Original Report

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Impact of Filmless Radiology on Frequency of Clinician Consultations with Radiologists

OBJECTIVE. The purpose of the study was to determine the impact of filmless operation on the relative frequency of in-person consultations in the radiology department between radiologists and clinicians.

CONCLUSION. The transition to filmless operation at the Baltimore Veterans Affairs Medical Center was associated with an 82% reduction in the in-person consultation rate for general radiography and a 44% reduction for cross-sectional imaging despite an increase in the volume of studies. The major reason for this decrease was the convenient access to current and prior images provided by the PACS (picture archiving and communication system). Radiology departments contemplating a transition to filmless operation should prepare for communication with clinicians to shift from being mostly in person to being conducted more and more through electronic forms of communication.

One of the basic tenets of the practice of radiology has been the importance of good communication between the radiologist and the referring clinician to optimize the quality of image interpretation and patient care. Studies comparing film interpretation between radiologists and nonradiologists have documented that radiologists are significantly more accurate than their clinical colleagues in image interpretation [1–4]. The need for this exchange of information between the radiologist and clinician has become further accentuated by our health care system's emphasis on cost containment. Three studies [5–7] have concluded that significant cost savings and more rapid clinical diagnosis can be achieved when clinicians consult with radiologists.

The increasing complexity of technologic choices available to clinicians may contribute to inappropriate use of diagnostic imaging procedures [8, 9]. Consultations between clinicians and radiologists may also help facilitate the choice of the best imaging study for each patient, reducing unnecessary expenditure [10–13]. The American College of Radiology [14] has advocated the development of practice policies, with the ultimate goal of reducing inappropriate use of medical technology at a national level. Two studies [15, 16] have shown that using radiologists as consultants in establishing guidelines for selection and appropriateness of imaging procedures can greatly enhance efficiency. This added importance of the radiologist as a consultant has led to the concept of the radiologist as a primary care extender [17].

Increased speed and ease of access to diagnostic images made possible by an enterprise-wide picture archiving and communications system (PACS) may decrease the tendency of clinicians to consult with radiologists [18]. We were unable to find any published studies that have established the rate of clinician consultations with radiologists or that have measured the change in consultation frequency after the transition to a hospitalwide PACS. This study was undertaken to prospectively determine the frequency of consultations between radiologists

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and clinicians in a film-based radiology department and to evaluate the impact of filmless operation on the frequency of these consultations.

Materials and Methods

Data collection forms were developed to compare clinician consultation frequency in both film-based and filmless environments. Data were collected at the Baltimore Veterans Affairs Medical Center before (February–June 1993) and 3 years after (1996) conversion to filmless imaging. Analogous data were collected at the Philadelphia Veterans Affairs Medical Center, which was selected as a control because of its similar academic affiliation, size, and location.

Using a modified work-sampling technique [19], direct observations were made by one of three independent observers over a 2-week period at the respective institutions. Information recorded included the date and time of each consultation obtained in the radiology department, the nature of the consultation, and the subsection within the radiology department in which the consultation occurred. Data were collected in two specific areas of the department: general radiography and body imaging (CT and sonography). The observers were physically stationed within the radiology department for 8-hr periods (9 A.M. to 5 P.M.) on consecutive weekdays. No observations were recorded during evening and weekend hours because no routine radiologist coverage took place during those times.

A consultation was defined as an interaction between a radiologist and one or more clinicians within the radiology department in which one or more radiology cases were discussed, reviewed, or both. A single consultation could occur within a few seconds or could require more than an hour. The interaction was recorded as a single consultation regardless of the number of clinicians involved. Telephone interactions between radiologists and clinicians were not recorded regardless of whether images were reviewed during the discussion.

The volume of studies performed in the departments for both general radiography and cross-sectional imaging were obtained from the hospital information system database. The consultation rate for each section (general radiology and cross-sectional imaging) was obtained for each medical center and was defined as the number of consultations divided by the number of studies performed (expressed as a percentage). For example, a ratio of one consultation per five examinations would represent a 20% consultation rate.

