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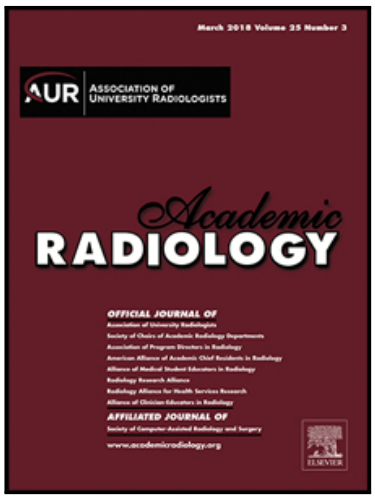

Radiology training program lessons learned during the Covid-19 pandemic

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Radiology training program lessons learned during the Covid-19 pandemic

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The Covid-19 pandemic caused dramatic changes throughout the field of radiology, including in radiology education. Training programs were forced to adapt quickly to a changing clinical environment, fluctuating patient volumes, redeployment of trainees in some cases, and the need for social distancing and isolation to prevent the spread of the virus. (1) Given the significant and rapidly changing challenges, trainees and program administrators reported negative impacts on education as well as morale and wellness (2), although there was also significant effort at sharing information and strategies, with both successes and failures, among programs. (3-7) Now, almost three years later, radiology training programs continue to regroup from the pandemic's effects.

The following are observations from different training programs across the country regarding their lessons learned since the beginning of the pandemic. Contributors were invited to give a variety of perspectives based on size of program, geographic location and setting (rural vs. urban), and primary type of teaching (in-person or remote), and they were instructed to describe successes and failures in their training programs during the initial and ongoing phases of the Covid pandemic, including temporary and permanent changes. All those invited participated, and their comments are below.

Claire Sandstrom, University of Washington

A nursing home in Kirkland, Washington, just across Lake Washington from the University of Washington (UW), was home to the first outbreak of COVID in the United States. UW was thus forced earlier than most medical centers to acknowledge and adapt to the emerging COVID pandemic. Our department covers multiple facilities spread across Seattle, and before 2020, radiology residents at UW rotated throughout these sites and engaged in residency-wide in-person lectures once per week and in-person or online site-specific morning and noon conferences other days of the week. In mid-March 2020, all classes and learning activities for all UW Radiology trainees were moved on-line, including case conferences, lectures, reading room case read-outs, and clinical consultations. Trainees no longer had to travel to different sites for in-person lectures, and the conference calendar was condensed, so all residents would log into a single conference at each offering. In-person reading room observation by medical students was transformed into a daily virtual reading room experience that moved around the department. Medical students from other institutions could participate in "visiting Radiology electives," in which the students participated in all clerkship activities virtually.

Virtual learning is here to stay – that is for certain. Two years into the COVID pandemic, our department conducted an internal survey of residents, faculty, and administrators to evaluate sentiments about online versus in-person learning. Most respondents preferred never to return to in-person lectures, some preferred in-person learning only for the weekly afternoon conference, and only a few thought all teaching sessions should be in-person. The convenience of having learners access conferences from multiple different sites without the time, expense, risk, and environmental toll of commuting, not to mention the benefit of lower risk of exposure to COVID or other contagious diseases, appears for many to outweigh the perceived benefits of in-person learning. Some residents report that virtual lectures allow them to better focus in a quiet environment, and they like the option of annotating and screen-capturing slides. Virtual lectures also reportedly "allow greater flexibility for those with families" and

"improve overall resident wellness," though these arguments suggest that some residents might be using the virtual format in such a way that might not prioritize their learning.

What, then, should be the role for in-person learning? In our residency program, the benefit is primarily a social one – to build and maintain camaraderie among one's coresidents. Without convening at a central location once per week, it is entirely possible for UW residents to go months without seeing more than a few peers. Another argument for in-person learning is audience participation and engagement with the teacher, though this benefit is mostly discussed by faculty members. There are certainly ways to engage an audience virtually, promote audience participation, and gauge learner understanding, for example, through anonymous polling. Trainees who are uncertain about the answer may be more likely to offer a guess via an anonymous poll, and some may be more likely to ask a question through a private chat box than in front of their peers. Live polls also allow residents to identify and focus their learning on personal areas of weakness compared to their peers. Training for faculty in creating live polls may be needed.

As a result of the survey and our pandemic experiences, we use a hybrid model for resident conferences, with three afternoons of virtual didactics (with liberal use of anonymous polling) followed by one afternoon of in-person, team-based "hot seat" conferences. We hope this provides a reasonable compromise between the convenience of virtual learning and the social and engagement benefits of a highly interactive in-person learning environment.

