



AI IN PATHOLOGY: A HEALING TOUCH IN DIAGNOSTICS

Abstract

Pathology, a cornerstone of healthcare, plays a critical role in diagnosis and treatment. Often defined as the science behind the cure¹, it is a broad discipline that is rapidly going digital. This paper explores the transformative power of artificial intelligence (AI) and interoperability in digitalizing pathology. It illustrates how AI-powered pathology is establishing itself as a new frontier in healthcare innovation as much in India as globally. This paper examines current standards, technological advancement, and emerging trends in pathology on the subcontinent, while understanding how these factors contribute to driving improvements in healthcare outcomes.

Introduction

In a hyper-digital world where access to quality healthcare is unequal, AI-driven pathology is proving to be a much-needed panacea. AI and interoperability in healthcare in general, and pathology in particular, are helping ease the disparities and promoting better delivery.

In India, healthcare infrastructure and resources vary significantly from region to region², shaped by diverse forces such as inadequate access to care, increasing medical inflation, income inequality, and other socio-economic conditions. Reliable diagnostics is essential to critical healthcare decisions.

Pathology – the science of the causes and effects of disease and illnesses – is indispensable in guiding medical decisions, charting treatment strategies, and defining patient care. Standing as a bridge between illness and wellness, it identifies diseases, their nature, progression, and possible treatments.

AI-powered pathology accelerates diagnosis using cutting-edge technologies. However, there is a dire need for standardization of processes, regulation around reporting, validation of testing methodologies, and development of appropriate skills. In this paper, we explore the journey to getting there.

AI-powered Pathology in India – Current Standards and Quality Measures

In a first-ever study quantifying pathology services across the world³, the United States (US) and India topped the list with the highest number of qualified pathologists. Recent research⁴ also shows that India has captured 2% of the US healthcare market through outsourced AI-led pathology. And yet, the country is grappling with a domestic shortage: there are about 3 lakh medical testing laboratories with only 5,500 certified pathologists⁵. The rest are mostly non-accredited. Further, these laboratories present variability in testing techniques and reporting methods, adversely impacting patient outcomes. Post the pandemic, the need for accurate diagnostics and preventive health checks has increased significantly. These facts highlight the immediate need for standardization and digitalization of this critical industry segment. AI and interoperability can empower pathologists with the bandwidth and capabilities to manage requirements at scale, while supporting the accreditation process from a quality perspective.

