A Picture Is Worth A Thousand Words:

Needs Assessment for Multimedia Radiology Reports in a Large Tertiary Care Medical Center

Lina Nayak, MD, Christopher F. Beaulieu, MD, PhD, Daniel L. Rubin, MD, MS, Jafi A. Lipson, MD

Rationale and Objectives: Radiology reports are the major, and often only, means of communication between radiologists and their referring clinicians. The purposes of this study are to identify referring physicians’ preferences about radiology reports and to quantify their perceived value of multimedia reports (with embedded images) compared with narrative text reports.

Materials and Methods: We contacted 1800 attending physicians from a range of specialties at large tertiary care medical center via e-mail and a hospital newsletter linking to a 24-question electronic survey between July and November 2012. One hundred sixty physicians responded, yielding a response rate of 8.9%. Survey results were analyzed using Statistical Analysis Software (SAS Institute Inc, Cary, NC).

Results: Of the 160 referring physicians respondents, 142 (89%) indicated a general interest in reports with embedded images and completed the remainder of the survey questions. Of 142 respondents, 103 (73%) agreed or strongly agreed that reports with embedded images could improve the quality of interactions with radiologists; 129 respondents (91%) agreed or strongly agreed that having access to significant images enhances understanding of a text-based report; 110 respondents (77%) agreed or strongly agreed that multimedia reports would significantly improve referring physician satisfaction; and 85 respondents (60%) felt strongly or very strongly that multimedia reports would significantly improve patient care and outcomes.

Conclusions: Creating accessible, readable, and automatic multimedia reports should be a high priority to enhance the practice and satisfaction of referring physicians, improve patient care, and emphasize the critical role radiology plays in current medical care.

Key Words: Multimedia reports; radiology reporting; digital images; communication; radiology practice.

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Traditional, text-only radiology reports are the major, and often only, means of communication between radiologists and their referring clinicians (1). In the era of nearly ubiquitous electronic access to radiology reports and the increasing use of teleradiology, there has been a decline in meaningful, direct in-person consultations at a time when the perceived value of a radiologist in patient care has never been more important to radiologists’ survival, both from an economic perspective and in the more far-reaching effort to maintain the status of the diagnostic imaging specialist as a central participant in patient care (2–4). And, although advances in image display and distribution has made some radiology images more readily available to a subset of referring clinicians, the concomitant increase in imaging data generated during each study (with thin-section multidetector computed tomography [CT] and magnetic resonance imaging [MRI] routinely including more than 1000 images per study) has make the task of reviewing complete imaging studies cumbersome and ultimately unrewarding for clinicians (5).

Despite the clear importance of the imaging report and despite radiologists’ daily work in a field defined by rapid progression of new techniques and innovative digital tools, most radiologists continue to create reports in a manner strikingly similar to that of their predecessors practicing 100 years ago (6). One way to leverage technologic advancement to improve communication of radiologic findings is through the introduction of multimedia reports, in which key images (including annotated images, maximum intensity projections, and three-dimensional postprocessed images) are embedded in a radiology report that also contains text and is easily accessible to all referring physicians (7,8).

Several studies have surveyed referring physicians about their preferences about radiology reports (9–12). The study by Plumb et al (9) addressed clinician preferences with regard to report length and tabular format of results and the study by Gunderman et al (10) focused on the usage of radiology and the general perceived value of radiology reports. Johnson et al (11) identified referring physicians desire for accurate and timely reports over those that are well organized and contain pertinent negatives and Clinger et al (12) identified referring physicians desire for timely reports. In addition, a two-reader study by Iyer et al (5) evaluated the perception of embedded images in reports but did not implement a larger-scale survey.
While there have been several attempts to study referring physicians' preferences about radiology reports, none have assessed their interest in reports that have embedded images ("multimedia reports"). Therefore, the purpose of this study is to quantify referring physicians' perceived value of multimedia reports (with embedded images) over text-based reports in improving radiologists' communication with referring physicians and in improving patient satisfaction.

MATERIALS AND METHODS

To quantify the referring physicians' perceived value of multimedia reports and to test the hypothesis that referring physicians would value reports with embedded images and view them as improving their satisfaction, a survey was designed. The questions were aimed to identify referring physicians' utilization of radiology reports and images and general perceptions about and preferences for reports with embedded images. A web-based survey instrument was constructed and administered to a test sample of five physicians and then revised. The revised 24-question survey was delivered via e-mail and a hospital newsletter containing a link to 1800 referring attending physicians from a range of specialties at our tertiary medical center between July and November 2012.