Jessica B. Robbins, University of Wisconsin

Being flexible, nimble, and adaptable are key. The upheaval experienced during the acute phase of the onset of the COVID pandemic was unlike anything we could have predicted. That said, the infrastructure our department had been building prior to the pandemic put us in the position to respond quickly. First, we were already in the process of outfitting our residents and fellows with PACS-enabled laptops. The pandemic accelerated completion of this process. Funding for the laptops was originally supplemented with COVID-relief funding from the hospital and is now a line-item in the annual educational budget for each incoming cohort of radiology residents. When used with two external monitors, also provided to residents by our department, the laptops are configured to enable a fully integrated diagnostic PACS and EMR. The flexibility the PACS-enabled laptops afforded our trainees was invaluable with respect to their education. They were able to continue with clinical work either from home or from physically-distanced locations within the hospital. The flexible setup allowed our trainees to feel physically safe while not missing out on valuable clinical learning experiences. We continue to support our residents and fellows with PACS enabled laptops for a multitude of reasons. The laptops allow our trainees to create and view educational materials and continue to support a flexible work arrangement, including the ability to work from home if quarantined or handling childcare issues. We recognize, however, that this "flexibility" could be perceived as negative, making it impossible to "escape" work, and it is incumbent upon us to ensure we empower our trainees to take time away if they are too ill to work or if their personal responsibilities take precedence.

Peer to peer learning is a collaborative and effective approach to education; in fact, retention rates are generally agreed to be higher when individuals teach others than when information is transmitted in a didactic format. (8) Peer to peer learning has flourished during the pandemic in ways that were

previously unimaginable. For instance, Discord (www.discord.com), a social platform for multimodal communication among communities including chat rooms, voice channels, and video capabilities was originally created for the gaming community and has been adapted to accommodate the needs of radiology residents. With the onset of the COVID-19 pandemic, a third-year radiology resident created the #RadDiscord community to help residents prepare for the American Board of Radiology (ABR) exams to foster real-time interactions among residents to discuss cases, ask questions, and share resources. (9) There are currently nearly 3,500 members of the #RadDiscord community, building meaningful relationships, fostering growth of burgeoning radiology careers, and preparation of three cohorts of radiology residents for the ABR Qualifying (Core) exam. This gigantic peer to peer learning network is an incredible opportunity for our trainees to capitalize on the digital world bringing together peers with diverse experiences, from different corners of the world, into a rich learning environment.

Donald J. Flemming, Penn State Health Milton S. Hershey Medical Center

Our medical center and residency program are based in a semi-rural location, and because of this, the required institutional response to COVID had a larger impact on the department and education mission than COVID itself. In the initial phase of the pandemic, trainees and faculty were “platooned” into groups that worked in-house one week at a time, with others at home with greatly reduced volume and responsibility. R1 residents were particularly vulnerable to reduced readouts and in-person teaching during this initial phase. R4 residents were identified to be re-deployed in the ICU or medicine clinics, as we believed R1 residents to be more vulnerable and in need of time on radiology rotations, and this was overall perceived to be the right choice (fortunately, no R4 residents were re-deployed). The purchase of remote workstations was an extremely popular decision, and the option of remote readouts will persist beyond the pandemic. This option allows flexibility for those who need to be home for childcare in urgent circumstances, and it allows residents to work from home when they have minor illnesses but feel well enough to work. However, certain rotations, such as breast imaging and interventional radiology, do not lend themselves to remote readouts.

Reduced volume encountered in the first part of the pandemic gave the faculty a much-needed break and allowed the opportunity for more in-depth teaching for residents that were assigned to reading rooms. It was a reminder of the often-negative impact that high-volume practice in a modern academic medical center has on education. It also gave department leadership motivation to reconsider the importance of time for successful teaching and how to create space and time to make more one-on-one education possible. It was also abundantly clear to faculty and residents that “at-home” reading assignments and video viewing did not adequately replace the teaching that comes from interpreting cases and receiving immediate feedback. R1 residents that had COVID-affected rotations were clearly behind the historical curve when they later returned to that rotation as R2s. As a result, the department purchased remote workstations for all residents; this was mostly from educational endowment funds, with a contribution from the department.

Remote conferences are popular among residents but are a major dissatisfier for faculty. Residents are much less likely to participate in learner-centered discussion when the session is remote. A full return to in-person conferences is expected.

