Ask the Expert: Medical Radiation Risk Communication

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I just had a CT scan – Should I Worry?
Projected Cancer Risks From Computed Tomographic Scans Performed in the United States in 2007

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**Background:** The use of computed tomographic (CT) scans in the United States (US) has increased more than 3-fold since 1993 to approximately 70 million scans annually. Despite the great medical benefits, there is concern about the potential radiation-related cancer risk. We conducted detailed estimates of the future cancer risks from current CT scan use in the US according to age, sex, and scan type.
How much radiation you've been exposed to may be the last thing on your mind on the way to the emergency room. But with the increasing use of computed tomography, or CT scans, and nuclear medicine screenings as highly accurate first-line tools in injuries, a new study suggests such and center.

The study, presented this week at the annual conference of the Society for Academic Emergency Medicine, confirms what many doctors have believed: that people may be receiving doses of radiation, sometimes unnecessarily, that put them at a heightened risk of cancer. Researchers found that a typical patient who visited the emergency room received a cumulative radiation dose of 40 millisieverts over a five-year period. Ten percent of patients ended up with a staggering 100 or more millisieverts. Both levels are well above the safety threshold for lifetime radiation exposure. Exposures above the threshold leave patients vulnerable to increased long-term risk of cancer. As a point of comparison, one chest CT is around 10 millisieverts of radiation and a traditional chest X-ray only 0.02 millisieverts.
The 100-year battle to make Fukushima safe: Grim prediction as brave workers expect to 'die within weeks'

Workers warned they’re facing a 100-year battle to make fuel rods safe
Those battling to stop nuclear meltdown are expected to die in weeks
American recruiter asked to hire technicians to help
World’s largest concrete pump is being flown from U.S. to assist
Evacuation zone refugees won’t be able to go home for months, admits Japanese minister
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FDA: Some foods from four Japanese prefectures can't enter U.S.
By Elizabeth Landau, CNN
March 23, 2011 7:14 a.m. EDT

Radiation rises in seawater near Fukushima plant
Japanese officials concede they are no closer to resolving nuclear crisis as high level of radiation is detected in ocean
How to Become a Medical Radiation Expert

Undergrad degree in Physics + Masters in Radiation Protection + 4 Years Medical School + Two Years Internal Medicine + Two Years Nuclear Medicine Training

OR

Put your name and e-mail address on a Web site that has something to do with “radiation”
Sir,

I had fracture ankle so had got 2 x-rays taken of my ankle joint at 6 weeks gestation. This is my 2nd pregnancy please advice, should I undergo an abortion.

Regards

geetanjali
WE WANT YOU
To Be a Radiation Expert!
Things to Consider

• Inappropriate Risk Communication

• Appropriate Risk Communication:
  – Understanding the Question
  – Researching the Answer
  – Conveying the Information
  – Putting Things into Perspective

• Some Illustrative Case Histories

• Putting Your Message Together
Inappropriate Risk Communication Strategies

1) Don’t Say a Word
2) Understate the Risk
3) Overstate the Risk

Adapted from: Picano E. Informed consent and communication of risk from radiological and nuclear medicine examinations: how to escape from a communication inferno. BMJ 2004;329:849–51
Don’t say a Word...
“It is better to remain silent and appear a fool, than to open your mouth and remove all doubt.”
Not So! It is Better…

- To not say “IT’S NOT MY JOB”
- To lend an ear to your caller’s concerns
  - You may not be able to help them with everything, but they need to know that someone is listening
- To have confidence in your abilities, and speak up!
Understate the Case...
You had a CT scan? No problem!
Overstate the Case...
You had a CT scan? You gonna DIE!
An Appropriate Strategy

• **Understand** the Question
  – Risk perception
  – Beware of charlatans!

• **Research** the Question
  – This may include some calculations

• **Share** the *Information*
  – Watch your language!

• **Provide Some** *Perspective*
What Are They Really Asking?
But Doctor…What Was My Radiation Exposure??

Danged If I Know!

