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Disruption of Radiologist Workflow

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The effect of disruptions has been studied extensively in surgery and emergency medicine, and a number of solutions—such as preoperative checklists—have been implemented to enforce the integrity of critical safety-related workflows. Disruptions of the highly complex and cognitively demanding workflow of modern clinical radiology have only recently attracted attention as a potential safety hazard. In this article, we describe the variety of disruptions that arise in the reading room environment, review approaches that other specialties have taken to mitigate workflow disruption, and suggest possible solutions for workflow improvement in radiology.

Introduction

Society has recognized the role of disruptions in creating accidents and mishaps. Wherever the ensuing mishaps have the potential to cause harm or loss of life, society has enacted restrictions to minimize disruptions of normal workflow. For this reason, drivers in many states are prohibited from sending text messages or using handheld devices while driving, and airline pilots are mandated to maintain a “sterile cockpit” during critical phases of flight where only mission-related tasks are discussed.

Medicine—where disruptions can easily cause harm and loss of life—has also started to respond to these challenges. The most publicized and mature examples to date involve the use of preprocedural checklists before surgery or central line insertion to enforce the integrity of critical safety-related workflows, resulting in dramatic improvements in patient safety and clinical outcomes.[1-3] However, the potential for significant workflow disruption extends far beyond periprocedural care. In a busy radiology reading room, for example, radiologists must contend with a complex and fast-paced workflow characterized by frequent disruptions, disruptions that may be particularly problematic given the high cognitive demand of image interpretation.[4-6] Unfortunately, the nonstandard nature of most radiology workflows reduces the potential effectiveness of basic interventions such as checklists and may require more sophisticated solutions.[7]

In this review, we describe the workflow disruptions with which radiologists must contend in daily practice, highlight steps that other specialties have taken to respond to workflow disruptions, and suggest measures that can be taken to mitigate similar disruptions in radiology. It is our hope that this review will draw attention to the urgent need for improved clinical workflow in the reading room and provide a blueprint for safer and more effective radiological care.

Workflow Disruptions in Radiology

The working environment in diagnostic radiology has undergone a tremendous change over the past 2 decades because of the widespread adoption of filmless imaging, introduction of speech recognition systems for report dictation, and the incorporation of electronic medical records (EMR) into an increasingly information-rich interpretive workflow.[8] Unfortunately, the promised efficiency gains of these systems have been partially offset by a paradoxical increase in the complexity of radiologists' workflow. This complexity reflects a number of converging trends, including the central and growing role of medical imaging in patient evaluation and management, as well as increasing fragmentation and disruption of interpretive workflows. In addition to their primary task of image interpretation and reporting, radiologists in modern practice must shoulder added responsibilities that can include frequent telephone communication, in-person physician consultations, technologist supervision, patient consent, ultrasound scanning, and management of contrast agent injections and adverse reactions.[4,5,8] Although these additional tasks are important, they distract and detract from the primary workflow of image interpretation, create barriers to productivity, and likely contribute to errors in the knowledge-intensive service environment of clinical radiology.[9]

Of these many potential sources of disruption, telephone communication is particularly problematic, in part because many different sources of disruption are funneled through this common communication channel. As an example, incoming telephone calls may come from clinical providers inquiring about imaging findings or selection of appropriate imaging tests, or from technologists requesting “scan checks” to assess study adequacy or seeking

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guidance for image acquisition (eg, protocol selection or solutions for specific technical challenges). Similarly, outgoing phone calls are often directed to providers to communicate time-sensitive imaging findings or solicit additional patient information. Recent work by Yu et al[5] describes their experience with telephone-based disruption of on-call radiologists' workflow. Their work reveals telephone interruptions of radiologists on a surprisingly large scale, with more than 10,000 after-hours calls directed to a single resident over a 3-month period. Incoming telephone calls occurred as frequently as once every 4 minutes during peak hours, which translated to roughly 2-3 expected interruptions during interpretation of a single CT of the abdomen and pelvis. Related work by Balint et al[4] has suggested that the frequency of telephone disruptions in the hour preceding resident interpretation of a study was positively correlated with the likelihood of an incorrect interpretation.

