Note: This copy is for your personal non-commercial use only. To order presentation-ready copies for distribution to your colleagues or clients, contact us at *www.rsna.org/rsnarights.*

Patient Perspectives and Preferences for Communication of Medical Imaging Risks in a Cancer Care Setting[1]

Raymond H. Thornton, MD
Lawrence T. Dauer, PhD
Elyse Shuk, MA
Carma L. Bylund, PhD
Smita C. Banerjee, PhD
Erin Maloney, PhD[2]
Lindsey B. Fox, BS
Christopher M. Beattie, MPH
Hedvig Hricak, MD, PhD
Jennifer Hay, PhD

Purpose: To identify opportunities for improving patient-centered communication about diagnostic imaging tests that involve the use of radiation in a cancer care setting.

Materials and Methods: Institutional review board approval and informed consent were obtained for this HIPAA–compliant study. Patient knowledge, information sources, and communication preferences were assessed in six focus groups during 2012. The groups consisted of patients undergoing treatment for metastatic colorectal carcinoma, women treated within the past 6 months for early-stage breast carcinoma, men undergoing surveillance after testicular cancer treatment, parents of patients treated for stage I–III neuroblastoma, patients in a thoracic oncology survivorship program, and participants in a lung cancer screening program. A multidisciplinary research team performed thematic content analysis of focus group transcripts. High-level findings were summarized during consensus conferences.

Results: Although they were aware of the long-term risk of cancer from exposure to ionizing radiation, most participants reported that their health care provider did not initiate discussion about benefits and risks of radiation from imaging tests. Most patients obtained information by means of self-directed internet searches. Participants expressed gratitude for tests ("That CT saved my daughter's life," "I'd rather have the radiation dosage than being opened up"), yet they expressed concern about having to initiate discussions ("If you don't ask, nobody is going to tell you anything") and the desire to be offered information concerning the rationale for ordering specific imaging examinations, intervals for follow-up imaging, and testing alternatives. Participants believed that such information should be available routinely and that conversation with their personal physician or endorsed, readily available reference materials were ideal methods for information exchange. Understanding imaging radiation risks and active participation in decision making about imaging were especially important to cancer survivors.

Conclusion: A substantial gap exists between patient expectations and current practices for providing information about medical imaging tests that involve the use of radiation.

©RSNA, 2015

Online supplemental material is available for this article.

[1] From the Departments of Radiology (R.H.T., L.T.D., L.B.F., C.M.B., H.H.), Medical Physics (L.T.D.), and Psychiatry and Behavioral Sciences (E.S., C.L.B., S.C.B., E.M., J.H.), Memorial Sloan Kettering Cancer Center, 1275 York Ave, Suite H118, New York, NY 10065. Received December 19, 2013; revision requested January 24, 2014; revision received November 7; accepted December 10; final version accepted December 10. Supported by a Radiology Department Seed Grant and MSKCC Emergency Management Committee Funding. **Address correspondence to** R.H.T. (e-mail: *thorntor@mskcc.org*).

[2] **Current address:** Center of Excellence in Cancer Communication Research, Annenberg School for Communication, University of Pennsylvania, Philadelphia, Pa.

©RSNA, 2015

In 2001, the Institute of Medicine proposed that patient-centered care, defined as "care that is respectful of and responsive to individual patient preferences, needs, and values," must guide clinical decision making to ensure consistent, top-quality medical practice throughout the nation (1). Patient-centered medicine emphasizes the primacy of the patient perspective and the cooperative work that clinicians and patients must do to achieve the best outcomes (2,3).

Shared decision making implies a need for patient-physician discussions about the benefits and risks of medical imaging examinations that involve the use of radiation. Such discussions may be challenging. Although, to our knowledge, indisputable data are lacking, prevailing scientific consensus supports the assertion that exposure to even low doses of ionizing radiation may increase lifetime risk of cancer (4–6). Yet there is also evidence to support the position that these risks are either uncertain or extremely small for adults (7). Most commonly, patients do not receive information on the risks and benefits of diagnostic imaging examinations that involve the use of ionizing radiation (8,9), and studies of patient perspectives on this topic are, to our knowledge, limited to several surveys (10,11). To develop models for shared decision making about diagnostic imaging, we must understand the perspectives of patients for whom ionizing radiation exposure from medical imaging is an important concern.

