From Traditional Reading Rooms to a Soft Copy Environment: Radiologist Satisfaction Survey

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Academic radiologists are experiencing increased clinical workloads. New technology such as picture archiving and communication systems (PACS) are often justified on the premise of increased efficiency. The authors believe that efficiency can be influenced by the image interpretation environment, and thus they set out to establish baseline satisfaction levels with this environment. The authors surveyed 90 Indiana University (IU) faculty radiologists, fellows, and residents. Their survey was implemented with a questionnaire sent via e-mail. Questions focused on satisfaction with the current soft-copy reading environments and preferences regarding improvements. Of the 90 radiologists surveyed, 55 (61%) responded. Several key findings emerged: (1) Overall satisfaction with the soft-copy environment is low, with nearly half (46%) of respondents rating themselves as "very dissatisfied" or "dissatisfied." (2) Faculty are least satisfied regarding work space ergonomics, room layout, and amount of work space. Appropriate lighting also emerged as an area with low satisfaction and high importance. (3) Ninety-eight percent of respondents indicated that an "ideal" soft-copy environment would have a positive effect on their efficiency. The dissatisfaction with the current soft-copy interpretation environments used by the IU radiologists indicates that this is an area that requires attention. Furthermore, there may be a direct relationship between radiologist efficiency and satisfaction with the image interpretation environment. Attention should be focused on this environment during a soft-copy technology implementation to ensure that planned efficiency gains are realized.

KEY WORDS: Reading room, soft copy, ergonomics

CLINICAL WORK BY ACADEMIC RADIOLOGISTS has always been the cornerstone that supports the threefold mission of academic radiology to flourish. However, there is a continuing trend toward an increased clinical workload and a resultant decrease in research output among academic radiolo-

gist.^{1,2} Arenson et al. reported results from the Society of Chairmen in Academic Radiology (SCARD) workload surveys showing an 18% increase between 1996 and 1998 in relative value units (RVU) per full-time equivalent (FTE) in academic radiology departments.³ Cortegiano analyzed workload data for academic radiologists from 25 institutions in 1999-2000 and found a 21% growth in RVUs per FTE radiologist in the period 1996-2000.⁴ Ever-increasing cost pressures in the academic setting, the declining pool of academic radiologists, and the increasing competition by private practice radiologists demand that a higher percentage of academic radiologists' time be devoted to clinical work. Greater efficiency and higher work volume with faster turnaround time are deemed necessary for department success. The transition to soft-copy interpretation via PACS is one technological advance that has been touted as promising increased productivity and improved report turnaround times.⁵⁻⁷ While PACS does provide a technological solution to several

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shortcomings in traditional film-based workflow, exploiting this technology to achieve improved work efficiency, especially in the academic setting, has been a challenge. Without the proper support in place to allow the radiologist the ability to interpret imaging in this soft-copy environment efficiently, effectively, and without excessive fatigue, the productivity advantages promised by PACS are not realized.

During our multi-facility PACS implementation, many of our radiologists voiced concerns about the soft-copy reading environment given existing reading room spaces: poor lighting (often via overhead fluorescents with on/off options only), cramped space, and few accommodations for large multi-monitor work stations. Radiologists expressed concern about shoehorning necessary items such as the Radiology Information System (RIS), dictation and other systems into existing space. For example, one reading room used by our chest and abdominal radiologists is approximately 8' × 18'. It contains four PACS work stations and two RIS stations in a linear arrangement. The RIS work stations are located between each pair of PACS stations. Four alternators are in this room. Because of the room's shape, two of the alternators are located directly opposite and facing the PACS work stations. Another example is the neuroradiology reading room at one of our sites. It measures approximately 16' by 16'. It contains two four-bank sets of monitors and one two-bank work station, as well as two RIS stations and one alternator. The alternator is directly opposite one of the four-bank work stations and perpendicular to the two-monitor station. A large file cabinet and a film file holder are also in the room, as are seven chairs, three of which have arms and height adjustment; all but one are wheeled. Other rooms evaluated in this survey accommodate between one to five radiologists. They range from an 8' × 10' space with a single two-monitor work station to a 24' × 30' room. All of the rooms contain light boxes and/or alternators, most positioned around the periphery. In most cases, the PACS work stations were added next to the alternators. The PACS work stations rest on computer tables that are not adjustable and have limited writing space. The dictation system and a tele-

phone also share the PACS work space. Most of the rooms are configured for one RIS station for every two PACS work stations. There is no uniformity of chairs in the reading rooms, and none of the chairs have lumbar support or adjustable arm options. Some are on wheels, and most do offer height adjustment.

