Policies and Guidelines for COVID-19 Preparedness:
Experiences from the University of Washington

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The coronavirus disease 2019 (COVID-19) pandemic initially manifested in the United States in the greater Seattle area and has rapidly progressed across the nation in the past 2 months, with the United States having the highest number of cases in the world. Radiology departments play a critical role in policy and guideline development both for the department and for the institutions, specifically in planning diagnostic screening, triage, and management of patients. In addition, radiology workflows, volumes, and access must be optimized for the expected surges in preparation for patients with COVID-19. In this article, the authors discuss the processes that have been implemented at the University of Washington in managing the COVID-19 pandemic as well as preparing for patient surges, which may provide important guidance for other radiology departments who are in the early stages of preparation and management.

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Since the initial report of the severe acute respiratory syndrome coronavirus 2, or SARS-CoV-2, virus outbreak in Hubei province in China in late December 2019, the virus has spread across the world, infecting more than 858,000 individuals and killing more than 42,000 over the span of 3 months (1). Washington state reported the first known case of coronavirus 2019 (COVID-19) in the United States in February 2020 and subsequently became the site of the first major outbreak in the country. In the current pandemic, it is vital for radiology departments to partner with the emergency operations teams in the health care enterprise for planning and coordinating diagnostic algorithms; patient management, treatment, and disposition; and management of patient surges.

Our health care system consists of our school of medicine, two academic urban hospitals, one community hospital, a network of outpatient primary and urgent care clinics, and an air transportation service. There are a total of 1173 inpatient beds and 186 intensive care unit beds among the three hospitals. Our hospital system is centered in King County, Washington, which currently accounts for 52% of all known COVID-19 cases in the state. Current forecasts indicate a potential need for 30%–60% additional acute care and intensive care unit hospital beds over current capacity across our health care system.

During the COVID-10 pandemic, the goal of our policies and preparedness has been to (a) reduce patient morbidity and mortality related to infection through early diagnosis and appropriate treatment and (b) prevent disease dissemination to our employees, patients, and the general community. We have also focused on preservation of health care resources, management of essential equipment such as personal protection equipment (PPE) and ventilators, and preparation for patient surge.

In this communication, we highlight the University of Washington experience, programs, and policies. Although guidelines are constantly changing as we learn more about this disease process, we hope our experiences will help other institutions as they prepare to deal with the COVID-19 pandemic.

Elective Imaging Examinations

To promote our efforts to protect our patients and employees from potential exposure while performing critical and time-sensitive noninvasive diagnostic imaging studies, we are rescheduling elective examinations. This is being accomplished by means of automated patient texting services and direct calls to patients from radiology scheduling. We seek to reschedule elective examinations for patients with flu-like symptoms (fever, new cough, dyspnea, weakness) and those with pre-existing conditions making them vulnerable to infection. As of now, the postponement will extend to May 18, 2020.

Our plan for planned postponement of elective diagnostic imaging has been communicated to referring physicians. We also requested that all orders for outpatient imaging include information on examinations that are crucial for patient care versus those that may be postponed (including the length of time for postponement). Each outpatient imaging requisition now includes in the indication section the dates between which the imaging should be performed. Screening mammography, lung cancer screening, and dual-energy x-ray absorptiometry are considered to be elective; therefore, all of these examinations have been postponed until late May.

Implementation of these processes resulted in a rapid decline in our imaging volumes. Across our medical system, radiology imaging volumes have declined 39%–60%, with a 55%–70% decrease in outpatient imaging volume.
The estimated total relative value unit loss during the 2-month time period of reduced outpatient scanning is 14,923.

Laboratory Testing

Our institution’s virology program began working on a reverse-transcription polymerase chain reaction (RT-PCR) test for COVID-19 in early January, when reports of the outbreak in China first surfaced (2). At present, we are fortunate to provide 3,000 RT-PCR tests for COVID-19 per day with a turnaround time of 10–24 hours. Testing capacity and turnaround time is expected to improve in the coming weeks. In comparison with Centers for Disease Control and Prevention and Department of Health comparator specimens, our RT-PCR test has near 100% sensitivity. However, in actual practice the sensitivity of testing is lower due to variation in swabbing technique and viral load of the specimen source (nasopharyngeal specimens are likely more sensitive than nasal and oropharyngeal specimens in early stages, and sputum is often more sensitive in late stages in the presence of pneumonia). Early studies suggest that sensitivity of RT-PCR ranges from 32% to 93%, depending on the source of the clinical specimen (3). To protect our health care workers, we screen all patients who are admitted as inpatients for COVID-19 with RT-PCR, regardless of the reason for admission.

