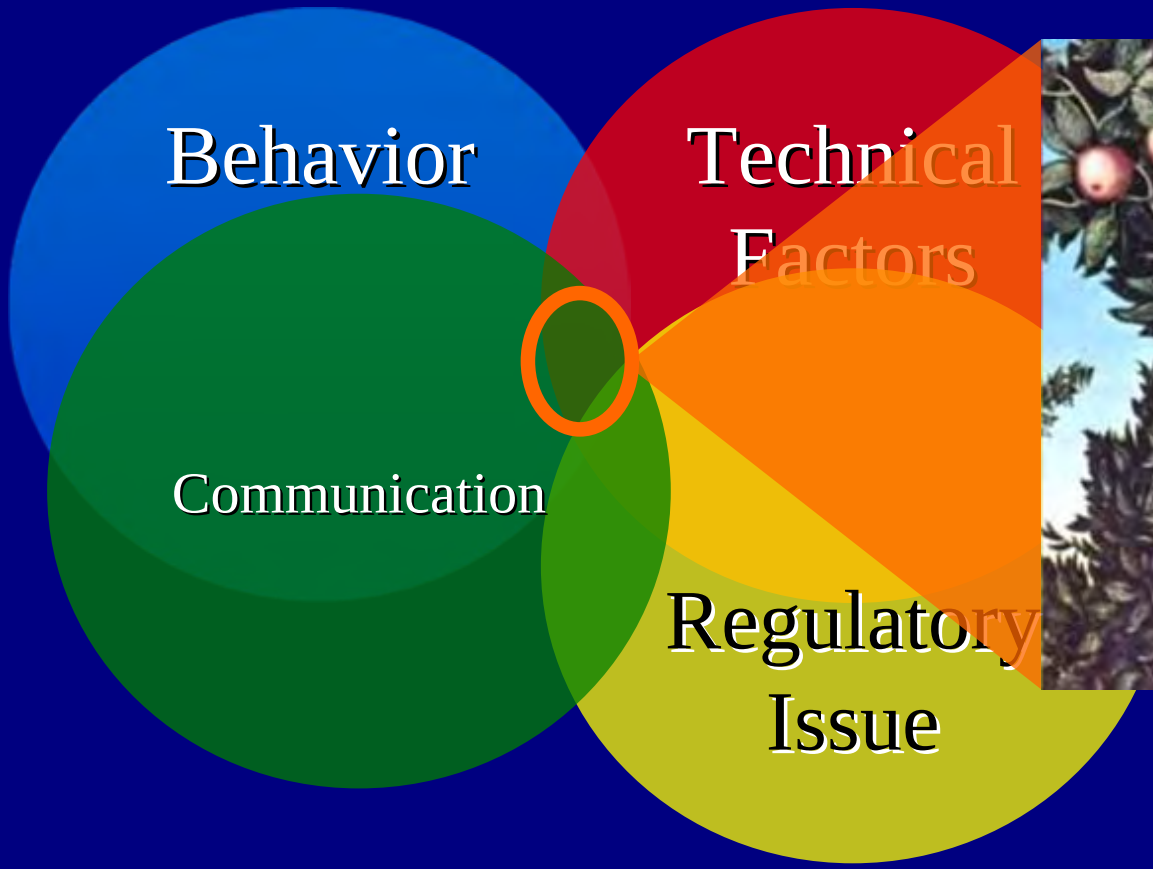
EVBM often does not!

Paul R. Sierzenski, MD, RDMS, FACEP. Sept 2009

Areas of Opportunity



Areas of Opportunity



Lets try Low Hanging Fruit First…
NOT any forbidden fruit. (high risk)

Behavior

- Education (Risk/Benefit)
- Provide Transparent Information (EMR)
- Increase ED-Radiology POC Communication
- Multiple factors impact diagnostic WU and CT ordering
- Variance is physician CT utilization and clinical decision making exists

The word is getting out

News Room > Annals of EM Press Releases

News Room

Patients in the Emergency Department Exposed to High Doses of Radiation

For immediate release
March 3, 2008

Julie Lloyd - (202) 728-0610 x3010

Washington, DC - The amount of radiation that adult trauma patients typically receive in the emergency department is significant, with the median radiation exposure equal to 1,005 chest X-rays, according to a study appearing online today in the *Annals of Emergency Medicine* ("Quantitative Assessment of Diagnostic Radiation Doses in Adult Blunt Trauma Patients").

Technology

- CT technology to affect dose
- EMR to aid in diagnostic work up
- EMR to aid in radiation exposure
- Increase ED-Radiology POC Communication

Regulatory

- Defensive medicine is real
- Malpractice modulation is essential
- ED regulatory statutes can be addressed to benefit patients and providers (EMTALA)
- Discussions of pathways to address patients that are extreme exposure outliers should begin

Communication

- Significant opportunity
- Global / International lessons
- Patient awareness
- Recognition of physician protection when diagnostic testing is excluded

Words Matter!

"We are concerned about the comparisons, generalizations and gross oversimplifications being made by the study, which could have grave consequence for patients facing emergency care," said Dr. Lawrence. "In addition, the fear of lawsuits is another reason CT scans are conducted by many physicians. Multiple successful lawsuits have been won against physicians for not performing CT scans, and the nation needs to reform the litigious system in which physicians are punished for using good judgment and not testing."

According to ACEP, one positive result of the study is that it further reveals the need to create a personal radiation exposure profile as part of a patient's medical record – to avoid excessive cumulative radiation exposure over a lifetime, and to foster discretion in using CT scans, particularly in pediatric patients. To that end, ACEP supports the proposed use of electronic medical records to supply emergency physicians with patient information (provided standards and cost issues are addressed).
The study, "Computed Tomography — An Increasing Source of Radiation Exposure," was published in the Nov. 29 issue of the New England Journal of Medicine.

-Linda Lawrence, MD FACEP, ACEP President on Nov 29, 2007 speaking about "Computed Tomography — An Increasing Source of Radiation Exposure," Nov. 29 issue of the New England Journal of Medicine.

Common Ground

- Agreement that inclusion of radiation exposure potential by diagnostic imaging is essential (Risk Benefit)
- Information gaps exist for all healthcare personnel
- Multiple factors impact diagnostic WU and CT ordering
- Variance is physician CT utilization and clinical decision making exists
  - Unique populations: Peds, Trauma
- Further research is needed!

Town Hall Issues

- Gate-keeping will not fly!
- Finger pointing
- Perception IS reality! (Wording matters)
- “Group Hug!”

Action Points to Consider

- Joint summary of NCRP proceedings
- Development of joint educational ventures Risk/benefit the simplest least expensive start. Pathway to mutual understanding
- A joint research approach for low lying fruit is key (renal colic / pediatrics / trauma / high users)
- Increase awareness of staged imaging
- Joint Guidelines discussions need to advance with discussions on CPOE inclusion

Paul R. Sierzenski, MD, RDMS, FACEP. Sept 2009