Editorial

Beyond business as usual: Radiology residency educational response to the COVID-2019 pandemic

ARTICLE INFO

ABSTRACT

The COVID-19 pandemic has disrupted standard hospital operations and diagnostic radiology resident education at academic medical centers across the country. Deferment of elective surgeries and procedures coupled with a shift of resources toward increased inpatient clinical needs for the care of COVID-19 patients has resulted in substantially decreased imaging examinations at many institutions. Additionally, both infection control and risk mitigation measures have resulted in minimal on-site staffing of both trainees and staff radiologists at many institutions. As a result, residents have been placed in nonstandard learning environments, including working from home, engaging in a virtual curriculum, and participating in training sessions in preparation for potential reassignment to other patient care settings. Typically, for residents to gain the necessary knowledge, skills, and experience to practice independently upon graduation, radiology training programs must provide an optimal balance between resident education and clinical obligations. We describe our experience adapting to the challenges in educational interruptions and clinical work reassignments of 41 interventional and diagnostic radiology residents at a large academic center. We highlight opportunities for collaboration and teamwork in creatively adjusting and planning for the short and long-term impact of the pandemic on resident education. This experience shows how the residency educational paradigm was shifted during a pandemic and can serve as a template to address future disruptions.

1. COVID-19 pandemic disrupts radiology operations

The novel severe acute respiratory syndrome-associated coronavirus (SARS-CoV-2 or COVID-19) has spread rapidly across the globe with the highest number of cases occurring within the United States [1]. The first confirmed case in our state was reported on February 1, 2020, and the number of cases began increasing rapidly in early March [2]. Public health guidelines encouraged social distancing, and a stay-at-home order was implemented in our state. Our institution is a large academic medical center with 793 beds; the radiology department consists of 11 subspecialty divisions, 128 faculty, and 41 residents (PGY-2 through PGY-5, or R1–4). At the hospital level, patient risk mitigation measures were taken by deferring outpatient elective care. At a radiology departmental level, the number of radiologists working in the hospital was reduced and interventional procedures were limited to essential operators in order to minimize exposure and preserve personal protective equipment. Radiologists' work location changed from several centralized, subspecialty-specific reading rooms to decentralized workstations spread throughout the hospital, in satellite locations and administrative offices, to allow for social distancing. Remote work was supported by remote desktop platforms and virtual conferencing tools. Multidisciplinary conferences and educational conferences at the department level were converted to online platforms. These interventions were modeled after strategies that were previously beneficial for institutions during the 2003 SARS outbreak [3].

2. Disruption of education during a public health crisis

In response to the COVID-19 pandemic and its disruption to graduate medical education, the Accreditation Council for Graduate Medical Education (ACGME) issued a new conceptual framework to provide guidelines for the effective operation of graduate medical education around the country [4]. Divided into three stages along a continuum, institutions in Stage 1 "Business as Usual" and Stage 2 "Increased Clinical Demands" would follow all regular accreditation requirements. Institutions who file for Stage 3 "Pandemic Emergency Status" have requirements waived for 30 days, during which time most trainees are assigned to patient care and the majority of educational activities are suspended. This framework allows programs to determine how they will adapt their medical education training in response to increased patient care needs at an institutional level during the COVID-19 pandemic, particularly at Stages 2 and 3.

In order to streamline decision-making and communication, our education leadership team, including the Diagnostic Radiology (DR) Program Director, Interventional Radiology (IR) Program Director, Associate Program Directors, Chief Residents, and Program Coordinators formed a "residency central command" to develop program changes impacting 41 residents. The residency leadership developed three staffing models that fit within the ACGME framework (Table 1), with the goal of coping with the public health crisis.

2.1. Scheduling & Staffing

Due to a decrease in overall imaging volume at our institution and in conjunction with social distancing measures, fewer residents and staff radiologists were required to work on site. To adapt to these new staffing requirements, the Chief Residents created a new block-schedule for the remainder of the academic year using Excel (Microsoft, Redmond, WA, USA) and in collaboration with division chiefs and core faculty members to match staffing supply with imaging demand. If a resident was not assigned to an on-site rotation, then the resident was assigned to a "virtual" rotation and instructed to follow governmental "work from home" directives [5].

The residency program academic year schedule consists of the 52-week academic year divided into predominately month-long (roughly 4-week) rotations on subspecialty-based services. We created several iterations of staffing models adjusting each resident's schedule based on predicted needs within the department. We reassessed 64 individual after-hours and weekend call rotations on the basis of equity, educational value, and clinical need. Furthermore, we modified backup call assignments used to cover residents who are out sick. Due to the infectious etiology of the public health crisis, a secondary backup call assignment schedule to increase flexibility in the case of multiple sick and/or quarantined residents.

