Radiation Risk
Communications and Conversations: Providing Care or Promoting Scare?

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No Disclosures

AAPM 2016 JUL 31–AUG 4
COMMUNICATING OUR VALUE. IMPROVING OUR FUTURE.
58TH ANNUAL MEETING & EXHIBITION | WASHINGTON, DC
• No risk discussion, but...
• Landscape
  – What is said
  – What is heard
• Messaging
• No risk discussion, but...

• Landscape
  – What is said
  – What is heard

• Messaging
Facts

• Radiation in diagnostic imaging is a “hot” topic
• Public and caregivers remain concerned
• There is mis-information
• The “harm and alarm” voice is loud
“We value virtue but do not discuss it. The honest bookkeeper, the faithful wife [or husband], the earnest scholar get little of our attention compared to the embezzler, the tramp, the cheat.”
We Are Giving Ourselves Cancer

By RITA F. REDBERG and REBECCA SMITH-BINDMAN JAN. 30, 2014

DESPITE great strides in prevention and treatment, cancer rates remain stubbornly high and may soon surpass heart disease as the leading cause of death in the United States. Increasingly, we and many other experts believe that an important culprit may be our own medical practices: We are silently irradiating ourselves to death.

The use of medical imaging with high-dose radiation — CT scans in particular — has soared in the last 20 years. Our resulting exposure to medical radiation

Neither doctors nor patients want to return to the days before CT scans. But we need to find ways to use them without killing people in the process.

radiation doses of CT scans (a series of X-ray images from multiple angles) are 100 to 1,000 times higher than conventional X-rays.

Of course, early diagnosis thanks to medical imaging can be lifesaving. But there is distressingly little evidence of
Radiologist: “As many as 1 in 300 children who get a CT scan of the abdomen, chest or spine will eventually develop a tumor as a result of the radiation…”

And, from USA accreditation authority in 2016 “…consensus opinion that … there is harm at low doses”
Consumer Reports: Surprising Dangers of CT Scans and X-rays ...

"that about one-third of those scans serve little if any medical purpose"
ALARA, Image Gently and CT-induced cancer

Mervyn D. Cohen

Introduction

The term As Low As Reasonably Achievable (ALARA) goes back to articles in 1980, 1986 and 1999 [1-3]. In 2001, a group of inspired pediatric radiologists introduced the ALARA concept into routine clinical radiology practice [4-7]. The ALARA and the Image Gently campaigns have been very successful in achieving their goals of reducing unnecessary imaging and radiation exposure, inspiring the development of new technology, and expanding our understanding of measuring radiation dose in humans [6-15].

ALARA and Image Gently evolved from a belief that even incidence from the survivors of the atom bomb can be extrapolated back in a linear fashion to cancer risk from tiny radiation doses. This threshold exists for cancer risk from radiation linear no threshold theory. With new data from survivors, this linear no threshold theory is being challenged [16-20]. Finally, I will discuss radiological studies that have linked CT to cancer, must be interpreted with great caution. I will pediatric radiologist with information regarding ALARA and Image Gently, and referring physicians.

Table 1 Media comments on the 2012 Pearce Lancet article, “Radiation exposure from CT scans in childhood and subsequent risk of leukemia and brain tumours: a retrospective cohort study” [32]

“CT scans in kids linked to leukemia, brain cancer risk”
ABC World News, June 6, 2012
“CT scans increase children’s cancer risk, study finds”
“CT scans boost cancer risks for kids”
National Public Radio (NPR), June 7, 2012
“CT scans warning after study claims too many could lead to brain cancer”
Guardian newspaper (UK), June 6, 2012
“CT scans can triple the risk of children getting leukemia”
The Times Newspaper (London), June 7, 2012
“CT scans could triple risk of a brain tumour in children”
The Telegraph Newspaper (London), June 7, 2012
“Multiple CT scans on children can increase risk of developing cancer”
BBC News, 7 June 7, 2012
“CT scans on children could triple brain cancer risk”
BBC News, June 6, 2012
“CT scans in children raise risk of cancer”
American Cancer Society, June 7, 2012
“Multiple CT scans in kids triples cancer risk, but researchers caution overall risk low”
CBS News, June 7, 2012
“Child CT scans could raise cancer risk slightly”
USA Today, June 6, 2012
“Childhood CT scans may raise brain cancer, leukemia risks slightly”
Huffington Post, June 6, 2012
“NIH study finds childhood CT scans linked to leukemia and brain cancer later in life”
National Institute of Health NIH News, June 7, 2012
“Child CT scans may up risk of brain cancer, leukemia”
U.S. News and World Report, June 7, 2012
“Children’s CT scans pose cancer risk”
Wall Street Journal, June 7, 2012
CT Scans May Reduce Rather than Increase the Risk of Cancer

