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

Outline

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

Motivation

Study: Unnecessary CT scans exposing patients to excessive radiation

CT scan increase could mean more cancer down the road

Overexposure

Doctors ‘shocked’ by radiation overexposure at Cedars-Sinai

U.S. probing more cases of CT radiation

Cedars-Sinai investigated for significant radiation overdoses of 250 patients
Skin reddening after CT overdose

Hair loss after CT overdose

January 22, 2001

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

“CT scans in children linked to cancer” — USA Today News

“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.”
### Consequences: Need optimization education

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

### 2nd 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.

### Consequences: Scared and anxious patients

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

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

Consequences: Can be lethal

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

Malformation

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

<table>
<thead>
<tr>
<th>Radiation (mGy)</th>
<th>0 mGy</th>
<th>10 mGy</th>
<th>50 mGy</th>
<th>100 mGy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Likelihood</td>
<td>96.00%</td>
<td>95.98%</td>
<td>95.90%</td>
<td>95.80%</td>
</tr>
</tbody>
</table>

From "Exposure to the pregnant patient to diagnostic radiations", LK Wagner et al. (1997)
Difficulties in discussing radiation risk

A Perception of risk increases when
- I can't see it
- I can't touch it
- I can't measure it
- I can't control it
  - Worse still if government or industry controls it
- I'm not familiar with it
- Experts tell me to trust them

Fear sells

Difficulties in discussing radiation risk

- Lack of education or experience regarding radiation
- Vinegar vs. hydrochloric acid
What do our children learn about radiation?
What does society “know” about radiation?

It’s bad

Scientific response:
We just need to educate people
Below 100 mSv, risk estimates are meaningless

The 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).

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

AAPM Position Statement 25 12/13/2011

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

These predictions are harmful because they
- lead to sensationalistic articles in the public media
- cause some patients to refuse medical imaging procedures
- place them at substantial risk by not receiving the clinical benefits of the prescribed procedures

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

Peto R et al., Lancet 2000;355:1822
"UK death rates from breast cancer fall by a third"

Cancer Intervention and Surveillance Network, NEJM 2005;353:1784
"UK death rates from breast cancer fall by a third"

Tabor et al., Radiology, 2011
"Swedish Two-County Trial: Impact of Mammographic Screening on Breast Cancer Mortality during 3 Decades"

Brown DK, BMJ 2000;321:849
"UK death rates from breast cancer fall by a third"
This is so logical. Why isn’t it working?

People don’t really think rationally

Especially when it comes to risk
Perception of Risk

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

Unknown

Smoking (disease)

Chainsaws

Motorcycles

Auto accidents

Guns

TNT

Risk Estimation (Odds) ≠ Risk Perception

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

• How bad/ scary is it (impact vs. odds)
• How will it affect my loved ones
• How much control do I have
• Can I trust the experts
• Do the experts have my best interest in mind
• My family and I are too valuable to take chances with
• Am I safe?
What We Do and Don’t Know about Radiation Risk in Diagnostic Radiology

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