We decided that changes needed to be made to improve the work environment and to ensure working conditions that do not hurt productivity. Before making permanent changes to reading room spaces, a survey of the radiologists was proposed to gain understanding of current satisfaction levels with the soft-copy reading environment and to identify the areas on which to focus improvement efforts.

To evaluate radiologists' satisfaction levels at our facilities and to identify the unique needs pertinent to soft-copy interpretation environments, a baseline satisfaction survey was implemented with the radiologists of the Indiana University (IU) School of Medicine.

MATERIALS AND METHODS

The population surveyed consisted of IU faculty radiologists, radiology fellows, and radiology residents. The purpose of the survey was to (1) assess satisfaction levels regarding the current soft-copy interpretation environments, (2) identify key drivers of satisfaction, and (3) identify other needs specific to a soft-copy reading environment. Our research survey was developed with Microsoft Excel, using a check box format. The survey was distributed by e-mail and required about 10 minutes to complete. It consisted of 19 closed-ended questions and one open-ended question. Nearly all return responses were received via e-mail, although three respondents elected to print the survey and return the completed hard copy. Identifying information was requested as optional.

Before we designed the quantitative survey instrument, we conducted a review of existing literature on soft-copy reading environments and computer work station ergonomics. In addition, we interviewed the radiologists who were most experienced in soft-copy reading environments. A document of "best practices" in soft-copy reading room design was developed. From the information uncovered in this research, as well as the concerns radiologists voiced about the current environment, the survey instrument was developed to assess satisfaction with our environment. An architect experienced in radiology department design reviewed the survey for completeness. The survey included questions about each attribute identified as a "best practice" as well as other items of interest. The survey was piloted with three faculty radiologists and was later implemented with no changes.

Fig 1. Graph shows the mean satisfaction rating by attribute.

RESULTS

The survey was sent to 90 potential respondents via e-mail in April 2002. In May, the survey was resent to all who had failed to respond to the initial distribution. By the end of June, 55 completed surveys were obtained, resulting in a 61% response rate.

When asked whether or not they currently perform soft-copy interpretation, 50 of the 55 respondents (91%) indicated that they did. Only those who were using soft copy environments were directed to complete the section of the survey regarding satisfaction levels with that environment. All respondents answered the final section of the survey regarding equipment and feature preferences in soft-copy environments.

The survey requested those currently reading in a soft-copy environment to rate their overall satisfaction level with that environment, as well as with 12 attributes in that environment. Respondents used a five-point Likert scale with verbally anchored points (where 1 = very dissatisfied and 5 = very satisfied). Results were

analyzed by several methods. First, mean values for each attribute were calculated. The top two box scores (the percentage of respondents rating themselves as either very satisfied or satisfied) were calculated as another measure of satisfied respondents.⁸ As a gauge of importance of each attribute, bivariate correlation was performed to identify the strength of the relationship between satisfaction with the soft-copy environment overall and each feature rated.

The mean response (total number of respondents, $n = 50$) for satisfaction with the current soft-copy interpretation environment overall was 2.68 (where 1 = very dissatisfied and 5 = very satisfied). Using the top two-box measurement, 30% (15/50) of respondents stated they were very satisfied or satisfied overall (Figs 1 and 2).

The soft-copy environment attributes showing the highest levels of satisfaction were "reading room is close to the restroom" (3.47 mean and 55% (27/49) top-two box score), "reading room is close to the building entrance/exit" (3.36 mean and 46% (23/50) top-two box

Fig 2. Graph shows the percentage of respondents by satisfaction rating for each attribute.