Bobby R. Scott, Ph.D.
Charles L. Sanders, Ph.D.
Ron E. J. Mitchel, Ph.D.
Douglas R. Boreham, Ph.D.

ABSTRACT

Extrapolating from data on atomic bomb survivors on the basis of the linear no-threshold (LNT) model as applied to radiation exposure, a recent paper concludes that within a few decades 1.5–2 percent of all cancers in the U.S. population could be caused by current rates of use of computed tomography (CT). This paper ignores the other war-related exposures of the Japanese population, which would be expected to shift the dose-response relationship for cancer induction to the left. Moreover, the LNT model is shown to fail in four tests involving low-dose radiation exposures. Considering the available information, we conclude that CT scans may reduce rather than increase lifetime cancer risk.

Introduction

In a Nov 29, 2007, article in the New England Journal of Medicine, Brenner and Hall argue that the potential carcinogenic effects from using computed tomography (CT) may be underestimated and that one-third of all CT scans performed in the United States may not be medically necessary. They estimated that more than 62 million CT scans per year are currently done in the United States as compared to 3 million in 1980. With such an increased rate Brenner and Hall speculate, based on extrapolations from cancer data derived from survivors of the atomic bomb

defenses. This effect has been called radiation activated natural protection (ANP). Radiation ANP includes selective removal of aberrant cells (e.g., precancerous cells) via apoptosis and stimulated immunity against cancer cells. Thus, radiation ANP can prevent some cancers (sporadic and hereditary) that would otherwise occur in the absence of radiation exposure. Recent papers by Bauer and by Portess et al. describe how low-dose radiation activates the selective removal of precancerous cells via apoptosis. The selective removal is mediated via intercellular signaling involving reactive oxygen and nitrogen species and specific cytokines (e.g., transforming growth factor β).

Numerous papers have been published related to low-dose radiation stimulating immunity against cancer cells. Because of radiation ANP, low doses and low-dose rates of x-rays and gamma rays can actually reduce rather than increase cancer occurrences. Conversely, high radiation doses suppress immunity and inhibit selective removal of aberrant cells via apoptosis, leading to an increase in the number of cancer cases to a rate greater than the spontaneous level.

Extrapolating Observed Radiation Effects from High to Low Doses

In order to obtain lifetime cancer risk predictions from small radiation doses such as those received from CT scans, many researchers extrapolate the risk from observed effects after moderate and high radiation doses using the LNT model. With this model, any amount of radiation is considered to cause some cancer fatalities in any large irradiated population. Doubling the radiation
“Risk of ALL was elevated in children exposed to three or more postnatal x-rays...”
Lancet June 2012
First direct assoc of CT and cancer

Increased risk of leukemia and brain tumors with childhood CT

“1 additional brain tumor per 10,000 childhood brain CTs”
Risk of cancer incidence before the age of 15 years after exposure to ionising radiation from computed tomography: results from a German cohort study


Received: 12 August 2014/Accepted: 12 December 2014/Published online: 8 January 2015

