

MAYO CLINIC

# 2012 AAPM Imaging Educational Course Radiation Risk in Diagnostic Radiology: A Critical Analysis of What We Do and Don't Know

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- MAYO CLINIC
- ## Outline
- É Risk Estimation versus Risk Perception
    - ó Cynthia McCollough
  - É Biology Versus Epidemiology: The Need for an Integrated Model of Radiation Risk
    - ó Richard Vetter
  - É An Analysis of Recent Literature Regarding Radiation Risk
    - ó Louis Wagner and John Boice
  - É BEIR VII: What It Does and Doesn't Say
    - ó Michael O'Connor

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## Motivation

**Study: Unnecessary CT scans exposing patients to excessive radiation**  
By Steve Sternberg, USA TODAY

**Report Links Increased Cancer Risk to CT Scans**  
By THE AP

**Cedars-Sinai investigated for significant radiation overdoses of 206 patients**  
The finding prompts the FDA to issue an alert urging protocols for CT scans. Class Action Lawsuit Filed Against Cedars-Sinai Over CT Radiation Overdose

**CT Scan Increase Could Mean More Cancer Down the Road**  
October 10, 2009 | Alan Zarembo

**U.S. probing more cases of CT radiation overexposure**  
WASHINGTON (Reuters) - U.S. regulators are probing more cases of patients who receive excessive radiation from CT scans, experts say.

**Doctors 'Shocked' by Radiation Overexposure at Cedars-Sinai**  
WASHINGTON (Reuters) - U.S. regulators are probing more cases of patients who receive excessive radiation from CT scans, experts say.

**CT scan radiation can equal nuclear bomb**  
10/11/09

**Study: CT scans raise cancer risk**  
WASHINGTON (Reuters) - U.S. regulators are probing more cases of patients who receive excessive radiation from CT scans, experts say.

**Study: Increased Use of CT Scan Poses Cancer Risk**  
WASHINGTON (Reuters) - U.S. regulators are probing more cases of patients who receive excessive radiation from CT scans, experts say.

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*Skin reddening after CT overdose*



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*Hair loss after CT overdose*



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*January 22, 2001*

É Brenner DJ, et al. *Estimated Risks of Radiation-Induced Fatal Cancer from Pediatric CT, AJR 2001*

É "CT scans in children linked to cancer"  
ó USA Today News

É "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."

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*Consequences: Need optimization education*

- É Modern medical imaging devices are sophisticated pieces of equipments
- É Multiple parameters with competing effects on image quality and dose
- É Keep doses ALARA
- É Keep benefits AHARA

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*2<sup>nd</sup> AAPM Summit on CT Dose*

Interdisciplinary Program on  
Scan Parameter Optimization for  
Imaging Physicians, Technologists and Physicists

**October 7-8, 2011**  
**Denver, Colorado**



Program made possible in part by generous contributions from  
ACR, RSNA, and NIBIB

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*Consequences: Scared and anxious patients*

- É Patients and family members seeking expert help after exposures
- É Parents in particular calling, in tears, about what they have allowed to be done to their child
- É One recent call, parent experienced 20 lb weight loss and grandparent was calling to get help

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*Consequences: Negative impact on care*

- É 84 y.o. male
- É Abdominal aortic aneurysm
- É Pre-surgical CT Angiogram ordered
- É Leaves message for physician requesting that his CT with the cancer-causing stuff be changed to an ultrasound
- É Numerous cancelled appointments after each round of media coverage

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*Consequences: Can be lethal*

- É 30 y.o. professional female
- É Pregnant with much anticipated first child
- É Physical exams reveals neck/armpit nodules
- É Chest CT and mammography performed to investigate (fetal dose essentially zero)
- É Mother and father consider therapeutic abortion on counsel of (non-Mayo) primary physician

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*Malformation*

Likelihood of having a healthy baby  
(i.e. no malformations)

0 mGy	10 mGy	50 mGy	100 mGy
96.00%	95.98%	95.90%	95.80%

From "Exposure to the pregnant patient to diagnostic radiations", LK Wagner et al. (1997)

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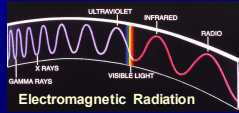
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### Difficulties in discussing radiation risk

É Perception of risk increases when

- ó I can't see it
- ó I can't touch it
- ó I can't measure it
- ó I can't control it