We sought to evoke those perspectives in a series of focus groups and to analyze the data by means of qualitative methods, an approach considered optimal when studying the patients' point of view (12). Our objectives were to characterize the knowledge and beliefs of patients at an oncologic center about ionizing radiation from medical imaging and to determine the information sources available to them, the information that patients with cancer want, and how they prefer to receive it.

Advances in Knowledge

- Participants perceived clear benefits from undergoing imaging such as x-ray, CT, and nuclear medicine examinations.
- Patient knowledge regarding which imaging tests involve the use of ionizing radiation was highly variable and generally poor.
- Most participants were highly aware of risks associated with exposure to ionizing radiation, including the long-term risk of cancer.
- Benefit-risk discussions about ionizing radiation from medical imaging are rare and seldom initiated by clinicians, yet most participants expressed a desire to receive this information from their own doctor.
- In addition to information about risks, participants reported a desire for other information, including the rationale for ordering a specific imaging examination rather than alternative tests and the rationale for imaging frequency.

Implication for Patient Care

- Many participants preferred to discuss benefits and risks of radiation from medical imaging with their personal physician; because evidence indicates that nonradiologist physicians may not have adequate training in this topic, an opportunity exists to develop educational materials for physicians and patients for use in these discussions.

Materials and Methods

Sample

With approval from the institutional review board, Health Insurance Portability and Accountability Act compliance, and informed consent, focus group discussions were conducted with six distinct subsets of participants that varied according to cancer diagnosis, stage, and current disease status. Guidelines for qualitative research were used to design a sampling plan with an appropriate study size of 24–36 participants. A purposive sampling (13) strategy was used to evaluate responses representative of important sectors of our oncologic patient community, including those with colorectal, breast, testicular, thoracic, and pediatric cancers as well as participants in a cancer screening program. Groups consisted of *(a)* patients undergoing chemotherapy for stage IV colorectal carcinoma, *(b)* women with early-stage breast cancer who had received up to 6 months of treatment, *(c)* men undergoing surveillance imaging after treatment for testicular cancer, *(d)* men and women enrolled in a thoracic cancer survivorship program, *(e)* men and women enrolled in a lung cancer screening program, and *(f)* parents of pediatric patients who were treated previously for stage I–III neuroblastoma. Clinicians specializing in gastrointestinal oncology, breast surgery, urology, pediatrics, pulmonology, and thoracic surgery agreed to identify potential study participants from their outpatient clinics. This work was supported by general research grants from Memorial Sloan Kettering Cancer Center (New York, NY), where all of the authors are employees. All authors had control of the data and the information submitted for publication.

Recruitment Strategy

To maximize opportunities for each participant to share individual viewpoints

Published online before print
10.1148/radiol.15132905 **Content codes:** HP OI SQ

Radiology 2015; 275:545–552

Author contributions:
Guarantors of integrity of entire study, R.H.T., S.C.B., E.M., J.H.; study concepts/study design or data acquisition or data analysis/interpretation, all authors; manuscript drafting or manuscript revision for important intellectual content, all authors; approval of final version of submitted manuscript, all authors; literature research, R.H.T., L.T.D., S.C.B., E.M., J.H.; clinical studies, R.H.T., L.T.D., H.H., J.H.; experimental studies, R.H.T.; statistical analysis, E.S., J.H.; and manuscript editing, R.H.T., L.T.D., E.S., S.C.B., E.M., L.B.F., H.H., J.H.

Conflicts of interest are listed at the end of this article.

during the 90-minute sessions, up to six participants were recruited per group. Study participants were recruited by a research study assistant (L.B.F. or C.M.B., with 2 and 4 years of experience, respectively) either in person during a clinic visit (for treatment of colorectal, breast, or testicular cancer, or for participation in lung cancer survivor groups) or by means of telephone follow-up to a recruitment letter (patients undergoing lung cancer screening, parents of neuroblastoma patients). Of 234 individuals approached in 7 months (152 in the clinic, 82 by mail), 37 (15.8%) agreed to participate. Six individuals did not attend their scheduled focus group, and one refused to sign the consent form because of confidentiality concerns, precluding participation. Thus, 30 individuals participated in the study. Each participant received $25.