Abstract: The aim of this cohort study was to assess the risk of developing cancer, specifically leukaemia, tumours of the central nervous system and lymphoma, before the age of 15 years in children previously exposed to computed tomography (CT) in Germany. Data for children with at least one CT between 1980 and 2010 were abstracted from 20 hospitals. Cancer cases occurring between 1980 and 2010 were identified by stochastic linkage with the German Childhood Cancer Registry (GCCCR). For all cases and a sample of non-cases, radiology reports were reviewed to assess the underlying medical conditions at time of the CT. Cases were only included if diagnosis occurred at least 2 years after the first CT and no signs of cancer were recorded in the radiology reports. Standardised incidence ratios (SIR) using incidence rates from the general population were estimated. The cohort included information on 71,073 CT examinations in 44,584 children contributing 161,407 person-years at risk with 46 cases initially identified through linkage with the GCCCR. Seven cases had to be excluded due to signs possibly suggestive of cancer at the time of first CT. Overall, more cancer cases were observed (O) than expected (E), but this was mainly driven by unexpected and possibly biased results for lymphomas. For leukaemia, the SIR (SIR = O/E) was 1.72 (95% CI 0.89–3.01, O = 12), and for CNS tumours, the SIR was 1.25 (95% CI 0.58–2.78, O = 7). Despite careful examination of the medical information, confounding by induction or reverse causation cannot be ruled out.

Although...

BJC: “This study suggests that the indication for examinations, whether suspected cancer or [predisposing factors] management, should be considered to avoid overestimation of the cancer risks associated with CT scans.”
Recently…

----Original Message-----
From:
To: imagegently
Sent: Tue, Jan 26, 2016 10:25 am
Subject: 6 Month Old Skull X-rays

Dear Dr. Frush,

Yesterday our 6-month-old son pulled a cord by a coffee table, and a lamp fell onto him, hitting his head. Although bruised, he seemed all right. Nevertheless, we had him checked at the ER, where he was given 5 skull x-rays.

This radiation dose for such a young age had me concerned. Not knowing where to go with my questions, I found your website and would greatly appreciate any insight on how this may affect him. Some sources indicate that infant skull x-rays can damage IQ. Should we be worried?

Thank you kindly for any feedback you may provide.

Sincerely,
Content is important...

- Image Gently
- Image Wisely
- RadiologyInfo.org
Global validation of need for communication and education
Tenets: Should Remember

• Imaging (CT) is beneficial
• Professionalism: patient autonomy
• We have responsibility to inform
• Content is important
Tenets: Should Remember

- Imaging (CT) is beneficial
- Patient rights
- We have responsibility to inform
- Content is important
- **Delivery is equally important**
  - when, who, how

Legalplanet.wordpress.com
Medical (Imaging) Environment

- Potential lack of control (helplessness)
- Unfamiliarity
- Decisions for others
- High anxiety
- Sense of urgency
- Potential consequences
- Limited access
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)^b</td>
<td>68/240 (28)^b</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)^b</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)^b</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)^c</td>
<td>15/100 (15)^c</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)^c</td>
<td>15/100 (15)^c</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.

^aPopulation 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.

^bExtrapolated from reported percentages.

^cThis study did not separate ultrasound and MRI results and thus was not included in our weighted averages.
Risk Communication

- Uncertainty is a challenge to discuss
- Patient/caregiver perspectives are challenges
- Low probability generally overemphasized
What do parents hear when you say “1 in 2,000 risk of cancer”

1 in 2,000 = “my child” AND 1999 others
• No risk discussion, but...
• Landscape
  – What is said
  – What is heard
• Messaging
• Uncertainty is a challenge to discuss
• Patient/caregiver perspectives are challenges
• Low probability generally overemphasized
• Relative risks: many ways to frame
  - CXRs, other radiation, other life events, days lost
• Keep it (simple) direct, anticipate divergence
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;

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

- **Partnership building**: the extent to which the physician invites the parents (and child) to state their concerns, perspectives, and suggestions during the consultation.
“Truly informed medical decision-making that respects patient autonomy requires appropriate framing of radiation risks in perspective with other risks and with the benefits of imaging. To follow the principles of personalized medicine and treat patients according to their specific phenotypic and personality profiles, diagnostic imaging should optimally be tailored not only to patient size, body region and clinical indication, but also to underlying disease conditions, radio-sensitivity and risk perception and preferences that vary among individuals.”
Fletcher et al. Perspective on Radiation Risk in CT imaging. Abdominal Imaging 2012
Table 1. Clinical questions about risks of CT, with distilled answers