Carl Flink, University of Cincinnati

Because of social distancing during the pandemic, the traditional side-by-side staff-out suddenly disappeared and was replaced by various forms of remote teaching. We can embrace this opportunity and use pandemic restrictions as the catalyst for improving and diversifying the educational experiences of our residents. The terms “virtual” and “remote” have been saddled with negative connotations and, as such, residency programs have been slow to incorporate the potential of the devices we carry with us. However, many other industries have been using remote strategies to conduct business, communicate, and educate, making radiology’s transition a matter of adoption as opposed to invention.

The traditional in-person staffing model will continue to have value, but resident education has always been more than just dropping in for a few moments to disseminate knowledge. Staff presence in the reading room is also about building trust, camaraderie, and longstanding relationships—it’s about being present, although not necessarily literally. Unfortunately for many residents, a remote attending was often a hidden attending, without even a phone number to call with questions. Emergency radiology, however, had a head start in the virtual world given that clinical volume, workflow, and coverage expectations often make teaching “at the viewbox” impractical. The pandemic allowed further development of the remote teaching tools that were already employed. The three main tools are as follows:

1. PACS viewer screen sharing: our system’s “collaborate” tool (Change Healthcare, Nashville, TN) allows shared, remote viewing of the PACS. The ability to scroll and see a mouse pointer makes this an effective tool. Residents can use it to ask questions about a case, and attendings can use it to simulate the traditional staff-out. It can also be used to demonstrate salient findings to referring clinicians. While the system does require a relaunch for each new case, some users prefer this to other systems (as below) that require a separate launch and log-in outside of the PACS.

2. Chat/text messaging: We have employed Microsoft Teams (Microsoft Corporation, Redmond, WA) for this function, though many options are available. This allows for quick feedback with minimal disruption to the workflow. It has also been an excellent way to build camaraderie and ensure connectivity by creating different group chats with social content. One downside is that the system must be launched separately from the PACS.

3. Video-presence: Video-presence has been used to improve connectivity of remote workers. The physical presence of a telephone or iPad on a resident’s workstation allows faculty to be embedded in the reading room without being intrusive. It’s easy to interact with residents, interject succinct teaching points without disruption, guide their conversations, aid consultation, or simply redirect their workflow. Additionally, we have found that it is just as easy to create group teaching moments virtually as it is while physically present in the reading room

Virtual education can be very effective, however the best learning experiences go beyond providing feedback about study interpretation and dispensing imaging pearls. Combining the three tools above, we not only educate, but also build camaraderie, trust, and lasting relationships. Unlike much of what we do in radiology, there is minimal barrier to entry as most of the technology we used to create a powerful virtual teaching experience has been at our fingertips already.

Tara Catanzano, UMass Chan Medical School - Baystate

The COVID 19 pandemic provided both challenges and opportunities to training programs. Much has been written about the almost instantaneous and near complete case volume reduction, which forced program directors to revamp rotations, call responsibilities, and educational offerings overnight. (2, 10, 11) The drawbacks of this shift clearly outweigh the benefits, however, some positive outcomes were realized in this new reality and will likely persist as programs and departments continue to iterate in the "new normal" COVID era.

It is unquestionable that education suffered in the pandemic. The reasons for the educational impact, however, were very different with each subsequent wave. The initial wave of the pandemic hit the Northeast early and severely, with some training programs redeploying residents to clinical care of patients. All formal education ceased during these declared GME emergency states. Each program responded to this pause in ways that aligned with their core values and were in what the program leadership believed were the best interests of the trainees, recognizing that no solution was optimal and would consistently change. At one institution, resident disposition was assigned based upon R level with R1 residents alternately social distancing while building foundational knowledge by assigned reading and video viewing and reading cases at the main hospital campus. R2 residents had the opportunity to build depth in their CVs for fellowship applications and were provided resources for socially distanced scholarly activities which required submission to a meeting or a peer reviewed journal. The R3 residents, in limbo with the now-rescheduled ABR Qualifying (Core) exam, alternated independent case reviews of already reported studies with real-time case reviews and focused study time. Graduating seniors completed required clinical rotations and supported junior residents. Faculty were largely remote during this period.

In subsequent waves, volumes were above historical trends as deferred examinations were completed. Additionally, case complexity and the emergence of acute manifestations of simmering diseases became the norm. This was both of training benefit (unusual presentations of common diseases) and detraction (less time per case review). The second major wave of COVID coincided with new R1 onboarding, requiring a rapid pivot to a new, remote curriculum. This pivot created a longitudinal opportunity to re-evaluate current curriculum constructs. The onboarding curricula were largely based on articles and recorded YouTube videos from various sources given the lack of new resident access to physical textbooks. The feedback from the new trainees was very positive as this type of learning style fit their expected millennial-learner expectations. The program has leveraged this feedback to undergo a curriculum refresh with a focus on designing curricula for our next-generation learners.