Imaging of Patients Known to Have or Suspected of Having COVID-19

The decision to image patients who are positive for COVID-19 or are suspected of having COVID-19 is based on how the imaging will impact patient care. Although we do not routinely use imaging for COVID-19 screening, imaging is performed in patients positive for or suspected of having COVID-19 to rule out other diagnoses that can be treated, including pulmonary embolism. In addition, emergent imaging may be necessary for evaluation of other urgent conditions, including stroke, trauma, infection, and other disease conditions (Fig 1).

The performance of CT and chest radiography in patients suspected of having or positive for COVID-19 is based on whether imaging will change patient management. In approximately 5000 patients tested for COVID-19 across our hospitals, we have performed 4700 chest imaging examinations, including 1300 CT and 3400 radiographic examinations. These include screening examinations, follow-up examinations, and other examinations including intensive care unit radiography, CT chest as part of trauma protocols, and CT pulmonary embolism protocols. Through communication, education, and case discussion with our colleagues in the emergency department, COVID-19 screening imaging requests anecdotally have progressively decreased at our primary COVID-19 hospital from six or seven CT chest examinations without contrast material and five or six chest radiographic examinations requested per day for COVID-19 screenings at our primary COVID hospital to few or no chest CT examinations without contrast material or radiographic examinations ordered on most days. CT pulmonary embolism studies continue to be ordered at our hospital, typically two to three per day, when there is concern for COVID-19 and other disease processes.

Approaches to Imaging

Portable radiography is the mainstay imaging tool for emergency department and inpatient settings. If imaging can be done with portable equipment (chest or abdominal radiography), the technologist dons PPE consistent with the potential exposure and performs portable radiography in the isolation room. For most imaging procedures, PPE consists of a gown, gloves, eye protection, and a mask (standard contact and/or droplet). Once radiography is complete, the technologist doffs PPE gear, preferably with a trained observer monitoring removal, ensures that the patient continues to wear a mask, and will direct the patient out of the department. Similar measures are taken for patients imaged with nonportable radiography, MRI, CT, US, or nuclear medicine sections, except imaging is performed in the respective imaging suites.

We limit patient transfers to limit staff exposures and to conserve PPE. By employing a modified version of processes developed during the 2014 Ebola outbreak, we can perform portable chest radiography either (a) through the glass of an isolation room door or (b) at a greater than usual distance (10–15 feet) across a semi-isolation antechamber into an isolation room. The patient is placed in a wheelchair or gurney inside the isolation room, facing the glass door or window. A
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Let and contact precautions apply to most patients, whereas standard airborne and contact precautions apply to patients who are critically ill or undergoing aerosol-generating procedures while in the room (4) (Fig 1).

Airborne and/or Contact Precautions

These precautions require replacement of the conventional surgical masks used for droplet protection with N95 filtering facepiece respirators or powered air-purifying respirators. N95 filtering facepiece respirators and powered air-purifying respirators protect health care workers from small infectious particles (>5 µm) and are adequate in the setting of aerosolizing COVID-19. N95 filtering facepiece respirators require individual fitting (facial shape and size). Advantages of powered air-purifying respirators include protection of head and neck (hood), use with facial hair and filtration of particles as small as 0.3 µm (equivalent to high-efficiency particulate filters) as well as those individuals who cannot be fit to an N95 filtering facepiece respirator.

Correct donning and doffing of protective measures is instrumental for the efficiency of PPE. At our hospitals, donning and doffing was practiced by each staff member in group sessions available during day and night shifts for all staff who are expected to come in contact with patients. Rapid N95 mask fit testing is offered concomitantly.
Airborne Precautions

Severe acute respiratory syndrome coronavirus 2 is believed to be primarily transmitted via droplets. Very small droplets (<4 µm) can be produced by virus-shedding patients through forceful coughing. As such, health care providers may become exposed to aerosols theoretically able to permeate N95 filtering facepiece respirators. Increasing air exchange per hour or high-efficiency particulate filtration of room air represent potential supplemental mitigation measures (5). Air exchange rates vary between imaging suites, depending on ventilation, air circulation, and room configuration. Infection control has reviewed our imaging suites to assess air circulation and the need for air exchange measures. For standard airborne and contact precaution, we use high-efficiency particulate filtration systems to increase air exchange, with the exception of MRI, as these units cannot be used in the MRI suite. Our MRI suites have better ventilation and hence better air exchange, so this is not thought to be an issue.

