The Radiation Dose Conundrum: Reconciling Imaging, Imagining and Managing

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No Disclosures
Topics and speakers

– Talking the Talk: Don Frush
– Dose Monitoring Opportunities and Challenges: Keith Strauss
– CR/DR: Steve Don
– Current Controversies in CT Dose Deduction: John Mackenzie
Ionizing Radiation
Dialogue should emphasize

• Benefit of imaging
Really?  Benefit Risk Balance?
Ionizing Radiation
Dialogue should emphasize

• Benefit of imaging
• Informed use, not just “reduction”
  – Sometimes more is better
• Certainty about risk uncertainty
• Content and delivery
• Consensus responsibility
Facts

• Radiation in diagnostic imaging is a “hot” topic
• Ionizing radiation imaging “rebounding”
• Public and caregivers remain concerned
• Individuals are (often) misinformed
• The “harm and alarm” voice is loud
• Increased regulation
The common denominator of most radiation exposure scenarios is fear. Just mention the word radiation, and you instill fear—a perfectly understandable response given the images of mushroom clouds and cancerous tumors that immediately come to mind. Those images would justifiably cause anyone to be anxious. Nevertheless, some people have also become highly afraid of diagnostic x-rays, luggage scanners, cell phones, and microwave ovens. This extreme level of anxiety is unwarranted, and potentially dangerous.
References: Radiation Misunderstanding

1. Steele JR, Jones AK, Clarke RK et al. Use of an online education platform to enhance patients’ knowledge about radiation in diagnostic imaging. *JACR* 2016;13 :768-774


Oncology Patient Perceptions of the Use of Ionizing Radiation in Diagnostic Imaging

Joseph R. Steele, MD*, Aaron K. Jones, PhD*, Ryan K. Clarke, MHA*, Sharon H. Giordano, MD*, Stowe Shoemaker, PhD*

Abstract

Purpose: To measure the knowledge of oncology patients regarding use and potential risks of ionizing radiation in diagnostic imaging.

Methods: A 30-question survey was developed and e-mailed to 48,736 randomly selected patients who had undergone a diagnostic imaging study at a comprehensive cancer center between November 1, 2013 and January 31, 2014. The survey was designed to measure patients’ knowledge about use of ionizing radiation in diagnostic imaging and attitudes about radiation. Nonresponse bias was quantified by sending an abbreviated survey to patients who did not respond to the original survey.

Results: Of the 48,736 individuals who were sent the initial survey, 9,098 (18.7%) opened it, and 5,462 (11.2%) completed it. A total of 21.7% of respondents reported knowing the definition of ionizing radiation; 35.1% stated correctly that CT used ionizing radiation; and 29.4% stated incorrectly that MRI used ionizing radiation. Many respondents did not understand risks from exposure to diagnostic doses of ionizing radiation: Of 3,139 respondents who believed that an abdominopelvic CT scan carried risk, 1,283 (40.9%) believed sterility was a risk; 669 (21.3%) believed heritable mutations were a risk; 657 (20.9%) believed acute radiation sickness was a risk; and 135 (4.3%) believed cataracts were a risk.

Conclusions: Most patients and caregivers do not possess basic knowledge regarding the use of ionizing radiation in oncologic diagnostic imaging. To ensure health literacy and high-quality patient decision making, efforts to educate patients and caregivers should be increased. Such education might begin with information about effects that are not risks of diagnostic imaging.

Key Words: Radiation, ionizing, patient education, caregiver, CT, MRI, health literacy

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Table 3. Responses to the question “Which activity results in the highest radiation dose?”

<table>
<thead>
<tr>
<th>Response</th>
<th>n</th>
<th>Correct Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole-body PET scan</td>
<td>1,499</td>
<td>274 2</td>
</tr>
<tr>
<td>Chest-abdomen-pelvis CT scan</td>
<td>840</td>
<td>15.4 1</td>
</tr>
<tr>
<td>Chest-abdomen-pelvis MRI scan</td>
<td>357</td>
<td>6.5 6</td>
</tr>
<tr>
<td>Taking a cross-country commercial airplane flight</td>
<td>264</td>
<td>4.8 5</td>
</tr>
<tr>
<td>Living in Denver for 1 year</td>
<td>232</td>
<td>4.2 3</td>
</tr>
<tr>
<td>Mammogram</td>
<td>217</td>
<td>24</td>
</tr>
<tr>
<td>They all result in approximately the same radiation dose</td>
<td>1,134</td>
<td>20.8 1</td>
</tr>
<tr>
<td>None of these activities result in exposure to ionizing radiation</td>
<td>1,089</td>
<td>18.7 1</td>
</tr>
</tbody>
</table>

Note: Rank scale of 1 (highest dose) to 6 (lowest dose). The question addressed in the table appeared on the initial survey (5,462 respondents) but not the nonresponder survey.