<table>
<thead>
<tr>
<th>Question (May Be Posed by Patient, or Framed by Physician)</th>
<th>Possible Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Why are you recommending CT?”</td>
<td></td>
</tr>
<tr>
<td>“Are there any risks of CT?”</td>
<td></td>
</tr>
<tr>
<td>“How great is this risk?”</td>
<td></td>
</tr>
<tr>
<td>“How does the risk from CT compare to the risk of [my child’s presenting condition]?”</td>
<td></td>
</tr>
<tr>
<td>“When will these risks be evident?”</td>
<td></td>
</tr>
<tr>
<td>“What is the safest course of action?”</td>
<td></td>
</tr>
<tr>
<td>“What are my options?”</td>
<td></td>
</tr>
</tbody>
</table>

“‘We need more information to clarify your child’s diagnosis, and to direct our treatment. CT can rapidly and accurately provide that information.’”

“One concern is the possibility of cancer resulting from radiation from CT.”

“The risk from CT is very small, if a risk at all. We are not certain that there is a risk at very low doses, like those doses in the vast majority of x-ray procedures or CT.”

“I have considered your current situation carefully, taking into account many factors.”

Depending on the circumstances:

- “I have significant concern that your child has an injury or serious medical condition. The risk of CT is at most very small by comparison, so CT is the right test to perform.”
- “At the present time, your child appears to have very low risk for a serious medical condition. Although the potential risks from CT are very small, CT is not the best test at this time. If your child’s condition worsens, CT might become necessary.”

“The risk of missing a serious diagnosis will occur now, in the coming minutes/hours/days. The effects from small radiation doses such as CT would take longer, even years, if these small risks exist.”

“Comparing the potential risks of CT against the risk of your child’s condition, the safest course is…”

“The options include performing CT now, or waiting. Other options include using a different medical test, such as ultrasound or MRI, performing surgery or medical therapy based on the information at hand (without CT), or watching for changes in your child’s condition. If your child’s condition worsens, CT may be necessary.”

*If the clinician cannot legitimately state that both diagnosis and treatment require CT, the decision to perform CT may warrant reconsideration.*
COMMUNICATING RADIATION RISK IN PAEDIATRIC IMAGING

What health care providers need to know to support risk-benefit dialogue

World Health Organization

April 2016
Message Mapping

- Tool for public health risk communication.
- Messages few in number (e.g., 3)
- Brief i.e., 9-10 words
- Language clear: 8th grade
- Layered, hierarchically organized:

  - anticipate the questions and concerns
  - organize in response to those questions and concerns
  - develop key messages and supporting information
<table>
<thead>
<tr>
<th>Stakeholder: parents</th>
<th>Anticipated question: How much radiation will my child receive from this head CT?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Key message 1</strong></td>
</tr>
<tr>
<td></td>
<td>This CT is recommended now to aid in diagnosis and guide the treatment of your child</td>
</tr>
<tr>
<td></td>
<td><strong>Key message 2</strong></td>
</tr>
<tr>
<td></td>
<td>Your child will receive the lowest possible dose without decreasing the diagnostic quality of the images</td>
</tr>
<tr>
<td></td>
<td><strong>Key message 3</strong></td>
</tr>
<tr>
<td></td>
<td>This CT is medically indicated and will be properly done, thus the benefits will outweigh the radiation risks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supporting Information 1-1</th>
<th>Supporting Information 2-1</th>
<th>Supporting Information 3-1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>We have evaluated the clinical condition of your child and agreed that we need to confirm the diagnosis to make a decision about the treatment (examples/stories)</td>
<td>There are many techniques to lower the dose without compromising the diagnosis (examples, visual communication)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The radiation dose will be small, similar to several months of exposure to natural background radiation (anal ogies, tables, visual communication)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supporting Information 1-2</th>
<th>Supporting Information 2-2</th>
<th>Supporting Information 3-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>We have considered alternative tests and agreed that this is the examination indicated for your child (referral guidelines)</td>
<td>This imaging facility uses equipment, protocols and techniques suitable for children (accreditation, audits)</td>
<td>The radiation risk is low and the likelihood of an adverse outcome (cancer risk) will be nearly the same as it is for any other child: lifetime cancer incidence risk of 35-40% (anal ogies, tables, pictorial resources for visual communication)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supporting Information 1-3</th>
<th>Supporting Information 2-3</th>
<th>Supporting Information 3-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>This examination has to be done now to avoid any delay in the treatment, in case the diagnosis is confirmed (examples, scientific data)</td>
<td>This facility periodically compares its doses with national and international reference values and stays within those ranges (paediatric DRLs)</td>
<td>The CT will be interpreted by imaging specialists trained to identify abnormalities and their significance. The report will be communicated to the referring physician who will make decisions about treatment and follow-up (stories, examples)</td>
</tr>
</tbody>
</table>

