Radiology

What Patients Want to Know about Imaging Examinations: A Multiinstitutional U.S. Survey in Adult and Pediatric Teaching Hospitals on Patient Preferences for Receiving Information before Radiologic Examinations[1]

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Purpose: To identify what information patients and parents or caregivers found useful before an imaging examination, from whom they preferred to receive information, and how those preferences related to patient-specific variables including demographics and prior radiologic examinations.

Materials and Methods: A 24-item survey was distributed at three pediatric and three adult hospitals between January and May 2015. The χ^2 or Fisher exact test (categorical variables) and one-way analysis of variance or two-sample *t* test (continuous variables) were used for comparisons. Multivariate logistic regression was used to determine associations between responses and demographics.

Results: Of 1742 surveys, 1542 (89%) were returned (381 partial, 1161 completed). Mean respondent age was 46.2 years ± 16.8 (standard deviation), with respondents more frequently female (1025 of 1506, 68%) and Caucasian (1132 of 1504, 75%). Overall, 78% (1117 of 1438) reported receiving information about their examination most commonly from the ordering provider (824 of 1292, 64%), who was also the most preferred source (1005 of 1388, 72%). Scheduled magnetic resonance (MR) imaging or nuclear medicine examinations ($P < .001$ vs other examination types) and increasing education ($P = .008$) were associated with higher rates of receiving information. Half of respondents (757 of 1452, 52%) sought information themselves. The highest importance scores for pre-examination information (Likert scale ≥4) was most frequently assigned to information on examination preparation and least frequently assigned to whether an alternative radiation-free examination could be used (74% vs 54%; $P < .001$).

Conclusion: Delivery of pre-examination information for radiologic examinations is suboptimal, with half of all patients and caregivers seeking information on their own. Ordering providers are the predominant and preferred source of examination-related information, with respondents placing highest importance on information related to examination preparation.

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Patient-centered health care, defined as "healthcare that establishes a partnership among practitioners, patients and their family to ensure that providers and systems deliver care that is attentive to the needs, values and preferences of patients" has seen greater emphasis following its inclusion as one of the goals of quality health care as outlined by the Institute of Medicine (1). Successful transition toward such a model in radiology requires that providers and institutions have a thorough understanding of what information patients "need, value and prefer." National radiology campaigns such as Radiology Cares by the Radiological Society of North America and Imaging 3.0 by the American College of Radiology have highlighted the fact that patient-centered practice "enhances [the patient's] understanding and comfort with their radiology exams and procedures and empowers them to make better informed decisions about their healthcare" (2–4).

To date, much of the effort in radiology to move toward patient-centered care has focused on the communication of imaging results (5–10). These efforts focus on patient engagement after the radiology encounter. Less attention has been paid to engaging patients prior to and during the radiology encounter. Radiology initiatives such as Image Gently, Image Wisely, and EuroSafe have taken steps to increase patient engagement and knowledge prior to an imaging procedure by suggesting questions patients might ask their physician or radiologist (11–13). These questions largely focus on radiation exposure despite the fact that patients seem less concerned about radiation risk and more concerned that the imaging examination aid the radiologist in making the correct diagnosis (14–17).

Identification of what information patients want before their imaging examination, from whom they want information, and how preferences differ based on demographics, prior radiologic examinations, and role (patient vs parent or caregiver of patient) is critical to the successful implementation of a patient-centered practice that focuses on the patient from the time an imaging examination request is placed through communication of the radiologist's report. Our purpose was to assess what information patients and parents or caregivers found useful before an imaging examination, from whom they preferred to receive information, and how preferences changed based on patient demographics, scheduled radiologic examination, and number of prior radiologic examinations completed.

Implications for Patient Care

- Just over one-fifth of patients and caregivers are not receiving information regarding their imaging examination, highlighting an opportunity to improve patient engagement and awareness before the radiology encounter.
- Prior to their radiologic examination, patients value information about examination preparation more than information on radiation exposure.
- Given that referring providers are the most common and preferred source for information about imaging examinations, this is an important group for educational outreach by the radiology community.

