Paperless Protocoling of CT and MRI Requests at an Outpatient Imaging Center

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ABSTRACT

We created our imaging center (IC) to move outpatient imaging from our busy inpatient imaging suite off-site to a location that is more inviting to ambulatory patients. Nevertheless, patients scanned at our IC still represent the depth and breadth of illness complexity seen with our tertiary care population. Thus, we protocol exams on an individualized basis to ensure that the referring clinician's question is fully answered by the exam performed. Previously, paper based protocoling was a laborious process for all those involved where the IC business office would fax the requests to various reading rooms for protocoling by the subspecialist radiologists who are 3 miles away at the main hospital. Once protocoled, reading room coordinators would fax back the protocoled request to the IC technical area in preparation for the next day's scheduled exams. At any breakdown in this process (e.g., lost paperwork), patient exams were delayed and clinicians and patients became upset. To improve this process, we developed a paper free process whereby protocoling is accomplished through scanning of exam requests into our PACS. Using the common worklist functionality found in most PACS, we created "protocoling worklists" that contain these scanned documents. Radiologists protocol these studies in the PACS worklist (with the added benefit of having all imaging and report data available), and subsequently, the technologists can see and act on the protocols they find in PACS. This process has significantly decreased interruptions in our busy reading rooms and decreased rework of IC staff.

KEY WORDS: Radiology workflow, workflow re-engineering, PACS

INTRODUCTION

We created our imaging centers (IC) to move outpatient imaging from our busy inpatient imaging suite to an off-site location that is more inviting to ambulatory patients. The setting affords a pleasant nonclinical atmosphere with expertly trained technologists and state-of-the-art equipment removed from the hustle and bustle of the busy inpatient imaging department. At the main hospital, outpatients can feel overwhelmed and their exams can be delayed due to emergency add-on exams from our intensive care units and emergency department. Nevertheless, patients scanned at our outpatient IC still represent the depth and breadth of illness complexity that we see with our tertiary care population. Thus, we perform tailored exams to answer the particular question of the ordering physician according to a scan protocol devised by the supervising radiologist. Individualized protocoling of the exams ensures that the ordering clinician's question is fully answered by the exam performed, to increase patient and ordering physician satisfaction, to comply with Joint Commission on Accreditation of Healthcare Organizations mandates for patient safety, and to improve patient care. Attention to detail, with review of prior images and reports

during the protocol process, assures that we obtain the most useful information from the scan performed. We believe that this approach prevents patients from having repeat imaging as might be the case if a routine protocol was used for all patients with similar scan requests. Please note, however, that this technical note does not analyze the benefits of individualized exam protocoling. For example, a scan request for abdominal pain may be protocoled as a routine abdomen and pelvis computed tomography (CT) scan with oral and IV contrast. However, in a different patient with abdominal pain, reviewing the available PACS record may show an ultrasound with cirrhosis. This patient would likely get a tailored protocol with a three-contrast-phase CT scan through the abdomen to evaluate for complications of cirrhosis (e.g., hepatoma, portal hypertension, or vascular occlusion).

Our radiology information system (RIS) (Novius version 26.1, Erlangen, Germany) is not able to support a paperless protocoling process and the legacy paper-based protocoling process is inefficient. Our paper-free process was created to decrease the paper handling and rework that our IC staff had to do and also to decrease the interruptions in the busy radiologist's reading room that was associated with paper handling. Thus, we developed a paper-free process whereby protocoling is facilitated through scanning of radiology requests into our PACS (Carestream Health version 10.0, Rochester, NY). Using the common worklist functionality common to most PACS, we created "protocoling worklists" in the PACS that contain these scanned radiology requests. Radiologists protocol these studies directly from the PACS worklist (with the added benefit of having all imaging and report data available at protocoling) and, subsequently, the technologists can see the protocols in PACS and act on the radiologist's prescribed protocols. We store the scanned documents as one of the DICOM series in the patient's CT or magnetic resonance imaging (MRI) scan. The scanned documents are found in the last series of the exam (i.e., series number 899). The scanned documents serve as an informal audit trail and as a permanent record for billing compliance purposes (i.e., our billing personnel must see the physician's request before they can charge the payer for the exam).