**WHO Communicating Radiation Risk in Pediatric Imaging 2016**
Your child may have a significant brain injury... so we need to do a CT scan

• Question: “I heard that CT scans can cause cancer. Will my son get cancer?”
  • Answer: “Possibly.”

• Question: “What is the radiation for the CT?”
  • Answer: “Relatively high; I don’t know exactly.”

• Question: “How do you do CT scans in children?”
  • Answer: “I don’t know.”

• Question: “How much medical radiation has he had?”
  • Answer: “I don’t know.”

...confidence?
What Should You Say?

1. That is a good question
2. I can answer that
3. We have (hopefully) expertise
   - know the doses
   - minimize radiation
4. This is a necessary/important exam
   - I avoid “numbers”
5. Other questions?
May 2016, 24 yr old professional:

“I don’t know how to use a house phone”
Imbalance of Opinions Expressed on Twitter Relating to CT Radiation Risk: An Opportunity for Increased Radiologist Representation

Objective: The purpose of this study was to assess perspectives and information relating to CT radiation risk on Twitter, a popular microblogging social network.

Materials and Methods: Publicly available posts on Twitter ("tweets") containing both the words "CT" and "radiation" were identified from the 1st week of each month in 2013. Type of user posting and source of linked articles were recorded. Two reviewers assessed the content of tweets and links regarding CT’s benefit-to-risk ratio (favorable, unfavorable, etc.).

Results: Six hundred twenty-two relevant tweets were tweeted by 357 unique users, of whom 90 (16%) were physicians (17 of these were radiologists), 30 (5%) were medical practices or hospitals, 34 (6%) were patients, 8 (1%) were physicists or technologists, and 395 (71%) were other types of users. Two hundred twenty-seven tweets included user commentary regarding CT’s benefit-to-risk ratio, of which 134 (59%) were unfavorable or concerned, 65 (29%) were

One recommendation was for more active engagement by radiologists on Twitter.
What About Consent?
2-2-11 Duke/UNC Survey:
34 Emergency Medicine MDs

- “Signed, informed consent for CT?”
  - 27 (79%) : No
  - 6 (18%)  : No opinion
  - 1 ( 3%)  : Yes, but then apologized for not understanding original question

... so, 0% wanted this consent
WHO Radiation Risk Communication in Paediatric Imaging
Informal Survey September 20th, 2010

- Patient/Parent Advocates
- Radiologists
- Medical Physicist
- Communication experts/officers
- Family Practitioners
- Pediatricians
- Regulators
- Nurses
- Technologists
- Ethicists
- Radiation Biologists
- Epidemiologists
- Radiation oncologists
- Public policy experts
Debriefing the Brief: It is Time for the Provision of Informed Consent before Pediatric CT

Diane M. Armoo, MD
J. Keith Smith, MD, PhD
Richard C. Semelka, MD

Informed Consent for Radiation Risk from CT Is Unjustified Based on the Current Scientific Evidence

H. Benjamin Harvey, MD, JD
James A. Brink, MD
Donald P. Frush, MD

Over the past several years, many sources of information have emerged regarding the potential risks of low-dose ionizing radiation from medical imaging. Many published educational materials and scientific studies have heightened awareness among patients, the public, and medical professionals. The press has extensively reported on this topic, sometimes omitting nuances regarding the strength of evidence supporting various statements or conclusions. With this background, some con-