Resident and attending physicians were surveyed at the Baltimore Veterans Affairs Medical Center in 1995 and 1996 (2 and 3 years after the transition to filmless imaging). One hundred thirty-eight (49%) of the 280 questionnaires that were sent out were completed, by 48 surgical and 90 medical staff members. Forty percent of the respondents were attending physicians and 60% were house staff. Respondents were asked to indicate whether their rate of direct consultations with radiologists had increased, remained the same, or decreased after the transition to a filmless environment. This assessment was made for conventional radiography, cross-sectional imaging, angiography, nuclear medicine, and the imaging department in general. The survey did not ask clinicians to indicate the reason for the change in consultation rates.

Results

The annual volume of studies performed at the Baltimore Veterans Affairs Medical Center increased from 36,563 in the 1992–1993 fiscal year to 51,770 studies in 1996–1997 (42%). The volume of conventional radiographic examinations increased by a smaller amount from 27,960 to 34,129 (22%) because of a decrease in the overall percentage of conventional radiographic studies from 76% to 66%.

Despite this increase in the total number of conventional radiographic studies, the number of consultations between clinicians and radiologists decreased (Table 1). Before the transition to filmless operation, the ratio of general radiographic examinations to consultations in the radiology department was 7.5:1. The consultation rate thus fell by a factor of 5.6 (82% decrease) to 42.1:1 examinations per consultation. The ratio of examinations to consultations for general radiography at the Philadelphia Veterans Affairs Medical Center was 13.3:1.

The total volume of cross-sectional body imaging studies (nonneuroradiology) performed at the Baltimore Veterans Affairs Medical Center between 1992–1993 and 1995–1996 also increased, from 6282 to 9407 (50%). The ratio of body imaging studies to consultations at the Baltimore Veterans Affairs Medical Center increased by a factor of 1.8 (44% decrease in consultation rate) from 3.1 to 5.5 during this interval. The ratio of studies to consultations at the Philadelphia Veterans Affairs Medical Center for body imaging studies was approximately 5.5 studies per consultation, equal to the ratio at the Baltimore Veterans Affairs Medical Center after the transition to filmless operation.

Data from the clinician surveys at the Baltimore Veterans Affairs Medical Center (Table 2) indicate that only 2% of the clinicians surveyed in 1995 believed that filmless operation had resulted in an increased number of consultations, 42% thought that consultation frequency had decreased, and 56% believed that it was unchanged. In 1996, clinician surveys

TABLE 1 Frequency of Clinician Consultations (General Radiography)

Medical Center	Annual Volume	Consultations Per 8-Hr (Weekday)	Studies Per Consultation	Consultation Rate
Baltimore 1993 (film-based)	27,960	12.0	7.5	13%
Baltimore 1996 (filmless)	34,129	2.6	42.1	2.4%
Philadelphia 1993 (film-based)	NDC	NDC	NDC	NDC
Philadelphia 1996 (film-based)	33,932	8.2	13.3	7.5%

Note.—NDC = no data collected.

TABLE 2 Frequency of Clinician Consultations (CT and Sonography)

Medical Center	Annual Volume	Consultations Per 8-Hr (Weekday)	Studies Per Consultation	Consultation Rate
Baltimore 1993 (film-based)	6282	6.5	3.1	32%
Baltimore 1996 (filmless)	9407	5.5	5.5	18%
Philadelphia	6914	4	5.5	18%

TABLE 3 Clinician Perception of Frequency of Consultations in a Filmless Environment

Section	Fewer (%)	No Change (%)	More (%)
Conventional radiography	32	59	9
Cross-sectional imaging (CT, MR, sonography)	26	66	8
Angiography	18	78	4
Nuclear medicine	17	77	6
Imaging department in general	35	57	8

indicated a further decrease in the perceived frequency of consultations with radiologists in the radiology department, with 59% indicating a decrease in consultation frequency and 35% indicating no significant change. The small number of respondents who thought the frequency of consultations had actually increased was slightly higher in 1996, from 2% to 6% of respondents. The degree of perceived consultation decrease varied according to subsections within the radiology department, with the least change in the areas of nuclear medicine and angiography and the most in general radiography (Table 3).