We created three levels of resident staffing models (Level 1–3) by adjusting each resident's schedule based on predicted needs within the department. In order to ensure that residents interacted with an adequate volume of studies for learning, staffing was determined in concert with division chiefs and core faculty using a data-driven approach by reviewing retrospective divisional imaging volumes from the previous week to determine the appropriate number of assigned residents for on-site rotations. These needs were then reconciled with the available pool of residents not being considered for reassignment (see Section 2.3), residents' previously scheduled rotations, and graduation requirements. At the onset of the COVID-19 pandemic, the Level 1 "minimal restriction staffing model" consisted of assigning residents to decentralized workstations, and staffing was reduced on a per-case basis depending on divisional volume. With continued decrease in clinical volume, the Level 2 "reduced staffing model" was implemented

Table 1

Model for different levels of resident staffing as needed in a crisis scenario. Our internal radiology staffing model was adapted base on ACGME guidelines [5].

Crisis situation structure for resident staffing				
ACGME guidelines	Program level	Workday hours	After hour call shifts	Interventional/ patient facing
Stage 1	Level 1 - minimal restriction (precautions)	Resident remain at same assigned workstation for duration of rotation to minimize exposure	No change	No change to regular workflow
Stage 2	Level 2 - staffing restriction (reduced staffing model)	One on-site resident per section. Most residents assigned to virtual rotations and may be called in as needed.	No change	Essential staff only
Stage 3	Level 3 – staffing restriction (minimal staffing model)	Only attending and fellows are on site. Residents assigned to virtual rotations and may be called in as needed.	No change	Essential staff only

consisting of one on-site resident assigned per division. The Level 3 "minimal staffing model" was gradually adopted during the month of April consisting of on-site residents only as needed. During Level 3 staffing model, the divisions that still had on-site residents included breast imaging, thoracic imaging, neuroradiology, and oncology. Due to both the frequently changing needs of the hospital and radiology department, final schedules were released one week at a time, allowing for maximum adaptability and flexibility. However, unlike the standard block schedule in which a resident had continuity in a rotation for up to a month, weekly scheduling resulted in stand-alone weeks of education.

The total number of weeks a resident was on-site was considered to evenly distribute clinical work. Additionally, on-site rotation priority was given to graduating fourth-year residents who needed clinical exposure to meet certification and graduation requirements, such as those required for breast imaging and nuclear medicine, as well as to first-year radiology residents, who were rotating through a division for the first time, to prevent deficiencies in their education. Adjustments were made to readouts so that interactions between trainees and attendings were predominantly virtual over the phone or an online platform. Our experience was recently described by a coauthor's paper that concluded virtual readouts are feasible and preferred given compliance with social distancing measures [6]. When possible, residents who had completed on-site rotations were subsequently placed on virtual rotations for a minimum of 2 weeks to meet 14-day self-quarantine guidelines in the event that they had unknowingly been exposed to COVID-19.

2.2. Educational content & competency

As more residents worked from home during the COVID-19 pandemic, the formal radiology curriculum was converted to distanced learning. To this end, we created a robust virtual curriculum incorporating a diverse array of online education offerings, which has anecdotally been well-received by residents based on initial unsolicited verbal and email feedback. Resident manuals specific to each rotation were established including level-specific competency and knowledge base expectations, with a menu of lectures and question banks. Learning resources were made available to all residents and consolidated on a password-protected server via SharePoint (Microsoft, Redmond, WA, USA). A target number of resources within the menu of options were suggested and determined by core faculty based on primary assigned rotations.

The virtual curriculum consisted of a combination of synchronous and asynchronous sessions. Synchronous sessions, hosted by the video-conferencing platforms Microsoft Teams (Microsoft, Redmond, WA, USA) and Zoom (Zoom, San Jose, California, USA), included didactic lectures, case-based discussions, and team-based case reviews. For example, subspecialty topic-based lectures, case rounds for abdominal imaging, and group readout for nuclear cardiac imaging were broadcasted daily for all radiology trainees to join. Faculty teaching case-based conferences were encouraged to use Poll Everywhere (San Francisco, USA) and Kahoot (Kahoot!, Oslo, Norway) to facilitate audience participation and engagement. Residents assigned to virtual rotations focused primarily on subspecialty subject matter related to their assigned rotation as set forth by each section. In addition, residents attended regularly scheduled morning and afternoon virtual conferences as well as regional or national virtual conferences, including the Association of Program Directors in Radiology (APDR) National Virtual Noon Conferences. The thoracic radiology division organized didactic sessions on the specific imaging features of COVID-19 and departmental reporting guidelines. COVID-related education also featured a resident-led teaching conference about departmental and institutional-specific policies, appropriate imaging criteria, critical alert guidelines, and institutional clinical management. Moreover, residents volunteered to teach medical students in a month-long virtual radiology core clerkship created by collaborative effort between radiology departments at multiple local institutions.