Table 4. Responses to the question “What are the risks from a CT scan of the abdomen and pelvis?”

<table>
<thead>
<tr>
<th>Response</th>
<th>n</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is no risk</td>
<td>2,323</td>
<td>42.5</td>
</tr>
<tr>
<td>There is risk</td>
<td>3,159</td>
<td>57.5</td>
</tr>
<tr>
<td>Item is a potential risk (multiple responses allowed)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cancer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sterility</td>
<td>1,283</td>
<td>23.5</td>
</tr>
<tr>
<td>Heritable mutations (genetic mutations passed to offspring)</td>
<td>669</td>
<td>12.5</td>
</tr>
<tr>
<td>Acute radiation sickness</td>
<td>857</td>
<td>12.0</td>
</tr>
<tr>
<td>Cataracts</td>
<td>135</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Note: Respondents who answered “There is no risk” were not presented with the other response options listed in the table. The question addressed in the table appeared on the initial survey (5,462 respondents) but not the nonresponder survey.

Table 2. Responses to the question “Which imaging modalities use ionizing radiation?” and to questions regarding knowledge of and desire to know radiation dose

<table>
<thead>
<tr>
<th>Response</th>
<th>Number Choosing “Yes”</th>
<th>Does the Modality Actually Use Ionizing Radiation?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do not know</td>
<td>3,605</td>
<td>38.8</td>
</tr>
<tr>
<td>CT (computed tomography)</td>
<td>3,259</td>
<td>35.1</td>
</tr>
<tr>
<td>PET (positron emission tomography)</td>
<td>3,253</td>
<td>35.0</td>
</tr>
<tr>
<td>MRI (magnetic resonance imaging)</td>
<td>2,729</td>
<td>29.4</td>
</tr>
<tr>
<td>Nuclear medicine</td>
<td>2,517</td>
<td>27.1</td>
</tr>
<tr>
<td>General radiography</td>
<td>2,408</td>
<td>25.9</td>
</tr>
<tr>
<td>Interventional radiology</td>
<td>1,812</td>
<td>19.5</td>
</tr>
<tr>
<td>Mammmography</td>
<td>1,715</td>
<td>18.5</td>
</tr>
<tr>
<td>Ultrasound</td>
<td>900</td>
<td>6.5</td>
</tr>
<tr>
<td>Cardiac</td>
<td>421</td>
<td>4.5</td>
</tr>
<tr>
<td>Catherization</td>
<td>241</td>
<td>-</td>
</tr>
<tr>
<td>None of these use ionizing radiation</td>
<td>270</td>
<td>2.9</td>
</tr>
<tr>
<td>Report knowing the radiation dose received</td>
<td>5,122</td>
<td>55.2</td>
</tr>
</tbody>
</table>

Note: Respondents who answered “do not know” were not presented with the other response options listed in the table. This question appeared on both the initial survey (5,462 respondents) and the nonresponder survey (3,825 respondents).
Ionizing Radiation Knowledge Among Emergency Department Providers

Noah Dzikofsky, MD, Haris N. Shekhani, MD, Megan Cloutier, MD, Zhengjia Nelson Chen, PhD, Chao Zhang, PhD, Tarek N. Hanna, MD

Abstract

Purpose: The aim of this study was to assess knowledge of ionizing radiation exposure from diagnostic imaging examinations among emergency department (ED) providers.

Methods: An electronic questionnaire was distributed to ED providers in a five-hospital university-affiliated health care system. Providers included attending emergency medicine (EM) physicians, EM residents, and midlevel providers (MLPs) (nurse practitioners and physicians assistants). Data were collected and analyzed.