METHODS AND MATERIALS

Paper-Based Protocoling Process (Before the Change to Paperless Protocoling)

When the IC first opened, we had one CT scanner and one MRI machine performing approximately 20 scans each day. Initially, paper-based protocoling was easy because the number of exams were small. However, with the growth of our ICs, the protocoling process grew unwieldy, eventually outstripping our ability to support it. We currently perform 85,000 studies each year at the IC, which is 22% of the department's total exams. Twenty-two percent of the exams are MRI and 24% of the exams are CT. The paper-based protocoling process was laborious for all those involved where faxed orders received at the IC business office were stored in file cabinets until 2 days prior to the patient's scheduled exam. Two days before the patient's exam, the IC business office faxed the requests to the various reading rooms at the main hospital, which is 3 miles away from the IC. Protocoling was performed by subspecialist radiologists [e.g., vascular studies were protocoled by noninterventional cardiovascular (NCV) imaging radiologists, musculoskeletal studies were protocoled by musculoskeletal (MSK) radiologists, brain and spine studies were protocoled by the neuroradiology (Neuro) service, and thoracoabdominal (TAB) studies were protocoled by two groups of abdominal radiologists—body CT protocoled by the TAB radiologists supervising CT and body MRI protocoled by the TAB radiologists supervising body MRI]. We faxed up to 100–150 sheets of paper daily to the various reading rooms. Coordinators in those
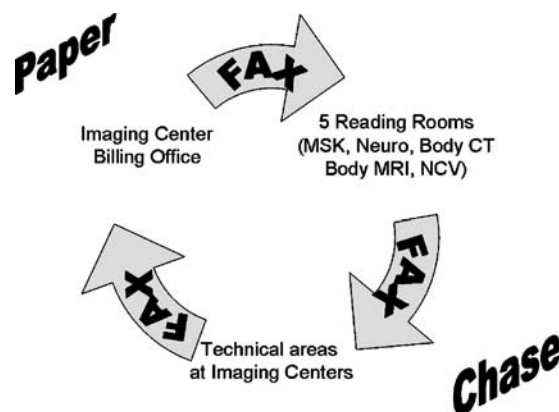

Fig 1. The paper chase.

reading rooms would collate this faxed paperwork and ask the radiologists to protocol the study by way of a handwritten note on the faxed document. Recollecting all this paperwork often took an entire day to complete. Once protocoled, the request with the handwritten protocol was faxed back to the IC technical area 1 day prior to the patient's scheduled exam in preparation for the next day's scheduled exams. The authors refer to this process as "the paper chase" (Fig. 1). At any breakdown in this process (e.g., fax malfunction), lost paperwork delayed patient exams and clinicians and patients became upset while simultaneously interrupting the entire IC workflow. For example, a patient's protocol may not be received by the IC technical area, and often this was not discovered until the day that the patient arrived for their scan. Still worse, a missing protocol may only be discovered by the technologist when getting the patient on the scan table. This resulted in a frantic call to a reading room by a technologist saying, "I have the patient on the table and I don't have a protocol." At that point, all work in the reading room would stop so that the exam could be urgently protocoled. Another problem commonly discovered on the day of the patient's appointment was the issue of protocols that conflicted with the request from the ordering physician. As independent diagnostic testing facilities, ICs are required by law to perform the exam ordered by the physician. If there is a scan change based on the radiologist's protocol, support staff must request an updated order from the ordering physician, if the ordering physician agrees to the change. A change could be something as simple as a protocol requiring contrast for a chest CT where the clinical indication is "adenopathy" but the ordering physician ordered a noncontrast chest CT in error. These changes are almost always agreed to by the ordering physician. However, the call to the ordering clinician would come while the patient is waiting for the exam. Worse yet, the call is made while the patient is already on the exam table, certainly delaying the exam and disturbing the ordering physician by asking him or her to urgently fax an updated order to the IC.