I’m embarrassed to admit it, but I’m REALLY WORRIED about breast cancer!
What They Really Want to Know

They will ask you what the DOSE is…

BUT

What they REALLY want to know is what their RISK is!
They Want to Know…

(1) The risk to their pregnancies

(2) The risk to their children

(3) The risk to themselves
Risk Perception and Risk Tolerance...
# Negative and Positive Perceptions of Radioactivity

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<tr>
<th>Attribute</th>
<th>Percentage</th>
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<tr>
<td><strong>Negative</strong></td>
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<tr>
<td>Fear of dangers of nuclear energy</td>
<td>84%</td>
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<tr>
<td>Fear of malignant diseases</td>
<td>78%</td>
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<tr>
<td>Diffuse feeling of threat</td>
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<td>Fear of contamination</td>
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<td>Fear of changes of DNA</td>
<td>21%</td>
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<tr>
<td>Distrust in institutions</td>
<td>16%</td>
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<td>Fear of death</td>
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<td><strong>Positive</strong></td>
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<tr>
<td>Medical benefit</td>
<td>75%</td>
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<td>Secure source of energy</td>
<td>37%</td>
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<tr>
<td>Source of evolution, hormesis</td>
<td>6%</td>
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FIGURE 1. Subjective patient perception of radioactivity on a scale of 1–5 (*n* = 68) (1 = positive, 2 = rather positive, 3 = neutral, 4 = rather negative, and 5 = negative). Changes with means of 3.5 (general) and 2.7 (RIT) are statistically significant (*P* = 0.01) (44).

### Pediatric Surgeons’ Estimates of Increased Risk From One Abdominal/Pelvic CT Scan

<table>
<thead>
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<th>Estimated Increased Risk</th>
<th>Percentage of Surgeons</th>
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<tr>
<td>1 in 1,000</td>
<td>31%</td>
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<tr>
<td>1 in 50,000</td>
<td>18%</td>
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<tr>
<td>1 in 100,000</td>
<td>15%</td>
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<tr>
<td>1 in 500,000</td>
<td>11%</td>
</tr>
<tr>
<td>None</td>
<td>32%</td>
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</table>

# Pediatric Surgeons’ Estimates of Dose From One Abdominal CT Scan

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<th>CT Equivalent Dose Estimates</th>
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<tr>
<td>≤ 1 CXR</td>
<td>32%</td>
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<tr>
<td>1 – 10 CXR</td>
<td>31%</td>
</tr>
<tr>
<td>10 – 100 CXR</td>
<td>40%</td>
</tr>
<tr>
<td>100 – 250 CXR</td>
<td>19%</td>
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<tr>
<td>&gt; 250 CXR</td>
<td>5%</td>
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</table>

Beware of the Charlatans
You can assume that your callers have already gone to the Web for answers!
The “Secondary Association” Effect Strikes Again!

A temporal association of a “blip” in the infant mortality rate with the Fukushima event does NOT imply causation!
1500

Abstracted from USA Today

Each year, about 1.6 million of those will die later.

What's more, CT or computorized axial tomography, or CAT scans, absorb two to six times more radiation than a traditional X-ray.

Doctors use CT scans on children. They're a huge number of people there got a tenth of a radiation dose given to people there were getting.

About 11% of the CT scans a child absorbs is the radiation dose given to people there were getting. Most people there were getting.

And they get 70% of the total radiation that adults, which are more susceptable to radiation.

The breast dose from a 20 mammograms. You'd
Research the Question
If You Don’t Know the Answer…

• **Make one up**
• Research the radiation dose literature
• Consult organizations with radiation protection expertise
  – Health Physics Society “Ask the Expert”
  – ORISE nuclear medicine dose compendia
  – NRC Regulatory Guidance
• Consult organizations with clinical expertise
  – ACOG and other professional organizations
• Consult your colleagues
Hand it Off...
I have heard that there is an increase in the number of people getting thyroid cancer. Is this true and is radiation from dental X-rays a cause of the increase?
Dental X-rays give a very low dose of radiation to the mouth. There is some scatter of radiation and the potential for some radiation absorption by the nearby thyroid and other organs. The American Dental Association notes that a leaded apron placed over the torso minimizes radiation exposure to the chest and abdomen and should be used when any dental X-ray is taken. The group also notes that a leaded thyroid collar can protect the thyroid from radiation and should be used whenever possible.