Data Collection

A trained specialist in qualitative methods (E.S., with 15 years of experience) moderated each focus group according to established techniques (14,15). A focus group guide (ie, a uniform set of open-ended questions and discussion prompts) was developed to probe for participants' knowledge, attitudes, and information sources about medical imaging examinations that involve the use of radiation; satisfaction with risk-benefit communication; and desire for information about medical imaging (Appendix E1 [online]). Sessions lasted approximately 90 minutes. At the conclusion of each session, either a radiologist (R.H.T., with 12 years of experience) or a medical physicist (L.T.D., with 25 years of experience) answered participant questions and/or clarified any misconceptions. All discussions were audio recorded and transcribed for analysis.

Qualitative Analysis

Transcripts were reviewed by using inductive thematic textual analysis, an iterative process of transcript review, interpretation, and consensus discussions (12,16–19). The analysis team consisted of a radiologist (R.H.T.), a medical physicist (L.T.D.), a clinical health psychologist (J.H., with 10 years of experience), a behavioral scientist (S.C.B., with 5 years of experience), postdoctoral research fellows (C.L.B. and E.M., with 7 and 2 years of experience, respectively), a qualitative methods specialist (E.S.), and research study assistants (L.B.F. and C.M.B). Initially, each member read the same transcript independently, identifying important content and emerging themes (20). Each prepared a summary written analysis. Next, the entire team met to generate collective, consensus findings for each focus group transcript. In the final analytic phase, higher-order descriptive and interpretive themes were generated to summarize key findings within each group and throughout all focus groups.

Results

The sample (n = 30) was primarily female (60%), white (80%), well educated (90% with college degrees), married (50%), and employed (52% working full time or part time). See Table 1 for full demographic information. More than 9 hours of conversation were transcribed for analysis. Six themes were identified as key, high-level findings of the entire study. Participant quotations illustrating these themes can be found in Table E1 (online).

Knowledge about Imaging Tests and Ionizing Radiation

Knowledge about imaging tests, including knowledge of which imaging tests involve the use of ionizing radiation, was highly variable. Participants in three groups (survivors of testicular and lung cancer and patients undergoing screening for lung cancer screening) were more knowledgeable about which medical imaging tests involved the use of ionizing radiation than were participants in the other three groups (patients with breast or colorectal cancer and parents of patients with neuroblastoma). Overall, x-ray examinations, computed tomography (CT), and positron emission tomography (PET) were more uniformly understood to deliver ionizing radiation than were mammography, bone scanning, or stress tests. Many participants were uncertain whether magnetic resonance (MR) imaging involved ionizing radiation. Less knowledgeable participants lacked understanding of how tests differed; the benefit an imaging test had in relation to another; and which tests delivered higher ionizing radiation doses. This lack of comprehension caused uncertainty and frustration for some participants, who questioned why several different imaging tests were needed and worried that some tests unnecessarily duplicated others. Some believed that a single best imaging test existed. Ionizing radiation from diagnostic medical imaging occasionally was confused with radiation therapy, and some participants seemed unable to distinguish between these.

Perception of the Benefit of Medical Imaging

Medical imaging was perceived to be highly beneficial. Participants described the primary benefit of imaging tests such as CT to be noninvasive diagnosis and early detection of disease. Those whose cancers had been detected by means of imaging associated very high value to imaging and felt no need to inquire about long-term risks from ionizing radiation. Comments such as "I owe my life to an x-ray," or "I might not be here (without that CT scan)" exemplified this perspective. Many participants emphasized that imaging reports were a patient's most important evidence of treatment efficacy. The psychological benefit of good results provided powerful and reassuring confirmation of well-being. Such benefits overpowered concerns about long-term risks.

Long-term Risks of Ionizing Radiation versus Immediate Concerns

Long-term potential risks of ionizing radiation from medical imaging were widely acknowledged, but participants emphasized the importance of their immediate concerns. Most believed that exposure to ionizing radiation could cause cancer in the long term. Repetitive imaging, such as the quarterly CT scans patients undergo during many chemotherapy treatments, caused