Other "silver lining" programmatic educational changes included the increased use of technology in our teaching strategies. Side-by-side case readouts were, of necessity, changed to web-based conferencing, telephone or secure texting, or PACS chat interactions. (5, 6, 12) Senior residents favored this type of read-out, preferring it to a more formal readout session, in part, due to the increased sense of practice autonomy. However, it remained clear that one-on-one in person teaching was essential for early career trainees who had not yet built enough radiology knowledge to effectively learn from remote sessions. The learning environment these new residents found themselves in was also not conducive to their educational experience. Remote faculty were not able to build relationships and develop the trust required for junior residents to be comfortable in making expected errors, which further eroded the learning climate. Faculty also had less experience with the new trainees and were, therefore, less able to identify potential learning gaps early in the academic year, further disadvantaging this group.

One final benefit that will continue is the ability to leverage web-based conferencing for educational reach. Increasingly physically distributed work environments are no longer barriers to faculty or trainees for conference preparation or presentation, or specialty case review. Grand round offerings have also increased as national experts can more easily be tapped for a lecture with time away for travel no longer a requirement. This has allowed smaller programs to flourish as they learn from radiologists at larger institutions.

Discussion/Conclusion

Many of the challenges to radiology education from the Covid-19 pandemic were shared across the country, although there was variation depending on the size and location of each training program. Contributors emphasized the following points:

- At the University of Washington there was a rapid switch to remote teaching, with a consequential challenge of defining a new normal for in-person teaching expectations. Surveys were utilized to determine faculty and trainee preferences, which ultimately resulted in a hybrid method.
- At the University of Wisconsin there was a trans-residency deployment of PACS-enabled laptops, and new electronically-enabled teaching and learning tools were utilized.
- At Penn State issues included the challenges of remote teaching, the initial decreased caseload due to the pandemic, and the vulnerability of junior residents to both of these new realities. Like many other systems, the program also dealt with scheduling issues of “platoons” and potential redeployment.
- The contributor from the University of Cincinnati gave a unique discussion of opportunities with remote work and virtual teaching, as this had been the standard for some time prior to the pandemic in the emergency division. This includes use of PACS viewer screen-sharing, chat/text messaging, video-presence, and virtual education.
- At U Mass Baystate there was a negative impact of decreased radiology caseload on the education mission, a need to balance resident preferences for virtual/electronic education tools and the need for face-to-face time with faculty, and recognition of the benefits of new shared electronic resources.

All contributors emphasized the benefits remote teaching and learning methods for both staff-outs and trainee conferences, but many programs described a desire, especially on the faculty side, to maintain in-person teaching both at the workstation and for conferences. Some residents, perhaps more often senior residents, seemed to appreciate the benefits of a virtual option, especially with conferences. There was a variety of outcomes among programs, with some returning fully to in-person experiences for conferences and some choosing a hybrid or heavily-remote system, and with numerous different arrangements for staff-outs. It seems that this will be an evolving area in years to come, with programs attempting to find the right balance based on trainee and faculty preference, the need to balance personal considerations (e.g. childcare) with work, as well as the logistics of the program (e.g. whether residents are at many separate sites or mostly at one site).

Some programs used surveys to determine specific resident and/or faculty preferences in these realms, and this seemed to provide helpful information when making decisions about new teaching methods. Contributors overall indicated that trainees should have input and engagement in their educational experience, and while faculty may have the best insight *what* trainees need to learn, the residents may

be able to offer insight on *how* best they can learn. In addition, there was significant variation in opinions and outcomes even among these five contributing programs, which underscores the importance of understanding the local ideas and preferences before making policy changes.

While some initial changes in response to the Covid pandemic have been abandoned by radiology residency programs, others have become more permanently incorporated. The diversity of thoughts and preferences across programs and sub-specialties, and sometimes between trainees and faculty, regarding the positives and negatives of the changing educational environment, especially the use of virtual case review and virtual conferences, is striking. Regular discussion and current understanding of the local culture is key in creating a good learning and working environment. Radiology education has rapidly evolved over the past three years, and no doubt there will be ongoing impact from the pandemic in years to come.

Declaration of Competing Interest

Tara Catanzano reports a relationship with Springer Nature that includes: funding grants. Tara Catanzano is an Associate Editor for Academic Radiology.

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