



A pandemic offers a silver lining for pediatric radiology training

Ross A. Myers¹  · Micheál A. Breen¹ · Tal Laor¹

Received: 12 May 2020 / Revised: 14 July 2020 / Accepted: 10 August 2020 / Published online: 21 August 2020
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Widespread changes

In 2020, the pediatric radiology community finds itself grappling with an unexpected and unprecedented threat to global health requiring many aspects of our lives to accommodate to a new norm [1, 2]. To respond to and mitigate the damages caused by the 2019 novel coronavirus (severe acute respiratory syndrome coronavirus 2 [SARS-CoV-2]) that causes coronavirus disease 2019 (COVID-19), pediatric radiology departments and divisions, which are so essential to the daily provision of pediatric health care, have had to rapidly implement operational changes to reduce risk of further viral transmission [3, 4]. These changes include social distancing among staff and — in the first wave — efforts to limit non-urgent and time-insensitive imaging. These changes, while necessary to protect patients and radiology staff, have had a disruptive impact on training [5], particularly for those completing or just beginning their 1-year subspecialty fellowships in pediatric radiology, and for the much larger number of radiology residents commencing their pediatric radiology rotations.

Social distancing during a pandemic substantially limits the number of US, fluoroscopic and interventional examinations being performed and the number of personnel and trainees who can be hands-on during such procedures, and considerably decreases the overall volume of imaging studies performed. Social distancing also renders the traditional in-person readout between attending and trainee all but impossible, limits the ability to gather together for daily didactic and case conferences, and has forced the cancellation of the annual 2020 general meeting and postgraduate course of the Society for Pediatric Radiology. But as the proverb says, “necessity is the mother of invention,” and many changes have been, and

continue to be, implemented and revised within the radiology department as we strive to maintain the highest quality of patient care as well as fellowship and resident training in a safe manner during these tumultuous times. We write this narrative with the recognition that this is just one institutional story during the early stages of the COVID-19 pandemic, and we hope it starts a conversation within the pediatric radiology community. A dialogue in which we all openly share our experiences, challenges and unique innovations implemented in response to COVID-19 can be used to improve pediatric radiology education in numerous settings for the duration of this pandemic and beyond.

Our department’s story

Our department is part of one of the largest free-standing children’s hospitals in the country, based in a city on the Eastern Seaboard that was faced with one of the country’s earliest COVID-19 outbreaks. Like all radiology departments, ours is integral to the hospital’s day-to-day operations and serves the ambulatory diagnostic imaging needs of providers throughout the region. In addition, our hospital functions as a referral site for national and international patients. One fundamental difference between pediatric and adult imaging is that a much greater proportion of pediatric imaging studies require hands-on contact during imaging acquisition. This is especially true not only for the large number of US and fluoroscopic procedures performed, but also occasionally for radiography, CT, MRI and nuclear medicine examinations. The arrival of COVID-19 and the necessary effort to maintain a safe work environment have had a major impact on all operational aspects throughout our pediatric radiology department.

To help reduce the rate of infection during the initial surge in February and March, we rapidly made numerous departmental changes that included temporarily closing most outpatient imaging facilities, canceling thousands of scheduled outpatient studies, and the limiting pediatric imaging to urgent, time-sensitive and emergent examinations only. In similar

✉ Ross A. Myers
ram5539@gmail.com

¹ Department of Radiology, Boston Children’s Hospital,
300 Longwood Ave, Boston, MA 02115, USA

practice to other institutions, the majority of radiologists and support staff were assigned to work remotely, leaving a skeleton service of radiologists, technologists and support staff working each day at the hospital [6]. The in-house radiologists were directed to use a minimal number of specific workstations that are routinely cleaned, negating the necessity to disinfect unused locations, which ultimately saves precious cleaning resources and time. Our department and hospital leadership moved decisively to implement these staffing changes in early March and maintained direct and open communication with staff, trainees, referring clinicians and patients throughout this tumultuous period of adjustment.