Demographic Characteristics by Focus Group

Demographic Characteristic	Colorectal Cancer ($n = 5$)	Testicular Cancer ($n = 5$)	Breast Cancer ($n = 6$)	Neuroblastoma ($n = 3$)*	Thoracic Cancer ($n = 5$)†	Lung Cancer ($n = 6$)‡	All ($n = 30$)
Age (y)§	53.2 ± 11.1	40.8 ± 6.8	59.7 ± 7.7	45.7 ± 5.5	61.8 ± 9.6	73.5 ± 2.3	57.2 ± 13.1
Sex							
Male	4 (80)	5 (100)	0 (0)	0 (0)	1 (20)	2 (33)	12 (40)
Female	1 (20)	0 (0)	6 (100)	3 (100)	4 (80)	4 (67)	18 (60)
Race or ethnicity							
White	3 (60)	4 (80)	6 (100)	1 (33)	4 (80)	6 (100)	24 (80)
Hispanic	1 (20)	1 (20)	0 (0)	1 (33)	0 (0)	0 (0)	3 (10)
Black	0 (0)	0 (0)	0 (0)	1 (33)	0 (0)	0 (0)	1 (3)
Asian	0 (0)	0 (0)	0 (0)	0 (0)	1 (20)	0 (0)	1 (3)
Other	1 (20)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (3)
Employment							
None	1 (20)	0 (0)	1 (17)	0 (0)	1 (20)	3 (50)	6 (20)
Full time	3 (60)	4 (80)	3 (50)	1 (33)	2 (40)	2 (33)	15 (50)
Part time	0 (0)	0 (0)	1 (17)	1 (33)	1 (20)	0 (0)	3 (10)
Family care	1 (20)	0 (0)	1 (17)	1 (33)	1 (20)	0 (0)	4 (13)
Other	0 (0)	1 (20)	0 (0)	0 (0)	0 (0)	1 (17)	2 (7)
Education							
High School	1 (20)	0 (0)	1 (17)	0 (0)	0 (0)	0 (0)	2 (7)
Technical	0 (0)	0 (0)	0 (0)	1 (33)	0 (0)	0 (0)	1 (3)
Undergraduate	2 (40)	4 (80)	3 (50)	0 (0)	2 (40)	0 (0)	11 (37)
Postgraduate	2 (40)	1 (20)	2 (33)	1 (33)	3 (60)	6 (100)	15 (50)
Other	0 (0)	0 (0)	0 (0)	1 (33)	0 (0)	0 (0)	1 (3)
Marital status							
Single	0 (0)	4 (80)	3 (50)	1 (33)	2 (40)	1 (17)	11 (37)
Cohabitating	0 (0)	1 (20)	0 (0)	0 (0)	0 (0)	0 (0)	1 (3)
Married	5 (100)	0 (0)	2 (33)	2 (67)	2 (40)	4 (67)	15 (50)
Widowed	0 (0)	0 (0)	1 (17)	0 (0)	0 (0)	0 (0)	1 (3)
Divorced or separated	0 (0)	0 (0)	0 (0)	0 (0)	1 (20)	1 (17)	2 (7)
Disease status							
Stage IV	5 (100)	NA	NA	NA	NA	NA	5 (17)
Mixed germ cell tumors	NA	4 (80)	NA	NA	NA	NA	4 (13)
Seminoma	NA	1 (20)	NA	NA	NA	NA	1 (3)
Stage I	NA	NA	5 (83)	NA	NA	NA	5 (17)
Stage II	NA	NA	1 (17)	NA	NA	NA	1 (3)
Stages I–III	NA	NA	NA	3 (100)	NA	NA	3 (10)
Stages IA and IB	NA	NA	NA	NA	3 (60)	NA	3 (10)
Thymoma	NA	NA	NA	NA	1 (20)	NA	1 (3)
Stage IIIB	NA	NA	NA	NA	1 (20)	NA	1 (3)

Note.—Unless otherwise indicated, data are number of patients, with percentage in parentheses. NA = not applicable.

* Data are for parents of pediatric patients.

† Data are for survivors.

‡ Data are for patients who underwent screening.

§ Data are means ± standard deviation.

some to worry about cumulative ionizing radiation risks. Participants often redirected discussions of potential long-term risks to express concerns about short-term risks such as the potential for kidney damage from intravenous contrast material and safety concerns about excretion of radioactive tracers. Parents of survivors of neuroblastoma were most concerned about the immediate risks of anesthesia during pediatric imaging. Psychological distress was repeatedly identified as a salient short-term risk of the imaging process for cancer patients. A period of escalating pretest anxiety was commonly described. The experience of being imaged was characterized as "lonely,"

causing distress even among some long-term cancer survivors because it conjured "memories of being a patient." After the examination, most described anxiety, uncertainty, dread, and fear that persisted until results were known.