The complete survey is included in Appendix A. In brief, the first four survey questions asked about referring physicians' years in practice and their radiology report usage (frequency and type of access). A "yes-or-no" question was used for physicians to express if they want to look at images while reviewing a final text report; a negative answer to this question exited the survey. A positive answer generated additional questions about general perceptions about and preferences for reports with embedded images, and most of these questions were on a 5-point, Likert-type scale (from "strongly agree" to "strongly disagree"). A "yes-or-no" question was used for physicians to express if they provide patients with access to an electronically formatted report of their radiology study; a positive answer to this question generated an additional question about perception of patient satisfaction on a 5-point, Likert-type scale (from "strongly agree" to "strongly disagree"). A free-text section was provided in which the physicians were invited to provide any additional comments. Two sample multimedia reports based on a chest radiographic study (Appendix B) and a mammographic study were included as a link in the electronic survey. While the sample reports provided were simple, survey participants were aware that reports containing cross-sectional images, three-dimensional reconstructions, and cine loops are technically feasible.

One hundred sixty referring physicians responded, yielding a response rate of 8.9%. Of the 160 respondents, 100 (63%) had more than 10 years of experience in practice. Survey results were analyzed using Statistical Analysis Software (SAS Institute Inc, Cary, NC). Institutional review board review was waived for this anonymous survey on multimedia reports.

RESULTS

When a "yes-or-no" question asked if referring physicians want to look at images while reviewing a final text report, 142 of the 160 respondents (89%) responded positively and completed the remainder of the survey questions. When asked to rate whether "reports with embedded images could improve the quality of my interactions with radiologists," 103 of 142 respondents (73%) agreed or strongly agreed. When asked to rate whether "having access to the significant/key images embedded in an electronic version of the text report would significantly reduce the time required for me to understand/process the information in the report," 97 of 142 respondents (68%) agreed or strongly agreed. When asked to rate whether "having access to the significant/key images when reviewing a text-based report enhances my understanding of the report content," 12 of 142 respondents (91%) agreed or strongly agreed.

Regarding physician satisfaction, 110 of 142 respondents (77%) agreed or strongly agreed that multimedia reports would "significantly improve referring physician satisfaction," and 85 of 142 respondents (60%) felt strongly or very strongly that multimedia reports would "significantly improve patient care and outcomes."

With regard to the design of multimedia reports, 80 of 142 respondents (56%) agreed or strongly agreed that "in order for embedded significant/key images to be useful, it is necessary to overlay annotations and labels (e.g., arrows, circles, or text)." Of 142 respondents, 72 (51%) agreed or strongly agreed that "if images were embedded in an electronically formatted text report, static 2D images would be sufficient (versus the "stack" mode sets of slices that a user can scroll through)"; another 35 of 142 respondents (25%) responded neutrally to this question.

A total of 46 free-text responses (optional on the survey) were submitted. Most comments were enthusiastic about implementing multimedia reports. Some comments expressed concern about the time it would take to download the multimedia reports, particularly when accessing them from home.

DISCUSSION

The results of our study indicate that radiology reports with embedded images are viewed very favorably by referring clinicians and may have the potential to enhance the practice of referring physicians, improve patient care and satisfaction, and highlight the critical role radiology plays in current medical care. Therefore, technological advances to support the creation of easily accessible, readable, and automatic multimedia reports should be pursued and considered a high priority.

There are several limitations to our study. This study was performed at a single institution. There may be some selection bias, as those who voluntary responded to this electronic survey format may not represent a random sampling. Further, they may be a bias related to positive association, whereby
respondents with a favorable opinion about multimedia reports responded positively to other questions (such as patient outcomes, etc) by association.

The development and incorporation of such image-oriented reporting into a multienterprise health care system could prove to be challenging for several reasons (2). First, several resources will be required for the development of an automated multimedia report. Computer programming to query images from key image codes in the report text, image processing algorithms (to resize images and overlay annotations), and multimedia document composition (such as an HTML page generator) would be necessary. In terms of hardware, a dedicated server for image processing and report composition would likely be necessary. In addition, integration with picture archiving and communicating system, radiology information system, the electronic medical record, and maintenance of these systems would be needed. Use of the National Cancer Institute’s Annotation and Image Markup schema may facilitate multimedia reports, so that image content can be easily accessed for search (13). The Medical Imaging Resource Center’s Teaching File and Clinical Trial Export integration profile may be used for key image selection (14).

Second, there must be a buy-in from radiologists and referring physicians. While some radiologists already annotate images, others will have to change their workflow to consistently integrate adding key image codes in the report and annotating significant images. This is a critical step, without which automated multimedia reports would not be possible. If it takes too long for radiologists to select key images or otherwise identify images for reporting, adoption will not be likely. Making this process integral to voice recognition dictation or structured reporting may be the solution to minimizing the time to author multimedia reports (15). And, while many referring physicians would embrace the multimedia reports, other may be hesitant to try a new technology, and there will be undoubtedly a period of adaptation and adjustment. Moreover, referring physicians, and even patients who have access to medical records, may be faced with the challenge of “information overload.” While the majority of referring physicians in this study supported the idea that “having access to the significant/key images embedded in an electronic version of the text report would significantly reduce the time required for me to understand/process the information in the report,” some referring physicians may find that reviewing images may be confusing and time consuming.