Paperless Protocoling Process
(After the Change to Paperless Protocoling)

Requests are received at the IC billing office at ordering or scheduling of the exam. Currently, we

scan these requests into PACS upon receipt of the order. We scan requests using commercial off-the-shelf (COTS) DICOM scanning software (PacsS-CAN, PacsGear, Pleasanton, CA, USA). The scanner used for scanning requests is a Fujitsu fi-5120c scanner (Fujitsu Computer Products of America, Sunnyvale, CA, USA). We scan each request separately. We enter two important patient identifiers into the scan software interface [i.e., patient name and medical record number (MRN)]. These two pieces of information allow PACS to store the images in PACS. More importantly, these two pieces of information allow PACS to identify patients with preexisting records in PACS. If a prior exam exists in PACS with the same name and MRN, PACS stores the scanned request under that patient's record. If no prior exams with the same name and MRN exist in PACS, a new patient record is created. In addition to the patient identifiers, the exam modality (e.g., CT vs MRI) is specified in the PacsSCAN software. Three days prior to the patient's appointment, the IC business office personnel sign into PACS and add the scanned requests to one of the five separate "protocol worklists." We created these permanent worklists based on which radiology service is responsible for protocoling and reading the requests (i.e., MSK, TAB–CT, TAB–MRI, Neuro, and NCV). IC business staff populates protocoling worklists with the scanned-in requests daily. There are ten of these worklists (i.e., five for the five reading areas for CT and another five for MRI). When adding the scanned requests to the protocoling worklists, IC business staff bring up the request by entering the patient's MRN using the PACS search function. Once retrieved, they add the worklist name (i.e., MSK, TAB–CT, TAB–MRI, Neuro, and NCV) to the "custom worklist" field and they append the scheduled exam date. An entry for an exam to be performed on June 1, 2009 and to be protocoled by MSK would appear as "MSK 06-01-2009" in the custom worklist. These steps assure that patient data are correct by verifying that the scanned requests can be located by the patient's MRN and that the request was joined to the correct PACS record (if one already existed). If an error is found, rescanning the request with correct information can be performed, if necessary, although editing the custom worklist fields in PACS is usually easier. At 2 PM, 3 days before the patient's scheduled exam, the IC staff

Patient ID	Patient Name	Date	Mod	Custom Worklist	Description	# Images
	test					
321test	Test Patient1	Dec 19, 2007	CT,PR	Body 12-21-08	ORDER IC	2
321test	Test Patient1	Dec 19, 2007	CT,PR	Body 12-21-08	ORDER IC	2
654test	Test Patient2	Dec 19, 2007	CT,PR	Body 12-21-08	ORDER IC	2
654test	Test Patient2	Dec 19, 2007	CT,PR	Body 12-21-08	ORDER IC	2

Fig 2. The protocoling worklist.

pages the radiologists that are responsible for protocoling the cases in the protocoling worklists. This reminder page states that "protocols are ready in PACS." Exams are placed into the protocoling worklist 3 days prior to the patient's scheduled exam date to allow enough time to obtain new orders if changes in the protocol require our technologists to request an updated order from the referring clinician. Three days was chosen as this still gives enough time on Friday afternoon to obtain updated orders before a patient arrives for a Monday appointment.