Room Cleaning

Imaging suites are sanitized by using standard cleaning procedures between patients. Quaternary ammonium- and/or alcohol-impregnated wipes or other Environmental Protection Agency–approved disinfectants are used in our standard cleaning procedure (6). For patients requiring airborne and/or contact precautions, radiology technologists will perform room sanitizing after imaging while still wearing the same set of PPE as used during patient transfers. Although evidence about the effectiveness of air-exchange measures is limited, use of large stationary high-efficiency particulate filters (except in MRI) in temporarily closed imaging suites can allow for sedimentation and removal of small aerosol particles. At our hospitals, imaging rooms are closed for 1 hour for airborne precautions in rooms with a minimum of six air exchanges per hour. We start the clock immediately after the patient leaves the imaging suite; cleaning time is included in the room closure downtime. Interventional radiology suites at one of our hospitals are closed for 1 hour after examination of every patient positive for or suspected of having COVID-19 (droplet or airborne precaution) due to limited air circulation, whereas at the other hospitals, the interventional suites are shut down for 1 hour only for airborne precaution.

Sick or Exposed Employees

In our health care system, employees exposed to COVID-19 who are asymptomatic are required to return to work, to attest to their health daily, and to self-monitor for symptoms twice per day. We do not require that employees wear masks after exposure to patients with COVID-19. This is because most exposures are unreported exposures occurring in the community. We do not perform RT-PCR tests on asymptomatic employees. Employees who exhibit symptoms of acute respiratory infection are asked to undergo RT-PCR testing for COVID-19 at drive-through testing clinics and are instructed to stay home. If COVID positive, employees are required to stay in isolation for a minimum of 7 days from symptom onset and must be symptom-free for 72 hours before returning to work (7). Employees who are COVID negative may return to work when symptom-free for 24 hours. In the radiology department, we have had one faculty member, two technologists, and one transporter test positive, all presumed to be community acquired. We had a clinical fellow who had a false-positive RT-PCR test, then on reassessment of the sample by the state laboratory, was determined to be negative.

Invasive Procedures in Patients with COVID-19

We use a three-tiered approach for scheduling procedures under consideration (Table). Procedure requests are reviewed individually by subspecialty radiologists (interventional radiology, body imaging, musculoskeletal radiology, and neuroradiology) and assigned a category in consensus with the ordering provider.

We perform crucial procedures that would adversely impact patient care if not immediately scheduled. For all crucial and time-sensitive procedures and imaging studies that involve anesthesia and may require intubation, a RT-PCR test for COVID-19 is performed before the procedure to ensure health care worker protection. To accomplish this, a

Figure 2: Chest radiography through glass. A, Technologists position the portable radiography unit outside the patient room, with the tube facing the wire-reinforced isolation room window. B, Anteroposterior chest radiograph obtained through glass is of diagnostic quality.
rapid 75-minute RT-PCR test has been employed for these emergency procedures. For critical trauma cases, stroke interventions, and active bleeding cases, the in-house rapid COVID-19 RT-PCR test is not performed. For these patients, we employ airborne and/or contact precautions with assumption of COVID-19 infection.

**Distribution of Patients for Imaging Procedures**

In radiology, we direct patients with COVID-19 infection or suspected infection who are scheduled to have time-sensitive imaging performed away from hospital centers with a high-volume of critically ill patients (ie, patients without COVID-19 infection) to outpatient imaging centers with lower patient volumes. A limitation of this approach is that patients may develop symptoms of infection between the time of infection and the date of the imaging examination.

**Radiology Faculty and Staff Protections**

Our department has accelerated the process of providing home workstations for radiologists. We upgraded our picture archiving and communication system servers to support an increased volume of radiologists doing remote interpretation. For on-site radiologists, we established 21 single-workstation reading room outposts across our various institutions to isolate radiologists. We have online sign-up sheets to reserve and use the above outpost rooms and an automated dashboard that tracks home and outpost interpretations. Employees are now provided with daily standard three-layer disposable ear-loop surgical masks for use during direct patient care. In addition, employees are permitted to wear these masks during nonpatient care. If masks become soiled or if working with a patient who is positive for or suspected of having COVID-19, the mask will be replaced with a new mask for use.