This spring, we had eight pediatric radiology fellows completing a 1-year Accreditation Council for Graduate Medical Education (ACGME) fellowship in pediatric radiology, and four fellows completing subspecialty training in pediatric neuroradiology and pediatric interventional radiology. Under normal circumstances, we also host 12–14 residents from radiology programs throughout the Northeast, usually for a 3-month pediatric radiology rotation. Most of these residents are local and come from our academic affiliated institutions, with another portion comprising rotating residents who come from other academic hospital networks in the region or neighboring states. However, the start of the COVID-19 outbreak in early March forced the recall of the residents to their respective institutions, leaving the fellows and attending radiologists to continue the day-to-day physician operations. Thus, the early trainee adaptations were directed toward the pediatric radiology fellows. With the return of residents to the radiology department this new academic year, the educational efforts are now directed toward and applicable to all trainees.

From the point of view of the fellows who remained, the most notable immediate loss was the in-person readout sessions with attending faculty members and their unique insights and wisdom shared through this traditional education model. The long-established readout is thought by many to remain the cornerstone of radiology education. The one-on-one workflow allows the teacher (usually, but not exclusively, the attending radiologist) to gauge the knowledge and abilities of individual learners in order to best guide and direct training. The in-person readout allows learners to ask specific questions and tackle knowledge gaps with experienced radiologists, many of whom have years and often decades of subspecialty expertise. The decrease in clinical volume has led to fewer case learning opportunities, as well as limited direct patient interaction afforded by outpatient fluoroscopy, US, MRI arthrography and interventional radiology examinations. Furthermore, having meaningful interactions with referring clinicians and clinical colleagues has become very challenging with the suspension of the informal discussions and image review in the reading room, which have remained somewhat distinctive to the pediatric setting over the last few years. Last, it is important to recognize that all members of the radiology

department have unique safety concerns during this pandemic, whether for themselves, their family, or their patients and colleagues.

In response to these challenges, our pediatric radiology department successfully implemented a series of innovations and adaptations to promote a culture of safety while allowing fellows to maintain an active role within the department and to continue their training. One of the biggest changes made from a logistical standpoint was an early decision to allocate unused picture archiving and communication system (PACS) workstations from reading rooms and attending radiologists' offices to fellows' homes, to facilitate remote clinical and educational assignments. To accomplish this, a huge effort was put forth by the Radiology Information Technology group that allowed for the successful transfer of the workstations. This step required that the fellows have a robust and fast home internet service and that they make other lifestyle modifications to be able to work remotely (Fig. 1). Many of the fellows must navigate working in the presence of family members, often including school-age and younger children who likewise have had their routines disrupted. For fellows who live alone, the challenges are different in that they have lost some of the social aspect of working in a busy, dynamic hospital setting and face greater isolation than their peers.

Clinical assignments

Although fellows participate in clinical rotations from a PACS workstation at home, when possible they come to the main hospital campus for rotations in US and fluoroscopy. This allows fellows to continue gaining experience and expertise

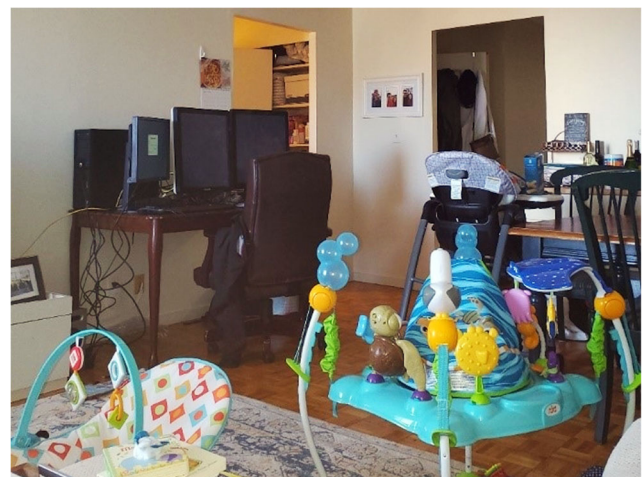


Fig. 1 Photograph of a redeployed home workstation, contributed by a fellow. He is the proud father of a brave and rambunctious 11-month-old boy who has a great sense of curiosity. Since this photo was taken, the fellow installed a baby safety gate