Availability of Basic Benefit-Risk Information about Ionizing Radiation

Availability of basic benefit-risk information about ionizing radiation from medical imaging was considered a fundamental component of patient care, but there were a wide range of contextually influenced individual perceptions about the importance of this information. Participants identified several contextual factors that would influence their desire to initiate a discussion about benefits and risks of medical imaging with a clinician. For example, most had low interest in shared decision-making processes when they understood an imaging test to be essential. Many preferred to cede all decision-making responsibility about imaging tests to the treating physician during active phases of therapy. Patients with advanced disease viewed imaging studies as nonnegotiable components of the research protocols that offered their best hope for ongoing treatment and survival. Several participants minimized the need for discussion on the basis of trust in the recommendations of their physician or confidence that the hospital protects them by using the best equipment and imaging protocols. However, even including those least inclined to ask for benefit-risk information, there was agreement that at least some benefit-risk information should be available as part of routine care.

Motivation to understand the risks of ionizing radiation from medical imaging was strongest among patients undergoing screening for and survivors of cancer. Survivors agreed that their heightened interest in this information correlated with the transition from treatment to survivorship. Desired information included how risk accumulates from multiple studies with time, whether additional ionizing radiation exposure could be avoided by substituting MR imaging for CT, and if longer intervals between follow-up examinations could be negotiated.

Benefit-Risk Discussions about Ionizing Radiation

Benefit-risk discussions about ionizing radiation from medical imaging are rare and seldom initiated by clinicians. Most of the participants had never discussed the benefits and risks of medical imaging with a health care provider; the few participants who did discuss these issues initiated the conversation with their health care provider. Time limitations of clinic visits were perceived as the main barrier to desired communication on this topic. The participants who had asked doctors, nurses, or radiology technologists for information about risks and benefits appeared to have been somewhat unsatisfied with the responses that they received. One participant recalled his doctor likening ionizing radiation from a CT scan to ultraviolet radiation from the sun, an analogy he discounted as too simplistic to be helpful. Those who independently sought information used self-directed internet searches.

Information Participants Wanted about Medical Imaging

Participants desired a wide range of information about medical imaging tests. Most of them wanted basic education about which imaging examinations involved the use of ionizing radiation and how doses compared among them. Most participants expected to receive information about both immediate adverse effects and long-term risks. In addition, nearly all participants wanted to understand how tests such as PET, CT, and MR imaging differ; what governs selection of one over another; and why multiple tests are sometimes ordered. Some participants wanted a schedule of the typical imaging requirements for their disease and current phase of therapy. Others wanted clarification about which imaging studies caused them to retain radioactivity, whether travel or childcare restrictions pertained, and what strategies could be used to rid their bodies of radiation after an imaging examination. Most agreed that learning about long-term risks was important, but that having this information probably would not alter their decision to proceed with a recommended test.

Best Ways to Provide Information

Participants expressed a range of preferences about the best way to provide information. They agreed that simple, objective presentation of risk information was desirable. However, there were few points of overwhelming agreement on the best way to deliver desired information. Many participants cautioned that discussions about the cancer-causing potential of ionizing radiation with survivors and patients at an oncologic center required special sensitivity. Opinions were sharply divided regarding whether it was desirable to be informed of the uncertainties that surround the estimation of cancer risk from medical imaging. For some participants, an open discussion portraying risk as "probably very small, but uncertain" seemed honest and promoted trust. To others, such a discussion was outrageous, useless, and frightening. Several participants expressed disbelief there could be any uncertainty about the risks "because tests like CT scans have been offered for many years and doctors are obligated to know the risks" associated with any test they recommend.

Participants preferred either of two modes of information exchange. For many, the ideal was face-to-face discussion with their personal physician, or if available, with a medical physicist or radiologist. Others favored various written resources, especially hospital-endorsed internet sites and take-away printed material to retain and use for reference as desired.

