BRIDGING THE GAP

Training and Education in the Pathology and Cytopathology Sphere

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Considerations for Remote Learning in Pathology During COVID-19 Social Distancing

> "They live completely apart and never see one another except under the most extraordinary circumstances."
>
> Isaac Asimov, *The Naked Sun*[1]

In his 1956 novel *The Naked Sun*, biochemist and science fiction writer Isaac Asimov described Solaria, a planet whose inhabitants communicate almost entirely through holography.[1] As communities throughout the world implement social distancing to reduce the spread of coronavirus disease 2019 (COVID-19), his descriptions of individuals working and socializing solely through remote video connections are unsettlingly familiar.[2] Clinics have replaced in-person appointments with video visits, all but the most urgent surgeries have been postponed, and teaching hospitals have reduced resident and faculty time on site, in some cases eliminating it altogether. Across the country, academic pathology departments have rapidly pivoted toward remote learning through broadcast sign-outs, didactics, and digital teaching slides.[3] Here, we take the opportunity to reflect on the subtle yet effective differences between in-person and remote experiences.

The Socially Distant Environment

According to recommendations by the Centers for Disease Control and Prevention, the accepted minimum physical distance between individuals is 6 feet. This distance precludes sign-out at most multiheaded microscopes, and, in fact, faculty and learners may be separated by even greater distances. Participation in teaching sessions may now occur from a separate room, separate hospital, or even home. Thus, many institutions have turned to broadcasting the microscope view to internet-enabled endpoints, including computers, smartphones, and tablets.

The amount and quality of remote learning will vary greatly, depending on the experience of the teacher, the experience and engagement of the learners, and the equipment and software used. These variables give numerous permutations, and, in most instances, institutions will begin with what is rapidly available and fill needs as they are identified. The most common setup consists of a camera attached to a microscope, with the camera software broadcasting the microscope view in real time to participants through videoconferencing software.

TABLE 1. General Benefits and Drawbacks to Remote Versus In-Person Learning

Benefits	Drawbacks
Reduced risk of infection	Decreased human interaction
Elimination of commute time and transportation expenses	Loss of nonverbal cues (body language)
Increased access to participants and larger audiences, including the development of virtual rotations	Decreased opportunities to communicate (fear of interruption; muting; poor audio connection)
Increased opportunities to communicate (eg, chat box)	Increased distractions[a]
Ease of joining and leaving sessions	Traditional methods of engagement do not translate
Reduced anxiety	Difficulty in assessing participant engagement
Decreased distractions[a]	Possible security issues with protected health information
Small areas of interest may be easier to show (digital zoom; annotation options)	Generally worse image quality
All participants view the same field orientation	Latency in focusing field and z-axis
Attendance can be easily tracked	Greater variation among presenters, based on comfort with technology and quality of technical setup
	Additional cost to maintain modern hardware, software, cameras, and quality network connection

[a]Distractions may vary depending on individual environments.

Although most trainees are able to stream video broadcasts at home without significant additional resources, program directors should be sensitive to potential increased financial costs. If trainees are required to learn from home, consideration should be given to providing adequate computer equipment and software. Faculty who are expected to teach remotely should also have access to adequate computers, cameras, software, and internet connections.

Even with appropriate distancing, some learners and faculty may feel uncomfortable being in the same room as others, or even in the hospital environment itself. Because many learners and teachers are able to choose their own environments, remote learning potentially also can promote safety, comfort, and a feeling of control, with attendant benefits in concentration and retention of material (Table 1).[4-7] However, learners may continue to have concerns about individual well-being, the safety of friends and family, childcare, rescheduled board examinations, and uncertainty in the financial and job markets, all of which are stressors that can hamper concentration.

Both faculty and trainees should be committed to decreasing background distractions during remote learning sessions. Sequestration at home or in a private office can be viewed as an opportunity to create a distraction-free environment that eliminates some of the interruptions of in-person learning, such as people entering or leaving a room. However, faculty should be sensitive that trainees may not have a dedicated study space and, in fact, may be more distracted than usual.

Managing and Moderating Online Sessions

The software used for broadcasting can undermine the immediacy and centrality of the microscope. For example, videoconferencing software increases the cognitive load of a teaching session by adding a point of failure as well as a layer of management functions. Multiple participants can join a session.