Materials and Methods

Study Details

Institutional review board approval was obtained for this prospective Health Insurance Portability and Accountability Act–compliant study involving six geographically diverse university medical centers in the United States. Sites were chosen based on interest received during informal discussion at an American Board of Radiology Foundation meeting and investigator research interests in patient-centered care. Three sites serve pediatric patients (Cincinnati Children's Hospital Medical Center [Site 1; Investigator, A.T.T.]; Riley Children's Hospital, Indiana University [Site 2; Investigator, L.R.D.]; Lucile Packard Children's Hospital, Stanford University [Site 4; Investigator, E.J.Z.]) and three sites serve predominately adult populations (Massachusetts General Hospital [Site 3; Investigator, V.V.M.]; University of Alabama at Birmingham Hospital [Site 5; Investigator, P.B.]; Yale-New Haven Hospital, Yale University [Site 6; Investigator, J.K.P.]). Formal documentation of informed consent was waived by each site's institutional review board with the understanding that completion of this voluntary survey implied consent to participate.

Survey Instrument

A 24-item survey (Appendix E1 [online]) was designed to include questions on demographics (age, sex, race, highest level of education attained, native language, and prior radiologic examinations), multiple-choice questions focused on participant preferences as to how best to receive information about radiologic examinations, and Likert scale questions (rating scale of 1–5; "not important" to "very important") to assess the importance of what specific information participants wanted before undergoing an imaging examination. The survey included material emphasized by national organizations (radiation awareness, radiation exposure, certification of radiologist and imaging site) and material identified during focus group sessions (examination preparation and experience) with patient advocacy groups at one adult (Yale New-Haven Hospital) and one pediatric

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

hospital site (Cincinnati Children's Hospital Medical Center) (11,12). English and Spanish language surveys were printed on opposite sides of a single sheet of standard 8.5 × 11-inch paper for distribution.

Outpatient adults (ages 18 years or older) and the parents or caregivers of outpatients younger than 18 years who were undergoing diagnostic radiologic examinations (excluding mammography and interventional radiology) were eligible for participation. Respondents were offered the survey during registration by front-desk radiology staff who were instructed to distribute the survey to every patient or caregiver. Respondents were instructed to complete the survey prior to their radiologic examination and surveys were collected by front-desk staff. Surveys were distributed between January and May 2015 during normal business hours on Monday through Friday, excluding public holidays.

Statistical Analysis

Given the high number of variables analyzed in the survey, a priori power analysis suggested 250 respondents per group would provide a power of 80% to detect a difference of 13% in frequency of responses (44% vs 57%) at the level of $\alpha = .05$ between an assumed equal split between respondents with a high (≥6 prior radiologic examinations) versus low frequency (<6 prior examinations) of imaging utilization based on the Fisher exact test. Therefore, we chose a target of 275 completed surveys per site (1650 total enrollees).

Descriptive statistics were used to summarize respondent demographics and pooled survey responses. Categorical variables were compared across sites and between respondent groups by using the χ^2 test or Fisher exact test as appropriate. Continuous variables were compared between groups by using one-way analysis of variance or the two-sample *t* test. Likert scale items were treated as categorical (ordinal) variables and compared by using χ^2 test to detect the difference in the proportion of Likert scale selections of 4 and 5 (important and very important ratings, respectively) between groups. The association between survey responses and respondent demographics were evaluated with multivariate (for categorical variables) logistic regression models with model selection based on stepwise criterion. Stepwise selection was used for regression modeling to address the possibility of colinearity of variables given the large number of independent variables in the analysis. Dependent variables used for modeling included the Likert scale items, the two yes/no questions related to whether information was provided and whether the respondent had tried finding information themselves, and the multiple-choice questions regarding respondent preferences (eg, who gave information, who would be the best to given information, how the respondent would like to receive information, and what sources the respondent used to find information). All six sites were treated as fixed effects in the model. Odds ratios with 95% confidence intervals were reported in the final models. Because of the small proportion of missing values (around 5%) and nonsignificant difference on demographics between sites, imputation was not used in the analyses. All analyses were completed by using SAS version 9.3 (SAS Institute, Cary, NC). A *P* value < .05 was considered to indicate statistical significance.

Results

Mean duration of survey distribution for each site was 35 days (range, 14–74 days) (Table 1). A total of 1742 surveys were distributed with 1542 surveys returned (89% return rate; Table 1). Demographic information for respondents and missing data are provided in Table 2. Among 1470 respondents, 856 (58%) were undergoing imaging themselves, whereas 614 (42%) had a child or other dependent undergoing imaging. Mean respondent age was significantly higher for the three adult (54.8 years, 56.3 years, 55.1 years) versus pediatric (35.7 years, 32 years, 38.7 years) sites ($P < .001$). Pediatric sites had a significantly higher proportion of female respondents (587 of 687, 86%) compared with adult (438 of 819, 53%) sites ($P < .001$). Most respondents were Caucasian (1132 of 1504, 75%) and spoke primarily English (1428 of 1510, 95%).