Some differences were noted among groups. Among patients undergoing chemotherapy for stage IV colorectal carcinoma (group 1), there was concern about long-term cumulative risks, yet evidence that patients tried to avoid thinking of the risks because imaging was a necessary part of their care. Among women treated for early-stage breast cancer (group 2), test

anxiety and concern about the risks of the use of contrast material and radioactive tracers were expressed commonly, as was confidence in the essential role of imaging for early detection of disease. Men undergoing surveillance imaging after treatment for testicular cancer (group 3) expressed highly varied perceptions. Some were concerned about cumulative cancer risks from ongoing imaging, and others voiced little concern on the basis of trust in their doctors and treating facility to provide state-of-the-art imaging services with prudent use of radiation. Patients in the thoracic survivorship group (group 4) were more concerned about the risk incurred from radiation treatments than from imaging studies and focused on the benefit of imaging, given their concern about the recurrence of lung cancer. Patients enrolled in the lung cancer screening program (group 5) strongly emphasized that the benefits of early detection exceeded concerns about long-term radiation risks. Parents of pediatric patients who were previously treated for stage I-III neuroblastoma (group 6) expressed more concern regarding the immediate risks of anesthesia used during imaging than regarding long-term risks of exposure to ionizing radiation.

Participants without current disease highly valued imaging for early detection of new or recurrent cancer and were less concerned about long-term cumulative risks. Among those with active or residual disease, opinions were mixed regarding the balance of perceived risks and benefits of imaging. Overall, participants in the colorectal and testicular cancer patient groups voiced more concern about cumulative risk, especially if alternative imaging modalities could be used, because they believed themselves to be predisposed to cancer already. In comparison, other patient groups, including those with a history of lung cancer, concurred that the benefits of imaging clearly exceeded its risks.

Discussion

In recent years, debate has increased about the need for informed consent before medical imaging examinations involving ionizing radiation. Those in favor of formal disclosure of risk argue that ionizing radiation is a known carcinogen and that major regulatory agencies accept the assumption that even small increases in ionizing radiation exposure, such as the low doses associated with medical imaging tests, may increase risk (21). Opponents have countered that the alleged risk represents "conjecture and unproven projections and extrapolations" (22,23), with no definite relationship to the low doses administered for imaging (24,25).

In light of the developing focus on patient-centered decision making as a quality-of-care indicator (26), it is important to evaluate how such divergent professional opinions relate to patients' desire for information. Our study provides important insights on this issue from a heavily imaged, diverse oncologic population, including patients in active treatment, cancer survivors, parents of pediatric cancer survivors, and participants in a cancer screening program. We specifically selected the study design (small focus groups followed by methodologically rigorous consensus analysis of transcripts) because we wished to discover the beliefs and perspectives of participants as they emerged during essentially unrestricted conversation of key topics. In comparison with surveys, for which results are constrained by the existing options for response, this technique invites a wide dynamic range of expression.

Nearly all participants perceived that there were clear benefits to undergoing imaging such as x-ray, CT, and nuclear medicine examinations; most were also highly aware of risks associated with radiation exposure, including the long-term risk of cancer. Nonetheless, patient knowledge regarding the examinations involving ionizing radiation was variable and generally poor. As in other studies (9,10), very few participants had ever discussed their concerns with a health care provider, relying on information from self-directed internet searches instead. The amount and type of information each participant wanted about imaging tests was extremely variable. Although we discovered many reasons a patient with cancer may not seek information about the risks of ionizing radiation from imaging, study participants clearly believed such information should be routinely available to patients. Similarly, Busey et al (10) found that 90% of patients felt that it was important to be informed of imaging risks. The transition to survivorship prompted increased concern about the risks of ionizing radiation from medical imaging among our participants. Desire for information regarding the potential risks of ionizing radiation appeared to be dynamic and linked to phase of disease. A patient who has no interest in shared decision making about imaging tests during active cancer treatment may have a high degree of interest in information and decision-making autonomy as a cancer survivor.

Providing patients with options responsive to this wide range of preferences will require changes in practice. Most participants wanted their own doctor to educate them about ionizing radiation concerns and believed this type of discussion did not occur because of time pressures during clinic visits. However, data in the literature suggest that primary care physicians may not be adequately prepared for such discussions. Authors of multiple studies (27–30) have shown that as many as one-third of nonradiologist physicians cannot distinguish imaging examinations for which ionizing radiation is used from those for which it is not, and most do not understand the dose of ionizing radiation associated with common imaging examinations or the corresponding risks.