MD Protocoling

The reminder page that "protocols are ready" is the cue to the subspecialist radiologists to open their respective protocol worklist. The protocol worklist filters retrieve the scanned documents for cases that need protocoling for scheduled exams to occur in the next 3 days. An example of a protocoling worklist filter includes date ≤3 days from today, limited by the particular service area (e.g., MSK), and limited by the particular modality (e.g., CT). From the protocol worklist, the MD sees all scheduled exams that have not yet been protocoled for the next 3 days (Fig. 2). Scans for 3 days hence are by far the most abundant, but add-on scan requests to be performed sooner than 3 days will also show up (and be protocoled) as well. The worklist loads automatically with the first case (determined alphabetically by patient's last name) displaying on one of the PACS monitors. Using the display protocol (DP) functionality (also known as hanging protocol functionality) that is common to most PACS, a custom DP has been created to display scanned requests, just as if they were an imaging study. Requests are displayed full screen on one of the PACS monitors. Also loaded into the workspace are the patient's prior exams with the most recent prior scan loaded on the other diagnostic monitor on our
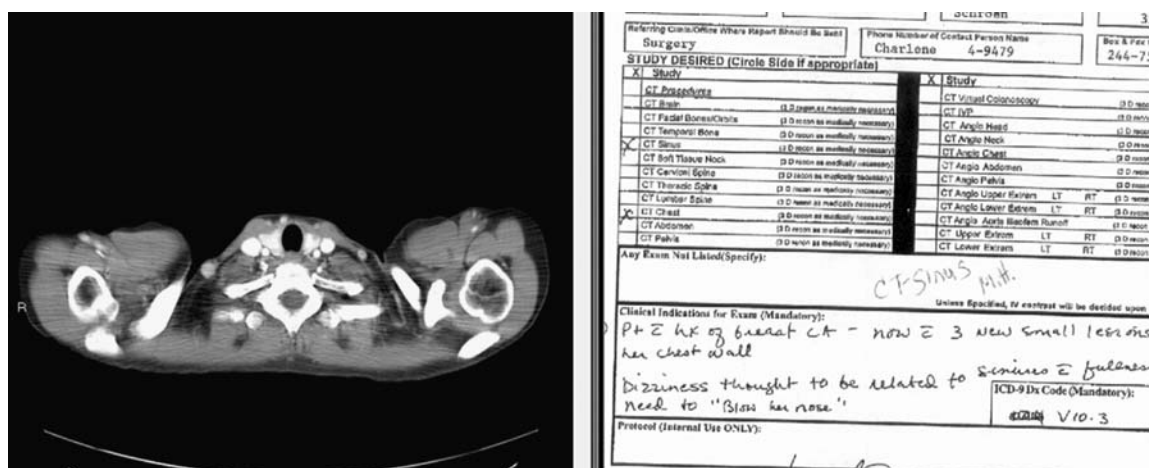

Fig 3. The paperless protocol DP. Prior relevant study is loaded onto PACS monitor #1 (*left image*) and scanned-in request loaded on PACS monitor #2 (*right image*).

PACS workstation (Fig. 3). DPs are automatically applied to a particular set of images as they load into the PACS viewer based on any number of fields in the DICOM header. Usually, a DP cues off of the body part (e.g., chest) and the modality (e.g., CT). Since a system-level DP exists in PACS for chest CTs, every time a chest CT is loaded into the PACS viewer the custom DP that exists in PACS is applied to the images each time they are loaded. Our PACS has a DP creation tool that is used by users and system administrators. Users have the ability to create individual DPs while system administrators can create user-level and system-level DPs. If a division director creates a DP and wants it to be a default for the entire division or department, the DP is taken from his or her personal DP list and added to the PACS system list. This DP now becomes the default for the particular studies for which it is intended based on body part and modality (or other parameters, like age for pediatric studies) of the images loaded. The custom DP for protocoling is no different. All exams and reports are available for viewing as the radiologist so chooses. Requests are reviewed together with prior images and reports. Protocoling uses the text annotation tool functionality that is common in most PACS. Clicking the text annotation tool places a text box over the scanned-in request on the PACS monitor. Utilizing a page of bar codes (Fig. 4), protocol entry is facilitated with the use of a hand-held, pen-shaped bar code reader (MS100 Pen Scanner, Unitech, Cypress, CA, USA). The sequence of events is as follows using the bar code reader: (1) bar code the protocol for the exam, (2) bar code the contrast requirement (Fig. 4, boxed-in area of bar code sheet marked "A"), (3) bar code any special requests to the technologists such as "need new order" or "MD Check" (Fig. 4, boxed-in area of the bar code sheet marked "B"), (4) bar code the responsible radiologist's ID and beeper number (Fig. 4, area of the bar code sheet marked "C"). This step also closes the text box and overlays the protocol text onto the scanned request, and finally (5) bar code the "save KEY image and mark DONE" (Fig. 4, boxed-in area of the bar code sheet marked "D"), which will save the scanned request with the overlaid protocol as a key image in PACS. This also closes the current case and moves on to the next request in the protocol worklist whereby the process repeats until the protocol worklist is empty. More than one radiologist can protocol from the worklist at any given time. The technologists can see the protocols for each patient created in step #5 by viewing the key images on a web version of the PACS. For additional clinical data, the hospital's electronic medical record (EMR) can be open in the background during protocoling and patient records can be queried as necessary. Contrast allergies are noted on the requests that come from our EMR (about 75% of our requests) and can be found on the scanned-in requests without having to look them up in the EMR. When an allergy is noted, protocols are prescribed without IV contrast or an MRI exam is suggested to the ordering physician, as appropriate. Protocoling 3 days in advance allows sufficient time to get pre-authorization for the MRI, instead of the CT, if the clinician agrees. Renal function issues cannot be easily addressed in advance through the paperless protocoling system. Creatinine (CRE) and estimated glomerular filtration rate (eGFR) are used in protocoling under the guidelines provided by the American College of Radiology. However, CRE/eGFR is not always available to us at the time of protocoling. When a patient arrives at the IC, renal function may be found to be inadequate for contrast-enhanced studies. These issues are handled on a case-by-case basis when the IC technologist or nurse going over the screening information with the patient recognizes a renal function issue. This issue is immediately discussed with the radiologist on site and the radiologist determines if the protocol needs to be altered (e.g., no contrast, reduced contrast, alternative contrast, or alternative imaging). The amended protocol is noted on the screening sheet and, following the scan, the screening sheet is scanned into PACS as a separate exam series along with other exam-related documents.