TABLE 2. Examples of Challenges Encountered While Remote Learning, With Possible Solutions

Problem/Concern	Possible Improvement
Poor computer audio connection	Dial-in using phone connection
	Designate a moderator to provide real-time feedback to the presenter
Poor image quality/ latency in image focus	Use scanned (digital) slides instead of viewing slides in real time
	Alter slide-driving habits by reviewing broadcasted images in real time; drive slides more slowly; become more cognizant of viewer experience
	Calibrate microscope
	Reconfigure imaging software
	Replace legacy hardware/equipment
	Designate a moderator to provide real-time feedback to the presenter
	Optimize network bandwidth (eg, eliminate video of faculty or participants)
Security concerns (protected health information)	Select more secure software; optimize security settings in current software
	Do not verbalize or show protected health information unless necessary
Poor participant engagement	Request participants to share video and/or remain unmuted
	Integrate dynamic polling of participants
	Provide scanned (digital) slides for review before didactic
	Ask more frequent questions; call on participants
	Use a *high-yield* sign-out format

Options can be set to control microphones, video, screen-sharing, chat, and recording. Various security management options usually are available and should be used to meet institutional guidelines. Managing all these aspects of a session can quickly overwhelm a teacher's ability to deliver educational content (Table 2).

One solution is to designate a moderator for some or all sessions. This role is crucial to the success of virtual education initiatives, as the moderator(s) can provide live support to session participants, thereby alleviating many basic issues and frustrations. Before a session begins, the moderator can help the teacher set up the correct participant management settings and ensure video, screen-sharing, and audio input/output functionality. Moderators can also troubleshoot minor technical issues, prompt the teacher if the audio/video stream falters, facilitate feedback between trainees and faculty members, and onboard faculty new to the remote teaching process.

Scheduling is an important component of a remote learning curriculum. Given that remote learning does not necessarily restrict the number of learners connected to a session, programs may be tempted to make every session available to all residents. However, this may create a burden for residents on service, especially because such sessions cannot all take place during protected didactics time. It is important to remember that, although case volumes have decreased, it is likely that the number of faculty and residents on service has decreased as well, resulting in similar or even higher daily workloads. The development of an easily accessible schedule to coordinate various remote teaching sessions is required to prevent scheduling conflicts and to keep trainees aware of available learning opportunities. Thus, programs may

TABLE 3. Departmental and/or Institutional Considerations in Support of Remote Learning

Suggestions for Institutional/Departmental Support
Financial supplement or arranged group discount for trainee internet connections
Online teaching modules to support remote learning and teaching
Provision of adequate computers for trainees and faculty
Online scheduling software to coordinate sessions
Adequate cameras and microphones for faculty
Sufficient number and quality of slide scanners with technicians
Provision of space on network drives and/or cloud-based servers to host digitized slides
Secure archival areas for didactic recordings
Frequent and on-demand microscope calibration
On-demand information technology support for software
Sufficient physical space for social distancing
Provision of uniform software to reduce variation in technology and training

find they need to devote more resources to schedule coordination. Moderators may be senior or chief residents in a program, but it is important that they are provided with the appropriate technology support, administrative assistance, and resources (Table 3).

Remote Scope Considerations

> "You're viewing me right now… I'm two hundred miles away from you at least. So how can it be the same thing?" Baley grew interested. "But I see you with my eyes." "No, you don't see me. You see my image. You're viewing me." "And that makes a difference?" "All the difference there is."
>
> Isaac Asimov, *The Naked Sun*[1]

The capture and transmission of live microscopy results in poorer image quality compared with the optical transmission of a multiheaded scope, but it is typically sufficient for the visualization of most important morphologic features. For participants, the overall experience may require an adjustment period during which even good-quality image broadcasts may seem suboptimal. Minor issues with microscope calibration or imaging software configuration may become magnified with remote broadcasts. Although better quality equipment may increase image broadcast quality, even the best equipment can be inadequate if misconfigured.