During asynchronous sessions, residents watched previously recorded lectures, navigated self-learning modules, answered question banks, and read relevant articles and textbook chapters as provided by several academic specialty and subspecialty societies including the Radiologic Society of North America, Association of University Radiologists, and Association of Program Director of Radiologists [7]. In order to document their specific educational experiences, we developed an "Educational Log" for residents including the details of the activity (e.g. asynchronous lecture, journal article readings, synchronous virtual read-outs, etc.), rotation division category (e.g. breast imaging, nuclear medicine, etc.), date, and hours spent (see Fig. 1). At the end of the week, the residents sent the Educational Log to the program coordinators for documentation.

2.3. Reassignment and clinical education of COVID-19

As the COVID-19 pandemic evolved, high resource utilization was demanded from the emergency department, internal medicine, and intensive care unit. Support from other medical specialties was needed to assist in the care of COVID-19 patients [8]. Based on institutional projections of the COVID-19 census, the institutional GME board consulted with program directors and determined how many housestaff and for what duration were needed to fill the gaps in coverage. Radiology was asked to cover general medicine and COVID-19 wards as well as Boston Hope, a field hospital for lower acuity patients. Within our department, all 20 enlisted residents (49% of all residents) were volunteers. These volunteers were removed from the pool of residents available for on-site radiology rotations and their radiology call shifts were also redistributed amongst other available residents.

Preparation for reassignment to inpatient care included learning current guidelines and hospital protocols including triage methods, respiratory management, and ongoing clinical trials. Volunteers participated in online training in order to learn electronic medical record (EMR) workflows, best clinical care practices, and hospital guidelines for COVID-19 clinical management. This was achieved through asynchronous learning material provided by the Department of Medicine and by participating in daily virtual rounds with inpatient medicine teams focused on caring for COVID-positive patients.

In preparation for a second wave, institutional GME and ACGME pandemic protocol will be followed and volunteers will be requested as first priority. Those who have already volunteered may have an opportunity to do so again if they wish, while residents with special conditions such as immunocompromised-state or pregnancy should be protected. The number of requested residents will be determined by the institutional GME board, accounting for inpatient volumes and census projections.

3. Challenges & future opportunities

A new paradigm of graduate medical education will be need to better evaluate and respond to the substantial educational disruptions from the COVID-19 pandemic and subsequent outbreaks.

3.1. Disruption of the longitudinal core curriculum

The educational impact on residents has been a challenging situation given unique concerns based on year in residency (see Table 2). First year residents missed baseline exposure to core rotations such as neuroradiology, cardiovascular imaging, and nuclear medicine. The emergency radiology rotation was prioritized so that junior residents would have exposure prior to taking call shifts in second year. Another major concern for residents has been missed clinical experience and volume of cases read prior to graduation, particularly for junior residents. However, the ACGME has reminded programs in the Specialty Letters that there are no baseline case volume requirements for individual competency; rather, case log minima were established for program accreditation [9]. Therefore, the current case minimum criteria need not be waived or changed due to the pandemic. At the same time,

Table 2
Specific concerns with each residency class and possible solutions.

Class	Challenges	Possible solutions
Intern, PGY-1	Some may have decreased general clinical experience and more COVID-specific experience.	Clinical experience is less important for radiology subspecialty.
R1, PGY-2	Potential clinical competency issues due to missing experience in some rotations.	Emergency radiology was prioritized so that R1s have preparation for after-hours call.
R2, PGY-3	Potential clinical competency issues due to missing experience in some rotations. R2s have less scheduling flexibility due to upcoming board exams the following year.	Planned rotations can be moved earlier to create more flexibility in upcoming R3 year.
R3, PGY-4	Board exam delayed until November of R4 year. 4-week AIRP rotation canceled.	Planned R4 rotations can be adjusted to accommodate exam time. Virtual AIRP curriculum.
R4, PGY-5	Decreased mini-fellowship experience. Need to fulfill graduation requirements.	Prioritize rotations required for graduation. Competency is determined by PD and CCC.

Fig. 1. Example of educational log in Excel with drop-down menu and automatic tally of nuclear medicine and breast imaging education hours.

determination of individual readiness to graduate remains at the discretion of the program director and the Clinical Competency Committee.