The total number of scheduled conferences between the radiology and clinical staff did not change at either the Baltimore or Philadelphia Veterans Affairs Medical Centers during the interval between 1993 and 1996.

Discussion

The transition to filmless operation using an enterprisewide PACS has resulted in many benefits, including elimination of lost examinations, improved image accessibility, and improved staff productivity [20]. Images and reports can be electronically accessed within a few seconds throughout all areas of the hospital, obviating travel to the radiology department as was often required for image review in a film-based system. Survey data (Protopapas Z et al., presented at the American Roentgen Ray Society meeting, May 1997) suggest significant clinician time savings associated with filmless operation, largely as a result of enhanced image and report accessibility. However, the improved accessibility of images to referring physicians outside of the radiology department may have the undesired effect of reducing the amount of communication between clinicians and radiologists.

Our data, based on direct observation of clinician consultations with radiologists in the radiology department, confirm that the number of direct consultations has significantly decreased. The 82% decrease in the general radiography consultation rate at the Baltimore center from 13% (before installation of the PACS) to 2.4% (1996) was greater than we had anticipated. In comparison, the consultation rate at the Philadelphia Veterans Affairs Medical Center in 1996 was three times greater than the rate at Baltimore (7.5%). This decrease occurred in Baltimore despite the fact that most general radiographic studies were performed in the outpatient clinics and emergency department, which are adjacent to the radiology department.

This decrease in the consultation rate was considerably less in the body imaging section, where the consultation rate dropped from 32% to 18% (decrease of 44%). Unlike the rate in general radiography, the 1996 consultation rate for body imaging was the same (one consultation per 5.5 studies) at both the Baltimore and the Philadelphia Veterans Affairs Medical Centers. The smaller decrease in consultation rates and the lack of significant difference from Philadelphia suggest that clinicians may have been more willing to overcome the inconvenience of the trip to the radiology department for CT and sonography studies.

The survey data suggest not only that clinicians are aware of this decreased tendency to consult with radiologists after the transition to the PACS but also that they are aware of the greater degree of reduction for conventional radiography than for cross-sectional imaging. The clinicians further suggested that the drop in consultations might be even less for nuclear medicine and special procedures (which were not included in the observational portion of the study) than for general and cross-sectional imaging (17% and 18% compared with 32% and 26%).

The explanation for the decrease in clinician consultations is undoubtedly multifactorial. The most likely explanation for this decrease is that with a hospitalwide PACS, images can be easily reviewed outside the radiology department. The convenience of obtaining a radiology consultation while already in the radiology department to retrieve or return films likely plays a major role in the number of consultations. Another major factor is the report turnaround time. The sixfold reduction in turnaround time from 24 to 48 hr (this time has improved to 2 hr recently because of a digital dictation system) to less than 8 hr means that reports were available for clinician review more rapidly. Our commercial PACS displays the ordering information and the radiology report before retrieving an imaging study.

The lesser reduction in the consultation rate for cross-sectional imaging (and, according to survey data, for nuclear medicine and special procedures) was probably due to the lower level of clinician confidence in their ability to read these imaging techniques. Additionally, patients who undergo cross-sectional, nuclear medicine, and special procedures tend to have more complex case histories and findings than those who undergo general radiography. Clinicians are more likely to consult with radiologists before or after they order a study in a patient with more complex imaging needs.

Because CT and sonography are reviewed in a single location by a body imaging fellow and attending physician, we do not have separate data concerning these two techniques. Our expectation is that the consultation rate would be greater for sonography than for CT, which might have made the CT consultation rate somewhat lower and more similar to that of general radiography. However, the consultation rate in CT could not have been significantly lower because sonography studies account for less than 25% of our total volume of cross-sectional imaging studies.

The number of direct consultations between clinicians and radiologists in the imaging department represents only a subset of the total communication between radiologists and clinicians. A substantial number of consultations occur outside the radiology department in conferences such as tumor board and grand rounds, and in the hallways, elevators, and so on. Although a change in the number or nature of these conferences could have had a significant impact on the consultation rate in radiology, no change was observed in either institution.