While the experts that I consulted do recommend use of a thyroid collar, none of the experts was especially worried that dental X-rays are a significant cause of thyroid cancer. There is however significant concern that radiation from other forms of medical testing may be causing some thyroid cancers. CT scanning is the medical procedure that concerns experts the most. It uses higher levels of radiation than conventional X-rays and much higher levels of radiation than are used in dental X-rays.
Share the Information
For Example, Information for Pregnant Women…

• ACOG Guidelines for Radiation Exposure:
  – Counsel patient that x-ray exposure under 50 mSv has not been associated with increases in fetal anomalies or spontaneous abortion.
  – Maternal health should not be compromised by irrational fears of the dangers of ionizing radiation to the fetus.
  – However, alternate imaging procedures (US, MRI) should be employed if applicable.
Helping Pregnant Patients and Employees

- Overcoming the “Fear Factor”: patient may already have been advised to terminate her pregnancy by family members or incompetent practitioners.
- *Logical process* based on stage of gestation at the time of exposure and calculated fetal dose, as well as other historical and environmental factors.
Scale of Fetal Radiation Doses (mGy) from Selected Procedures

- CXR
- LS X-ray
- V/Q
- FDG
- MIBI Stress
- MDCT Chest
- HIDA, MDP
- MDCT Renal
- MDCT Pelvis
- VCU
V/Q Scan or Helical CT?

V/Q: Fetal Dose ~ 35 millirem
CT: Fetal Dose ~ 70 millirem

In either case, the dose to the fetus is **insignificant**. Go for the study that gives the **best diagnostic information**.
Fetal Radiation Exposure From X-ray Procedures: To Do, or Not to Do?
Early Gestation

1st Trimester

2nd Trimester

3rd Trimester

Careful – Organogenesis In Progress!
Just do it
The Bottom Line…

• *Do not defer x-ray or nuclear studies if mother’s health at risk*

• Reduce kVp and mAs (or administered activity) as much as feasible consistent with adequate image quality

• Shield fetus if doing so does not interfere with exam
Provide Perspective
The 100-year battle to make Fukushima safe: Grim prediction as brave workers expect to 'die within weeks'

- Workers warned they're facing a 100-year battle to make fuel rods safe
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20,000+ DEAD
450,000 HOMELESS
1 MILLION NO WATER
20,000+ DEAD
## Radiation Dose to Breast From Selected Procedures

<table>
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<tr>
<th>Procedure</th>
<th>Breast Dose (mGy)</th>
<th>Equivalent Natural Bkg</th>
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<tr>
<td>PA Chest</td>
<td>0.012</td>
<td>36 hours</td>
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<tr>
<td>LAT Chest</td>
<td>0.20</td>
<td>24 days</td>
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<tr>
<td>AP Chest</td>
<td>0.36</td>
<td>44 days</td>
</tr>
<tr>
<td>$^{13}\text{NH}_3$ PET</td>
<td>0.94</td>
<td>3.8 months</td>
</tr>
<tr>
<td>$^{99}\text{mTc}$ MIBI SPECT</td>
<td>2.3</td>
<td>9.2 months</td>
</tr>
<tr>
<td>Mammogram</td>
<td>2.9</td>
<td>10.4 months</td>
</tr>
<tr>
<td>$^{18}\text{FDG}$ PET</td>
<td>5.1</td>
<td>1.7 years</td>
</tr>
<tr>
<td>$^{201}\text{TI}$ SPECT</td>
<td>5.2</td>
<td>1.7 years</td>
</tr>
<tr>
<td>Std Dx Cardiac Cath</td>
<td>8.3</td>
<td>2.8 years</td>
</tr>
<tr>
<td>Gated CT Coronary Angio</td>
<td>83.4</td>
<td>27.8 years</td>
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<tr>
<td>Activity</td>
<td>Lifetime risk</td>
<td></td>
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<tr>
<td>---------------------------------------------------</td>
<td>---------------</td>
<td></td>
</tr>
<tr>
<td>Assault</td>
<td>214</td>
<td></td>
</tr>
<tr>
<td>Accident while riding in car</td>
<td>304</td>
<td></td>
</tr>
<tr>
<td>Accident as pedestrian</td>
<td>652</td>
<td></td>
</tr>
<tr>
<td>Choking</td>
<td>894</td>
<td></td>
</tr>
<tr>
<td>Accidental poisoning</td>
<td>1,030</td>
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<tr>
<td>Drowning</td>
<td>1,127</td>
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<tr>
<td>Exposure to fire or smoke</td>
<td>1,181</td>
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<tr>
<td><strong>Cancer from $^{18}$F-FDG PET scan (10-y-old)</strong></td>
<td>1,515</td>
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<tr>
<td>Falling down stairs</td>
<td>2,024</td>
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<tr>
<td><strong>Cancer from $^{99m}$Tc-MDP bone scan (10-y-old)</strong></td>
<td>2,560</td>
<td></td>
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<tr>
<td><strong>Cancer from $^{18}$F-FDG PET scan (40-y-old)</strong></td>
<td>2,700</td>
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<tr>
<td>All forces of nature</td>
<td>3,190</td>
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<tr>
<td>Accident while riding bike</td>
<td>4,734</td>
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<tr>
<td><strong>Cancer from $^{99m}$Tc-MDP bone scan (40-y-old)</strong></td>
<td>4,760</td>
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<tr>
<td>Accidental firearms discharge</td>
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<tr>
<td>Accident while riding in plane</td>
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<tr>
<td>Falling off ladder or scaffolding</td>
<td>10,606</td>
<td></td>
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<tr>
<td>Hit by lightning</td>
<td>84,388</td>
<td></td>
</tr>
</tbody>
</table>

