Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Where will telemedicine go from here?

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The COVID-19 pandemic accelerated the adoption of telemedicine internationally. The reproductive clinics that thrived in this tumultuous time had access to fully electronic medical records with user-friendly telehealth platforms and remote support staff for physicians. However, complete transition from in-person visits to telehealth uncovered many opportunities for innovation. At-home semen testing is not yet widely recognized, and patients still require an in-person visit for ultrasounds, procedures, and physical examinations. Although emergency policies and waivers have made it easier for providers to legally practice across state borders and receive payments from insurance companies, they vary from state to state and have not been cemented into law. Finally, clinical training for medical students, residents, and fellows has been affected by decreased clinical and surgical volume. However, trainees have also proven to be the most adaptable, quickly shifting to remote learning practices through social media, online surgical atlases, and wide distribution of "virtual visiting professor" lectures. As countries have eased physical distancing guidelines, patients ultimately benefit from having the option of a telehealth appointment. Although there is still much work to be done to improve telehealth, the COVID-19 pandemic has at least proven that it is a safe method of patient care and teaching. (Fertil Steril® 2020;114:1135–9. ©2020 by American Society for Reproductive Medicine.)

Key Words: Telehealth, fertility, at-home testing, out-of-state care, remote teaching

Before the COVID-19 pandemic, telemedicine struggled to achieve widespread adoption owing to several challenges, including reimbursement, regulations, user and provider resistance, and technology. However, the unique and sudden imperative to socially distance imposed by the pandemic accelerated widespread acceptance and use. This review addresses telehealth lessons learned in the COVID-19 era, how fertility specialists have overcome the challenges of shifting testing, teaching, and general care outside of traditional clinic settings, and medical license implications of treating out-of-state patients.

TESTING—IN HOME VERSUS LAB BASED

The current criterion-standard male fertility evaluation includes a comprehensive history, physical examination, and laboratory semen analysis testing (1). The semen analysis is the "cornerstone of the male evaluation" and evaluates multiple parameters thought to be associated with men's fertility status, including seminal volume, seminal pH, sperm concentration/count, motility, progressive motility, and morphology. According to the American Urological Association's best-practice statement on the optimal evaluation of the infertile male, at least two samples should be collected after a defined period of abstinence of 2–3 days, either at home or at the laboratory, and should be examined within 1 hour of collection. The laboratory where semen testing is performed should conform to the standards outlined in the Clinical Laboratory Improvement Amendments (CLIA). Traditional laboratory-based semen analysis is generally performed by means of either complex manual inspection with the use of a microscope or computer-assisted semen analysis. At baseline, conventional semen testing presents several barriers, including high cost, patient apprehension and inconvenience, logistics and scheduling, and interlaboratory variation of semen analysis techniques (2). With the current pandemic, additional barriers, including laboratory closures and patient fear of presenting to a health care setting, have led to an even greater push to consider home-based semen testing.

Multiple home-based tests have entered the market, using a variety of methods to analyze semen and operating within different parameters (2, 3). SpermCheck is a Food and Drug Administration (FDA)–approved test that uses solid-phase chromatographic immunoassay technology to assess for sperm concentration $>20 \times 10^6$ sperm/mL (4). Trak is a home test that also assesses for sperm concentration only. It has clearance from the FDA and uses a centrifuge and measurement of the cell pellet to report concentration

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in three categories; low (<15 million/mL), moderate (15–55 million/mL) and optimal (>155 million/mL) (5). The FertilityScore and Swim Count both assess for progressively motile sperm concentration with the use of colorimetric reaction. FertilityScore uses a single detection limit of 20×10^6/mL, and Swim Count uses a reference strip to assess if motile concentration is <5 million motile sperm/mL or ≥20 million motile sperm/mL (6, 7). Several tests use smartphone cameras to assess for motile sperm concentration: Men's Loupe, Seem, and YO. Men's Loupe is inexpensive (<$50) but relies on the patient to determine the concentration and then manually calculate the motility. The FDA-approved YO device and Seem ask the patient to record a video, which is analyzed for motile sperm concentration. Future approaches include paper-based testing, microfluidic devices, and lensless on-chip microscopy (3). Currently available tests range in price from $15 to $200 and claim accuracies ranging from 83% to 98%.

