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Rapid Deployment of Home PACS Workstations to Enable Social Distancing in the Coronavirus Disease (COVID-19) Era

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OBJECTIVE. Social distancing is considered an effective mitigation strategy for coronavirus disease (COVID-19), and remote interpretation of radiologic studies is one approach to social distancing within the radiology department. We describe the rapid deployment of home workstations to achieve social distancing in the radiology department at the University of Alabama at Birmingham.

CONCLUSION. Transitioning from on-site interpretation to remote interpretation requires a careful balancing of hospital and departmental finances, engineering choices, and educational and philosophical workflow issues.

Keywords: coronavirus disease, COVID-19, PACS, professionalism, teleradiology

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Around mid March of 2020, when it became clear that coronavirus disease (COVID-19) would not spare the southeastern United States, the department of radiology at the University of Alabama at Birmingham sought mitigation strategies to ensure seamless delivery of radiologic interpretation, even if one or more radiologists were to fall ill or be required to be quarantined for testing positive for, or for exposure to, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Social distancing is considered an effective mitigation strategy for COVID-19 [1]. To achieve social distancing, protect the radiologists who are at risk for complications if they were to be infected with SARS-CoV-2, and ensure that timely interpretations would continue as the pandemic swept through the state, our department decided to deploy a number of interpretation PACS workstations at the homes of various radiologists.

Before this pandemic, our department had eschewed remote interpretation because we considered physical presence within the hospital and clinics essential for interactions with radiology technologists, resident and fellowship trainees, referring clinicians, and other radiologists. Other reasons to avoid deploying remote PACS workstations included challenges with remotely maintaining and supporting several PACS and hardware costs for these workstations. Before the emergence of COVID-19, we had deployed only two remote PACS workstations. One of these workstations was placed with a radiologist in the emergency radiology section who lived out of the state for 2 of every 3 weeks and occasionally helped the abdominal and cardiothoracic imaging sections remotely during his 2 weeks away. The other workstation was placed with a semiretired neuroradiologist. However, with a potential COVID-19 crisis around the corner, we decided to rapidly deploy more than 2 dozen remote PACS workstations.

Financial Challenges and Engineering Choices

Our first challenge was to obtain funding for the workstations in a difficult financial environment. Several of our radiologists offered computers from their laboratories or offices for redeployment as PACS workstations. Other institutions have recently followed this model successfully [2]. Unfortunately, many of the offered computers either did not have the processing or memory capacity to serve as PACS workstations or did not have the requisite connections to support all the peripherals needed. Additionally, standardizing the hardware and software for all the remote workstations was essential for efficient remote maintenance.

The University of Alabama at Birmingham uses iSite (Philips Professional Healthcare) for our PACS. Each of the PACS workstations is built around a Z4 tower (Hewlett Packard) consisting of a central processing unit with eight cores running at 3.6 GHz, a solid state drive with 500 GB capacity, mem-

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ory of 32 GB double data rate 4 RAM, an Nvidia P400 (Nvidia) video card with 2 GB RAM for driving up to three nondiagnostic displays, and an MXRT-5600 video card (Barco) with 4 GB memory to drive up to four displays. Each workstation also includes two high-end monitors for display of medical images; two additional monitors, one for display of the iSite navigation panels and one for display of a worklist solution (Primordial, Nuance Communications); voice recognition software (Powerscribe, Nuance Communications); and peripherals including a keyboard, mouse, and a microphone for dictation.

Luckily, we had in our storage 25 Z4 computer towers with keyboards, monitors, and dictation microphones, and 14 pairs of high-end display monitors that had been purchased recently to replace end-of-life PACS computers and monitors in the hospital and clinics. We had to purchase two additional standard monitors to supplement each of the 14 high-end monitor pairs. We decided to build the other PACS workstations with standard display monitors because the high-end monitors were only needed for display of radiographs and not required for display and interpretation of CT, ultrasound, and MRI studies. Therefore, we needed to purchase 44 of the less expensive, standard display monitors.

To ensure that these remote workstations would mirror the functionality of on-site PACS workstations, we used a hardware virtual private network (VPN) solution (Meraki, Cisco Systems). Although hardware VPNs do result in some lag in response time, they are faster than purely software VPN solutions. The solution includes a hardware device to be plugged into the home Internet router with an Ethernet cable and a software license. All radiologists who were to be assigned remote workstations were required to have an Internet connection with a speed of at least 100 Mbps.

To facilitate remote maintenance, we installed TeamViewer Remote Access and Support (TeamViewer) on all the workstations. This software allows PACS administrators to log in, install, upgrade, remove, troubleshoot, and change system settings remotely.

Ultimately, our financial request from hospital administration mainly consisted of support for the hardware VPN system and the standard display monitors, which we were able to secure within a week after conceptualization of the project. Order placement and delivery of the hardware took another week, and we were able to start deploying remote PACS workstations by the third week from the start of conceptualization.