Results: One hundred six of 210 providers (41 attending physicians, 32 residents, and 31 MLPs) completed the survey, for a response rate of 50.5%. More than two in five providers (44.6%) could not correctly identify which of six common imaging modalities used ionizing radiation. MLPs were more likely to incorrectly identify radiography (25%) and fluoroscopy (29%) as modalities that did not use ionizing radiation ($P = .01$ and $P = .25$ respectively). Fewer attending physicians (14.6%) than residents (37.5%) were not very comfortable or were uncomfortable explaining the risks of radiation to patients. Nearly half of attending physicians (47.5%) and nearly three-quarters of residents (71.9%) were not very comfortable, were uncomfortable, or were extremely uncomfortable explaining the amount of radiation in certain imaging tests to patients. MLPs were more likely to incorrectly rank a selection of imaging tests by radiation exposure ($P = .002$). MLPs were more likely to incorrectly answer a question on the effects of ionizing radiation on patients ($P = .01$).

Conclusions: Among ED providers, there are knowledge gaps regarding the presence and effect of ionizing radiation in diagnostic imaging tests. MLPs were more likely to make factual errors, while EM residents were least comfortable counseling patients about radiation risks.

Key Words: Radiology, emergency department, radiation, medical imaging
“Nearly half of attending physicians (47.5%) and nearly three-quarters of residents (71.9%) were not very comfortable, were uncomfortable, or were extremely uncomfortable explaining the amount of radiation in certain imaging tests to patients.”
Fig 2. Answers to the question “How comfortable are you in explaining the risks of radiation exposure to a patient?” presented by provider type. MLP = midlevel provider.

Fig 3. Answers to the question “How comfortable are you in explaining the amount of radiation in a given imaging test to a patient?” presented by provider type. MLP = midlevel provider.
Fig 1. What imaging modalities use ionizing radiation? For the modality bars, red is the percentage of providers who correctly identified if ionizing radiation was used, while blue denotes incorrect responses. The first bar is a summation: 55.45% of providers had all six responses correct, 29.7% had five of six responses correct, 5.94% had four of six correct, and so on. NM = nuclear medicine; US = ultrasound.
CONCLUSION. Despite growing concerns regarding medical radiation exposure, there is still limited awareness of radiation-induced cancer risks among patients and physicians. There is also no consensus regarding who should provide patients with relevant information, as well as in what specific situations and exactly what information should be communicated.

Radiologists [the imaging team] should prioritize development of consensus statements and novel educational initiatives with regard to radiation-induced cancer risk awareness and communication.
### TABLE 3: Physician Understanding of the Ionizing Radiation Risk of Ultrasound and MRI

<table>
<thead>
<tr>
<th>Reference</th>
<th>Year</th>
<th>Location</th>
<th>Method</th>
<th>Population</th>
<th>Ultrasound</th>
<th>MRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shiralkar et al. [27]</td>
<td>2003</td>
<td>England</td>
<td>Written survey</td>
<td>130 physicians (120 nonradiologists, 10 radiologists)</td>
<td>6/130 (5)</td>
<td>11/130 (8)</td>
</tr>
<tr>
<td>Jacob et. al. [12]</td>
<td>2004</td>
<td>England</td>
<td>Written survey</td>
<td>240 physicians (218 nonradiologists, 22 radiologists)</td>
<td>23/240 (10)</td>
<td>68/240 (28)</td>
</tr>
<tr>
<td>Thomas et al. [14]</td>
<td>2006</td>
<td>Canada</td>
<td>Written survey</td>
<td>220 pediatricians</td>
<td>8/220 (4)</td>
<td>—</td>
</tr>
<tr>
<td>Soye and Paterson [17]</td>
<td>2008</td>
<td>England</td>
<td>Written survey</td>
<td>153 physicians (140 nonradiologist, 13 radiologists)</td>
<td>15/153 (10)</td>
<td>34/153 (22)</td>
</tr>
<tr>
<td>McCusker et al. [18]</td>
<td>2009</td>
<td>Ireland</td>
<td>Written survey</td>
<td>269 medical students and junior physicians</td>
<td>—</td>
<td>73/269 (27)</td>
</tr>
<tr>
<td>Heyer et al. [24]</td>
<td>2010</td>
<td>Germany</td>
<td>Written survey</td>
<td>134 pediatricians</td>
<td>—</td>
<td>19/134 (14)</td>
</tr>
<tr>
<td>Bosanquet et al. [28]</td>
<td>2011</td>
<td>England</td>
<td>Written survey</td>
<td>112 physicians</td>
<td>16/112 (14)</td>
<td>15/100 (15)</td>
</tr>
<tr>
<td>Uri [21]</td>
<td>2012</td>
<td>UK</td>
<td>Online survey</td>
<td>100 physicians</td>
<td>15/100 (15)</td>
<td>15/100 (15)</td>
</tr>
</tbody>
</table>

Note—UK = United Kingdom. Numeric data are given as no. (%), where numbers represent participants who believed ultrasound or MRI emitted ionizing radiation. Dash indicates not reported. Numbers may not add up owing to rounding.

