Radiologists’ Burden of Inefficiency Using Conventional Imaging Workstations

Research conducted by ACR Image Metrix, Philadelphia, Pennsylvania in partnership with GE Healthcare

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INTRODUCTION

Although there has been recent leveling in the growth of medical imaging utilization, imaging saw rapid increases in use during the latter half of the 1990s and into the first decade of the 21st century. Indeed, from the year 2000 until 2006, the rate of growth in the use of imaging examinations outstripped increases in all other physician-directed services in the Medicare program with the greatest growth occurring in complex, computerized examinations like x-ray computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography (PET). The management and interpretation of this burgeoning number of examinations would have been impossible without concurrent improvements in information technology. Picture Archiving and Communications Systems (PACS), voice recognition systems for reporting, and especially the transition of radiologists interpreting films placed on light boxes to reviewing and reporting imaging studies on PACS systems with computerized workstations all resulted in greater efficiencies that improved productivity and expedited patient care.

Although PACS workstation-based interpretation has revolutionized medical imaging, a number of aspects of PACS image review products and the dedication of specialized workstations to just a single imaging modality are less than ideal. Flaws in system design and the flow of information among the components of information technology, a lack of intuitiveness to workstation operation, among other failings, generate inefficiencies that may diminish radiologists’ productivity, cause fatigue that may reduce accuracy, and distract radiologists from delivering the highest quality interpretations.

In order to inform its current and future efforts to reduce the inefficiencies associated with their PACS design and better address radiologists’ needs, GE Healthcare contracted with ACR Image Metrix† to design, conduct, and analyze a study surveying a small number of radiologists’ experiences and perceptions concerning inefficiencies integral to their respective workflows. The goals of the study were to:

• Arrive at some understanding of the most significant impediments the current workflows pose to efficient exam interpretation and reporting
• Develop an estimate of the severity of the various inefficiencies
• Generate hypotheses for further investigation.

The information obtained would guide GE Healthcare’s efforts to remedy current deficiencies and develop improved diagnostic imaging products in the future.

SELECTION OF RESPONDENTS AND SURVEY METHODS

The project was designed and conducted by an ACR Image Metrix (ACRIM) team consisting of Chief Scientific Officer Bruce J. Hillman as lead investigator, along with its Director of Imaging Operations Mehdi Adineh, and consultant Spencer B. Gay, MD of the University of Virginia. This team of researchers collaborated with the GE Healthcare Information Technology group (GE HCIT) to develop a 48-item survey that Dr. Hillman administered by telephone to five volunteer radiologists whom he recruited from a list of moderate-to large-sized institutions. The small number of respondents reflects both the exploratory nature of the study and the espoused goal of generating hypotheses about the bottlenecks affecting radiologists interpreting and reporting imaging studies using their current equipment and workflows to support future research. The selection of the five participating radiologists was based on the following criteria:

• Regularly perform clinical work using PACS and/or diagnostic workstations at their institutions for a period of at least three years after the completion of their training
• Have an interest in the design or improvement of imaging workstations
• Reputation for critical thought about workflow and other management issues important to radiology.

Each phone interview lasted 40-45 minutes. Because of the large number of survey items and to prepare respondents to be thinking about the issues involved, the respondents were sent the survey several days in advance of their interviews. The survey included both open-ended and multiple choice questions. For many of the items, we asked the respondents to estimate the amount of time expended on specific aspects of their experiences. The respondents agreed to be recorded and were told that the sponsor would present the information they provided only as a composite of all responses. The study was conducted as a blinded survey as respondents were not apprised of the sponsor nor how the information would be used.

DESCRIPTION OF THE RESPONDENTS

The radiologists’ experience interpreting imaging examinations ranged from seven to 39 years (mean=24.4) in post-training clinical practice. They represented four academic institutions and one community practice. The institutions ranged from 300 to 1,000 beds and generated volumes of 300,000-800,000 imaging exams per year. Each institution was unique with regard to the information technology and the types of diagnostic imaging workstations in use.

All respondents currently practice at least part of their time in a hospital, but two also spend some time in an outpatient center and one in an office setting. All had at least some experience using multi-modality, multi-function workstations but continued to use some workstations dedicated to a single modality for at least some of their practice. They variously interpreted 20-100 exams per day on clinical service (mean=52). This considerable variability is at least in part related to the complexity of the exams associated with their subspecialty and the types of studies they most frequently interpreted. Each radiologist had a different subspecialty and portfolio of imaging examinations: musculoskeletal radiology (plain films and MR), abdominal radiology (ultrasonography and CT), cardiothoracic radiology (thoracic plain films, CT, and MR), neuroradiology (spinal plain films, CT, and MR), and breast imaging (mammograms, ultrasonography, and MR).

