Published in final edited form as:

J Am Coll Radiol. 2010 March ; 7(3): 205–210. doi:10.1016/j.jacr.2009.10.014.

Added Value of Selected Images Embedded Into Radiology Reports to Referring Clinicians

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Abstract

Purpose—The aim of this study was to evaluate the added utility of embedding images for findings described in radiology text reports to referring clinicians.

Methods—Thirty-five cases referred for abdominal CT scans in 2007 and 2008 were included. Referring physicians were asked to view text-only reports, followed by the same reports with pertinent images embedded. For each pair of reports, a questionnaire was administered. A 5-point, Likert-type scale was used to assess if the clinical query was satisfactorily answered by the text-only report. A “yes-or-no” question was used to assess whether the report with images answered the clinical query better; a positive answer to this question generated “yes-or-no” queries to examine whether the report with images helped in making a more confident decision on management, whether it reduced time spent in forming the plan, and whether it altered management. The questionnaire asked whether a radiologist would be contacted with queries on reading the text-only report and the report with images.

Results—In 32 of 35 cases, the text-only reports satisfactorily answered the clinical queries. In these 32 cases, the reports with attached images helped in making more confident management decisions and reduced time in planning management. Attached images altered management in 2 cases. Radiologists would have been consulted for clarifications in 21 and 10 cases on reading the text-only reports and the reports with embedded images, respectively.

Conclusions—Providing relevant images with reports saves time, increases physicians' confidence in deciding treatment plans, and can alter management.

Keywords

Radiology reporting; radiology practice; communication; digital images

INTRODUCTION

The radiology report is intended to provide timely, relevant, and informative description and interpretation of an imaging study, and it attempts to answer the specific question for which the study was performed. The imaging examination report provides an important means of communication between the radiologist and the other physicians rendering care and is often the only form of communication between the radiologist and the referring physician, especially in the increasingly common practice of teleradiology [1]. As radiology reports become permanent parts of patients' medical records, constituting important legal documents when there is contention, radiologists have an obligation to convey the interpretation of imaging procedures in a manner most useful to ordering physicians.

Several studies to assess referring physicians' preferences as to the form and content of radiology reports [2-6] have identified areas for improvement. This recognition has led to increasing structure, evolving from the traditional narrative prose to reports with separate paragraphs for "procedure," "findings," and "summary" and, more recently, to itemized reporting with subheadings for each anatomic area depicted.

Suggestions for improving communications with referring clinicians by the creation of multimedia reports have been made before [7-11]. This idea even predates the widespread deployment of PACS [7-10]. The advances in image distribution technology, especially image distribution using Web servers and applets, has made radiology data readily available throughout hospital systems as part of patients' electronic medical records. However, the abundance of imaging data generated during thin-section multidetector CT and MRI, sometimes with >1,000 images in each study, can make the task of reviewing images cumbersome and ultimately unrewarding for clinicians. Some radiologists routinely indicate series and image numbers of key images in their reports. This approach still requires that busy clinicians access the studies from appropriate servers and depends on concordance of the image numbers across platforms. Unfortunately, with Web-based image distribution systems, image and series numbers may not coincide with image numbers on PACS workstations.

It has been suggested that providing referring physicians with selected images embedded in text reports over the Web could improve and support the information contained in the reports [12]. To study this next step in evolution of the radiology report, we undertook this study to measure the utility to referring physicians of radiology reports with attached, relevant images of the abnormal findings.

MATERIALS AND METHODS

Radiology Report Selection

This institutional review board-approved, single-center study was performed at a 900-bed, urban, multispecialty academic hospital. Two full-time staff physicians, a gastrointestinal medical oncologist and a gastrointestinal surgeon, who refer their patients for abdominal-pelvic CT scans participated as readers. Our database of radiology cases was reviewed for 2007 and 2008 to select the CT scan reports of patients referred by these physicians. This case review was conducted in 2009, so this was a retrospective study.

Twenty-one cases from a cohort of 1,037 cases referred by the medical oncologist were selected, and 14 cases from a cohort of 62 cases referred by the surgeon were selected. The cases were selected by a radiologist with 13 years of training (M.G.H.) to represent a cross-section of imaging findings that are commonly encountered in patients seen by the specialties practiced by participating readers. The cases selected to be viewed by the

oncologist included 11 patients with colonic adenocarcinoma, 2 with rectal adenocarcinoma, 2 with pancreatic carcinoma, 2 with hepatocellular carcinoma, 1 with duodenal adenocarcinoma, 1 with gastric adenocarcinoma, and 1 with cholangiocarcinoma. These patients had been referred by the oncologist for routine imaging follow-up for detecting metastases. One additional patient with a pancreatic neuroendocrine tumor had been referred for further evaluation of pain and swelling in the right lower quadrant of the abdomen. Among the cases selected to be viewed by the surgeon, 3 patients had been scanned for preoperative evaluation of pancreatic cancer, 3 for preoperative evaluation of colon cancer, and 1 for preoperative evaluation of gastrointestinal stromal tumor. Four patients were being referred to follow progression in the size of intra-abdominal masses. One patient was being evaluated to determine the cause of right lower quadrant pain, 1 to determine the cause of weight loss after Whipple's surgery, and 1 to determine the presence of a colovesical fistula.