Population noted was the total number included in the data analysis of the study, and the denominators for the reported results are based on the number of respondents per survey question.

Extrapolated from reported percentages.

This study did not separate ultrasound and MRI results and thus was not included in our weighted averages.
What’s in a name?

Understanding CT: Health Care Provider Knowledge ofComputed Tomography Radiation Dose and Associated Risks

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b Department of Radiology, Royal University Hospital, University of Saskatchewan, Saskatoon, Saskatchewan, Canada
c Department of Community Health & Epidemiology, College of Medicine, University of Saskatchewan, Saskatoon, Saskatchewan, Canada
d Department of Community Health & Epidemiology, Clinical Research Support Unit, College of Medicine, University of Saskatchewan, Saskatoon, Saskatchewan, Canada
This bill would, commencing July 1, 2012, require hospitals and clinics, as specified, that use computed tomography (CT) X-ray systems for human use to record, if the CT systems are capable, the dose of radiation on every CT study produced during the administration of a CT examination, as specified. The bill would require the dose to be verified annually by a medical physicist, as specified, unless the facility is accredited.
July 2015, TJC mandates that:

1. “The [hospital/practice] documents the radiation dose (CTDI$_{vol}$ or DLP) on every study produced during a computed tomography (CT) examination. The radiation dose must be exam specific, summarized by series or anatomic area, and documented in a retrievable format.”, and

2. “The [hospital/practice] reviews and analyzes incidents where the radiation dose (CTDI$_{vol}$ or DLP) emitted by the computed tomography (CT) imaging system during diagnostic CT exams exceeded expected dose ranges identified in imaging protocols.”
NEMA Standard Attributes on CT Equipment Related to Dose Optimization and Management (XR-29)

- DICOM structured dose reporting,
- A CT Dose Check feature for dose alerts and notifications,
- Automatic Exposure Control (AEC) to help manage radiation dose and image quality, and
- Reference Adult and Pediatric Protocols “pre-loaded”

Not Meeting Guidelines:
- January 2016: 5% reimbursement reduction
- January 2017: 15% reimbursement reduction
Radiation Protection Guidance for Diagnostic and Interventional X-Ray Procedures
Federal Guidance Report No. 14

CT: pages 58-64

Updated the interpretive guidelines for the hospital Conditions of Participation (CoPs) for the below to reflect current accepted standards of practice.

Background

Radiologic and nuclear medicine services have improved the ability to detect and treat a wide

... “updated the interpretive guidelines for the hospital Conditions of Participation (CoPs) for the below to reflect current accepted standards of practice”
Benefit of imaging
Informed use, not just “reduction”
  – Sometimes more is better
Certainty about risk uncertainty
Content \textit{and} delivery
Consensus responsibility
Ionizing Radiation
Dialogue should emphasize

• Benefit of imaging
• Informed use, not just “reduction”
  – Sometimes more is better
• Certainty about risk uncertainty
• Content *and* delivery
• Consensus responsibility
Content is important...

- Image Gently
- Image Wisely
- RadiologyInfo.org
Tenets: Should Remember

- Imaging (CT) is beneficial
- We have responsibility to inform
- Patient rights: engage patients
- Content is important
Tenets: Should Remember

- Imaging (CT) is beneficial
- We have responsibility to inform
- Patient rights: engage patients
- Content is important
- Delivery is equally important
  - when, who, how
Communicating With Children and Families: From Everyday Decision-Making Skill in Conveying Distressing Information
Marcia Levetown
Pediatrics 2008;121:e1441
DOI: 10.1542/peds.2008-0565

The online version of this article, along with updated information about this article, is located on the World Wide Web at:
http://pediatrics.aappublications.org/content/121/5/e1441.full

### TABLE 1  Physician “Competencies” for Health Care Communication

1. Develop a partnership with the patient
2. Establish or review the patient’s preferences for information
3. Establish or review the patient’s preferences for his or her role in decision making
4. Ascertain and respond to the patient’s ideas, concerns, and expectations
5. Identify choices (including those suggested by the patient) and evaluate research in relation to the individual patient
6. Present information and assist the patient to reflect on the impact of alternate decisions with regard to his or her lifestyle and values
7. Negotiate a decision with the patient
8. Agree on an action plan and complete arrangements for follow-up
Effective Communication

- **Informativeness**: quantity and quality of health information provided by the physician; be informed.