The consultation rate also underestimated the number of cases in which a consultation occurred in the radiology department in two ways. First, clinicians often consulted about multiple cases in a single interaction with a radiologist. However, because of the anticipated difficulty that our observers might have in deciding the number of studies discussed, a single discussion with multiple cases discussed was counted as only one consultation. This quantification system was used even in cases in which a medical team spent time with a radiologist discussing all of their patients with the radiologist. Second, discussions with a group of clinicians were counted only as a single consultation even when multiple discussions occurred with different clinicians about a number of patients. Consequently, our consultation rate does not reflect the percentage of cases in which a discussion with a radiologist took place but merely the ratio of direct single or group consultations with a radiologist in the radiology department to the total number of studies.

We were unable to find any reports in the literature to document consultation rates at other facilities to determine how those at the Baltimore and Philadelphia Veterans Affairs Medical Centers compare with other medical centers. Consultation rates probably vary greatly depending on whether the practice is private or academic, whether it is mostly inpatient or outpatient, the size of the practice, location of referring clinicians, and so on.

In addition to in-person consultations, clinicians and radiologists can communicate in other ways such as a comment on the radiology request form, a letter, facsimile, or telephone call. In a filmless and paperless department such as the Baltimore Veterans Affairs Medical Center, the opportunity for communication based on writing on the request form or in a letter is limited. Instead, the ways in which radiologists and clinicians communicate have also made the transition to a digital environment.

Radiologists can communicate findings electronically by annotating images using the PACS. A nodule can be circled, a pneumothorax delineated, and a fracture pointed out using drawing tools available at the workstations. Clinicians in the emergency department use the PACS to type in preliminary impressions [21]. Radiologists are anecdotally more likely to use the telephone and electronic mail in a digital environment than in a film-based one, although these alternative forms of communication were not included in this study.

As a result of these alternative locations and forms of communication, we could not determine the effect of filmless operation on the total number of consultations in all formats. However, the decrease in the total number of direct consultations in radiology does have significant implications for the practice of radiology in a filmless environment. Regardless of whether alternative forms of communication are actually more optimal for patient care, the lack of direct consultation may have the undesired effect of depersonalizing the practice of radiology. We believe that interpersonal interaction is important to establish the role of the radiologist in selecting optimal studies and in the interpretation of imaging studies. The relative clinical and marketing value of an interactive discussion between the radiologist and clinician while they review images is difficult to determine. The electronic equivalent of this interaction, which would use an interactive cursor and a discussion via telephone or videoconference, is not available at our institution.

The emergency department and intensive care units account for a substantial percentage of our general radiographic studies. The PACS offers radiologists the potential to perform primary interpretation of imaging studies while they are in these and many other locations in the medical center. This distributed model of radiologist workstations would undoubtedly increase the consultation rate with clinicians. Unfortunately, most clinical areas are not well suited to the environmental requirements of radiologists, which include optimal lighting and acoustic conditions.

In conclusion, the role of the diagnostic radiologist as a consultant has been in a state of flux since the advent of radiology. As radiology evolves from a film-based to a filmless environment, the role of the radiologist will continue to evolve. Radiologists will need to learn to use new tools to effectively communicate with their clinician colleagues in a digital imaging department. They will also need to enthusiastically reach out to clinicians to foster and maintain good interpersonal relationships with referring clinicians. This will involve radiologists participating in multidisciplinary conferences, inviting clinicians to the department to discuss patient information and review images, and participating on hospital committees. Radiologists will need to work diligently to make up for the decreased number of clinicians who visit the imaging department in a filmless environment by making themselves readily accessible and by encouraging clinicians to seek their advice.

PACS provides a tool that can result in substantial savings in dollars and in efficiency, and this tool, if used properly, can improve communications between radiologists and their clinician colleagues and help radiologists maximize their added value in patient care.

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The reader's attention is directed to the commentary on this article, which appears on the following pages.