Mail-in testing options are also available. Andrologists may contract with ReproSource, a company focused on fertility testing and information. The patient is able to collect a sample at home and ship it to a ReproSource laboratory, where it undergoes a standard evaluation of concentration, motility, morphology, and inflammation markers. This home collection overcomes many of the barriers to testing that arose with the current pandemic but remains costly and must be ordered through a provider's office. An alternative provider-independent option is the Fellow kit, which costs $189, and is easily ordered online (8). Results (volume, concentration, motility, and morphology) are provided online 5 days after the kit is received in the California-based CLIA-certified laboratory.

Currently, most at-home systems can provide a basic analysis which allows the person to decide whether to pursue further testing or not. This increased accessibility could help broaden the catchment of male patients screened for infertility who might otherwise not have pursued screening. However, sperm can be normal in one parameter and abnormal in another, leading to false negatives and a delay in appropriate testing. For this reason, these tests are not considered to be a replacement for laboratory analysis. Formal evaluation with a fertility expert is still recommended (9). One area where home testing may be most appropriate is in confirmation of sterility following vasectomy. Postvasectomy testing ensures surgical success, but follow-up rates are low (10). Because the only parameter of concern is sperm concentration <100,000 sperm/mL, a home-based test could be valuable and convenient and potentially improve patient compliance. Major barriers at this time include cost and lack of insurance coverage, as well as accuracy concerns if the concentration limit is >100,000 sperm/mL.

With increasing use of telehealth tools and continued innovation in the home testing market, one can posit that use of home testing as a screening tool, combined with virtual consultation with a fertility expert, could become the standard initial evaluation of male fertility patients. This would allow for greater access and compliance, while still ensuring appropriate interpretation and thus management. It could also allow for targeted laboratory-based testing to be performed before the in-person visit if necessary.

TELEHEALTH LESSONS FROM COVID-19

After initial reports of a novel virus in China in early January 2020, the virus quickly spread through Europe before becoming widespread in the United States. Therefore, many lessons were learned by our reproductive medicine colleagues overseas.

Perhaps no clinic was better prepared for the pandemic than IVI-RMA Physicians, a private reproductive medicine group with more than 65 offices in nine countries. In Spain and Italy, the first European epicenters of the virus, the last in-person reproductive treatments occurred on March 20, 2020, and did not resume again until April 26, 2020 (11). Dr. Pellicer and his colleague Dr. Veragara Bravo recalled having 3 days to switch their physicians to working from home. This involved creating a virtual private network (VPN), writing protocols to access the VPN from home, and establishing a remote information technology (IT) department for troubleshooting. With an in-house workforce reduced to only the necessary laboratory staff, physicians were primarily responsible for their own scheduling and for determining which patients were appropriate for a remote visit.

Before the pandemic and the associated shift in practice, IVI-RMA's international patients and those coming from remote parts of the country regularly used a mobile app or the group's online portal to correspond with providers. Physicians similarly would upload results and notes as needed to allow for remote patient access. IVI-RMA also provided their physicians with access to medical illustration software that allowed them to easily demonstrate normal anatomy over the virtual health platform, alter the image for the patient's specific anatomy, and finally guide the patient through a proposed procedure. These images and videos were saved to the patient's portal for easy reference. These tools supplemented in-person consultations and took greater prominence in supporting a more comprehensive transition to telemedicine in light of the pandemic and associated lockdowns. In this way, technology enhanced the encounter by improving patient counseling, minimizing room for error and miscommunication, and increasing efficiency.