Importantly, disruptions to radiologists are not confined to the reading room; dysfunctional or inefficient workflows in other areas of the radiology department can secondarily increase burdens on radiologists. For example, inadequate systems to identify and triage patients for imaging may create a need for frequent radiologist involvement in study prioritization.[8] Similarly, poorly designed systems for information transmission between different members of a radiology department (eg, radiologists, technologists, and patient transporters) can hinder effective care of patients, thereby requiring increased radiologist involvement to maintain appropriate and timely care.[10]

If left unchecked, the scale of workflow disruption is likely to increase. As the information economy of medicine continues to grow in scale and complexity, there is likely to be increased reliance on specialties such as radiology that can create and share objective patient information. Against this backdrop, inefficient or ill-defined clinical workflows are likely to produce ever-increasing disruptions to radiologists. Thus, implementing solutions to dysfunctional workflows is a key component in building and maintaining an efficient information economy.

Managing Workflow Disruption in Nonradiological Settings

Disruptions in workflow are not unique to radiology but are also experienced by other hospital-based specialties such as emergency medicine,[11-19] critical care,[20-25] and surgery.[26-32] The solutions to these disruptions vary based on the specific workflow patterns in each patient care setting, but they can generally be grouped into several themes.

Filtering Interruptions by Activity

A basic strategy to improve workflow is to create physical or temporal barriers to interruption during activities that are of critical importance or particularly susceptible to disruption. In some cases, this strategy may amount simply to having individuals address potential sources of interruption at a convenient time, such as refilling intravenous fluids before nursing handoffs to prevent unnecessary alarming during transfer of care.[23] In other cases, physical barriers—including possibilities such as signs or colored vests for individuals seeking to avoid interruption, or colored floor tiles or shields for specially designated areas—may be of value.[23,33,34] These basic interventions can have a profound effect. One study found that implementing a visible "No Interruption Zone" around a medication dispensing station resulted in a 41% decrease in interruptions,[33] while another found that erecting a wall around the medication dispensing station decreased interruptions by 81%.[34] Alternatively, there may be value in gentler approach that allows for interruptions even during critical activities, provided the interruption conveys important patient-related information. In this context, interruptions may be mitigated by increasing the transparency of task importance so that potential interrupters can determine if interruption is appropriate.[22]

Filtering Interruptions by Acuity

A large percentage of interruptions—even during critical tasks such as transfer of care discussions ("sign out") and clinical rounds—are nonessential, with only 11% of interruptions during morning sign out and 27% during morning rounds being essential to patient care.[21] As such, filtering nonessential interruptions may streamline workflow. Young et al[35] describe a system in which nurse requests to send after-hours pages to resident physicians are reviewed by a charge nurse and categorized by acuity, with emergent pages transmitted immediately, urgent pages batched, and nonurgent pages deferred until the morning. Following implementation of this system, the total number of pages and number of nonurgent pages sent after-hours to house staff decreased.

Asynchronous Communication

Synchronous channels of communication require simultaneous participation of both parties, preventing the recipient of an interruption from managing the timing of that interruption.[11] In contrast, asynchronous channels of communication provide the recipient of a message with control over the timing of disruptions, and this may therefore represent a practical method for acuity-based filtering, task prioritization, and reduced communication burden.[36]

Voicemail capability may be an effective means to reduce disruption. In a study of emergency department (ED) providers equipped with mobile phones, the lack of voicemail capability contributed significantly to workflow interruption, as the providers were forced to immediately answer any incoming call.[13] Alternatively, landlines with a clerical receptionist may serve a similar role and help to reduce unnecessary interruptions.[11]

Alphanumeric pagers may also permit filtering of nonurgent interruptions,[11,37] provided that the recipient of a message is provided with sufficient information to judge the urgency of the page. Unfortunately, a large percentage of alphanumeric pages contain only basic callback information, thereby preventing the receiver from performing effective task prioritization and mandating an immediate callback to determine the acuity of the page.[37] A proposed explanation for this behavior is that synchronous communication provides receipt confirmation for the interrupter; asynchronous communication may benefit from a confirmation mechanism to encourage broader adherence.[36]

Technology-Assisted Workflow

Electronic and nonelectronic whiteboards have been used extensively in a variety of care settings to organize and facilitate communication and workflow.[36,38-42] For example, when used in the operating room as a basic information display system, electronic whiteboards can facilitate integration of safety checklists into preoperative workflow and aid intraoperative communication between multiple team members.[43,44]

Chaotic and disruptive workflows can be further streamlined with electronic systems that go beyond basic information display to serve as an integrated information technology (IT) solution.[45] Aronsky et al[46] have described the implementation of such a system in an ED, which allowed for easy information access, information sharing, and decision support using data from multiple hospital information systems, with resulting dramatic