Fields viewed through the microscope may not be completely represented by the video broadcast, and faculty should frequently monitor the broadcasted image to ensure that areas of interest are both in the broadcasted field as well as in focus. Alternating between the microscope and the video broadcast requires additional time and patience on the part of the participants and the faculty (Fig. 1). Faculty must also be aware of the latency between image-capture and broadcast. Movement of the slide is difficult to visualize compared with optical transmission, and *ghosting* of the field will occur with even the slightest movement. When areas of interest are encountered, faculty should pause and ensure that the area of interest is in focus on the video broadcast before teaching. Frequent movement between fields and magnifications without adequate pauses will almost certainly render a video broadcast useless.

The remote broadcast of cytopathology microscopy is further complicated by at least 4 issues: 1) the 3-dimensionality of the specimens (z-axis), 2) the high magnifications used for many diagnoses, 3) the often focal nature of diagnostic cells, and 4) learner discomfort with cytopathology specimens. For the first 3 issues, faculty need to be additionally sensitive to ensuring that cells of interest are focused on the video broadcast and that time is allowed for each plane of focus to be broadcast while focusing within the z-axis of a specimen. Learners sometimes require additional time to adjust their eyes to cytologic specimens, especially at the start of rotations. This adjustment period may take longer while viewing slides remotely. A possible solution is for trainees to view cytopathology teaching sessions on a regular basis, even when not on a cytopathology rotation.

Faculty can use either the microscope arrow or the mouse cursor to highlight areas of interest in a field. One benefit of a video broadcast is that all participants see the field and microscope arrow in the same orientation. Although variation exists among types of camera software, most will allow faculty to capture and annotate images. Digital zoom can allow for areas to be enlarged (particularly useful in cytopathology) and for extremely small features to be better demonstrated compared with optical transmission. Images can be captured relatively quickly during sign-out and shared in a saved folder for future review by residents, quality assurance (QA) conferences, sharing on social media, or documenting in a case report. Trainees also benefit from witnessing how to best identify and capture a field of interest.

The Learner-Teacher Interaction

> "Ideally you're supposed to be proper, but no one ever is. Not when viewing. There's no personal presence involved so why take any pains?"
>
> Isaac Asimov, *The Naked Sun*[1]

Perhaps the most challenging difference between remote and in-person learning is the interaction between the learner and the teacher. Remote learning, even if participants share video streams, cannot capture the nonverbal cues that teachers and learners may rely on when physically adjacent; some of these cues may be subtle and only subconsciously identified. The level of learner engagement may also be difficult to assess. It is possible that some learners who are otherwise hesitant to speak at sign-out may feel more comfortable speaking during a remote session or by using the software's chat function. Conversely, some learners may speak less because of audio connection problems, the lack of a computer microphone, overuse of the mute function, unfamiliarity with the technology, and/or uncertainty with the overall experience. Likewise, teachers may have similar issues.

A multipronged approach can solve these problems. Both teachers and learners should become familiar with the software, which may require training. The use of a single videoconferencing platform within the institution decreases the need to learn multiple methods. Teachers should encourage learners to *speak* through a specified method (eg, by voice or chat) and provide additional opportunities for communication by asking questions and fostering conversation among participants. If available, the chat box should not be ignored; the moderator or another participant can be assigned to check the chat regularly.

Faculty should be cautious to avoid language that may be misinterpreted, especially in an environment with fewer nonverbal cues. It may be difficult—perhaps impossible—to judge a learner's response to an off-hand remark. If a sign-out session is now open to viewing by additional participants, a trainee may become more readily embarrassed by a misdiagnosis or an improperly answered question. It may be appropriate for the faculty member to mutually agree with the trainee as to whether a sign-out session should be *open* for viewing. Alternatively, screensharing may be configured to allow the faculty to see a trainee's diagnosis without sharing to the broader audience, and any necessary critiques can be shared afterward.