Fig 3. Graph shows mean satisfaction and correlation coefficient by attribute.

score), and “access to dictation systems” (3.06 mean and 40% (20/50) top-two box score). Attributes identified as having the lowest satisfaction levels were “work space ergonomics” (2.23 mean and 10% (5/48) top-two box score), “room layout” (2.35 mean and 16% (8/49) top-two box score, $n = 49$), “amount of work space” (2.48 mean and 28% (14/50) top-two box score), and “noise level” (2.5 mean and 32% (16/50) top-two box score). Three at-

tributes showed a higher overall mean than “noise level” but a lower top-two box score; these three attributes were also considered as demonstrating low satisfaction. These were “room space” (2.6 mean and 30% (15/50) top-two box score), “ability to access RIS” (2.6 mean and 22% (11/50) top-two box score), and “ability to control room temperature” (2.68 mean and 28% (14/50) top-two box score). Two additional attributes measured resulted in sat-

Fig 4. Graph shows the percentage of respondents who desired each telephone feature in the soft copy reading room.

Fig 5. Graph shows the percentage of respondents who desired each chair feature in the soft copy reading room.

isfaction levels between the highest and lowest rated factors already described. They were “chairs” (2.78 mean and 34% (17/50) top-two box score), and “appropriate lighting” (2.86 mean and 36% (18/50) top-two box score).

Spearman correlations were calculated for each pairing of attribute with overall satisfaction using SPSS (SPSS, Inc., Chicago, IL) statistical software. Attributes with the highest correlation were “room layout” (.790), “appropriate lighting” (.718), and “work space ergonomics” (.657). Secondary improvement opportunities were identified as “amount of work space” (.596) “chairs” (.589), and “room space” (.563) (Fig 3).

The next section of the survey dealt with feature and equipment preferences in soft-copy environments. All respondents, including the

five who were not then reading in soft-copy environments, completed this section ($n = 55$ for all questions in this section). Respondents were asked what features were desired of the telephone in a soft-copy environment. They were able to select multiple options so the totals do not sum to 100%: 33 (60%) respondents indicated a preference for cordless sets; 24 (44%) indicated a need for hand-held receivers, 17 (31%) desired a speakerphone, and 6 (11%) desired a headset (Fig 4).

Respondents were asked about the types of chairs that would be most desirable in a soft-copy environment. They were able to select multiple options so the totals do not sum to 100%: 54 (98%) of the 55 respondents indicated a strong preference for a rolling chair. They also preferred adjustable height (49/55, 89%), swivel

Fig 6. Graph shows the percentage of respondents who desired various types of equipment in the soft copy reading room.

Fig 7. Graph shows the perceived impact of the "ideal" soft copy reading room on efficient use of the radiologist's time.

capability (48/55, 87%), arms (43/55, 78%), and lumbar support (34/55, 62%). Forty percent (22/55) indicated a desire for recline ability with tilt adjust and 9% (5/55) desired a chair without arms. None of the respondents indicated a preference for stationary chairs (Fig 5).

Respondents were queried about other equipment they would like to have available in the soft-copy reading room. We included questions regarding dictation and voice systems in this section, because we use both in our facilities. Respondents indicated they would like to have a separate computer (50/55, 91%), a view box (43/55, 78%), a printer (37/55, 67%),

voice recognition system (35/55, 64%), fax machine (24/55, 44%), stereo (20/55, 36%), and dictation system (13/55, 24%) (Fig 6).

The final question on our survey dealt with the radiologists' perceptions regarding how much an "ideal" soft-copy environment would affect their efficiency. The perception among the respondents was that developing a more "ideal" soft copy interpretation environment would significantly improve their efficiency. Fifty-nine percent (32/54) stated that they would be "much more" efficient, 39% (21/54) indicated they would be "somewhat more" efficient, and 2% (1/54) indicated "no impact" on efficiency. None indicated a negative impact (Fig 7).