A few focus group participants had asked allied health care providers in the radiology department questions about the risks of ionizing radiation. Some authors (21) have proposed that radiologic technologists or physician assistants may be best positioned to present benefit and risk information to patients, with a radiologist available to provide additional information, if required. Although this plan allows health care

workers who encounter patients in a radiology department to use their knowledge and abilities, it is not responsive to the desire of our study participants to rely on their doctor, a radiologist, or a medical physicist as the primary source for risk-benefit information. In addition, a risk discussion timed just before a scheduled examination does not promote patient involvement in the decision to undergo imaging.

The degree to which study participants wanted to learn more than just benefit-risk information about medical imaging tests was striking. Substantial opportunities exist to allay many patient concerns about seemingly duplicative studies by helping patients understand how different imaging tests often provide different information about the same anatomy. Radiology departments should develop patient education materials on this topic and make them available to referring clinicians and patients.

We recognize several limitations of this study. Our research was conducted in a tertiary cancer care setting, so our findings are not generalizable to a population of patients without cancer. Although we sought participation from the full array of eligible individuals, those who attended the focus groups were predominantly white, well educated, and generally middle aged or older; a broader demographic sample might have yielded different results. Participants might have had a special interest in or awareness about the topic, leading them to have more knowledge or different expectations than did those who declined participation. Study participants were highly educated; therefore, we may have overestimated the knowledge and desire for information among all cancer patients in the United States on the basis of our findings. A larger study is needed to capture this information. Finally, the qualitative methods design we used is well matched to the task of discovery where little or no information exists on a topic. The data it produces are observational, not quantitative, and are intended to generate information for subsequent studies in which statistical significance can be ascertained.

Our findings suggest that to respond to the wide array of patient preferences and expectations about communication, a variety of new approaches are required. Educational tools appropriate for primary physicians, radiologists, and allied health practitioners must be designed, tested, and disseminated. Communication strategies that include techniques for discussing uncertainty must be developed and disseminated in parallel. More patient-friendly written references are needed, including internet-based references that can be endorsed locally and linked to patient portals. Radiologists and medical physicists, particularly those with special interests in health communications about risk and uncertainty, should be identified as consultants for patients who desire more in-depth information. Such consultants might identify or assist in content development for internet sites that referring physicians and radiologists can recommend to interested patients.

In conclusion, patients in an oncologic center who participated in focus group discussions expressed a desire to receive routine information from their health care provider about the risks of ionizing radiation, alternative tests, and the rationale for ordering the specific test and for the recommended interval for future tests. They believed that such information should be routinely available, they expressed a wide range of personal preferences regarding desired content, and they believed that conversation with their personal physician and written reference materials would be ideal methods for information exchange. Participants reported that active exchange of relevant information between doctors and patients remains practically nonexistent. This appears to be an especially important gap in care for cancer survivors, a group that has grown in size to approximately 4% of the U.S. population (31).

Disclosures of Conflicts of Interest: R.H.T. disclosed no relevant relationships. **L.T.D.** disclosed no relevant relationships. **E.S.** disclosed no relevant relationships. **C.L.B.** disclosed no relevant relationships. **S.C.B.** disclosed no relevant relationships. **E.M.** disclosed no relevant relationships. **L.B.F.** disclosed no relevant relationships. **C.M.B.** disclosed no relevant relationships. **H.H.** disclosed no relevant relationships. **J.H.** disclosed no relevant relationships.