performing US and fluoroscopic studies despite the overall drop in volume, while wearing appropriate personal protective equipment. Between 4 pm and midnight, one pediatric radiology fellow has been assigned to an in-house shift, covering all urgent, emergent and time-sensitive outpatient, inpatient and emergency examinations. In the pre-COVID era, the attending supervision for this evening assignment was traditionally direct and in-house with the fellow. Following discussion with faculty members and fellows, it was decided that fellows would continue to take this shift as an in-house assignment with indirect attending supervision provided remotely, or directly in-house as needed. At our annual program evaluation, both faculty members and fellows reported an unexpected positive result of this change: both groups thought it had an extremely beneficial effect on fellow autonomy and decision-making. For the first half of this upcoming academic year, the new pediatric radiology fellows are working with an increased on-site attending-physician presence. Supervision during the 4 pm–midnight shift will routinely be by an on-site attending radiologist, but as the year progresses and the fellows gain experience and competence milestones, this workflow will be re-evaluated and indirect attending supervision might well be reinstated because the graduating fellows strongly believe that the autonomy has been to their educational advantage.

At the start of this new academic year, the COVID-related training changes have been adjusted to accommodate the commencement of the new 2020–2021 fellows and the return of the local radiology residents. These changes are, in part, thanks to some alleviation of restrictions, related to a steady decline in local pandemic magnitude, which has allowed for a greater number of in-house attending radiologists and trainees during regular working hours and call shifts. Furthermore, a resident is now able to accompany a fellow performing US and fluoroscopy exams. Diagnostic workstations also have been set up in off-site faculty offices converted to reading sites for other rotating residents, who are thus able to review and dictate radiologic examinations despite working remotely from the radiology department. The visiting residents from other academic institutions to date, however, have not returned. In the event of an ongoing long-term challenge, we record the daily didactic and case conferences, which can be shared to assist in their pediatric radiology education and to maintain a sense of camaraderie and inclusivity with their intended rotation site. Ultimately, we will be able to share useful educational materials on a larger scale with other radiology departments in smaller children's hospitals, pediatric sections within adult hospitals, and non-academic practices. Our graduated fellows continue to join the conferences from their new locales.

To support these new workflows, regular and reliable communication among radiology trainees, attending radiologists, technologists and referrers is imperative. Contact lists have been updated to include cellphone numbers in addition to pager numbers and email addresses. An early morning daily

password-protected “clinical huddle” using videoconferencing software has proved very effective in helping faculty and trainees review staffing needs and make action plans for the day. Sign-outs at the end of work shifts usually are performed via telephone but with secure encrypted email backup to ensure safe transfer of information.

The fellows who have been designated to work remotely have responded positively to being able to continue to actively participate in the day-to-day clinical operations of the department. The remote fellows remain able to triage studies for appropriateness and timing of the imaging modality selected, and are able to communicate with the technologists prior to, during and following the study, as needed. These remote fellows concentrate on protocoling studies; interpreting radiographic, CT and MRI examinations; and facilitating videoconference-based consultation sessions with referring clinicians. The workflow has proved surprisingly successful for most clinical rotations, albeit with reduced clinical volumes. As restrictions ease and the imaging volume continues to increase, this arrangement still allows for the continuation of social distancing while adjusting to the workload. We have found that using the “share screen” capability of videoconferencing software allows the attending radiologist and the pediatric radiology trainee to successfully review images together in real time, and has proved especially useful when a subtle finding needs to be illustrated or a nuanced question asked. Trainees who are either on different clinical rotations or not clinically assigned that day can also participate in the readouts of their colleagues, which further contributes to the educational opportunities; a virtual sign-out is easily transformed into a group learning opportunity. One challenge we have encountered is the ability to implement a continuous video chat throughout the workday because, given the considerably increased demand, the supply of webcams available for purchase remains markedly limited. Laptop computers that have integrated cameras and microphones do not have sufficient monitor resolution to allow for a readout, and using both a laptop and a diagnostic workstation simultaneously is burdensome and often impractical.