Table 3 provides data related to the scheduled imaging examination and the respondents' prior experience with radiologic examinations. Most respondents were scheduled for magnetic resonance (MR) imaging (401 of 1523, 26%), ultrasonography (373 of 1523, 24%), or computed tomography (CT) (323 of 1523, 21%). Most respondents or their dependents (1249 of 1444, 87%) had undergone prior imaging, with most (624 of 1444, 43%) having undergone 2–5 prior radiologic examinations.

Provision and Gathering of Information prior to Radiologic Examination

Among respondents, 78% (1117 of 1438; range, 64%–88% across sites) reported receiving information about their examination before presenting for imaging. Relevant to the prediction of sample size, respondents with the highest level of prior radiology utilization (≥6 examinations) reported a higher frequency of receiving information than did those with lower (<6 examinations) prior radiology utilization (483 of 592, 82% vs 587 of 769, 76%; $P = .019$). At univariate analysis, Asian respondents more than Caucasian respondents ($P = .005$), respondents with a higher number of prior examinations ($P = .01$), respondents presenting for MR imaging or nuclear medicine examinations (vs other examination types; $P < .001$), and respondents with more years of education ($P = .007$) were statistically significantly more likely to report receiving examination information prior to the examination. At multivariate logistic regression, only examination type and years of education remained significant predictors of whether examination information was provided. Information was more likely provided for more complex examinations (333 of 384, 87% for MR imaging and 109 of 131, 83% for nuclear medicine; $P < .001$ vs other examination types). Respondents who reported receiving information had slightly more years of schooling (14.7 years ± 2.7 [standard deviation] vs 14.3 years ± 2.8; $P = .008$).

The single most common source of information about the radiologic examination was the ordering provider (overall: 64%, 824 of 1292; range, 42%–80% across sites). Radiology department or imaging center (overall: 19%, 242 of 1292) or staff members (nursing, reception, scheduling) (overall: 16%, 203 of 1292) were the next most common. At univariate analysis, site ($P < .001$) and examination type ($P < .001$) were statistically significantly associated with who provided information. With multivariate regression, site ($P < .001$), examination type ($P < .001$), and race were significant predictors ($P < .001$). The ordering provider was the most common individual to provide information to the respondent for all types of imaging, but the radiology department or imaging center provided information to a greater subset of respondents undergoing MR imaging (33%, 129 of 393) than did other examinations (range, 6% [12 of 201] for x-ray to 21% [28 of 135] for

Table 1

Survey Collection Data

Site No.	Total Surveys Collected and Distributed	Completed Surveys	Partially Completed Surveys*	Collection Dates in 2015†
1	280/296 (95)	238/280 (85)	42/280 (15)	January 21–February 17 (18)
2	264/275 (96)	205/264 (78)	59/264 (22)	January 15–May 1 (74)
3	355/400 (89)	214/355 (60)	141/355 (40)	February 9–March 1 (14)
4	163/190 (86)‡	146/163 (90)	17/163 (10)	January 26–May 7 (72)
5	238/280 (85)	166/238 (70)	72/238 (30)	February 3–February 27 (17)
6	242/301 (80)	192/242 (79)	50/242 (21)	January 22–February 11 (14)

Note.—Unless otherwise specified, numbers are raw data, with percentages in parentheses.

* Surveys with at least one nondemographic question answered.

† Data in parentheses are the total number of weekdays excluding public holidays.

‡ Site did not complete full enrollment because of a job change for site investigator.