In addition, the display of multimedia reports must be easily accessible to referring physicians. The lack of uniform electronic standards for transmitting and viewing images may serve as a hurdle in developing a uniform reporting system that relies heavily on images. Creating reports that may be easily viewed on a number of types of displays, from standard radiology workstations to personal computers to cell phones, and easily transported from one institution to another will be important (2). Future directions for this project may be to implement the survey at other institutions and other practice settings (for example in the community setting). In addition, identifying the different needs of different groups of referring subspecialists may enhance the development of multimedia reports (for example, including the RECIST [Response Evaluation Criteria In Solid Tumors] for oncologists). Further, developing a pilot for generating automatic multimedia reports may prove to be very informative.

In conclusion, the results of our study suggest that multimedia reports have a very high perceived value amongst referring physicians and may have the potential for enhancing the practice of referring physicians, improving patient care and satisfaction, and highlighting the critical role radiology plays in current medical care. Therefore creation of easily accessible, readable, and automatic multimedia reports should be a high priority.

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REFERENCES

APPENDIX 1

SURVEY QUESTIONS AND ANSWERS

1. Years in practice?
   <10
   >10

2. On an average, how many radiology reports do you receive (review) per day?
   0–5
   5–10
   >10

3. Think about all of the image reports that you review. In what format(s) do you access and review the content of radiology reports (provide % for each category, with the total = 100%)?
   Electronically formatted text
   0%
   25%
   50%
   75%
   100%
   Paper-formatted text (e.g., printed version)
   0%
   25%
   50%
   75%
   100%
   Accessing the dictation system to listen to dictation report
   0%
   25%
   Other
   0%
   25%
   50%
   75%
   100%

4. I am happy with the standard report format that is text-only content. (Strongly disagree = 1; Strongly agree = 5)
   1
   2
   3
   4
   5

5. Do you want to look at images while reviewing a final text report?
   No, I primarily rely on information in the text report
   Yes

6. Under what general circumstances do you want to look at images while reviewing a final text report? (You may select more than one answer, if relevant)
   For specific types of studies
   For studies reporting significant positive findings
   For postprocedure/postintervention to check status
   For special images, such as those from 3D or other post-processing techniques
   For studies in which I am assessing change in a specific finding or process over time
   For most studies, independent of findings

7. When you are reviewing the text reports, what are the primary reasons for wanting to view the images concurrently?
   Deficiencies, inadequacies, or ambiguity in text information
   My own interest in correlating the reported result with a specific appearance/image or confirming for myself a specific finding that the radiologist has reported
   My need to use an image to direct or plan an intervention or therapy (e.g., biopsy or line placement)
   My need to use an image to assess progression of a process myself

8. If you want to view images while reviewing a text-based report, which of the following typically characterizes your situation:
   I have access to remote viewing of the images using a desktop or web application
   I make a special trip to the radiology department to view images
   I view them during a planned, routine trip to the radiology department
   Although desirable, I don’t routinely view images while reading the text-based report because the process of accessing and viewing is too cumbersome

9. From your perspective, how difficult is it to access and view images while you are reviewing the text-based report? (Easy to use = 1; Very difficult = 5)
   1
   2
   3
   4
   5

10. Reports with embedded images could improve the quality of my interactions with radiologists (Strongly disagree = 1, Strongly agree = 5).
    1
    2
    3
    4
    5
11. On an average, what is the percentage of reports for which you wish to view only the significant/key images (i.e., the images with the key findings, or abnormalities)?
   Number entry

12. Having access to the significant/key images when reviewing a text-based report enhances my understanding of the report content. (Strongly disagree = 1; Strongly agree = 5)
   1
   2
   3
   4
   5

13. Having access to the significant/key images embedded in a text-based report would be appealing to me: (Strongly disagree = 1; Strongly agree = 5)
   1
   2
   3
   4
   5

14. Having access to the significant/key images embedded in an electronic version of the text report would significantly reduce the time required for me to understand/process the information in the report: (Strongly disagree = 1; Strongly agree = 5)
   1
   2
   3
   4
   5

15. In order for embedded significant/key images to be useful, it is necessary to overlay annotations and labels (e.g., arrows, circles, or text). (Strongly disagree = 1; Strongly agree = 5)
   1
   2
   3
   4
   5