Report With Embedded Images

For each selected CT examination, a second report was created that included the same text as the first report. In addition, selected images of pertinent findings described in the text report were attached at the end of the report in the same Microsoft Word (Microsoft Corporation, Redmond, Washington) document. These selected images were exported from the PACS workstation (AGFA Impax; AGFA Technical Imaging Systems, Ridgefield Park, New Jersey) in a JPEG format and appended to the text report. In case comparisons were made with specific images in prior abdominal-pelvic CT examinations performed at our institution, the corresponding images from the prior CT examinations were also attached. All pertinent images were selected and annotated with arrows highlighting the imaging findings discussed in the text reports. Thus, for all 35 cases, pairs of reports consisting of a text-only report and a report with embedded images were created.

Questionnaire

A questionnaire was developed to assess the utility of providing reports with embedded, selected pertinent images (Appendix). As a preliminary, the physicians were asked to review the clinical notes in which the imaging studies were requested by them, so that they might recall the specific clinical queries. Subsequently, the readers reviewed the text-only reports and then the reports with embedded images. The readers were asked to complete a questionnaire after reviewing the pair of reports for each patient. The questionnaire first asked the physicians to rate their satisfaction with the capacity of the text-only report to answer the clinical query 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 the report with embedded images answered the clinical query better than the text-only report; a positive answer to this question generated 3 additional "yes-or-no" queries to examine whether the report with embedded images helped in making a more confident decision on patient management, whether it reduced the time spent formulating a management plan, and whether it altered management. The physicians were asked to rate, on a 5-point, Likert-type scale, to what extent images embedded in the report represented the most important features described in the text. A free-text section was provided in which the physicians were invited to comment about any additional findings they would have liked to view as attached images. The questionnaire asked whether readers would have contacted a radiologist with queries about the described findings after reading the text-only report and after viewing the report with images. The physicians were also asked if they would prefer to receive reports with images embedded in each case.

Statistical Analysis

Responses to these questions were recorded, and 95% exact confidence intervals (CIs) were calculated for the results. Responses for questions on whether a radiologist would be

consulted after reading the text-only report and the report with embedded images were analyzed by further dividing them into 3 groups: cases in which a radiologist would be consulted after reading both the text-only report and the report with embedded images, cases in which a radiologist would not have been consulted in either case, and cases in which a radiologist would have been consulted after viewing the text-only report but not after viewing the report with the embedded images.

RESULTS

Among the 35 selected cases, 30 CT scans were performed with intravenous iodinated contrast and 5 without. All except 1 scan were performed with oral contrast; rectal contrast was administered in the other. Thirty-one cases were performed on 16-slice helical CT scanners, 2 cases were performed on 8-slice helical CT scanners, and 2 cases were performed on 64-slice helical CT scanners. The average number of images per examination for the oncologist and surgeon were 236 and 361, respectively. The examinations with the maximum number of images for the oncologist and surgeon had 441 and 1,045 images, respectively. The selected cases were read on-site by fellowship-trained gastrointestinal radiologists at the time of initial interpretation. Reports provided to the referring physicians at the time of the initial interpretation were itemized reports, with each anatomic region described under a separate subheading.

When asked to rate whether the text-only reports satisfactorily answered their queries on a 5-point, Likert-type scale, the participants agreed that the text-only reports provided satisfactory information in 32 cases (91.43%). In the other 3 cases (8.57%), they neither agreed nor disagreed. When asked if the reports with embedded images answered their clinical questions better than the text-only reports, in 32 cases (91.43%; 95% CI, 76.95%-98.20%), participants felt that the clinical questions were better answered by the reports with images embedded. In all of these 32 cases, the reports with the images helped the participants make more confident decisions while formulating management plans and also saved time taken to formulate the plan (95% CI, 89.11%-99.99%).