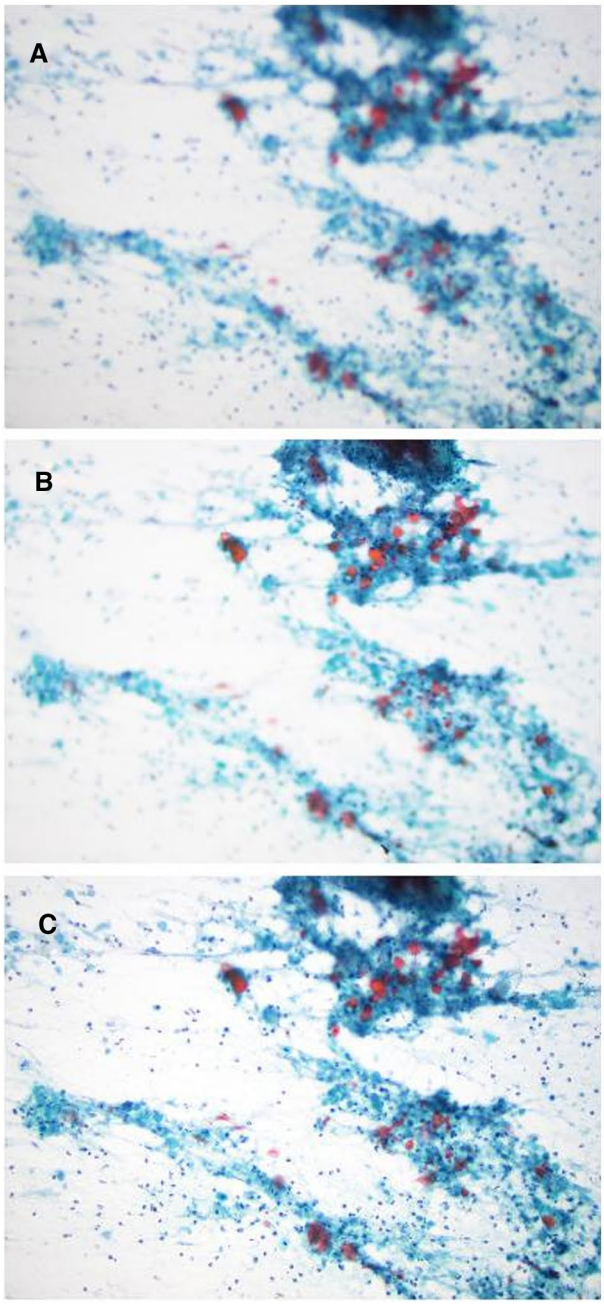

FIGURE 1. Images provide an example of the latency of camera focusing and image transmission to remote learners. During movement between fields or refocus within a z-axis, lag time exists between the optical transmission seen directly through the microscope by the presenter, the autofocus of the camera on the computer screen, and the transmission of a focused image to the remote learners. Faculty should verify that an image is focused on the computer screen before speaking about the microscopic findings. (A) After movement of the slide, the resting image begins out of focus before the camera's autofocus has been completed. The out-of-focus image is transmitted to the participants, whereas the image is in focus at the speaker's microscope. (B) After the passing of several milliseconds, the tissue fragment in the upper right corner has come into focus, whereas the background remains out of focus. (C) This is the in-focus image once the camera autofocus has finished.

Remote learning allows for an expanded audience, as learners are no longer limited by the number of *heads* on a multiheaded scope, or physical room location. Faculty should be aware that a larger attendance may reduce participation, as no single participant feels *on the spot* to answer questions or interact.

Integrating Remote Learning With Clinical Service and Education

Sign-out

Learner 1: "I always learn better when I make mistakes."

Learner 2: "If I have not previewed the slides, I have not found the remote sign-out as helpful… it is exacerbated in cytopathology because I am less comfortable with the material."

Although some institutions may choose to have trainees work strictly from home, unless clinical slides can be rapidly scanned, cases must be previewed at the hospital. Reviewing cases with an attending physician is the traditional method for pathologists in training to learn pathology. It is an intimate learning experience in which the trainee is not only verbally taught by the attending but also learns different approaches to reviewing a slide (physically and theoretically)—connecting findings to clinicoradiologic impression, wording a diagnosis, constructing a note, and communicating with the clinical team.

A benefit of remote sign-out is the ability of trainees to join sign-outs for services outside of their currently assigned rotation. Many trainees may wish to spend more time reviewing cytopathology cases to prepare for the board examination as well as before starting their first jobs. In addition to accommodating additional trainees, remote sign-out has the potential to include cytotechnologists, expert pathologists from other services for on-demand consultation, and members of a patient's clinical team. Additional trainees joining a sign-out session likely have not previewed cases and lack a sense of ownership, leading to reduced interest. The traditional sign-out process itself is not high-yield, and time is spent reviewing areas that may not be diagnostic or important; many cases do not provide new learning opportunities. However, new opportunities may arise unexpectedly and may be missed by remote learners who are not fully engaged in sign-out. Remote sign-outs typically take longer because of broadcast latency and the need to switch between video broadcast and patient records, which may exacerbate impatience among trainees who are viewing cases they have not previewed.

