Practical Applications of Telepathology Using Morphology-Based Anatomic Pathology

Dennis P. O’Malley, MD

The struggle of today, is not altogether for today—it is for a vast future also.

Abraham Lincoln (1809–1865), US president

This article is an overview of a presentation from the 2007 College of American Pathologists Foundation Futurescape of Pathology meeting. At this meeting, the goal was to envision the future of pathology in light of technological advances. In this context, this article addresses practical applications of telepathology in anatomic pathology. This area is referred to by a number of names including distance pathology, digital pathology, and virtual pathology. All of these terms refer to the application of digital scanning of traditional histologic slides and review of these slides at remote sites using a computer-based interface.

The current US LABS (LabCorp) (Irvine, Calif) model focuses on the application of digitized whole slide imaging for the interpretation of immunohistochemical stains and image analysis. In the case of immunohistochemistry, unstained slides or blocks are sent to US LABS (LabCorp), stains are performed, and then slides are digitized. These digitized slides are then available in a Web-based viewer for evaluation by the originating pathologist. Based on experience at US LABS (LabCorp), the scanned images are diagnostic in more than 90% of cases. Regardless, in all cases, glass slides are sent by express mail for review in difficult cases and for archival purposes.

There are several advantages that can be obtained using this type of model of digital microscopy. These are discussed in the following sections.

RAPIDITY

In some cases, US LABS (LabCorp) is able to return results from immunohistochemical stains faster than a local laboratory, even though it may be located across the country. This is because we have 24-hour operations and multiple shifts of technical staff. After receipt by express mail, the slides can be completed within 4 hours and available for review on the Web. These are, of course, optimal numbers, but the advantages can easily be illustrated. If the originating laboratory only has a single run of immunohistochemical stains per day, with a cutoff sometime in the early or midmorning and results available in the mid or late afternoon, then express mail plus overnight processing could match or better the results by having overnight processing on any case that needed staining after the day’s deadline.

ADDED TEST MENU

Because of volume, it is feasible for US LABS (LabCorp) to offer an extremely broad test menu of immunohistochemical stains and image analysis products. At present, we offer close to 300 antibodies or combination stains. In many cases, it is not financially sensible for smaller laboratories to stock ‘rare use’ antibodies, which would expire before the reagents were completely used. An example is an immunohistochemical stain for parvovirus B19. Although a valuable stain in a specific clinical context, only the highest volume hematopathology or pediatric pathology practices would justify having this stain on their menu.

Using the same process, scanned slides can be used for a variety of image analysis applications. Using the same scanned digital slides, US LABS (LabCorp) has Web-based image analysis programs for predominantly breast cancer and prostate cancer evaluation including immunohistochemical stains for human epidermal growth factor receptor 2 (HER2), estrogen receptor, progesterone receptor, Ki-67, p53, and androgen receptor. Using the digitized area of slides, the pathologist selects the field of interest. These selected fields are then analyzed using an appropriate image analysis algorithm, and consistent quantitative results are generated. As expected, quantitative results generated by image analysis are more consistent and reliable than those that are manually evaluated, although the prognostic value of quantitative results of immunohistochemical stains is only of value in select cases (eg, HER2).

SHARED EXPERTISE

In anatomic pathology, it is a constant struggle to keep abreast of all new developments in testing and diagnosis, especially in smaller practices. In many cases, this has lead to the development of more subspecialty practitioners. The advent of telepathology allows for sharing of difficult cases with colleagues who may not be on-site. There are many references to the use of telepathology being used...
for consultation and in specific subdisciplines of pathology including cytology, neuropathology, and dermatopathology. 2,4 Many of these articles have accepted that although the practice of digital pathology has “arrived” it has not yet reached the level of the glass slide era. The fact that it is being used regularly in a variety of settings speaks to the acceptance of this technology, but it should be noted that the technologic advances will undoubtedly make the practice as near to equivalent as glass slide pathology as possible but have several other advantages.