Due to the reduced imaging volumes and need for social distancing, we have restructured our shift coverage for faculty and trainees. We have one faculty radiologist, one imaging fellow, and one resident in the reading room at any given time. Radiologists in the reading room sit at every other workstation to maximize their separation. Trainees have their own workstation, and communication is achieved by conversation in the same room or by means of screen control enabled video conference with trainee and staff sitting at different physical locations. On some services, such as nuclear medicine, we also created two rotating teams for in-person clinical daytime coverage, with each consisting of one faculty, one fellow, and one resident that exclusively work together for service coverage for a week at a time; they rotate 1 week on and 1 week off. The off team provides remote support when needed. This limits cross-exposure between teams to limit transmission of disease that may negatively affect the team.

On-site radiology employees fill out mandatory daily online attestations to their health status when they arrive at work. For radiologists, these attestations pop up on picture archiving and communication system workstations every 4 hours. Answers get routed to supervisors to inform them of symptomatic team members.

All meetings are encouraged to be held by video conference. We require that any meeting with more than six attendees be virtual or be cancelled. All faculty and trainee interviews are online, and our grand rounds and visiting professorships are held online as well.

**Enterprise-wide Coordination and Communication**

Early in the outbreak, our health care system created a command center to coordinate the system response to the myriad facility, staffing, safety, and resource needs. A secure central repository was established for COVID-19–related policy and procedure documents and outbreak-related resources, such as childcare and personal counseling (covid-19.uwmedicine.org). Daily command center briefings are available to all employees. Weekly enterprise huddles summarize recent actions, remunerate on-going initiatives, and review regional and enterprise situation status.

At the department level, communication is facilitated through virtual daily huddles with department leadership and weekly faculty meetings. Daily huddles at each radiology site maintain safety and practice standards and provide an opportunity to answer questions.

**Disaster Preparedness**

Most models predict exponential increases in COVID-19 cases, hospitalizations, and deaths over the next few weeks, with depletion of hospital resources, including hospital beds (specifically intensive care unit beds), ventilators, and PPE. Hospital systems and radiology departments must prepare for a COVID-related patient surge.

University of Washington Medicine hospitals are erecting triage tents outside the hospital to keep patients with noncritical COVID-19 and other patients with respiratory symptoms outside the hospital. Radiology is providing supporting imaging equipment, including portable chest radiography equipment in adjacent spaces with imaging performed through glass doors or in adjoining triage tents. At Harborview Medical Center, access to MRI, CT, and US equipment for those COVID-positive

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### Approach for Scheduling Procedures

| Procedure Category | Designation     | Description                                                                 |
|--------------------|-----------------|-----------------------------------------------------------------------------|
| 1                  | Elective and/or nonurgent | If delayed, will not harm patients in the next 2–6 months; these procedures can be delayed until after postponement period |
| 2                  | Time sensitive  | Short delay is acceptable, within a certain time frame                       |
| 3                  | Critical        | Cannot be delayed; these procedures should be scheduled immediately           |

Note.—Procedure requests are reviewed by radiologists in consensus with the ordering clinician.
patients who may require advanced imaging for other indications—including the evaluation for pulmonary embolism or a brain or spine abnormality—is available in adjacent Harborview Medical Center dedicated scanners. Harborview Medical Center has two 1.5-T MRI scanners, one 3-T MRI scanner, three 128-slice CT scanners, one dual-energy CT scanner, one SPECT/CT scanner, seven US units, and four angiography suites. For potential surges, the plan is to dedicate the SPECT/CT scanner to COVID-19 CT imaging, with protocols developed for contrast material–enhanced imaging and an additional CT scanner if needed, as well as dedicating one or two radiography suites beyond the portable equipment deployed and an US unit. There has been planning of placement of a portable CT scanner in the triage tent at University of Washington Medical Center-Montlake. At University of Washington Medical Center-Northwest, the plan is to scan those patients who need CT in the isolated SPECT/CT scanner in close proximity to the tent to limit in-hospital transit.

The hospital has prepared for the inpatient surge through rental of 180 patient beds and ventilators that are loaded on a truck and awaiting deployment. We have created scanner throughput plans, including designated CT scanners and imaging suites for COVID-19–positive patients. In addition, we have created imaging screening mitigation plans in case our laboratory testing algorithm gets overwhelmed.

The radiology department has submitted all able-bodied and nonvulnerable faculty into a general faculty pool that may be recruited for emergency department and inpatient direct patient care with support and guidance provided. There is a separate pool of residents and Accreditation Council for Graduate Medical Education–accredited fellows.

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