Among residents who were asked, remote sign-out was uniformly ranked as the lowest yield activity because of the lack of previewing. For trainees who had previewed slides, remote sign-out was a critically important experience, similar to in-person sign-out. In the absence of social distancing, all trainees on service can be physically present in the hospital and thus multiple trainees can preview the same case to increase engagement. In the setting of social distancing, the number of trainees at the hospital are limited, and fewer trainees have the opportunity to preview each case.

The separation between the trainee and attending responsible for a given case may alter preexisting workflows that have developed to prevent slide misidentification. For instance, a workflow in which both the trainee and the attending verify the slide label together would no longer be possible if they are 6 feet apart or are signing out in separate rooms. A sign-out workflow should be developed that maintains a slide verification process. Because protected health information (PHI) is often presented when verifying a slide's accession number and/or patient name, as well as during discussion of a patient's history, such sessions should not be recorded for later review. Participants who attend the session should be in a position of trust, and the broadcast connection needs to be highly secure. Regardless of a session's security, PHI should not be unnecessarily discussed or broadcast.

The high-yield *sign-out*

Learner 3: "The attending takes all the interesting or educational cases during sign-out and places them in a pile. In the afternoon, at a set time every day, the attending goes through the high-yield cases in 15 to 20 minutes."

One idea for better engaging trainees who did not preview cases for regular sign-out is to hold a subsequent *high-yield* sign-out in which interesting cases are presented. This may coincide with a daily QA conference or may be run as a separate session. As opposed to QA conferences, high-yield sign-out sessions focus on teaching at a trainee level and provide time for trainees to ask questions about cases. The drawback is the additional effort of saving slides and marking interesting cytomorphologic areas during regular sign-out, as well as scheduling and running an additional sign-out session. Trainees who opt for a high-yield session may miss out on intangible learning opportunities that occur during regular sign-out, as described above.

Quality-assurance conference

Many anatomic pathology divisions run a daily QA conference in which cases requiring a second opinion are shown. QA conferences can be broadcast to facilitate remote learning, but caution should be taken to avoid accidentally sharing PHI, which is normally not needed during QA. Although these conferences may improve trainee engagement because they are enriched for high-yield and interesting cases, they are often run at a fast pace that may not allow for all the teaching points of a case to be presented or for trainees to ask questions about a case.

Lectures

Remote broadcasts of lectures prepared using presentation software (such as PowerPoint; Microsoft Corporation) differ little from a lecture given to a large audience, but the use of conferencing software to broadcast lectures adds a layer of technology between the audience and speaker, which can pose management issues. Dynamic audience polls can be helpful, and the use of a chat box to ask questions eliminates the need for the speaker to hear a question asked in the back of a crowded lecture hall. Because PHI is not presented, lectures can be recorded and archived for later review. The number of attendees is essentially limitless, and the size of the audience does not negatively affect other learners.

Slide-based teaching sets

Learner 2: "Having the teaching set on hand to re-watch when you are previewing… is invaluable."

Learner 4: "…If there had been recordings of cytopathology teaching sets available before my first cytopathology rotation, that would have been the first resource I used to prepare."

In discussions with trainees, slide-based teaching didactics were uniformly rated as the best remote learning opportunity compared with broadcasted sign-outs and lectures. By using preexisting teaching sets or preselected slides, the faculty broadcasts live microscopy with commentary. This method is similar to the video microscopy tutorial sessions that are run at many pathology meetings and has the benefit of providing high-yield information on a focused topic. Because the teaching is more spontaneous than in a lecture and does not contain PHI, faculty may be more willing to allow sessions to be recorded and archived for later review and for learners who cannot attend the live session. A modicum of preparation on the part of the instructor can greatly improve the educational value of a session, specifically by identifying slides that best demonstrate teaching points and by organizing slides into themes or focused topics. Familiarity with the selected slides and *predotting* allows the faculty to quickly identify important areas during the session, thus avoiding time wasted searching for relevant findings. Preselected slides can also be digitally scanned for broadcast, and digital versions can be preannotated, allowing areas of interest to be found rapidly during a session. Digital slides can be shared on a network drive or cloud service, providing trainees with an opportunity to preview slides before the session, which can increase engagement.