Patient visits that do not require a physical examination or ultrasound are of course much easier to move to telemedicine. Before COVID-19, ~50% of IVI-RMA's genetic counseling and immunology appointments were via telehealth video. An early step taken by IVI-RMA was to make that figure 100%. Unsurprisingly, ultrasound continued to be a limiting factor to telemedicine. During the quarantine, all egg retrievals and embryo transfers were delayed. Patients instead were able to use telemedicine for follow-up visits to review results and for initial consultations to outline options, cost, and timing. By previewing their treatment course, patients were able to save on travel costs, more efficiently plan their schedule, and seek second or even third opinions.

With the end of the lockdown and a significant decline in case numbers, workers in Spain and Italy returned to their

offices on July 1, 2020. The IVI-RMA providers speculate that because COVID-19 has normalized telemedicine for patients and providers, it will continue to play a larger role in their work than it did before the pandemic.

Of course, there are other limitations to telemedicine. Although a patient may be observed over a video platform, there is no formal physical examination. As Dr. David Ralph and Dr. Pippa Sangster of University College London Hospital have noted, part of our expertise as andrologists is a specialized physical examination, with the ability to accurately measure testis size, assess testicular firmness, establish the presence and grade of a varicocele, and assimilate this information with laboratory data to provide a diagnosis and ultimately guidance for the patient and partner to achieve pregnancy. While some exams can reliably be performed by local physicians, as a consulting specialist much of our value comes from our physical exam. Clinical varicoceles may be missed, and it is doubtful a general practitioner has calipers or a gonadometer to measure testis size. In this regard, the telemedicine visit easily serves as a follow-up visit and initial consultation. When patients present to care for laboratory tests or semen analyses, their visit may be coordinated with a brief office appointment for the physical exam. Alternatively, if the patient has a local urologist, one possibility would be for a local exam with remote andrology telehealth consultation.

Another hurdle that telemedicine has trouble overcoming concerns patient comfort. Older patients who are less technologically inclined may be more comfortable with in-person visit. Conversely, younger patients who are adept at internet-based applications may prefer a virtual option, given the associated decreased transportation cost and time, time away from work, and overall greater convenience. As our patients age and the virtual visit becomes a standard vehicle for health care, it seems inevitable that telemedicine will capture a greater percentage of patient volume, but it is important to be cognizant of insecurities and discomfort with the virtual medium among our current older patient population.

The European Association of Urology offered recommendations on telemedicine in urology (12), noting that it requires:

- A coordinated effort among physicians, nurses, administrative staff, laboratories, and IT.
- Electronic records accessible from home and in compliance with privacy and data protection regulations (usually through a VPN).
- Ready access to language-line services.
- Patient consent to teleconsultation.
- An integrated telehealth platform with safe communication.
- Providers who can recognize when a face-to-face appointment is necessary.

Already, other branches of urology have reviewed the patient's experience with telemedicine. Ambrosini et al. moved 93.3% of a multidisciplinary oncology team's patients to telemedicine visits during the peak of the COVID-19 crisis (13). Of those 60 patients, 68.3% completed a post-visit anonymous survey, with the majority assigning a high satisfaction (4.75/5) rating to the virtual visit. Boehm et al. surveyed established patients in a German oncology practice in March 2020 regarding their willingness for a telemedicine versus in-person visit. The majority of patients, who were also at high risk for COVID-19 complications, elected for telemedicine. Only 19% declined, citing either technical challenges which precluded telemedicine (e.g., poor internet connection) or a general preference to see their physician in person (14).

OFF-SITE IMAGING AND TELEMEDICINE REVIEW

Although comprehensive physical examination and laboratory testing are not possible virtually, telemedicine has been shown to be an excellent tool for review of off-site imaging. Connor et al. evaluated 1,008 patients with acute renal colic, who were referred to a virtual clinic for follow-up. To be included in the study, patients had to have a noncontrast computed tomographic scan of the abdomen, which was reviewed at the time of their virtual visit. Of those patients, 34.5% were able to be effectively discharged from the clinic without an in-person visit. Furthermore, no patient complaints were received (15). For the andrologist, although imaging is not part of the standard evaluation, transrectal ultrasound for a patient with suspected obstructive azoospermia, or testicular ultrasound to investigate an abnormality on examination, can be easily obtained on an outpatient basis and reviewed over a telemedicine platform.