The Evidence Regarding the Carcinogenicity of LDR

For many, the current interest in the risks of diagnostic radiation in the field of medicine started in 2006, when the Biological Effects of Ionizing Radiation (BEIR) VII report endorsed a linear no-threshold (LNT) risk model for low-dose radiation (LDR) based on available data (1). The LNT model states that the risk for cancer from radiation exposure proceeds in a linear fashion irrespective of the dose, without a threshold.
Will you discourage having the examination?
Informing Parents About CT Radiation Exposure in Children: It's OK to Tell Them

David B. Larson, Scott B. Redel, Howard P. Forman, Laura Z. Fenton

OBJECTIVE. The purpose of our study was to determine how parents' understanding of and willingness to allow their children to undergo CT change after receiving information regarding radiation dose and risk.

MATERIALS AND METHODS. One hundred parents of children undergoing non-emergent CT studies at a tertiary-care children's hospital were surveyed before and after reading an informational handout describing radiation risk. Parental knowledge of whether CT uses radiation or increases lifetime risk of cancer was assessed, as was willingness to permit their child to undergo both a CT examination that their child's doctor recommended and one for which their doctor thought observation might be equally effective.

RESULTS. Of the 100 parents who were surveyed, 66% believed CT uses radiation before reading the handout, versus 96% afterward (p < 0.01). Before reading the handout, 13% believed CT increases the lifetime risk of cancer, versus 86% afterward (p < 0.01). After reading the handout, parents became less willing to have their child undergo CT given a hypothetical situation in which their doctor believed that either CT or observation would be equally effective (p < 0.01), but their willingness to have their child undergo CT recommended by their doctor did not significantly change. After reading the handout, 62% of parents reported no change in level of concern. No parent refused or requested to defer CT after reading the handout.

CONCLUSION. A brief informational handout can improve parental understanding of the potential increased risk of cancer related to diagnostic CT without causing parents to refuse studies recommended by the referring physician.

Keywords: CT, pediatric imaging, radiation

DOI: 10.2214/AJR.07.02946

Released December 1, 2006; accepted after revisions March 28, 2007.

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3Department of Diagnostic Radiology, Yale School of Medicine, New Haven, CT.

AJR 2007; 189:371–376

© American Roentgen Ray Society

AJR 189, August 2007

TABLE 1: Reported Change in Understanding of Risks

<table>
<thead>
<tr>
<th>No. (%) of Parents</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 (28)</td>
<td>I already knew this before visiting my child’s doctor.</td>
</tr>
<tr>
<td>13 (13)</td>
<td>My child’s doctor explained all of this to me.</td>
</tr>
<tr>
<td>30 (30)</td>
<td>My child’s doctor explained some risks to me, but this information made it more clear.</td>
</tr>
<tr>
<td>29 (29)</td>
<td>All of this was new to me—my child’s doctor did not explain any of it.</td>
</tr>
<tr>
<td>100</td>
<td>Total</td>
</tr>
</tbody>
</table>

TABLE 2: Willingness to Allow Child to Undergo CT Before and After Reading Handout

<table>
<thead>
<tr>
<th>No. (%) of Parents Before</th>
<th>No. (%) of Parents After</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>67 (67)</td>
<td>51 (58)</td>
<td>Willing to allow CT, no concerns</td>
</tr>
<tr>
<td>32 (32)</td>
<td>40 (40)</td>
<td>Willing to allow CT, some concerns</td>
</tr>
<tr>
<td>1 (1)</td>
<td>2 (2)</td>
<td>Willing to allow CT, strong concerns</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>Unwilling to allow CT</td>
</tr>
<tr>
<td>100</td>
<td>99</td>
<td>Total</td>
</tr>
</tbody>
</table>

"NO"

Larson et al AJR 2007; 189
Dear Dr. Frush,

Thank you kindly for taking time out of your week to reply back to me on this issue. Our family's fears are allayed. Moreover, this experience and Image Gently have raised our awareness and clarified radiation in general amidst much online confusion.

Thank you very much again. Please have a blessed weekend yourself, sir.

Appreciatively,
Really?  Benefit Risk Balance?
Conclusions

• CT is invaluable
• Understand your audience
• Content *and delivery* must be considered