RESULTS AND DISCUSSION

Before the change to paperless protocoling, we faxed approximately 100–150 pieces of paper to various reading rooms at about 15 s per case. Please note that, for this technical note, we did not do explicit timing studies on this step in this process. We cannot give accurate measures of the faxing component alone since the secretaries often multitask during faxing (e.g., filing, answering phones, computer entry, and other tasks) so the

Chest

ABD

3PLiver

CA

AP

4PLiver

CAP

Pelv

Adrenal

CTIVP

HiResChest

Stone

PANCProtocol

Cystogram

RenalMass

Colonography

VirtualBronch

Enteroclysis Rule out Obstruction

EntercolysisROObstxn

Enterography Rule out Lesion

EnterographyROLesion

CONTRAST

MDCheck

WITH

Needneworder

WO

B

W&WO

A

mjb30420

C

Make Key & Done

D

Fig 4. The protocol barcode sheet.

Table 1. Faxing vs Scanning

	Faxing	Scanning/add to worklist
Pieces of paper	Request (1)	Request (1)
Time	15 s	15 s
Rework	10% not protocoled	<1% not protocoled
	Cancel, R/S, N/S	Paperwork already in PACS, simply change date to new appointment

Comparison and time savings between faxing (old paradigm) vs scanning (current paradigm)
R/S rescheduled, *N/S* no show

faxing is not an event done in exclusion of other duties. Following the change to paperless protocoling, it takes about 15 s for IC business office staff to scan the request, input patient data such as name and MRN, and add the case to the protocoling worklists in PACS. So, we do not save any time between these two processes. However, there are significant time savings with the elimination of rework (Table 1). Before the change, approximately 10% of faxed requests went unprotocoled. Despite many possible sources, the exact cause for these cases remaining unprotocoled, though myriad, was impossible to pin down and eliminate. Following the change to paperless protocoling, less than 1% of cases remain unprotocoled. This small percentage of unprotocoled requests results from an occasional technical error in PACS where images with text >64 characters will not display as key images. Our PACS vendor is aware of this bug. Interruptions in our reading rooms, and by implication patient delays, are significantly decreased (Fig. 5). For the 7 weeks before paperless protocoling, there was an average of 23 interrup-