DISCUSSION

Academic radiologists are often asked to interpret imaging in a variety of locations and sites, sometimes within a single day. Unlike smaller hospitals where a radiologist may have sole access to a reading room, and therefore autonomy regarding the set-up and design to optimize a reading room for personal use; in an academic setting, a single work station may be used by many different radiologists during a single day. It is therefore crucial that the work space meet the broadest range of user needs. Further, we suspect that radiologist satisfaction with their reading environment is linked to productivity and quality of work.⁹⁻¹¹ By improving satisfaction levels with the interpretation environment, we believe that productivity will improve. According to a study led by Dr. Eliot Siegel, at the VA Medical Center in Boston,¹² "lighting and ergonomics have an important impact on the radiologist's comfort, speed, and accuracy in soft-copy interpretation." Further, he concludes, "optimization of soft-copy reading room design is likely to result in decreased fatigue and increased productivity."

With this perspective on the importance of the soft-copy environment to radiologist satisfaction, productivity, and quality of output, our survey establishes a baseline for soft-copy environment satisfaction and key improvement opportunities. The results provide us with specific information about how existing facilities fare with regard to the soft-copy interpretation environment and on radiologists' needs in this environment. We believe that the opinions obtained were unbiased because of the anonymity of the responses. Our study did not capture opinions outside our own academic practice group. We would contend that many academic and non-academic settings are faced with the same conditions that prevail in our facilities—namely, a requirement to interpret imaging in a number of different settings, lack of adequate funding for refurbishing reading rooms, unavailability of space to create new rooms, poor lighting control, and a "move over the light boxes and move in the PACS work stations" mentality.

There are several key points to be drawn from our data. Our radiologists are dissatisfied with the soft-copy environment across our facilities. All of our "new" soft-copy reading rooms were once film-based rooms. With the implementation of PACS, very few improvement's or modifications were made to these rooms. In fact, the major change involved the purchase of special tables to hold the multi-monitor work stations. Our survey data show that moving PACS work stations into existing reading rooms without modification is probably not a satisfactory plan. Our data further indicate that radiologists perceive that by addressing the special needs of a soft-copy environment, they will be able to use their time more efficiently.

Another key point lies in the issue of where to focus renovation efforts. Clearly, academic institutions are often struggling to maintain current space allocations, and certainly face major challenges in obtaining new space to create soft copy reading rooms. With limited space and even more limited funding, often stalling efforts to remodel, we must understand what is most important to radiologists in the soft-copy environment—where we can achieve the "biggest bang for our buck." Correlation analysis is a useful technique to identify linkages between performance attributes and overall satisfaction. Correlation coefficients provide a better assessment than do means in identifying those attributes most highly related to overall satisfaction. The assumption is that the higher the correlation between one attribute and overall satisfaction, the more important it is to respondents. Although correlation does not prove causation, it is reasonable to assume for survey research applications.^{8,13} Through correlation analysis, we were able to identify three key areas of focus for our improvement efforts, lighting, room layout, and work space ergonomics. When faced with the choice between expensive sound-deadening panels to improve noise control versus dimmable recessed lighting, we now know where to focus our improvement dollars.

As for equipment issues, radiologists would like to have not only the "essentials" in the reading room, such as additional computer access, telephone, fax, and dictation/voice systems, but also other conveniences such as a

stereo. The desire for a stereo should be tempered with the knowledge that its use could interfere with speech-recognition systems. The telephone should be feature-rich, with hands-free capability, a speakerphone, a headset, and cordless.

Radiologists suggested equipping the soft copy environment with chairs that include features such as wheels, recline, lumbar support, swivel, and adjustable height.

Clearly, soft copy interpretation is becoming the norm in academic and private practice settings, and radiologists will continue to be pressed into demonstrating the workflow improvements thought to be possible with PACS technology. To exploit these improvements in efficiency to the fullest, radiologists must be able to withstand the “fatigue factor” associated with high-volume clinical duties that may span several institutions. One way to support this is through adequate attention to the soft-copy interpretation environment.

CONCLUSIONS

Dissatisfaction with existing soft-copy interpretation environments used by the IU radiologists indicates that this is an area that requires attention. Furthermore, there may be a direct relationship between radiologist efficiency and satisfaction with their image interpretation environment. Attention should be focused on this environment during a soft-copy technology implementation to ensure planned efficiency gains are realized.

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