† ACR Image Metrix is an imaging contract research organization (iCRO) wholly owned by the American College of Radiology (ACR)
CONSIDERATIONS OF INEFFICIENCY
An open-ended question at the outset of each interview asked respondents to list in order of importance the three aspects of their diagnostic workstations that most severely diminished their productivity. The most frequently cited problems included:

• Having to exit one application to use another, such as querying PACS for a previous exam or consulting the electronic medical record
• Poor or absent integration of PACS and voice recognition software
• Having to wait a long time for post-processing to occur
• Insufficient automation of hanging protocols

However, when the respondents were queried about specific possible bottlenecks and the time and effort expended, it became evident that there were broader challenges and inefficiencies with their current PACS and workstation products. In response to these individual questions, the majority of respondents cited the following as important inefficiencies that they dealt with on a daily basis:

Table 1. Respondents’ Assessment of Diminished Productivity and Fatigue for Specific Items

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Number responding</th>
<th>Mean decreased productivity rating*</th>
<th>Mean fatigue rating*</th>
<th>Mean estimated minutes lost per day**</th>
<th>Range estimated minutes lost per day**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dedication to one modality</td>
<td>4/5</td>
<td>2.4</td>
<td>1.8</td>
<td>22</td>
<td>0-45</td>
</tr>
<tr>
<td>No advanced visualization</td>
<td>3/5</td>
<td>2.2</td>
<td>N/A</td>
<td>9</td>
<td>0-30</td>
</tr>
<tr>
<td>Variability in tools/options</td>
<td>4/5</td>
<td>2.4</td>
<td>2.2</td>
<td>13</td>
<td>0-30</td>
</tr>
<tr>
<td>Problems communicating with HIS and RIS</td>
<td>5/5</td>
<td>3.0</td>
<td>2.8</td>
<td>33</td>
<td>0-60</td>
</tr>
<tr>
<td>Accessing information from other sites</td>
<td>3/5</td>
<td>2.0</td>
<td>1.8</td>
<td>13</td>
<td>0-45</td>
</tr>
<tr>
<td>Accessing images from mini-PACS</td>
<td>3/5</td>
<td>1.8</td>
<td>1.8</td>
<td>8</td>
<td>0-20</td>
</tr>
<tr>
<td>Navigation among studies to facilitate consultation</td>
<td>5/5</td>
<td>2.6</td>
<td>2.4</td>
<td>14</td>
<td>5-30</td>
</tr>
<tr>
<td>Displaying images according to personal preferences</td>
<td>4/5</td>
<td>2.0</td>
<td>2.6</td>
<td>12</td>
<td>0-30</td>
</tr>
<tr>
<td>Comparing between time points</td>
<td>3/6</td>
<td>2.4</td>
<td>2.4</td>
<td>12</td>
<td>3-25</td>
</tr>
<tr>
<td>Performing QA</td>
<td>4/5</td>
<td>2.4</td>
<td>1.6</td>
<td>7</td>
<td>0-15</td>
</tr>
<tr>
<td>Creating timely, relevant reports</td>
<td>4/5</td>
<td>1.8</td>
<td>2.2</td>
<td>23</td>
<td>0-75</td>
</tr>
<tr>
<td>Importing images and measurements into reports</td>
<td>3/5</td>
<td>2.4</td>
<td>1.8</td>
<td>7</td>
<td>0-20</td>
</tr>
</tbody>
</table>

*On a four-point scale: 1. Not at all; 2. A little; 3. Somewhat; 4. A whole lot
**Includes the answers of all five respondents, rounded to the nearest minute.
† We imputed a score of ‘0 minutes’ for a response of 1. Not at all.

The results cited above take into account only the time estimates of those respondents who felt the item actually represented a productivity problem, whereas Table 1 summarizes the assessments of all respondents, assigning an estimate of ‘0’ minutes when the respondent felt there was no effect of the item on his or her productivity.†

All five respondents also faulted the lack of intuitiveness of their systems for causing them inefficiencies. Because their workstations did not easily present to them the full range of tools and options available, they felt they lost, on average, 8 minutes per day. Variability in user interfaces among their different workstations was estimated to cost them 14 minutes per day. The training effect for new users was thought to be more severe (44 minutes/day), but respondents agreed that this effect diminished rapidly with familiarity of use.