In 2 cases (6.25%; 95% CI, 0.77%-20.81%), the management plans were modified after viewing the images embedded in the reports. Both these changes were made by the surgeon. In 1 case, the surgeon would have performed dissection of an enlarged lymph node shown in the image attached to the report but would not have dissected this node after reading its description in the text-only report; in the second case, the surgeon would have ordered an additional imaging study after viewing attached images. In both these cases, the surgeon had visited the radiology department to review the cases with a radiologist while originally formulating the patient's management plan, so that appropriate care had been rendered.

When asked to rate on a 5-point, Likert-type scale whether the images embedded in the reports represented the most important features described in the reports, the participants strongly agreed in 7 cases, agreed in 21 cases, neither agreed nor disagreed in 1 case, and disagreed in 6 cases. The majority of comments about additional images to be included were related to ancillary findings, including a request to provide images of lesions in bones, adrenal glands, and lymph nodes and images of omental nodules when these were mentioned in the text. The other images requested included hyperdense lesions in the liver and pertinent negative findings. In all 35 cases, the physicians were pleased with the convenience of receiving reports with images embedded.

The radiologists would have been consulted in 21 and 10 cases after the text-only reports and the reports with embedded images, respectively. After viewing the reports with embedded images, the participants changed their decisions to consult the radiologists in 11

cases (31.43%; 95% CI, 16.85%-49.29%). Thus, in 11 cases, after seeing the embedded images, the clinicians changed their minds and felt that they no longer needed to consult radiologists. In no case did seeing the images instigate a radiologic consultation.

DISCUSSION

The results of our study indicate that although clinicians' queries are satisfactorily answered by the current itemized reports, providing additional images conveys useful additional information. It may enable referring clinicians to formulate management plans more rapidly and with increased confidence. Rarely, it may also alter a management plan. Consultations with radiologists would have been reduced by 50%. In all cases, clinicians liked the convenience of attached pertinent images.

In the current age of digital radiology, Web-based image viewing technology has made hospital-wide access to images a reality. With the evolution of imaging technology, the number of images for each study has increased. In this scenario, when physicians wish to see what it was that led radiologists to their conclusions, reviewing the multitude of images can be time-consuming and sometimes futile. The difficulty associated with this task may be discouraging to referring doctors, leading them either to blindly agree with radiologists or to spend valuable clinical time trying to assimilate the images and the reports. This explains why in all cases, the referring doctors in our study liked seeing embedded pertinent images. This is also the possible explanation for why clinicians felt that they could make more confident decisions on the patients' management plans after viewing the images.

To understand further how attached images may have helped, in each case, the questionnaire asked whether time was saved in reaching a management plan. In a majority of the cases, the clinicians found that the attached images saved time in formulating management plans. Because this study included only reports of abdominal-pelvic CT scans, which had an average of 284 images, we postulate that attached images saved the time spent in scrolling through all the study images before seeing the relevant ones. This study was performed at a large multispecialty center at which referring clinicians often contact the radiology reading rooms via telephone or in person for further clarifications of reported findings. This time spent in consultation for explanations of radiologists' conclusions might have been reduced in some cases, thus saving the clinicians' time. Further studies should try to accurately quantify the amount of time saved by reviewing reports with attached images as perceived by clinicians.

The finding of saved time should further be interpreted in the light of responses to questions on whether the radiologists would have been consulted after viewing the text-only reports compared with the reports with embedded relevant images. Even in the 10 cases in which radiologists would have been consulted despite viewing the reports with attached images, clinicians felt that time was saved. This could mean that after a quick review of attached findings, the clinicians knew that these did not answer their questions and could consult the radiologists without having to look through all images. There are growing concerns about the disintegration of direct face-to-face consultations between referring doctors and radiologists [13]. It might be a concern that embedding images in reports could further reduce such consultations. After viewing the images with attached reports, the number of times a radiologist would be consulted was reduced by 50%. In these cases in which the decision to consult the radiologists changed after viewing the reports with relevant images, it may be that the images reduced the ambiguity of the radiology reports. The images may also help clinicians identify findings that are small in size, such as small lesions in the liver. Thus, although consultations with radiologists are not fully eliminated, embedded images eliminate consultations simply to have radiologists point out the findings described in

reports. Because telephone and in-person consultations are disruptive events during image interpretation, adding images to reports may allow for uninterrupted image interpretation. Moreover, at large institutions, the original radiologist might not be available, and a clinician might have to consult a different radiologist unfamiliar with the case.