MEDICAL LICENSE IMPLICATIONS OF OUT-OF-STATE CARE

As the proverb states, necessity is the mother of invention. The COVID-19 pandemic has changed our society in innumerable ways, and time will only tell which changes and innovations will remain long after the pandemic has ended. In the medical community, the pandemic has accelerated the adoption of telehealth by providers, patients, and insurance companies. Owing to the obvious need and rapid widespread adoption, the rules regarding payment and licensing have lagged behind use. Traditionally, practicing telehealth across state borders had been possible but was a time-consuming process. During the COVID-19 pandemic, the need for dramatic changes forced temporary emergency policies and waivers to be rapidly adopted by both state medical boards and insurance providers to facilitate the transition. These policies vary by state and insurance provider, have unclear end dates, and continue to evolve.

On March 17, 2020, Medicare announced it would reimburse providers for telemedicine services at the same rate as in-person visits throughout the public health emergency (16). This included providing services to patients outside of the physician's licensed state. By April 21, according to the Federation of State Medical Boards website, 47 states had adopted waivers of state rules, making it easier for a necessary consulting physician to care for out-of-state patients (17). However, these waivers vary greatly in content and therefore generalizations are impossible to make. In addition, most are

active until "the end of the state of emergency" or "until further notice," meaning that the policy could change at any time. It remains to be seen whether these pandemic-created concessions will become permanent law. The waivers also differ regarding chronic pain treatments, controlled substance prescriptions, and types of health care provider (e.g., nurse practitioners, physician assistants, mental health providers, physical therapists) (18).

Many states, e.g., Alabama, Alaska, California, Georgia, Indiana, Kentucky have allowed out-of-state licensed professionals to treat patients by offering courtesy or telehealth licenses if registered with the local state licensing board . Some states, such as New York, Florida, and Kansas, issued emergency orders that temporarily allowed physicians with valid unrestricted licenses in other states to provide telehealth services to persons in their state, even without a state license (19). Delaware passed a similar edict but rescinded this authorization for everyone but mental health providers in July. Idaho permanently allowed out-of-state providers to engage in telemedicine appointments with Idaho residents. A number of states, including Illinois, Maine, Rhode Island, and Arkansas extended the ability for out-of-state providers to offer telehealth to patients who already have an established patient relationship (20).

The Federation of State Medical Boards (FSMB) has been developing a program to help physicians gain access to cross-state licensure and registration through their Interstate Medical Licensure Compact (ILMC). This offers a pathway to licensure for qualified physicians who want to practice in multiple states and was designed to increase access to health care for patients in underserved or rural areas. The ILMC application process was expedited during COVID-19. Once qualified, it allows the physician to practice in any number of other Compact states.

Given the complex and varied waivers as well as the ever-changing nature of these policies, relevant state law should be carefully reviewed before providing care via telehealth for a person who is not in the state. The Federation of State Medical Boards website provides an updated list by state as well as links to the individual state policies (21). The Center for Connected Health Policy also outlines recent updates to licensing codes for many states (18). In addition, providers should check with their malpractice carrier to ensure they are covered to practice over state lines.

EFFECT ON STUDENTS, FELLOWS, AND RESIDENTS AND HOW TO MANAGE

The future of medicine depends on appropriate training of our medical students, residents, and fellows. COVID-19 has profoundly affected the medical system in all aspects and will continue to affect medical training for the foreseeable future. Downstream effects of the pandemic on trainees include:

- Decreased surgical case volume with cancellation of nonemergency surgeries and limiting the number of participants in surgical cases to only essential personnel, with the goal of minimizing exposure and personal protective equipment use.
- Decreased clinical exposure with transition from face-to-face consultations to telehealth to comply with physical distancing requirements.
- Decreased specialty exposure with redeployment of staff to pandemic-related services.
- Cancellation of in-person didactics and mentoring.
- Cancellation of medical student rotations, visiting medical students, and opportunities for in-person hands-on learning, especially in the clinical years.