† i.e. the numerator, stated in minutes, is the same in both text and Table 1, but the denominator is different. In Table 1, the denominator is always 5, while in the text above, it is the number of radiologists who indicated that the item caused lost productivity.
Table 2: Respondents’ Expectations of Possible Improvements to Workstation Functionality

<table>
<thead>
<tr>
<th>Item</th>
<th>Improved Productivity Rating*</th>
</tr>
</thead>
<tbody>
<tr>
<td>All tools necessary for all exams in one workstation</td>
<td>3.4</td>
</tr>
<tr>
<td>One-click access to medical records</td>
<td>3.2</td>
</tr>
<tr>
<td>Learns to display images by individual preferences</td>
<td>2.6</td>
</tr>
<tr>
<td>Including selected images in reports</td>
<td>2.4</td>
</tr>
<tr>
<td>Advanced post-processing like 3D rendering – value to clinicians</td>
<td>2.4</td>
</tr>
<tr>
<td>Advanced post-processing like 3D rendering – value to radiologists</td>
<td>1.8</td>
</tr>
</tbody>
</table>

*Assessments of all five respondents on a four-point scale:

FEATURES THAT WOULD IMPROVE PRODUCTIVITY AND REDUCE FATIGUE

Table 2 details the respondents’ opinions concerning possible future workstation features that potentially might improve productivity and reduce their fatigue. The features judged most important to improving productivity by a majority of those surveyed included: the system automatically learning individual reader’s image display preferences for each type of exam; one-click access to the electronic medical record; and easy access to advanced post-processing easily available. All five respondents agreed that a product that provided all the tools necessary for post-processing, interpretation, and quantification for all the different types of exams they interpreted as part of their clinical work would make them more efficient at interpreting and reporting imaging studies (on a four-point scale ranging from ‘not at all’ to ‘a whole lot,’ four out of five responded ‘a whole lot’).

As might be expected, respondents’ assessments of the extent to which various inefficiencies caused them fatigue paralleled their estimates of reduced productivity; however, the estimates of associated fatigue were generally lower than estimates of diminished productivity.

RESPONDENT’S INTEREST IN ADVANCED IMAGING

Each of the respondents acknowledged that they post-processed some studies each day on clinical service (range 3-10 cases), and four of them did the work on at least some of the cases themselves. Technologists were responsible for any post-processing not performed by the radiologists. The enormous variability in how much time different radiologists expended on post-processing, one to sixty minutes (mean = 18 minutes), probably relate to differences in the nature of the examinations and the ease of use of the equipment they have available. Nonetheless, despite burgeoning interest in advanced image processing, there was little enthusiasm for additional capabilities beyond what is available today. To some extent, this response appeared to reflect satisfaction with the capabilities of their current technology, but it may also relate to difficulty imagining future post-processing advantages as imaging technology continues to develop.
Our investigation reveals a number of shortcomings associated with the information technologies radiologists employ to review, interpret, and report diagnostic imaging examinations. Despite the considerable variability among our respondents' estimates of the amount of time lost to individual survey items - to be expected given the exploratory nature of the study and the diverse information systems employed at our respondents' institutions - the substance of what each of them told us was the same. The additive effect of the imperfections we studied meaningfully diminishes radiologists' productivity.

Radiologists are stressed with regards to the volume of their clinical work. Radiologist productivity, measured by the annual number of exams interpreted per radiologist, increased rapidly during 1996-2006, the era of the greatest growth in imaging utilization. The annual increases in imaging utilization have leveled off during the past several years in response to the policies of government and private insurers, employers shifting a greater share of the financial responsibility for health care to their workers, and a world-wide recession that has disenfranchised many from employment-based insurance. However, the stresses to improve workflow and productivity continue unabated. Many radiology practices have clamped down on hiring, deferring the replacement of a retiring or departing radiologist in an effort to maintain members' incomes in the face of falling prices for imaging examinations. The upshot is that many practices are demanding greater productivity of their radiologists than ever before.

Clearly, the inefficiencies we investigated present a challenge to beleaguered practices. Adding together the average number of minutes per day our respondents estimated they wasted because of PACS and workstation inefficiencies totals an estimated 173 minutes per day. Even allowing that our respondents' estimates are rough approximations and that there almost certainly is some overlap among the inefficiencies affecting the various tasks, there is a considerable opportunity for imaging IT system designers to improve upon their current products.

The effect of manufacturers improving radiologists' productivity by developing more intuitive, more efficient multi-modality, multi-function systems would be to free up time for them to pursue non-interpretive responsibilities, such as collaborating with other physicians and consulting with patients. Developers of future diagnostic imaging solutions have an opportunity to remedy those aspects of current systems that reduce productivity while simultaneously helping to improve the value of radiologists' work to patients and referring clinicians.

References
3. Lee DW, Levy F. The sharp slowdown in growth of medical imaging: an early analysis suggests a combination of policies was the cause. Health Aff 2012;31:1876-1884.
About GE Healthcare
GE Healthcare provides transformational medical technologies and services that are shaping a new age of patient care. Our broad expertise in medical imaging and information technologies, medical diagnostics, patient monitoring systems, drug discovery, biopharmaceutical manufacturing technologies, performance improvement and performance solutions services help our customers to deliver better care to more people around the world at a lower cost. In addition, we partner with healthcare leaders, striving to leverage the global policy change necessary to implement a successful shift to sustainable healthcare systems.

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