Table 2

Study Population Demographics

Variable	Total ($n = 1542$)	Site 1 ($n = 280$)	Site 2 ($n = 264$)	Site 3 ($n = 355$)	Site 4 ($n = 163$)	Site 5 ($n = 238$)	Site 6 ($n = 242$)
Individual being imaged							
Child	579 (38)	239 (85)	218 (83)	0 (0)	115 (71)	1 (0.4)	6 (2)
Other	35 (2)	5 (2)	6 (2)	5 (1)	4 (2)	5 (2)	10 (4)
Self	856 (56)	36 (13)	0 (0)	348 (98)	31 (19)	226 (95)	215 (89)
Missing data	72 (5)	0 (0)	40 (15)	2 (1)	13 (8)	6 (3)	11 (5)
Age of individual completing survey (y)*	46.2 ± 16.8	35.7 ± 9.7	32.0 ± 9.0	54.8 ± 16.7	38.7 ± 10.9	56.3 ± 15.0	55.1 ± 14.4
Age of child (y)*	8.2 ± 5.9	8.1 ± 5.8	6.7 ± 4.9	…	10.4 ± 5.4	…	11.9 ± 10.2
Sex of individual completing survey							
Female	1025 (66)	229 (82)	228 (86)	161 (45)	130 (80)	154 (65)	123 (51)
Male	481 (31)	45 (16)	30 (11)	186 (52)	25 (15)	82 (34)	113 (47)
Missing data	36 (2)	6 (2)	6 (2)	8 (2)	8 (5)	2 (1)	6 (2)
Race							
Asian	56 (4)	3 (1)	2 (1)	18 (5)	25 (15)	3 (1)	5 (2)
African American	168 (11)	27 (10)	63 (24)	13 (4)	4 (3)	46 (19)	15 (6)
Caucasian	1132 (73)	237 (85)	180 (68)	276 (78)	71 (44)	176 (74)	192 (79)
Hispanic	98 (6)	4 (1)	14 (5)	20 (6)	39 (24)	6 (3)	15 (6)
Multiple	10 (1)	1 (0.4)	1 (0.4)	0 (0)	7 (4)	0 (0)	1 (0.4)
Other	40 (3)	6 (2)	2 (1)	13 (4)	9 (6)	3 (1)	7 (3)
Missing data	38 (2)	2 (1)	2 (1)	15 (4)	8 (5)	4 (2)	7 (3)
Language							
English	1428 (93)	276 (99)	249 (94)	319 (90)	133 (82)	229 (96)	222 (92)
Spanish	42 (3)	0 (0)	9 (3)	12 (3)	12 (7)	3 (1)	6 (2)
Other	40 (3)	3 (1)	1 (0.4)	19 (5)	10 (6)	0 (0)	7 (3)
Missing data	32 (2)	1 (0.4)	5 (2)	5 (1)	8 (5)	6 (3)	7 (3)
Education attained (y)*†	14.7 ± 2.7	14.7 ± 2.4	13.9 ± 2.4	15.5 ± 2.7	15.3 ± 2.8	14.1 ± 3.0	14.6 ± 2.9

Note.—Unless otherwise specified, data in parentheses are percentages. Number of responses for each question does not always match number of participants per site because of incomplete survey responses.

* Data are means ± standard deviation.

† For numerical conversion, college was considered to reflect value of 16 and postgraduate training 18.

Table 3

Study Population Radiologic Examination Information

Variable	Total (*n* = 1542)	Site 1 (*n* = 280)	Site 2 (*n* = 264)	Site 3 (*n* = 355)	Site 4 (*n* = 163)	Site 5 (*n* = 238)	Site 6 (*n* = 242)
No. of radiologic exams (including current exam)							
1	195 (13)	42 (15)	67 (25)	18 (5)	29 (18)	20 (8)	19 (8)
2–5	624 (40)	88 (31)	123 (47)	150 (42)	72 (44)	89 (37)	102 (42)
6–10	238 (15)	47 (17)	38 (14)	52 (15)	16 (10)	40 (17)	45 (19)
>10	387 (25)	100 (36)	24 (9)	100 (28)	37 (23)	64 (27)	62 (26)
Missing data	98 (6)	3 (1)	12 (5)	35 (10)	9 (6)	25 (11)	14 (6)
Exam(s) presenting for*							
CT	323 (21)	55 (19)	25 (10)	96 (29)	24 (14)	40 (16)	83 (35)
MR imaging	401 (26)	81 (27)	2 (1)	64 (19)	118 (70)	49 (20)	87 (37)
Nuclear medicine	138 (9)	35 (12)	10 (4)	0 (0)	0 (0)	49 (20)	44 (18)
US	373 (24)	87 (29)	117 (47)	79 (24)	20 (12)	54 (22)	16 (7)
X-ray	288 (19)	37 (13)	95 (38)	90 (27)	6 (4)	52 (21)	8 (3)
No. of exams presenting for							
Single	1335 (94)	243 (91)	233 (97)	315 (98)	145 (93)	213 (93)	186 (87)
Multiple	92 (6)	24 (9)	8 (3)	7 (2)	11 (7)	15 (7)	27 (13)

Note.—Data in parentheses are percentages.

* Based on number of observations, not number of subjects.

nuclear medicine). Analysis revealed that respondents preferred to receive information from the ordering provider the most (72%, 1005 of 1388), which was significantly related to who had provided information for the scheduled examination ($P < .001$). The radiology department or imaging center was the second most preferred source (overall: 21%, 397 of 1388). No difference in whom respondents preferred to receive information from based on prior high radiology utilization (≥6 examinations) versus prior low utilization (<6 examinations; $P = .18$) was observed.