tions in the reading room per day, and after implementation of paperless protocoling the number of interruptions dropped to an average of 12. The purpose of this technical note was not to measure interruption times and, although not directly measured, we conservatively estimate that each interruption lasted between 2 and 5 min. Please note that it does not take 5 min to protocol a case with the protocoling worklist but it may take 5 min for a technologist to explain exactly what the interruption was for, with the radiologist subsequently stopping what they were doing to review the pertinent paper documents and accessing information systems so that a protocol can be rendered. We approximate anywhere from 22 min up to almost 1 h of saved physician time each day due to the decreased interruptions (e.g., 11 interruptions/day multiplied by 2–5 min per interruption=22–55 min/day). Interruptions in the reading room for patients with no protocol have dropped nearly to zero while the bulk of the remaining interruptions relate to renal function and contrast-related questions. Although we did not look at these data specifically, we feel that patient delays and ordering physician interruptions likewise should have dropped. With timely thoughtful protocoling, we believe that patient care has been accentuated. Frustrating rework by the IC business office and technical staff has also dropped off significantly combined with enthusiastic embrace of this simple change from a paper-based to a paperless protocol process. New processes spawned from paperless protocoling have also increased IC personnel efficiency. For example, when patients would not show (N/S) for or canceled their scheduled exams, the paperwork would be shredded and a new exam request was required from the ordering physician when the patient was rescheduled. After implementation of paperless protocoling, completed exams are marked as "DONE" in the protocol worklist. For
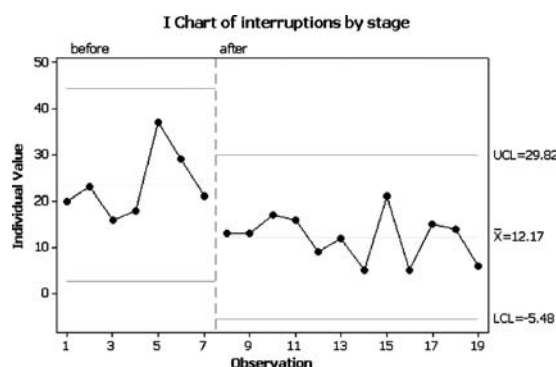

Fig 5. Number of interruptions before and after implementation of paperless protocoling at the IC. X axis is weeks, with end of week 7 representing before and after week 7 representing after implementation of paperless protocoling. Y axis is the number of interruptions per day in the reading room at IC.

patients who did not show for whatever reason, statuses such as N/S, canceled, and rescheduled are also noted in the custom worklist field in PACS. These statuses actually create a secondary worklist in PACS that our IC schedulers utilize to reschedule patients who missed their original appointment. Now, the scanned request remains in PACS. When a patient is rescheduled, the IC staff simply changes the date field in the protocoling worklist to the new exam date. A new order is not required of the ordering physician and, since the original order with the protocol is already saved as a key image in PACS, no rework is required of the radiologist. That is to say, since there is an existing protocol, the protocoling worklist will bypass this request and the radiologist will not even see it, but the technologists performing the scans will see it in their PACS worklist on the date of the patient's rescheduled exam. This process assists our schedulers in rescheduling >60% of patients who originally were N/S or canceled patients.

Some unintended benefits of the process have since been revealed. For example, by looking at the protocol worklist for the day that one is scheduled to read exams at the IC, radiologists can get a close approximation of their workload for the day. We have enthusiastic attending physicians reviewing their fellow's and resident's protocols and correcting the protocols before scan completion: both performing a teaching function and ensuring appropriate patient care and safeguards. Our professional billing compliance officer insists that radiology billing personnel who handle the professional charge component personally see the physician's request for an exam before the charge can be submitted to payers. Previously, this too required faxing of the request from the technical IC billing office to the professional billing office in another office building. Now, the requests are all viewed on PACS by our professional billing staff before they submit the charge. Finally, paper processes have been in place for decades but the success of this project has paved the way for another paperless process, namely, paperless reading, which has even bigger challenges. Since all paperwork necessary to read a study is now in PACS, some of our more adventurous residents and fellows will dictate cases before receiving the paper request. This is moving us one step further toward a fully paperless radiology department.

We acknowledge that the process outlined above is but one of many potential fixes to the problems we experienced with the growth of our IC. An up-to-date RIS with scanning features should perform the same functions. Some would argue that routine protocols for all patients is how their practice has chosen to handle the question of protocols, but that is not how we have chosen to practice. Finally, there are those who feel the technology is not mature enough to replace the paper process, and thus they "throw people at the problem." The methods described in this manuscript utilize COTS and common PACS functionalities that can be used for a protocoling process or some other process that may help reduce paper-based work flows (e.g., rescheduling patients).

CONCLUSION

This technical note on our paperless protocoling process clearly represents an improvement in workflow for all involved with a resultant decrease in interruptions to radiologists and, we hope, decreased delays to patients and decreased frustration to ordering physicians. Patient and ordering clinician satisfaction remains high. Support staff has enthusiastically embraced the process due to its simplicity and reduction of rework. While somewhat geared to our particular IC workflow, the PACS functions mentioned are standard on most PACS (worklists, display or hanging protocols, text annotation, key image creation), so the workflow should be generalizable to other radiology departments.