Lifetime risk of 304 for accident while riding in car indicates that 1 of every 304 Americans will die as result of accident while riding in car during his or her lifetime.

A Circular Perspective on Risk

- Patients have heard that the dose from a CT scan is *two hundred times higher* than the dose from a chest x-ray!
- They have also heard that radiation risk is proportional to dose!
- What they *haven’t* heard is that the risk from a chest x-ray is virtually *ZERO*
- Be prepared to address this
Risk vs Benefit
Case #1: Understand the Question

• A doctor calls you and says she has a patient in the room who wants to know the radiation dose from a CT guided needle placement for analgesia of sacroileitis
• You say you don’t know right now, but you’ll do some research and call her back
• She says “YOU MEAN YOU CAN’T HELP HER NOW??”
• What do you do?
Case #1: Understand the Question

• You ask to speak to the patient
• You ask the patient how you can help her
• The patient really DOESN’T want to know the dose; she just wanted to know the difference in risk between having the procedure done using the proposed CT technique and having it done using fluoroscopy
• She admits to having “Googled” it beforehand, but only became more confused
A 42 year old woman has “five x-rays” of her lower back taken because of pain. Two days later she finds out she is pregnant. She is very upset and concerned that the x-rays may cause problems.

Her OB has determined that her gestational age was 5 weeks at the time of exposure. You compute the fetal radiation dose to be 1.2 mGy. What do you tell her?
Case #3: How Long Does She Have to Wait Before She Can Resume Nursing?

I just got 20 millicuries of $^{99m}\text{Tc}$ for a bone scan!

Dang!
Instructions must be given to the mother to interrupt nursing if the dose to the infant could exceed 100 mrem!

There are specific regulatory requirements in 10 CFR 35.75 for nursing women!
### Interruption of Breast Feeding by Nuclear Medicine Patients

<table>
<thead>
<tr>
<th>Nuclear Medicine Exam</th>
<th>Length of Time to Interrupt Nursing</th>
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<tbody>
<tr>
<td>Tc-99m MAA (V/Q)</td>
<td>3 – 12 hr</td>
</tr>
<tr>
<td>Tc-99m MDP (Bone)</td>
<td>3 hr</td>
</tr>
<tr>
<td>Tc-99m MIBI (Cardiac)</td>
<td>3 hr</td>
</tr>
<tr>
<td>TI-201 (Cardiac)</td>
<td>48 – 96 hr</td>
</tr>
<tr>
<td>I-131 &gt; 0.4 μCi</td>
<td>Must cease nursing</td>
</tr>
</tbody>
</table>

Source: NUREG 1556 v.9 Appendix U
Case #4: Research the Issue

• Mother of premature baby develops shortness of breath two days after delivery
• Doctor orders a lung scan; she gets 2.2 mCi of Tc-99m MAA
• Doctor tell her not to breast feed for 48 hours
• So instead she pumps breast milk, and nurse puts it in the refrigerator
• The next day, the pumped milk is mistakenly given to someone else’s baby
• Nurse calls you in a PANIC!
What Do You Tell Her To Do?