A survey of urology residency programs revealed that patient contact-time had decreased from 4.7 to 2.1 days per week to allow for physical distancing and reduced exposure risk. Redeployment was reported by 26% of programs, and 60% of programs reported concerns regarding residents meeting case minimums (22).

Given the changes in education, evaluation of residents, fellows and training programs will also have to adapt. Many residents are unable to complete clinical rotations or achieve case log minimums. The Accreditation Council for Graduate Medical Education (ACGME) indefinitely postponed all scheduled and required accreditation site visits until it is felt that site visitors can safely travel. The ACGME announced availability of a self-declared pandemic emergency status for institutions, allowing for a 30-day suspension of all program requirements, excluding resident/fellow work hours, supervision, and safety requirements. The case log minimums would remain in place for each surgical specialty but need to be interpreted in the context of the impact of the pandemic on the 2020 graduate logs (23).

The pandemic and need for physical distancing have necessitated and accelerated the adoption of telemedicine, teleconferencing, and remote learning. This period of rapid innovation has led to new solutions and methods to overcome challenges with medical and especially surgical education. Training programs will need to adapt and embrace technology and new methods of teaching. Academic conferences via teleconference have been widely adopted, and a significant portion of residency programs have reported that they plan to continue using videoconferencing (22). Videoconferencing technology has allowed for clinical departments to hold lectures, teaching sessions, and meetings remotely. This technology has also been used for reciprocal teaching conferences where didactics from world-class highly specialized academic institutions are made available to other institutions and smaller hospitals. These lectures can be saved as a repository for future learning for students and physicians out in practice. World-class experts can act as "virtual visiting professors" without travelling, allowing for wider exposure and dissemination of knowledge and ideas, in addition to saving time and money on travel and lodging. This technology can also be used to expose trainees to interdisciplinary teaching from other specialties, and bidirectional learning can occur in webinars and group discussions (24).

Medical curricula has recently moved toward active learning and flipped classrooms, which can easily be transitioned to an online format. The flipped classroom strategy involves providing learners with didactic material in a prerecorded video lecture that is watched at any time before

the conference. The conference is then used for synthesis, application, and case-based discussion (25). This strategy can also be used in residency didactics, and evidence suggests that these active techniques are preferred by trainees (26).

Clinical education has unique challenges to adapt to remote learning. Surgical video libraries and interactive group viewing are available options that once built, can be widely disseminated and used for generations of students. Online anatomy atlases with three-dimensional models may take the place of in-person surgical libraries. Practice questions and quiz banks are not new, but programs have expanded these with case-based interactive questions development. Even social media in the form of podcasts and Twitter have played a role in clinical education as a source of information, cutting-edge research, and teaching opportunities and even as an access point to experts in the field. Resident participation in telehealth clinics has become more widely adopted, and revisions in the Common Program Requirements to allow greater use of telesupervision were adopted by the ACGME Board of Directors (23). Finally, there has been interest in the development of simulation programs at home, given the suspension of hospital-based simulation training programs. These would allow trainees to view a simulated procedure and then practice at home under video supervision.

The pandemic has forced training programs to adapt in a very short period of time. As such, programs will need to embrace and refine new technologies and methods of education. The medical academic community will need to create new methods of assessment and accreditation. Moving forward beyond the pandemic, programs must evolve and distill the best aspects of in-person and remote learning to create the education of the future.

CONCLUSION

The COVID-19 pandemic forced the medical community, its patients, insurance companies, and lawmakers to face the challenges of telemedicine that had previously stood in the way of its broader adoption. Although there is still work to be done to make telehealth as effective as the traditional in-person visit, COVID-19 created the right environment to demonstrate that telehealth is a safe vehicle for the appropriately selected patient. COVID-19 has normalized seeing one's physician over a computer screen. It is unlikely that the patients who have enjoyed the advantage of minimizing their overall appointment time to just that spent with their physician will be willing to return to the old model of traveling to and from appointments, waiting in the reception area, and losing time from work or home life. Advances in home testing, video platforms, and other supportive technologies will only help to streamline telemedicine for the future.

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