16. I would find it easier to read a multimedia radiology report that combines text information with images overlaid with annotations and labels. (Strongly disagree = 1; Strongly agree = 5)
   1
   2
   3
   4
   5

17. If images were embedded in an electronically formatted text report, static 2D images would be sufficient (versus the “stack” mode sets of slices that a user can scroll through). (Strongly disagree = 1; Strongly agree = 5)
   1
   2
   3
   4
   5

18. If 3D images were embedded in an electronically formatted text report, it is essential that they be viewable as a cine/movie (versus static). (Strongly disagree = 1; Strongly agree = 5)
   1
   2
   3
   4
   5

19. I believe multimedia reports will significantly improve referring physician satisfaction. (Strongly disagree = 1; Strongly agree = 5)
   1
   2
   3
   4
   5

20. I believe multimedia reports (electronically formatted text content with embedded images) would significantly improve patient care and outcomes. (Strongly disagree = 1; Strongly agree = 5)
   1
   2
   3
   4
   5

21. I believe that for cancer patients, multimedia reports that include images summarizing each lesion to facilitate RECIST (Response Evaluation Criteria in Solid Tumors) scoring is crucial. (Strongly disagree = 1; Strongly agree = 5)
   1
   2
   3
   4
   5

22. Do you provide your patients with access to an electronically formatted report of their radiology study?
   I would if I could
   No
   Yes
23. My patients would find it appealing to be able to view images along with the electronically formatted text content of the report. (Strongly disagree = 1; Strongly agree = 5)

1

2

24. Free-text comments

APPENDIX 2

STANFORD HOSPITAL AND CLINICS
RADIOLOGICAL STUDY REPORT

Exam Requested: Chest 2 Views
Requesting Physician: Jackson, Samuel MD
Date Scheduled: 12/01/2012 13:10:00

Patient Name: WINDS, SUMMER
Patient MRN: 1234567-8
Patient DOB: 11/18/1963
Sex: F
Date of Exam: 12/01/2012 13:13:00
Accession No: 1234567

Reason for Exam: Chest pain, weight loss and cough.

Radiological Report:

CHEST, 2 VIEWS: 12/01/2012

COMPARISON: 5/22/06

CLINICAL HISTORY: A 49-year-old with left chest pain and supraclavicular swelling, with cough for three months and approximately 20 lb unintentional weight loss.

FINDINGS: Compared with 05/22/2006, there has been significant interval change. The heart size is unchanged and within normal limits, but there is development of fullness in the superior mediastinum, bilateral hila, and left supraclavicular area, consistent with extensive lymphadenopathy. Trachea remains midline.

The bilateral lungs are also abnormal. There is a diffuse pattern of fine reticular opacity throughout both lungs. In the right lung base, there is a somewhat more nodular opacity on the order of 1.3 cm diameter. This has ill-defined borders and is not well localized on the lateral view. Some other subtle areas of nodularity are evident but no other measurable nodules are identified. There is a small left pleural effusion. There is no evidence of pulmonary edema. Bony structures are unremarkable.

IMPRESSION:

1. SEVERAL SIGNIFICANT ABNORMALITIES INCLUDING MEDIASTINAL, LEFT SUPRACLAVICULAR, AND BILATERAL HILAR LYMPHadenopathY AS WELL AS DIFFUSE BILATERAL PULMONARY PARENCHYMAL ABNORMALITIES. THE LUNG
FINDINGS ARE SOMEWHAT RETICULAR BUT ALSO SOMEWHAT NODULAR.

2. GIVEN THE CLINICAL HISTORY AND THESE FINDINGS, THE MOST LIKELY ETIOLOGY IS DEVELOPMENT OF MALIGNANCY. SARCOIDOSIS WOULD BE ANOTHER POSSIBILITY BUT THOUGHT TO BE MUCH LESS LIKELY.

3. THE RESULTS WERE DISCUSSED WITH DR. JACKSON ON 12/1/12 AT APPROXIMATELY 1430 HRS. I RECOMMEND OBTAINING A CONTRAST ENHANCED CT STUDY OF THE CHEST AND ABDOMEN AS THE NEXT STEP IN THE WORKUP.

SUMMARY: 4-POSSIBLE SIGNIFICANT FINDINGS, MAY NEED ACTION.

==================================================================
  Report Author: Wilhelm Roentgen, MD
  Report Approver: Wilhelm Roentgen, MD

  Creation Date: 12/01/2012 03:03 PM
  Approval Date: 12/01/2012 03:03 PM

THIS REPORT WAS RECEIVED FROM THE CENTRICITY RIS-IC INFORMATION SYSTEM
==================================================================

![Comparison X-Rays](comparison_cxr.png)

**COMPARISON CXR 5/22/2006**

**CURRENT CXR 12/01/2012**