• Relax. Tell her you’re sure that no harm will come to the infant, but you will check some resources and follow up with her ASAP

• For Tc-99m MAA, the recommendation is to resume nursing after 3 – 12 hours

• Given that 24 hours have elapsed (2 – 4 additional half-lives), the risk to the inadvertently exposed infant is low
Oh Gawd…I’m pregnant! What am I doing in here??

Case # 5

Pregnant Nurse in OR Who is Frightened to be Around Deadly Radiation
Case #5: Do a Calculation

- Pregnant nurse wanders into OR where neurosurgery procedure in progress.
- Didn’t know intraoperative fluoroscopy was in use
- Surgeon continued to fluoro even though she yelled out that she was pregnant
- Was 15 feet away; beam was on for 4 sec per shot x 4 shots before she ran out in a panic. What was the dose to the fetus?
What is the risk to her fetus? You can do this one in your head!
“Back-of-Envelope” Calculation

• Assume patient exposure rate = 4 R/min (conservative)

• For 16 sec (~1/4 min), exposure ~ 1 R

• At one meter, the exposure from scatter = about 1 / 1,000th of exposure of primary beam = 1 mR, or ~1,000 μR

• At 15 feet (about 4 meters), exposure is reduced to 1 / 16th by inverse-square law = 63 μR

• Maternal tissue shielding reduces exposure by ~50% for final dose of about 30 μrad to the fetus
Case #6: Research the Question

• An eighty year old man is scheduled to have a CT scan and bone scan to rule out metastatic disease from his newly-diagnosed lung cancer.

• He calls you because he read in the *New York Times* that CT scans can cause cancer, and he is very worried about this possibility.

• *What do you tell him?*
How Do You Explain That His Risk is Very Low?

Support it With Facts!

BEIR VII, Phase 2

National Academies Press
1st edition (March 31, 2006)

ISBN: 030909156X
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NOTE: Number of cases per 100,000 persons exposed to a single dose of 0.1 Gy.

*These estimates are obtained as combined estimates based on relative and absolute risk transport and have been adjusted by a DDREF of 1.5, except for leukemia, which is based on a linear-quadratic model.*
Cancer Cases per 100,000 Men Exposed to 0.1 Gy
Case #7: Research the Question

• You tell him:
  – A single CT scan is not a cause for concern
  – Radiation risk from repeated CT scans may be a concern in children and young adults, but would not be a concern in man his age.

• It would also help him to know that the benefit of having his lung cancer properly staged and treated far outweighs the hypothetical radiation risk
Putting the Message Together
Putting It Together

• **Put the most important point at the beginning of your reply**
  – “First of all, we don’t expect any harm…”

• **Send a clear message, supported by facts:**
  – Avoid technical jargon
  – Use plain English; provide perspective

• **Acknowledge any uncertainties**

Source: *Risk Communication*, by R. Lundgren and A. McMakin, Battelle Press, 2004
Putting It Together

• Reassuring information will be appreciated
  – Genuine reassurance is indicated in most diagnostic and vicarious radiation exposures

• Accompany reassurance with a suggestion of additional evaluation and follow-up, if appropriate
Barriers to Effective Risk Communication

• *Disagreement Among Experts on the Acceptable Magnitude of Risk*
  – There are valid arguments, supported by data, for and against the LNT theory

• *Mistrust of the Risk Assessment*
  – A result of the above argument

• *Lack of Faith in Science and Institutions*

Source: *Risk Communication*, by R. Lundgren and A. McMakin, Battelle Press, 2004
QUESTIONS?