É Worse still if government or industry controls it

- ó I am not familiar with it
- ó Experts tell me to trust them

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Fear sells

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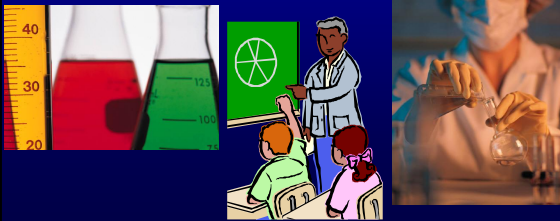
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### Difficulties in discussing radiation risk

É Lack of education or experience regarding radiation

É Vinegar vs. hydrochloric acid



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*What do our children learn about radiation?*

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*What does society "know" about radiation?*

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*It's bad*



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*Scientific response:  
We just need to educate people*

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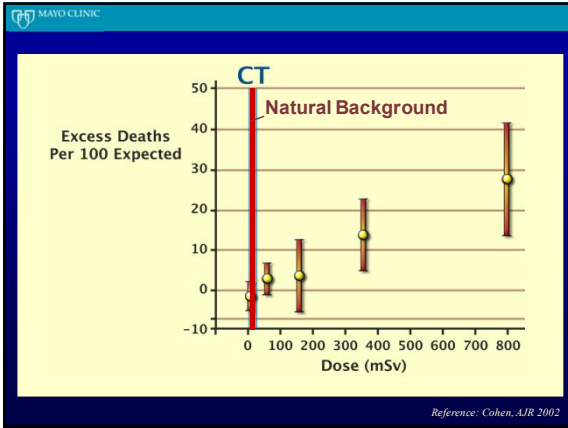
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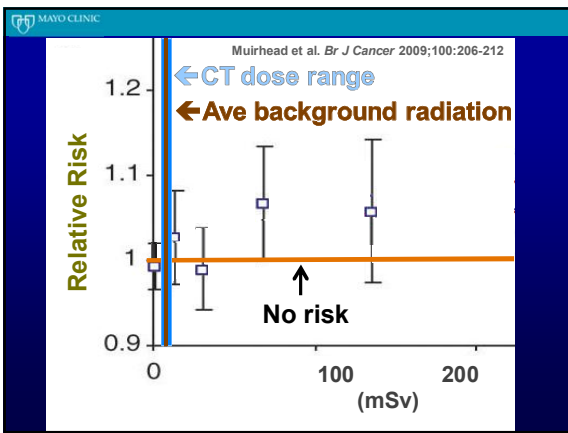
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**Radiology**

**The Linear No-Threshold Relationship Is Inconsistent with Radiation Biologic and Experimental Data<sup>1</sup>**

Mauricio Tubiana, MD  
Ludwig E. Ferencik, MD  
Chihuan Yang, MD  
Joseph M. Kaminski, MD

*Radiology* 251 (2009)

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Review Article

**CHECKING THE FOUNDATION: RECENT RADIOBIOLOGY AND THE LINEAR NO-THRESHOLD THEORY**

Brant A. Ulsh\* *Health Physics* 99 (2010)

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*Below 100 mSv, risk estimates are meaningless*

É Health Physics Society recommends against quantitative estimation of health risks below an individual dose of 50 mSv in one year or a lifetime dose of 100 mSv (above that received from natural sources)

É Below 50-100 mSv, risks of health effects are either too small to be observed or are nonexistent

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*AAPM Position Statement 25 12/13/2011*

É Predictions of hypothetical cancer incidence and deaths in patient populations exposed to such low doses are highly speculative and should be discouraged.

É These predictions are harmful because they

- ó lead to sensationalistic articles in the public media
- ó cause some to refuse medical imaging procedures
- ó placing them at substantial risk by not receiving the clinical benefits of the prescribed procedures

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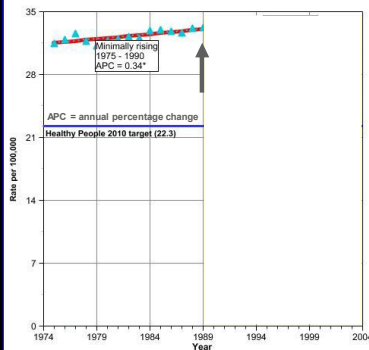
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Figure E2b. U.S. death rates for common cancers - female breast: 1975-2003



**~ 30% decline in breast cancer mortality attributed to use of screening mammography in women over 40**

Tabor et al., *Radiology*, 2011  
 "Swedish Two-County Trial: Impact of Mammographic Screening on Breast Cancer Mortality during 3 Decades"  
*Cancer Intervention and Surveillance Network, NEJM* 2005;353:1784  
 Brown DK, *BMJ* 2000;321:849  
 "UK death rates from breast cancer fall by a third"  
 Peto R et al., *Lancet* 2000;355:1822  
 "UK and USA breast cancer deaths down 25% in 2000 at ages 20-69 years"