Among 1452 respondents, 757 (52%) indicated they had tried to find information about the radiologic examination on their own. Most respondents (overall: 43%, 306 of 714) sought information from multiple sources. The most common sources from which respondents sought information were the ordering provider's office (34%, 430 of 1279 total sources selected) and general Web sites such as Google or WebMD (31%, 399 of 1279). Materials and/or Web content provided by radiology centers accounted for 22% (275 of 1279) of sources used by respondents, whereas materials produced by national radiology organizations (eg, Image Wisely, Image Gently, and RadiologyInfo) accounted for only 5% (63 of 1279).

When asked how most respondents preferred to have information about their upcoming imaging examination delivered, the most preferred route was phone (overall: 52%, 747 of 1439) followed by in-person delivery (overall: 37%, 525 of 1439). These relative preferences were similar across all sites. At univariate analysis, age ($P = .009$), sex ($P = .008$), race ($P < .001$), examination type ($P = .048$), and years of education ($P < .001$) were all significantly associated with how respondents preferred to receive information. At multivariate analysis, sex ($P < .001$), race ($P = .04$), and years of education ($P < .001$) remained the only significant predictors of how respondents preferred to receive information. Receiving information via phone was favored most by both women (43%, 552 of 1275 selected methods of communication, with some respondents selecting multiple methods) and men (35%, 193 of 555 selected methods of communication). In-person communication was the next most favored route of communication by both sexes (women, 27% [349 of 1275] vs men, 30% [167 of 555]). With regard to race, respondents of all racial backgrounds favored receiving information by phone with the exception of Hispanic respondents, who equally favored phone and in-person communication (40%, 47 of 118 for in-person vs 38%, 45 of 118 for phone). Increasing years of education was associated with a preference for receiving information via e-mail or Web site (odds ratio of 1.1; 95% confidence interval: 1.0, 1.2).

Information Patients Value prior to Radiologic Examination

Respondents felt that all the information covered by the Likert scale questions, inclusive of questions about radiation and specific examination preparation, was at least somewhat important to very important for all items (Likert score 3–5). Table 4 displays frequencies of higher importance scores assigned, defined as Likert scores greater than or equal to 4. The information type most frequently assigned the highest importance score for the overall population was information about examination preparation (74%), which held true across four of

Table 4

Percentage of Likert Scale Scores Greater than or Equal to 4 Reported by Respondents for the Importance of Specific Information prior to Their or Their Dependent's Examination

Question	Total (n = 1542)	Adult Patients (n = 891)*‡	Pediatric Patients (n = 579)†‡	Site 1 (n = 280)	Site 2 (n = 264)	Site 3 (n = 355)	Site 4 (n = 163)	Site 5 (n = 238)	Site 6 (n = 242)
How do I prepare for my imaging test?	74 (72, 76)	64 (61, 67)	88 (85, 91)	87 (83, 91)	84 (80, 89)	54 (49, 60)	89 (84, 94)	69 (63, 75)	72 (66, 78)
What will the imaging test be like?	68 (66, 70)	57 (54, 61)	82 (79, 85)	80 (75, 84)	81 (77, 86)	46 (40, 51)	82 (76, 88)	63 (56, 69)	68 (62, 74)
Does the imaging test use radiation?	64 (62, 67)	53 (50, 57)	79 (75, 82)	75 (70, 80)	80 (75, 85)	46 (40, 51)	77 (70, 83)	58 (51, 64)	62 (55, 68)
How much radiation will the imaging test use?	60 (58, 63)	50 (47, 53)	73 (70, 77)	67 (62, 73)	77 (72, 82)	42 (37, 47)	74 (68, 81)	55 (49, 61)	58 (52, 64)
Is there an imaging test that I could have instead that doesn't use radiation?	54 (52, 57)	45 (41, 48)	66 (62, 70)	60 (55, 66)	72 (67, 78)	37 (32, 42)	64 (56, 71)	48 (42, 54)	51 (45, 58)
Will I need an intravenous (IV) line or will I need to drink anything for my imaging test?	68 (66, 71)	58 (55, 62)	83 (80, 86)	83 (79, 88)	81 (77, 86)	51 (46, 56)	79 (73, 85)	62 (56, 68)	62 (56, 68)
How long will my imaging test take?	63 (60, 65)	53 (49, 56)	77 (74, 81)	78 (73, 83)	75 (70, 80)	43 (38, 49)	76 (70, 83)	54 (47, 60)	60 (54, 66)
Is the imaging facility or doctor (radiologist) certified by the American College of Radiology or another group?	66 (64, 69)	61 (57, 64)	74 (71, 78)	74 (68, 79)	78 (73, 83)	52 (47, 57)	68 (61, 75)	70 (64, 76)	63 (57, 69)
Is my imaging test really needed?	71 (69, 73)	63 (60, 67)	81 (78, 84)	81 (76, 85)	82 (78, 87)	55 (49, 60)	76 (70, 83)	70 (64, 76)	69 (63, 75)

