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## REVIEW ARTICLE

### DIGITAL PATHOLOGY: LOOKING INTO THE FUTURE

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#### ABSTRACT

Digital Pathology extends the limits of microscopy, enabling students, educators, researchers and clinicians to share tissue samples. Images sent or shared over the Internet or through specific analysis software open the path to a new and exciting microscopy tool. Software applications make it possible to see and share images beyond microscopes such as studying images on computer monitors, laptops, iPads and other portable devices. In some circumstances, multiple researchers are able to observe and discuss the same sample in real time over the Internet. Researchers that use a microscope as part of his/her daily regime can use Digital Pathology software to make digital slides, create a database and use advance programming to recognize and classify a tissue sample as well as identify abnormalities. Digital imaging technology advances possibilities in the realm of microscopy, providing a means to preserve, share, duplicate, and study a specimen. A standardized method of obtaining, storing and sharing digital images is needed and can lead to better diagnostic techniques and consultation methods for pathology diagnosis, however, these procedures have yet to materialize. In addition, utilizing digital images for teaching and consultation can be more effective for storage purposes and have easier accessibility as compared to traditional print photographs and slides. There is very little data assessing the utilization of microscopic digital images in India.

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#### INTRODUCTION

Digital pathology provides an environment where information is image-based. It is dependent on computer technology and helps in better information in the form of a digital slide. Glass slides are converted into digital slides with the use of virtual microscope that can be viewed, managed, and analyzed on a computer monitor. Pathology is facing a growing demand to improve quality, patient safety and diagnostic accuracy in present scenario because of the increasing emphasis on sub-specialization. Apart from this, consolidation and centralization of diagnostic services are the need of the hour. These factors are leading to the development of systems that can further optimize access to expert opinion and highly specialized services in this field. The field of digital pathology is regarded as one of the most promising avenues of diagnostic medicine with the use of Whole-Slide Imaging. It helps in achieving better, faster and economical diagnosis, prognosis and prediction of cancer and other important diseases. Digital photographs document depict the true pictures of the

pathological changes and thereby, eliminating the inaccuracies resulting from variations in descriptive ability. The transition to the digital medium has opened up numerous applications. The inclusion of quality digital images into lectures and electronic documents is crucial. When incorporated with synoptic texts, reports are more accurate and concise. Image analysis using algorithms, coupled with computer-assisted diagnosis and 3D-imaging are several digital imaging applications which are emerging in pathology. It has enhanced the field of biomedical informatics. We require a new quantitative mentality in pathology for the adoption of this new technology. Pathologists need to learn the use of both their analogue and digital eyes to see an exact picture of a disease. Scientists all over the world can study and discuss any sample with any new air or when blood disease appears. When scientists discover new compounds or unusual tissue findings, they can collaborate with their colleagues around the globe. Digital Pathology can save time, money and lives in such situations. Digital Pathology leads to sharing information and providing good service to patients. It is beneficial for patients of urban areas as well as of rural areas also who have limited access to the technologies and bigger hospitals. Accessibility to lesser-known pathogens might raise interest, thereby, increasing the number of pathologists working to find cures.

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Pathogens that appear in 3rd world countries can be identified more quickly. Imaging analysis software can also be used to detect anomalies within a single sample or create a quantitative database. High-tech instruments can recognize morphology and structure; the sensitivity of certain pathology analysis can even include a genetic or protein profile. Various issues associated with sharing slides like degradation of samples and inability to share samples of live cells can be eliminated through Digital Pathology to some extent. Specimen images can be transferred to colleagues in a short span of time and quality can be maintained at the same time. Various benefits are:

- Diagnosing the disease – Pathologists can share slide image all over the world, thereby decreasing the time taken in diagnosing and treating a pathogen.
- Education in medical colleges –Medical students and professors will be able to study images of live and dead cells through a network database or online from database of samples. Thus it saves money on histological slides
- Finances – It is economical as the purchasing of glass slides, cover-slips, adhesives and dyes is decreased or eliminated. Similarly, the cost to preserve and send pathology specimens to colleagues or institutions is also reduced.
- A large number of pathologists can discuss the same aspect of the sample using networking tools. Digital slides can be reproduced an unlimited number of times. Pathologists and researchers can share images uploaded on certain software applications. For implementation of digital pathology, there is a need to transform infrastructure in the area of lab-to-lab communications through direct interfaces with Laboratory Information Management Systems (LIMS) and Laboratory Information Systems (LIS). Virtual pathology services at remote sites need to be started. Integrating the management of laboratory test results across multi-site labs like hematology, immunology, microbiology, cytology and biochemistry; facilitating, referrals and second opinions can result in increased efficiency in processing data and supporting the function of multi-disciplinary teams. It will lead to improvement in service delivery, patient safety, patient care, reduces error, economical and efficient use of data. It also supports patient with long-term conditions to self-manage their disorders. It facilitates sample management with automated sample identification to control the collection and transport of samples to laboratories from hospitals. It can be used in education, training and for presenting cases at tumor boards. Database helps to understand pathology processes and then using the derived information to improve pathology services. Quantitative and automated image analysis provide risk-based case prioritization and leads to identification of areas of interest, primary diagnosis of disease, personalized medicine therapies can be tailored. Pathologists can extract prior data and analyze data from a spectrum of different data sites to understand the links between tests and treatments thereby, geographical boundaries and limitations and improving interactions with patients directly.

### Environment of Digital Pathology includes

**Scanning of slide:** Digital slides are created from glass slides by the use of a high quality scanning device. Creation of digital slide under digital pathology must be free of dust, scratches, and other obstructions.

**Accessibility:** Digital slides are accessible through a computer monitor and with the use of software either locally or remotely via the Internet.

**Management:** Digital slides are maintained in an information management system that allows for archival and intelligent retrieval.

**Networking:** Digital slides can be stored and send over the Internet or private networks, for viewing and consultation.

**Analyzing:** Image analysis tools are used to derive objective quantification measures from digital slides. Various tools like pattern recognition and visual search tools are used to classify specimen images and identify medically significant regions of digital slides.

**Integration:** Digital pathology workflow is integrated into the institution's traditional operational environment.

**Sharing:** Digital pathology helps in sharing information for the purpose of education, diagnostics, publication and research.

**Issues and Challenges:** Since it is a new technology, there are many questions and concerns that pose barriers to the adoption of whole slide imaging (WSI). Technical concerns and regulatory issues are two main challenges that need to be addressed. Firstly, Technical concern include digital slide scanning technology, e.g., the ability to scan slides at high magnification and multiple focal planes (the z-axis), image quality, image access speeds and computer hardware limitations for processing and storing extremely large image files need to be solved. Secondly, regulation related to purchase of components of WSI and its operation and its interpretation by third party. What will be the extent of regulatory approval about WSI? Whether it will cover all types of diagnostic work, or will some tissue types, disciplines, analyses or diagnostic entities be excluded? How should WSI be validated? How much data and what types? These are the few questions that need to be answered to adopt Digital Pathology in future

### Validation of WSI for primary diagnostic application

- Separating the device from the practitioner
- Pathologist experience (in practice and with the device)
- Washout and validation setting for concordance studies
- Types of data generated
- Measuring accuracy
- Measuring bias
- Measuring precision (intra-rater, inter-rater and inter-instrument)
- Sample size
- Generalizability of the findings

Regulatory pathways in Canada and EU member states are now open for primary diagnosis of whole slide images (WSI). But it's not the same in US. There are still some regulatory barriers in the U.S. market. The FDA regulates WSI systems as Class III high-risk devices. Their position has slowed adoption of this technology. Scoring of digital images of manually selected regions of interest of immunohistochemically stained slides is a small step of FDA to adopt digital pathology.

## Conclusion

Digital technology will transform healthcare and the future delivery of pathology services. It will be beneficial to all the stakeholders. Few concerns pertaining to adoption of the technology need to be addressed like key drivers to adoption of digital pathology, economic models, the exact usage and applications of the technology are not very well known in India and who are the decision makers? A standardized method of obtaining, storing and sharing digital images is needed around the globe that can lead to better diagnostic techniques and consultation methods for pathology diagnosis. However, such procedures have yet to materialize. In addition, utilizing digital images for teaching students and consultation can be more effective and have easier accessibility as compared to traditional print photographs and slides. Storage of slides is easy and can be used whenever needed.

There is very little data assessing the utilization of microscopic digital images in India. We need to strengthen our internet network, basic infrastructure required for this and above all, the awareness among people and training to professionals.

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