- **Interpersonal sensitivity**: affective behaviors that reflect the doctor’s attention to, and interest in, the parents’ and child’s feelings and concerns; be sensitive.

- **Partnership building**: the extent to which the physician invites the parents (and child) to state their concerns, perspectives, and suggestions during the consultation. be engaging.
Ionizing Radiation
Dialogue should emphasize

- Benefit of imaging
- Informed use, not just “reduction”
  - Sometimes more is better
- Certainty about risk uncertainty
- Content and delivery
- Consensus responsibility
Have-A-Heart Campaign

- Presentations: May 2017
- Publications going to
  - Pediatric Radiology (Rigsby lead)
  - JACC-I (Hill lead)
Have-A-Heart Campaign: JACC-I


Endorsed by the American College of Cardiology (ACC), American College of Radiology (ACR), American Academy of Pediatrics (AAP), American Society of Nuclear Cardiology (ASNC), American Society of Radiologic Technologists (ASRT), American Association of Physicists in Medicine (AAPM), Heart Rhythm Society (HRS), North American Society for Cardiovascular Imaging (NASCI), Pediatric and Congenital Electrophysiology Society (PACES), Society for Cardiac Angiography and Interventions (SCAI), Society for Cardiovascular Computed Tomography (SCCT), Society for Pediatric Radiology (SPR), and Society of Nuclear Medicine and Molecular Imaging (SNMMI).

Kevin D. Hill, MD, MS, Donald P. Frush, MD, B. Kelly Han, MD, Brian G. Abbott, MD, Aimee K. Armstrong, MD, Rob DeKemp, PhD, Andrew C. Glatz, MD, MS, S. Bruce Greenberg, MD, Alexander Sheldon Herbert, RT, Henri Justino, MD, Douglas Mah, MD, Mahadevappa Mahesh, PhD, Cindy Rigsby, MD, Timothy C. Slesnick, MD, Keith J. Strauss, MS, Sigal Trattner, PhD, Mohan N. Viswanathan, MD, and Andrew J. Einstein, MD, PhD on behalf of the Image Gently Alliance

From the aDepartment of Pediatrics, Duke University Medical Center, (Image Gently Alliance representative), bDepartment of Radiology, Duke University Medical Center (Image Gently Alliance and SPR representative), cDepartment of Radiology, Children’s Heart Clinic at The Children’s Hospitals and Clinics of Minnesota (SCCT representative), dDepartment of Medicine, Warren Alpert Medical School of Brown University (ASNC representative), eDepartment of Pediatrics, Nationwide Children’s Hospital, Ohio State University (ACC representative), fDepartment of Engineering and Physics, University of Ottawa (SNMMI representative), gDepartment of Pediatrics, Children’s Hospital of Philadelphia, Perelman School of Medicine at the University of Pennsylvania (Image Gently Alliance representative), hDepartment of Radiology, Arkansas Children’s Hospital, Little Rock, Arkansas (NASCI representative), iDepartment of Radiology, New York-Presbyterian Morgan Stanley Children’s Hospital Image (ASRT representative), jDepartment of Pediatrics, Texas Children’s Hospital, Baylor College of Medicine (SCAI representative), kDepartment of Pediatrics, Boston Children’s Hospital (HRS representative), lDepartment of Radiology and Radiological Science, The Johns Hopkins University School of Medicine (AAPM representative), mDepartment of Radiology, Ann and Robert H Lurie Children’s Hospital of Chicago (ACR representative), nDepartment of Pediatrics, Children’s Healthcare of Atlanta, Emory University School of Medicine (AAP representative), oDepartment of Radiology, Cincinnati Children’s Hospital Medical Center (Image Gently Alliance Representative), pDivision of Cardiology, Department of Medicine, Columbia University Medical Center (Image Gently Alliance representative), qDepartment of Internal Medicine, Stanford University (PACES representative), and rDivision of Cardiology, Department of Medicine, and Department of Radiology, Columbia University Medical Center and New York-Presbyterian Hospital (Image Gently Alliance representative)
The Radiation Dose Conundrum: Reconciling Imaging, Imagining and Managing

- Imaging is useful
- Misunderstanding radiation continues
- Rethink approach
  - Be informed; delivery of this information important
  - Mindful, *assuring* dialogue