Educational modifications

From an educational perspective, our department has taken numerous steps to maintain the traditionally strong culture of teaching. Following a brief week-long suspension in mid-March, all previous morning, noon and late afternoon educational activities, such as didactic lectures, case-based reviews, quality and safety rounds, and multidisciplinary and interdepartmental conferences have been reinstated as virtual conferences, broadcast and recorded using the password-protected videoconferencing software. This change has had an unexpected benefit because it allows for a much larger

attendance than had previously been possible when the conference was held in a hospital location and many faculty were assigned to satellite facilities. In our new model, many more faculty members and trainees, both those working clinically on campus and those based at home, can participate via the videoconference software. Interdepartmental faculty attendance also has increased, which has led to expanded interactions. Additionally, new educational conferences given by faculty and primarily directed toward the various modality technologists have been instituted and are open to participation of the fellows and other learners.

The COVID-19 pandemic has encouraged us to tap into a large array of previously recorded teaching conferences and grand rounds. After many years of deliberating and debating on how best to curate this digital archive, in less than a week, an intradepartmental website was developed to organize these materials and make them available to current and future fellows. In addition to previously recorded materials and the daily teaching conferences now delivered by faculty using the videoconferencing software, an electronic “case of the day” is now distributed to all faculty and trainees across all divisions several weekday mornings, which has prompted insightful and interesting discussions via email. The fellows and faculty members alike contribute to these endeavors.

Numerous online and web-based resources are available to trainees all over the world that can be accessed regardless of location of the training program. Many specialty imaging societies such as the Society for Pediatric Radiology (SPR) have made available extensive collections of conference and other lectures and additional materials for fellows to continue their education during the COVID-19 pandemic. The SPR has taken special measures to institute a weekly pediatric radiology learning curriculum covering a multitude of pediatric subspecialties through taped lectures, key articles and other self-guided learning materials provided to members via email. In addition, the SPR has a generous catalogue of online learning material (SPR Xpress), unknown case competitions, and a member-compiled shared online document with references to countless valuable educational resources, to name a few. There are additional case-of-the-day websites, such as the “Case in Point” offered through the American College of Radiology (ACR) and Aunt Minnie websites, a weekly international teaching network conference offered through the American Society of Pediatric Neuroradiology, and a compendium of web lectures on the American Roentgen Ray Society (ARRS) website available to members in training as well.

Wellbeing

Other challenges that fellows and faculty members alike have experienced and are coping with include maintaining general wellbeing throughout this extended period of pandemic-

related isolation. Our department has taken steps to maintain a spirit of camaraderie and avoid a sense of isolation or burn-out among attending radiologists and trainees [7]. The fellows, program director, and education coordinator schedule a weekly “coffee hour” via video chat and there have been several informal “virtual happy hours” for fellows and faculty members, with a positive reception. For the first time, radiology attending physicians are getting a virtual window into their fellows’ homes, and vice versa. Being introduced to so many pets, children and significant others on-screen in the midst of such upheaval and uncertainty has offered us a unique opportunity to form stronger personal connections. Hospital-based wellness resources have been and continue to be made available, including on-line yoga and other home-based exercise sessions, to help promote healthy and balanced living during these tumultuous times. Our hospital graduate medical education office has created a crowd-sourced list of local wellness links and resources. We also have ensured that faculty and fellows are aware of the other institutional supports that are available, such as the Office of Clinician Support. Our department has also contributed a list of wellness resources to the SPR education website for dissemination to our colleagues across the world.