Note.—Data are percentages, with 95% confidence intervals in parentheses.

* Respondent indicated they were presenting for imaging of self or another adult.

† Respondent indicated they were presenting for imaging of a child.

‡ 72 respondents did not indicate whether the individual being imaged was an adult or child.

six sites (range, 54%–89%). The item least frequently assigned the highest importance score was whether an alternative imaging examination (not using ionizing radiation) could be substituted for the scheduled examination (54% overall), which held true across all sites (range, 37%–72%). The relative frequency of high importance scores assigned was statistically significantly different between the items with the highest and lowest frequency ($P < .001$). The frequency of high importance scores was significantly greater for all items for respondents presenting for imaging of their child or dependent (66%–88% [pediatric] vs 45%–64% [adult]; $P < .001$). When specifically looking at differences between respondents with low (<6 prior examinations) versus high (≥6 prior examinations) frequency of prior utilization of imaging, low-frequency imaging users more frequently assigned high importance scores (Likert ≥4) for five of the nine information items. Significant differences were present for the items concerning preparation for the examination (632 [77%] vs 446 [71%]; $P = .007$), what to expect (595 [73%] vs 393 [62%]; $P < .001$), whether the examination uses radiation (551 [67%] vs 389 [62%]; $P = .03$), how much radiation is used (525 [64%] vs 356 [57%]; $P = .004$), and how long the examination will take (544 [67%] vs 378 [60%]; $P = .01$).

Discussion

Our purpose was to determine information preferences of patients and parents or caregivers related to the radiology encounter, with an aim to define the information patients want before their imaging examination and how and by whom they want it delivered. Overall, most (78%) respondents reported having received some information before their imaging examination, but over one-fifth (22%) reported receiving no information. Examination type and years of schooling were significant predictors of whether information was given before arrival. We suspect the effect of examination type is related to a greater perceived need for information regarding more complex cross-sectional and nuclear medicine examinations by patients and providers. This notion is concordant with a recent study showing 63% of patient-driven radiology inquiries through a patient portal were related to either CT or MR imaging examinations (10). Although patient portals are increasingly being used to allow communication of radiologic examination results, they may also offer an opportunity to disseminate examination information prior to the examination. This notion is supported by recent work showing improved patient awareness of ionizing radiation and examinations that use ionizing radiation after viewing an online educational module prior to their examination (18). Although a statistically significant relationship

existed between schooling and delivery of information, the slight difference in years of education between respondents who did and did not receive information is likely not clinically or epidemiologically meaningful. That said, data exist showing that patients who are less educated are at higher risk of "missed care opportunities" when they fail to make their radiology appointment (19). One other group that may warrant targeted information is female care providers of pediatric patients who are undergoing imaging examinations. Although sex was not predictive of any particular response on the survey instrument, women represented the vast majority of respondents accompanying children to their imaging examinations.

Our study revealed that the ordering provider was the most common source of information about imaging examinations. The frequency of 64% at which the ordering provider communicated information was greater than the rate of 47% reported in a smaller study assessing information source prior to CT (16). This finding highlights a need to engage with and provide resources and information to referring providers, which could occur either locally or at the level of professional radiology organizations. Only 35% of respondents stated they received information from "radiology," mostly via the imaging center performing the examination (19%). This finding suggests either a lack of uniform processes in place at radiology departments to communicate information and/or a lack of utilization of available information by patients, and provides an opportunity for improved communication tailored to patient preferences.