Combination lecture/slide-based teaching sets

Teaching sessions that combine lecture slides with live microscopy require additional organization but can provide a synergistic learning experience for participants. Live microscopy emulates the typical sign-out experience and teaches the approach to a slide, whereas lecture slides can show high-quality photographs that illustrate certain morphologic features and include bulleted text that can be later referenced by trainees. The lecture slides can be saved in a hand-out format that, if provided in advance, can be used for note taking by participants.

Ownership of enduring materials

Like Metallica[8] and other musicians, artists, and inventors, many academic pathologists have spent years perfecting the placement of their unique ideas into concise, effective presentations. Learners should not record or archive material without permission. For instances in which a faculty member agrees that a recording can be archived for intradepartmental access only, the pathology department should provide a secure server. Some software allows for more secure (though less shareable) recordings through proprietary formats. However, faculty should be aware that any remotely viewed broadcast can be recorded and distributed without their knowledge or permission. Faculty should be willing to compromise, with the understanding that the creation of enduring teaching material is a worthy goal.

Soliciting feedback

Learner 2: "Some teachers are uncomfortable with remote lecturing and would need to adjust their teaching style and slide movement… Every new method meets with resistance."

Even at institutions with well established digital workflows, it is likely that some teaching faculty will have no prior experience with remote teaching. Although moderators can provide real-time feedback about audio and visual quality, teachers should solicit feedback on a frequent basis to improve the quality of their remote teaching. A style of teaching that may have worked in the past for a given teacher may no longer be appropriate for a remote learning session. This may lead to changes in teaching style and content or the identification of technical issues that can be addressed in subsequent sessions. Faculty should review their recorded material for the purposes of self-critique and improvement.

Finally, institutions and/or academic departments should consider developing online teaching modules in this area for faculty that include basic teaching principles. Just as small problems with microscope adjustments become magnified with a video broadcast and remote learning, poor teaching methods and/or a poor attitude toward teaching can also become magnified. With remote learning, it is even more important for teachers to be dedicated, enthusiastic, and prepared.

Moving Forward

> "The desire not to [meet his neighbor] has led to the development of even more perfect viewing equipment, and as the viewing equipment grew better there was less and less need to ever see one's neighbor. It was a reinforcing cycle."
>
> Isaac Asimov, *The Naked Sun*[1]

Social distancing because of COVID-19 will not last forever; its need may return in the future, or it may not. Although in-person learning should be pursued when available, we should be prepared to transition to remote learning when necessary. This requires that departments maintain the proper equipment and software and that trainees and faculty receive training on remote learning. Online schedules for both in-person and remote learning should be maintained, and archives of recorded didactics should be kept in an accessible repository and regularly curated.

Even in the absence of social distancing, certain elements of remote learning should be continued to help maintain an institution's remote learning technical infrastructure and faculty familiarity. On the basis of trainee feedback, broadcasting and recording slide-based didactics and selected high-yield QA and other conferences likely will continue at our institutions, whereas remote sign-out sessions would have limited value because of poor engagement by those who have not previewed cases.

In Conclusion

"Viewing is no substitute for seeing."

Isaac Asimov, *The Naked Sun*[1]

In contrast to Solarians, we Earthlings are likely to continue our desire for in-person meetings. The complexities of human nature do not allow for remote interactions to satisfy our need for or appreciation of face-to-face contact. Although remote learning cannot be a complete substitute for in-person learning, it has the potential of becoming an integral component of training. Pathology is on the verge of becoming primarily digitized; while cytopathology is more challenging because of the presence of a z-axis, it will still surely follow. Today, we wonder whether we can properly teach pathology remotely, but—reflecting upon our best memories as teachers, colleagues, and students—we should also wonder how we will still fuel our passion for teaching, learning, and sharing pathology during an era in which we may not be able to sit together at the scope in the same way again.

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