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*This is so logical. Why isn't it working?*



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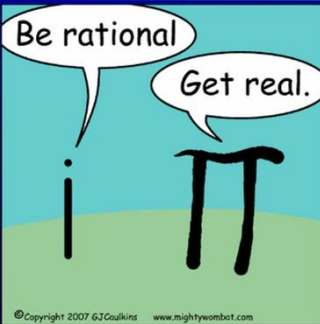
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*People don't really think rationally*



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*Especially when it comes to risk*



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# Perception of Risk

- É Paul Slovic, Professor of Psychology
- É *Science*, 1987
- É Psychometric paradigm of risk perception
- É To experts: risk means statistical odds of harm
- É Logical, factual, scientific, quantifiable, data driven

**Perception of Risk**  
PAUL SLOVIC

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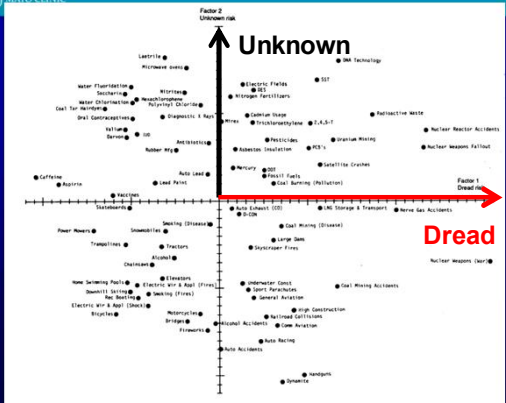
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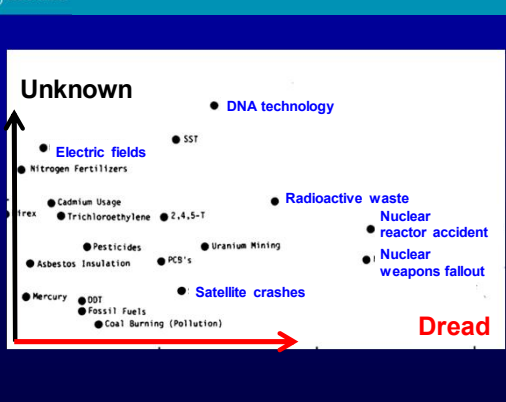
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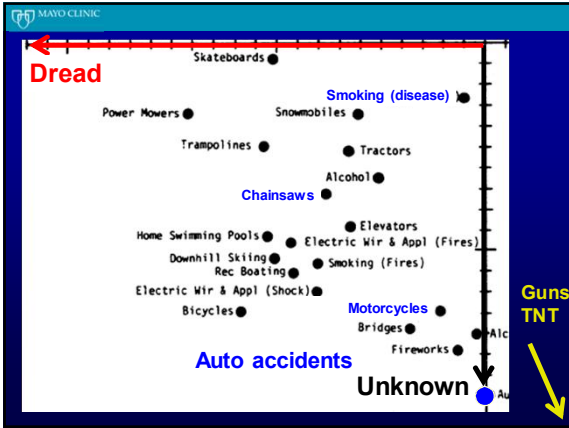
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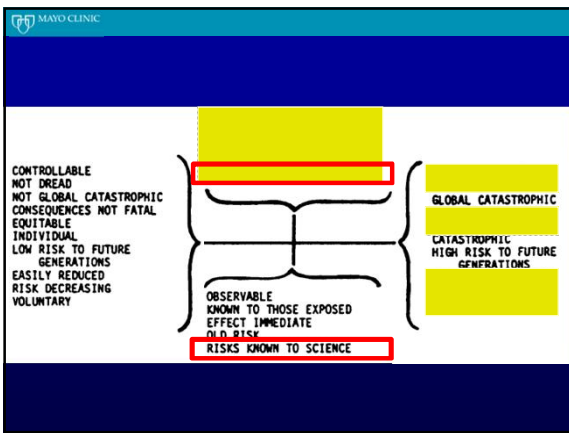
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*Risk Estimation (Odds) ≠ Risk Perception*

É To public/patients: risk means so much more than odds

- ó How bad/ scary is it (impact vs. odds)
- ó How will it affect my loved ones
- ó How much control do I have
- ó Can I trust the experts
- ó Do the experts have my best interest in mind
- ó My family and I are too valuable to take chances with
- ó Am I ösafeö


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*What We Do and Don't Know about  
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