**MEDIÇOLEGAL PROTECTION**

As mentioned previously, shared expertise, using digitized slides as a methodology, allows for distant evaluation of materials. It is not inconceivable that solo or small practices may band together to share or complement one another and provide secondary reviews of difficult or litigious cases. This methodology may become a more common method of submitting consultation cases to national experts as well, limiting the factors of lost slides and transit time. This degree of interconnection may provide a degree of medicolegal protection, by having consultative and collaborative review of cases to prevent misdiagnosis.

**ELEVATED STANDARD OF CARE?**

In addition to sharing expertise, distance pathology allows a “leveling of the playing field” for a variety of pathologists. In the current circumstances, the offering of technical services at large centralized laboratories allows the remote pathologist to have all of the same services and techniques as the largest institutions. Limitations are not based on the resources of the institution but on the abilities of the interpreting pathologist. This can lead to an elevation of the standard of care, allowing all pathologists an entry into the newest technologies and testing.

**CAPITAL EXPENDITURE**

Perhaps one of the strongest motivating factors in current health care strategies is cost-cutting measures. Digital pathology allows smaller practices or hospitals to partner with companies to provide technical services through telepathology options. This in turn allows the hospital staff to pick and choose which technologies it thinks are necessary to have locally and which services can be done through distance solutions such as telepathology. This is no different than the current practice of using a send-out laboratory for esoteric tests. In the case of US LABS (LabCorp), virtual immunohistochemistry is simply choosing to use the space, personnel, and reagent costs for sources other than immunohistochemistry and performing the professional interpretation, rather than supporting all the associated costs of the technical production.

**OTHER VALUES**

When using digital solutions in anatomic pathology, there are additional advantages that may be less immediately apparent but are still worthwhile to consider. Results are available in a digital form, allowing for an unprecedented flexibility in reporting and documenting results. Not only can images be embedded into the reports, as is currently done using the US LABS (LabCorp) system and other systems, but they become part of the electronic medical record. Paperless reporting can be quite easily accomplished as well as customization of reports. At present, there are many practices that allow for different types and formats of reports to be generated for different users, each containing the same information but perhaps for different levels of understanding. An example would be a separate report for the pathologist, oncologist, and patient, each of which has customized information that would be pertinent to each “end user.”

Also, anatomic pathology information that is obtained digitally has the capability of being formatted to be directly compatible with electronic medical records. This provides a freedom and portability of anatomic pathology information that was heretofore unthinkable. Because the material is in digital format, most of the viewer systems including those used by US LABS (LabCorp) allow taking digital “photos,” photos from the digital slides without the use of a camera. These digital images can then be used for presentations, included in reports, or archived with other medical records.

Digital pathology represents an innovation that has arrived—its application is only a matter of time. In his book on the diffusion of innovations, E. M. Rogers mentions these 5 attributes of innovations: relative advantage, compatibility, complexity, trialability, and observability. 7 The attributes of telepathology have proven that they meet these criteria. There is a relative advantage, as discussed previously. The degree of compatibility with current systems is similar enough that most pathologists would be able to transition to telepathology solutions. Further, the complexity is no more than the application of simple computer programs and navigation of the Internet. Trialability refers to the use of applications on a limited basis. This attribute has been used by many clients of US LABS (LabCorp) virtual immunohistochemistry, with little risk and essentially no capital expenditure. Observability is the degree to which the change in technology is visible to the community that could use the innovation. If the US LABS (LabCorp) experience is representative, then the adoption of telepathology is continuing apace.

One can perceive a digital environment in pathology in which there are electronic versions of clinical information, gross photographs, radiologic images, histology slides, immunohistochemical stains, and other molecular and genetic results available at a workstation. This workstation could be located remotely from the site of data acquisition, with pathologists manning stations at sites of their choice, remote from the acquisition of the information. The vast future opens before us.

**References**