Delay of the American Board of Radiology (ABR) Core Exam until February 2021 has created challenges for the current R3 class. In order to accommodate the core exam, R4 year schedules will need to be altered to account for on-call schedules and time spent on elective rotations. Mini-fellowship experiences may be scheduled to begin before the exam date and continued afterwards. In addition, the American Institute for Radiologic Pathology (AIRP) course was canceled during spring 2020, resulting in 4 weeks of schedule disruption and absence of the month-long rad-path correlation education. Given that two classes will be taking the core exam within several months of each other, call shifts will need to be staggered for each class accordingly. Adequate clinical coverage of subspecialties will be discussed with core faculty and will likely rely on fellows as well as junior residents.

3.2. Opportunities to move toward competency-based education

Residency programs should adequately prepare residents for independent practice and specialty board certification. However, educational time lost during the COVID-19 pandemic will not be directly recovered, and it will not be feasible to replace each week of lost clinical experience in future schedules. An alternative to time-based graduation requirements is needed to avoid significant delays in resident progress through residency. According to the American Medical Association (AMA), specialty boards should allow flexibility in assessments of the competence of trainees and where possible, these assessments should not delay program completion nor eligibility for certification [10]. Instead of a time-based approach, a time-variable, competency-based advancement paradigm has been proposed at our institution as part of a grant from the AMA [11].

The immediate post-COVID-19 pandemic time may be an opportune time to explore competency-based advancement. Competency-based paradigms may consist of a minimal number of on-site weeks for each rotation complemented by off-site virtual material and self-learning, followed by a competency assessment. Nationally validated tools such as the RadExam [12], a standardized multiple-choice exam database developed by the Association of Program Directors in Radiology (APDR) and the American College of Radiology (ACR), may be helpful for competency assessment throughout residency. A comprehensive competency assessment could involve a global oral objective structure clinical examinations (OSCE) [13,14] during the last year of residency (R4) prior to graduation using representative unknown cases from each subspecialty section. This final assessment tool, in additional to rotation-specific OSCEs and faculty evaluations, would help the CCC to determine graduation readiness.

4. Lessons learned

The COVID-19 pandemic has resulted in a significant disruption of residency education and will likely have persistent effects over the foreseeable future. Below we share final lessons learned from our experiences in the initial phases of COVID-19 pandemic.

4.1. Centralized decision-making addressed discrepancies amongst divisional approaches

It is important for residency educational leaders to be involved early and to make rapid but informed decisions impacting workflow. Initially, decentralized changes to workflow amongst a variety of social distancing solutions were disorienting to residents as they were managed by individual divisions. For example, some divisions assigned residents and staff radiologists to different workstations on a week-to-week basis and variation in the preferred method for remote readouts were confusing. Several divisions simply asked residents to stay home or

sent residents home mid-day if volumes were low. While some residents were sent home, others remained on-site despite low clinical work volumes. As such, decentralized decision-making generated disparate experiences for residents. Once a more centralized approach was taken by the educational leadership as described above, discrepancies in resident education and clinical experience were minimized.

4.2. Proactive communication through virtual channels

Our experience with adapting the residency schedule required department-wide collaboration and teamwork. By setting up regular channels of communication through means such as daily virtual meetings of the radiology "residency central command," we built stronger professional and social networks. During times of crisis and uncertainty, it was especially important for these regular channels of communication to extend to include the entire residency so that new guidelines and procedures could be directly disseminated. This was achieved through weekly resident town halls with program leadership in the initial stages of the pandemic. Proactive communication with residents was also bolstered by weekly virtual office hours with the Chief Residents and the Program Director to provide a channel for raising concerns, asking questions, and solving issues informally. An anonymous, virtual feedback survey was also employed and proved essential for assessing resident dissent, collecting controversial comments, and providing an additional outlet for residents to express their frustrations. At a departmental level, regular virtual forums were hosted by the Chairman and Vice-Chairmen. At the institution level, leadership and decision-makers kept staff up to date with regular town halls and institution-wide emails that discussed their assessment of the ongoing pandemic, including census data, updated hospital policies, institutional guidelines, and technological advancements.

5. Conclusion

Weathering a crisis takes a tremendous amount of teamwork and collaboration. Longitudinal educational planning will be needed in order to support our residents through the current crisis and through their remaining time in residency, which may ultimately require customized approaches for each residency class. Although significant disruptions occurred during the COVID-19 pandemic, many opportunities and new approaches for teaching and learning have come to light, including an acute need to employ competency-based advancement. This experience can serve as a template to address future disruptions to radiology education.

Author contributions

JS: conceptualization, original draft preparation, editing and approval of final draft; NM: validation, original draft preparation, editing and approval of final draft; BD/AK/PS/SM/JU/JG/GG: conceptualization, editing and approval of final draft.

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