References

1. Committee on Quality of Health Care in America, Institute of Medicine. Crossing the quality chasm: a new health system for the 21st century. Washington, DC: National Academies Press, 2001.
2. Bardes CL. Defining "patient-centered medicine". N Engl J Med 2012;366(9):782–783.
3. Charles C, Gafni A, Whelan T. Shared decision-making in the medical encounter: what does it mean? (or it takes at least two to tango). Soc Sci Med 1997;44(5):681–692.
4. Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation, National Research Council. Health risks from exposure to low levels of ionizing radiation: BEIR VII Phase 2. Washington, DC: National Academies Press, 2006.
5. The 2007 Recommendations of the International Commission on Radiological Protection. ICRP publication 103. Ann ICRP 2007; 37(2-4):1–332.
6. Brenner DJ, Hricak H. Radiation exposure from medical imaging: time to regulate? JAMA 2010;304(2):208–209.
7. Tubiana M, Feinendegen LE, Yang C, Kaminski JM. The linear no-threshold relationship is inconsistent with radiation biologic and experimental data. Radiology 2009;251(1): 13–22.
8. Lee CI, Haims AH, Monico EP, Brink JA, Forman HP. Diagnostic CT scans: assessment of patient, physician, and radiologist awareness of radiation dose and possible risks. Radiology 2004;231(2):393–398.
9. Fletcher JG, Kofler JM, Coburn JA, Bruining DH, McCollough CH. Perspective on radiation risk in CT imaging. Abdom Imaging 2013;38(1):22–31.
10. Busey JM, Soine LA, Yager JR, Choi E, Shuman WP. Patient knowledge and understanding of radiation from diagnostic imaging. JAMA Intern Med 2013;173(3):239–241.
11. Takakuwa KM, Estepa AT, Shofer FS. Knowledge and attitudes of emergency department patients regarding radiation risk of CT: Effects of age, sex, race, education, insurance, body mass index, pain, and seriousness of illness. AJR Am J Roentgenol 2010;195(5):1151–1158.
12. Green J, Thorogood N. Qualitative methods for health research. London, England: Sage, 2004.

13. Patton MQ. Qualitative research & evaluation methods. Thousand Oaks, Calif: Sage, 2002.

14. Krueger RA, Casey MA. Focus groups: a practical guide for applied research. Thousand Oaks, Calif: Sage, 2008.

15. Morgan DL. Focus groups as qualitative research. Thousand Oaks, Calif: Sage, 1997.

16. Bernard HR. Research methods in anthropology: qualitative and quantitative approaches. Lanham, Md: AltaMira, 2006.

17. Boyatzis RE. Transforming qualitative information: thematic analysis and code development. Thousand Oaks, Calif: Sage, 1998.

18. Creswell JW. Qualitative inquiry and research design: choosing among five traditions. Thousand Oaks, Calif: Sage, 1998.

19. Patton MQ. Enhancing the quality and credibility of qualitative analysis. Health Serv Res 1999;34(5 Pt 2):1189–1208.

20. Miles MB, Huberman AM. Qualitative data analysis: a sourcebook of new methods. Thousand Oaks, Calif: Sage, 1994.

21. Semelka RC, Armao DM, Elias J Jr, Picano E. The information imperative: is it time for an informed consent process explaining the risks of medical radiation? Radiology 2012; 262(1):15–18.

22. Hendee WR, O'Connor MK. Radiation risks of medical imaging: separating fact from fantasy. Radiology 2012;264(2):312–321.

23. Berlin L. Informing patients about risks and benefits of radiology examinations utilizing ionizing radiation: a legal and moral dilemma. J Am Coll Radiol 2011;8(11):742–743.

24. Brink JA, Goske MJ, Patti JA. Informed decision making trumps informed consent for medical imaging with ionizing radiation. Radiology 2012;262(1):11–14.

25. Brink JA, Goske MJ, Patti JA. Informed consent for radiologic procedures. JAMA 2011;305(9):888–889; author reply 889–890.

26. Uphoff EP, Wennekes L, Punt CJ, et al. Development of generic quality indicators for patient-centered cancer care by using a RAND modified Delphi method. Cancer Nurs 2012;35(1):29–37.

27. Wong CS, Huang B, Sin HK, Wong WL, Yiu KL, Chu Yiu Ching T. A questionnaire study assessing local physicians, radiologists and interns' knowledge and practice pertaining to radiation exposure related to radiological imaging. Eur J Radiol 2012;81(3): e264–e268.

28. Keijzers GB, Britton CJ. Doctors' knowledge of patient radiation exposure from diagnostic imaging requested in the emergency department. Med J Aust 2010;193(8):450–453.

29. Puri S, Hu R, Quazi RR, Voci S, Veazie P, Block R. Physicians' and midlevel providers' awareness of lifetime radiation-attributable cancer risk associated with commonly performed CT studies: relationship to practice behavior. AJR Am J Roentgenol 2012; 199(6):1328–1336.

30. Thomas KE, Parnell-Parmley JE, Haidar S, et al. Assessment of radiation dose awareness among pediatricians. Pediatr Radiol 2006; 36(8):823–832.

31. Siegel R, DeSantis C, Virgo K, et al. Cancer treatment and survivorship statistics, 2012. CA Cancer J Clin 2012;62(4):220–241.