A second reason for radiologists' being consulted despite reading the reports with images may be that the attached images were not the most relevant images for the clinicians. In 6 cases, the referring doctors did not find the attached images to be the most relevant images. The free-text comments in the questionnaire indicate that clinicians find images of ancillary and incidental findings helpful. Attaching images of pertinent negative findings were also considered helpful to clinicians. Surveys on referring clinicians' preferences in text reports have indicated that mention of pertinent negative findings in reports are valuable [2]. Additional studies and consultations with focus groups representing different clinical specialties can help radiologists and their referring colleagues reach a consensus about the best images that referring doctors would like to see in often-encountered clinical conditions. Such radiology reports might improve the quality of our communication with referring doctors.

For cases in which a management plan changed because of the images, it is important to examine the reasons. It could be that the wording of the reports did not convey the need to take the steps in management that were taken by the doctors after seeing the images. It is difficult to estimate if such changes in management would have had any beneficial effects on the patients' outcomes. Attached images may circumvent the problem of not wording radiology reports in a manner most useful to clinicians. On the other hand, this might induce nonradiologists to make unfortunate management decisions on the basis of their own interpretations of selected images.

A similar concept of improving reports was suggested by Reiner and Siegel [12]. In their study, they found that structured reports with embedded images were given highest overall satisfaction ratings by referring clinicians [14]. Even before the widespread use of PACS, it was suggested that radiology reports should include images to facilitate communication with referring clinicians and as tools for patient education [15]. In the days before PACS, studies suggested the generation of multimedia reports with links to specific images to improve radiologist-clinician communication [8]. The ability to create a selected sample of relevant images is supported by the Digital Imaging and Communications in Medicine format and should be supported more aggressively by technology, so that radiologists can generate reports with embedded images with minimal efforts [11]. A mechanism to provide clinicians with reports containing embedded images has been addressed by the *Integrating the Healthcare Enterprise* handbook, a joint effort of the Radiological Society of North America, industry, and several professional organizations [16]. *Integrating the Healthcare Enterprise* outlines "integration profiles," which are descriptions of how the Digital Imaging and Communications in Medicine and Health Level 7 standards are to be implemented to address specific clinical integration needs [17]. The Key Image Note integration profile describes a mechanism by which technologists, radiologists, and others involved in the performance of radiologic procedures can flag images as significant and attach comments to those images [18]. The Simple Image and Numeric Report integration profile provides templates for reports with titles, report text, measurements, image references and links to images, and other coded entries [18]. To incorporate these integration profiles in a department, the technical framework for the profiles can be requested from vendors during installation and upgrading of PACS. Despite these efforts, the lack of standardization in report creation and transmittal poses a significant hurdle to the widespread use of image-rich reports. Wider utilization and expansion of the Integrating the Healthcare Enterprise

initiative might be a solution to standardize radiology reporting with image-rich reports and to optimize communication with referring clinicians.

The drawback of our study was that only 2 physicians were included in this initial exploratory study. No comparison was made between their responses. The responses were not compared because any significant difference in their answers could be attributed to the respondents and would not be representative of the responses of the specialties. Additionally, a larger number of cases need to be studied. Also, in this retrospective study, the respondents knew the cases. The results of this study are encouraging and indicate that prospective studies with larger numbers of respondents in different medical specialties and with a greater number of cases are required.

In conclusion, providing referring clinicians with a selected subsample of relevant images attached to reports improves radiologist-clinician communication. Such reports have the ability to save clinicians' time and possibly improve patient management. Technological advances to support the creation of reports with attached sub-samples of images should be pursued, as they are viewed favorably by referring clinicians.

APPENDIX

Questionnaire to Assess the Utility to Referring Physicians of Selected Embedded Images

1. The report satisfactorily answers your clinical query.
☐ Strongly agree
☐ Agree
☐ Neither agree nor disagree
☐ Disagree
☐ Strongly disagree
2. The report plus the relevant images satisfactorily answers your clinical query better than report alone.
☐ Yes ☐ No
3. If yes,
 - Does having relevant images with the report help you make a more confident decision on management?
☐ Yes ☐ No
 - Does having relevant images reduce the time spent in forming a management plan?
☐ Yes ☐ No
 - Does having the relevant images alter your management of the patient?
☐ Yes ☐ No
4. The images displayed with the report represent the most important features described in the report.
☐ Strongly agree

- ____ Agree
 ____ Neither agree nor disagree
 ____ Disagree
 ____ Strongly disagree

Would you have liked any other images to be included in this case?

____ Yes ____ No

5. Would you discuss the case with a radiologist to have your queries answered, after reading the report?
 ____ Yes ____ No
6. Would you discuss the case with a radiologist to have your queries answered, after reading the report with attached relevant images?
 ____ Yes ____ No
7. Would you like having images attached to the radiology report?
 ____ Yes ____ No

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