Our study also confirmed the ordering provider as the preferred source of information related to the radiologic examination. Only 21% of respondents preferred to receive information from the radiology center and only 9% preferred to receive examination information from providers directly involved in either performing or interpreting the examination. This preference may relate to lack of awareness of the role of technologists and radiologists in the imaging examination (6,7,20,21). Our data revealed that the respondent's choice of the best source of information was highly associated with who had provided information for their current examination. This finding suggests that patients are either content with who provided information about their examination (possibly related to familiarity) or are unaware of other methods of receiving it (9). Although the authors believe the radiology community is well versed to provide this information, the data supports that the referring physician is the preferred source of information at this time (22). Given this, the radiology community is obligated to ensure the information provided by referring providers is accurate. Prior studies have found poor knowledge of radiation dose and risk among patients and many physicians. Recent surveys found that only 28% of physicians were aware that mammography uses ionizing radiation and only 14.5% of emergency medicine physicians discussed radiation risks of CT with patients (15,18,23–26).

Our study showed that as level of respondent education increased, the preference for receiving information via more advanced technology (Web sites, e-mail) increased. Similar trends in patient preferences based on educational level have been reported when studying preferences on receiving examination results and knowledge of radiation risks, highlighting the importance of developing multiple communication lines to meet the needs of a diverse patient population (21,27). Slightly over half (52%) of respondents independently sought information about their imaging examination. Only 4.9% reported using Web sites such as *https://radiologyinfo.org* that were developed by the radiology community to provide examination information in a patient-centric format (22). This finding suggests a lack of awareness and/or usage of these resources among our patient population. Given that patients prefer to receive information from their provider, radiology organizations may wish to promote their patient information sites directly to the provider in addition to the patient or caregiver.

When asked what specific information patients wanted prior to their radiologic examination, greater frequencies of high importance scores were reported for basic information about the examination (eg, necessity, preparation, what the test is like). Lower frequencies of high importance scores were assigned to radiation issues (whether a radiation-free examination is available and how much radiation will be used), despite the fact that radiation issues receive the greatest attention in the popular press and in most patient resources available through radiologic societies (2,3,11–13). Not surprisingly, our data also showed that respondents with lower prior radiology utilization more frequently assigned higher importance scores to all Likert scale items related to information on examination preparation and what to expect from the examination. Overall, the importance scores were more frequently high for respondents presenting for imaging of their child or dependent than for those of respondents undergoing imaging themselves, a disparity that may reflect parents' feelings of guardianship of their child. The discordance between the information patients feel is important (preparation) and the information that is emphasized by radiologic societies (radiation) suggests that a shift in emphasis is needed and reflects an opportunity to engage more with patients on topics that are of higher importance to them.

Our study had several limitations. Although our sample size was large, response rates were not uniform across all sites and could be subject to site-specific bias. Our response rate (89%) was higher than typical for a survey study, which may mean that a subset of patients refused the offered survey, rather than returning an incomplete survey. Missing data (shown in Tables 2–4) from patients that did not fill out portions of the survey cannot be inferred on the current study. Because of the number of locations where the survey was offered, we could neither

accurately compute the total number of patients imaged at each site that would have been eligible and presumably declined the survey, nor could we exclude that a respondent was offered the survey more than once at different times during the study collection period. Additionally, although we included a geographic mix of adult and pediatric hospitals, all sites were teaching hospitals. We also had a large percentage of responses from women, and most of our respondents (95%) listed English as their primary language. Therefore, our data may not be generalizable to other practice settings that serve different patient populations. Assessing preferences without an intervention is subject to reporting bias, which may be present in this study because we did not actively test different means of communicating with patients. Lastly, we could not independently verify the information provided by respondents and we did not ask patients to create a ranking of which information was most important to least important, but instead asked for Likert scale rankings for all information items independently. Future studies are needed to look at changes in preferences after interventions aimed at improving the dissemination of information to both patients and providers, and to increase the role radiology plays in this process.

In conclusion, this study provides insight into the effectiveness of current delivery of pre-examination information, patient (and parent or caregiver) preferences on receiving information, the importance of specific examination-related information, and methods patients currently use to obtain information on their own. The knowledge gained should help design, improve, and implement a more patient-centered model of health care delivery in radiology.