Assignment of Workstations

Because we did not have the funding to equip all of our radiologists with remote PACS workstations, we had to make difficult choices regarding who would benefit the most from these workstations, and conversely who, if equipped with these workstations, could benefit the department the most. The easiest part of this decision was with respect to the emergency radiology section, which had five of nine members living out of state and traveling to the university once every 3 weeks. Because of a concern that these radiologists might have challenges traveling to and from Birmingham, we assigned four of the new workstations to four of the emergency radiology section members (one already had a remote workstation). The advantages of providing remote PACS workstations to emergency radiologists were apparent, because they could interpret across a spectrum of modalities (radiography, ultrasound, CT, and MRI) and across a spectrum of organ systems (abdominal, cardiothoracic, musculoskeletal, and neuroradiologic). Thus, these radiologists could provide remote services if a large portion of our radiologists in Birmingham were to be infected with SARS-CoV-2. Additionally, provision of remote capabilities will likely prove beneficial for future crises such as weather events or other unexpected disruption in health care delivery.

For the other sections, a careful balance had to be struck between getting the work done and protecting at-risk radiologists. This task was assigned to the various section chiefs because they were closer to the workloads in their sections and were also more aware of any health considerations for their sections' members. Workstations were provided to abdominal, cardiothoracic, musculoskeletal, and neuroradiology sections. In the initial phase, each section was asked to pick three members (the neuroradiology section was provided five workstations because their workflow was designed around daytime and evening shifts). Most section chiefs chose either more senior members in their division or those who had health considerations because the morbidity and mortality of COVID-19 disproportionately increases with age and underlying health conditions such as hypertension, diabetes, cardiovascular disease, and respiratory system disease. The section chief also chose an additional person who could read images from multiple modalities [3]. Workstations were not provided to the mammography section because outpatient imaging was expected to be severely curtailed and few breast emergencies were anticipated; in addition, mammography workstations require a significantly higher investment for monitors that meet Mammography Quality Standards Act certifications. Nuclear medicine was provided a secondary route whereby they could remotely log in to their office workstations and run their specialized PACS solution (MIM, version 6.9.7, MIM Software).

If all radiologists cannot be provided remote PACS workstations, there is a potential to create a class system, or the appearance of one, within the workforce. To prevent this and achieve equity between radiologists who are assigned remote workstations and others who need to work on-site, several different models of workflow assignment can be explored. First, individuals provided with remote reading ability may be required to work more shifts than those who must work on-site. Second, even those individuals who are provided remote PACS workstations may be required to work on-site for a portion of a week or month.

We require radiologists provided with remote PACS workstations to sign a contract laying out the basic framework of the services that the department will provide. We particularly emphasize that the workstations belong to the institution and are to be used for work only. The workstations are provided temporarily for the duration of the COVID-19 crisis with the understanding that they will be eventually recovered for redeployment to the reading rooms to replace the end-of-life computer towers. Any damage to a radiologist's workstation will be charged back to the radiologist's professional development fund. Radiologists are required to ensure that they have adequate desk space for the workstation and an appropriately lit room to ensure effective interpretation. As noted before, a high-speed Internet link with a minimum download speed of 100 Mbps is required; most radiologists have obtained dedicated commercial Internet service for their workstations. Most software maintenance and upgrades can be performed remotely by the PACS administrators, but if hardware must be repaired or replaced, the radiologist must bring the equipment to the hospital.

Workflow Redesign

Along with departments around the country, the University of Alabama at Birmingham

is experiencing severe drops in imaging volumes, and several of our sections have combined outpatient and inpatient worklists. This drop in demand, added to remote reading, has resulted in a significantly reduced number of interpreters on-site, and effectively achieves social distancing in the reading rooms. We now have three or fewer readers per reading room, depending on the size of the rooms. We make sure that each section has at least one radiologist on-site to provide technologists with backup and to reassure them of our constant presence and availability. For the same reason, we require radiologists with evening or weekend call responsibilities to appear in person. During these evening and weekend shifts, we have a very small number of radiologists on-site and dispersed in different rooms, which increases social distancing.

For the first 2 weeks of our limited business model, resident trainee presence was also limited; only a small number of residents were on-site and the rest were given the opportunity to catch up on book learning. As we slowly increased the number of residents on service, we scattered them across reading rooms at various off-site locations and some within clinic buildings that are essentially closed to other functions.

Of course, in-person, real-time discussion with residents is a very important aspect of their training, and this can suffer without adequate conscious virtual efforts to engage them. Our training directors have encouraged all attending radiologists to begin each shift by identifying the remote residents that are assigned to each worklist, acknowledging their presence, and encouraging them to call in with questions. We check in with residents periodically using the Primordial communication tool on the PACS workstation. The reduced workload has provided the opportunity to have telephone and videoconferencing discussions for interesting cases. To simultaneously scroll through cases with residents, we use several different HIPAA-compliant screen-sharing tools and are evaluating them to converge on a single departmentwide solution [4].

Conclusion

Remote interpretation of imaging studies can contribute to social distancing, protect vulnerable radiologists and others in the hospital, and ensure seamless interpretation capabilities in emergency scenarios. We have described our institution's imaging informatics team's rapid response to provide remote interpretation capabilities to a significant number of our radiologists and hope that the processes we discussed can be useful to other institutions considering remote interpretation solutions.

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