Ongoing evaluation and adaptation — our pandemic response ‘audit cycle’

We are proud of the adaptations and innovations that have been implemented in a short period of time at our institution and urge all pediatric departments and divisions to take pride in their unique solutions. Locally during this process, we are continually reconvening to discuss what’s working well and what isn’t, and to consider additional interventions or changes that should be attempted — an ongoing “audit cycle” during a time of uncertainty and change. Most important, we strive to regularly check in with all our colleagues as human beings, rather than as attendings or trainees, during this major life crisis. Examples of iterative improvements include further and expanded use of continuous screen-sharing during virtual readouts to better simulate traditional readout sessions. An additional end-of-the-day huddle has been considered, as well, to allow for a debriefing of the events of the workday and to create an additional opportunity for constructive feedback. We are also working on implementing audience response software into our didactic and case conferences to help create a real-time feedback loop for the presenter and to allow for greater audience interaction. We strongly believe that ongoing evaluation and iterative adjustments will help us to create the most optimal working and training environment given the anticipated need for continued social distancing within the foreseeable future. We are further developing and improving electronic evaluations for faculty members and fellows to ensure we

remain responsive to continual feedback during a period of ongoing change and uncertainty.

What comes next? Incoming fellows and residents

The measures implemented have been positively received, but we recognize that a large part of the initial success reflects the seniority of the fellows who had completed 8 months of fellowship training when the pandemic first struck and their familiarity with our large and complex department and how it functions. The challenge of adapting training programs and operational workflows to support new fellows and rotating residents unfamiliar with our hospital, department, faculty and technology systems has only just begun. In anticipation of this, we paired graduating fellows to serve as a mentor to each of the incoming fellows who were scheduled to begin in July 2020, and encouraged frequent online communication. We also initiated videoconferencing mixers for graduating and incoming fellows with program leaders and faculty members. Program leaders worked to convert as much of the traditional “first week of July orientation” into an online/virtual format, much of which could be completed by new fellows prior to the formal July 1 start date. To address the ongoing limitations for in-person tours and hands-on training, educational program directors and coordinators meet regularly with departmental and clinical leaders and have secured support for ongoing adaptation and curation of our educational curriculum to a predominantly online model. We will continue to solicit feedback from learners and teachers throughout the upcoming months and use this feedback to further improve and grow our online curriculum. Additionally, we are committed to sharing and collaborating with colleagues and other training programs and look forward to developing a multi-institutional curriculum with the support of the SPR Fellowship Program Directors Committee and the SPR Education Committee.

While many aspects have been uniquely challenging to our program, in other ways we recognize that our pediatric radiology department has been fortunate. Given the lower incidence and severity of COVID-19 in pediatric patients [8] to date, we have not experienced redeployment to other areas within the hospital or to other hospitals [5], unlike some of our faculty and fellow colleagues working within adult hospitals. Our children’s hospital in the early stage served as a diversion destination within the city, taking care of pediatric patients who presented to other local facilities, freeing up other institutions’

hospital staff and resources to take care of the adult patients affected by COVID-19. This provided our trainees with additional cases, and graduating fellows reflected on the benefits of the different and more general case mix and diverse patient population they encountered as a result.

Our pediatric radiology department has a large faculty and fellowship program, posing both unique advantages as well as challenges, which we recognize might differ from those in smaller departments, divisions and non-academic practices. The COVID-19 pandemic has been and will remain a huge challenge for us all. We hope that sharing our experiences can prompt further discussion among the pediatric radiology community at large. We see this moment of unprecedented disruption as an opportunity for all pediatric radiology departments and for the SPR to preserve the fundamental aspects of pediatric radiology training as we adapt and innovate to ensure that we continue to provide excellence in education and patient care for the duration of this pandemic and beyond.

Compliance with ethical standards

Conflicts of interest None

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