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References

1. Institute of Medicine (US) Committee on Quality of Health Care in America. Crossing the quality chasm: a new health system for the 21st century. Washington, DC: National Academies Press, 2001.
2. Radiology cares. Radiological Society of North America. http://www.rsna.org/Radiology-Cares/. Accessed December 12, 2015.
3. Imaging 3.0. American College of Radiology. http://www.acr.org/Advocacy/Economics-Health-Policy/Imaging-3. Accessed December 12, 2015.
4. Dwamena F, Holmes-Rovner M, Gaulden CM, et al. Interventions for providers to promote a patient-centred approach in clinical consultations. Cochrane Database Syst Rev 2012;12:CD003267.
5. Basu PA, Ruiz-Wibbelsmann JA, Spielman SB, Van Dalsem VF 3rd, Rosenberg JK, Glazer GM. Creating a patient-centered imaging service: determining what patients want. AJR Am J Roentgenol 2011;196(3):605–610.
6. Pahade J, Couto C, Davis RB, Patel P, Siewert B, Rosen MP. Reviewing imaging examination results with a radiologist immediately after study completion: patient preferences and assessment of feasibility in an academic department. AJR Am J Roentgenol 2012;199(4):844–851.
7. Mangano MD, Bennett SE, Gunn AJ, Sahani DV, Choy G. Creating a patient-centered radiology practice through the establishment of a diagnostic radiology consultation clinic. AJR Am J Roentgenol 2015;205(1):95–99.
8. Henshaw D, Okawa G, Ching K, Garrido T, Qian H, Tsai J. Access to radiology reports via an online patient portal: experiences of referring physicians and patients. J Am Coll Radiol 2015;12(6):582–6.e1, e1.
9. Ollivier L, Apiou F, Leclère J, et al. Patient experiences and preferences: development of practice guidelines in a cancer imaging department. Cancer Imaging 2009;9(Spec No A):S92–S97.
10. Mervak BM, Davenport MS, Flynt KA, Kazerooni EA, Weadock WJ. What the patient wants: an analysis of radiology-related inquiries from a web-based patient portal. J Am Coll Radiol 2016;13(11):1311–1318.
11. What can I do as a parent? The Image Gently Alliance. http://www.imagegently.org/what-can-I-do-as-a/Parent. Accessed July 8, 2016.
12. Radiology risks & benefits for patients. Image Wisely. http://www.imagewisely.org/patients. Accessed July 8, 2016.
13. Radiation and patients. European Society of Radiology. http://www.eurosafeimaging.org/information-for-patients. Accessed July 9, 2016.
14. McNierney-Moore A, Smith C, Guardiola J, Xu KT, Richman PB. Patient understanding of radiation risk from medical computed tomography: a comparison of Hispanic vs. non-Hispanic emergency department populations. PeerJ 2015;3:e937.
15. Zwank MD, Leow M, Anderson CP. Emergency department patient knowledge and physician communication regarding CT scans. Emerg Med J 2014;31(10):824–826.
16. Caoili EM, Cohan RH, Ellis JH, Dillman J, Schipper MJ, Francis IR. Medical decision making regarding computed tomographic radiation dose and associated risk: the patient's perspective. Arch Intern Med 2009;169(11):1069–1071.
17. Rosenkrantz AB, Flagg ER. Survey-based assessment of patients' understanding of their own imaging examinations. J Am Coll Radiol 2015;12(6):549–555.
18. Steele JR, Jones AK, Clarke RK, et al. Use of an online education platform to enhance patients' knowledge about radiation in diagnostic imaging. J Am Coll Radiol 2017;14(3):386–392.
19. Khalilzadeh O, Yu AY, Carrodeguas E, et al. Do socioeconomic disparities exist in radiology? Multivariate analysis of socioeconomic factors impacting access to imaging services [abstr]. In: Radiological Society of North America Scientific Assembly and Annual Meeting Program. Oak Brook, Ill: Radiological Society of North America, 2015; 160.
20. Zucker EJ, Newman B, Larson DB, Rubesova E, Barth RA. Added value of radiologist consultation for pediatric ultrasound: imple-

mentation and survey assessment. AJR Am J Roentgenol 2015;205(4):822–826.

21. Cabarrus M, Naeger DM, Rybkin A, Qayyum A. Patients prefer results from the ordering provider and access to their radiology reports. J Am Coll Radiol 2015;12(6):556–562.

22. Rubin GD, Krishnaraj A, Mahesh M, Rajendran RR, Fishman EK. Enhancing public access to relevant and valued medical information: fresh directions for RadiologyInfo.org. J Am Coll Radiol 2017;14(5):697–702.e4.

23. 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.

24. Krille L, Hammer GP, Merzenich H, Zeeb H. Systematic review on physician's knowledge about radiation doses and radiation risks of computed tomography. Eur J Radiol 2010;76(1):36–41.

25. 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.

26. Ricketts ML, Baerlocher MO, Asch MR, Myers A. Perception of radiation exposure and risk among patients, medical students, and referring physicians at a tertiary care community hospital. Can Assoc Radiol J 2013;64(3):208–212.

27. 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.