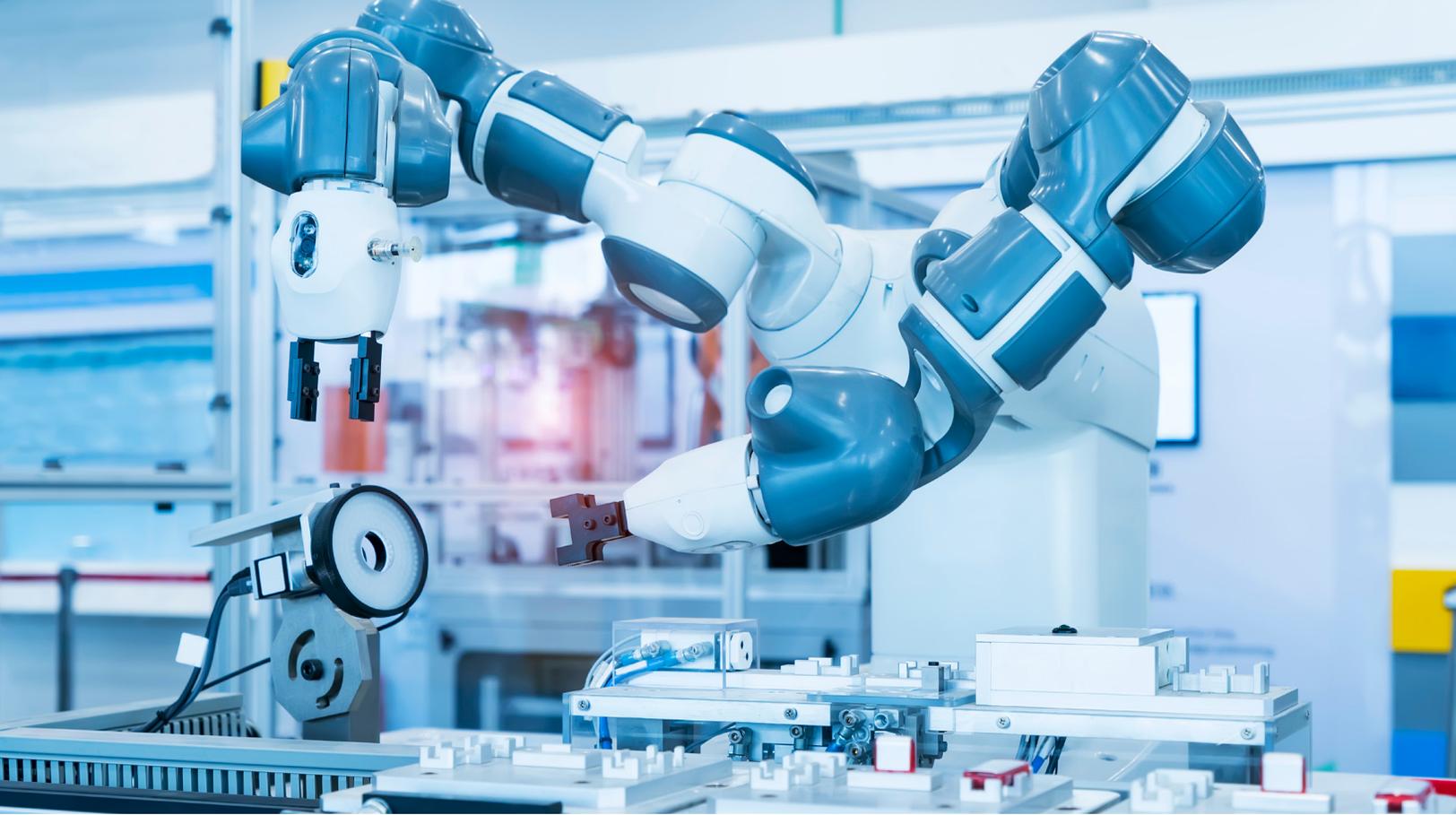
Standardizing pathology practices in India in terms of laboratory protocols and reporting systems can be a formidable challenge. Dr Vishal Bali, Executive Chairman, Asia Healthcare Holdings, explains that in the US, “insurance has been a big standardization player,” with several federal health insurance agencies collaborating to bring in quality control and regulation. Accreditation also serves as a quality assurance marker in the US, with healthcare providers recommending accredited diagnostic services as much as consumers demanding them. He emphasizes that the standardization journey is now gaining momentum in India as well.

Healthcare standardization and quality assurance in India is driven mainly by the Quality Council of India (QCI), with the National Accreditation Board for Hospitals and Healthcare Providers (NABH) playing a pivotal role. NABH follows a peer-to-peer model, similar

to the College of American Pathologists (CAP), an internationally recognized laboratory inspection program⁶, where teams of inspectors visit labs to ensure adherence to standards. With CAP standards being more global, there are several reputed laboratories that look to acquire CAP accreditation while others opt for NABH.

Dr. Alok Sharma, Director – Renal Pathology and Electron Microscopy, Dr Lal PathLabs, points out that while standards exist, “accrediting remote non-corporate individual labs in remote and rural areas of country remains a challenge due to issues of accessibility and affordability.” One of the ways, he believes, is to organize the laboratory market by registering with central bodies and associations such as the Indian Association of Pathologists and Microbiologists (IAPM). This approach can also help in educating the pathology community on accreditation and standardization. Dr. Bali recommends a tiered approach that stratifies laboratory offerings, making accreditation accessible and cost-effective. As smaller players in the healthcare services market evolve into larger institutions, tiered accreditation can foster a culture of quality and equitable care. AI-powered digital transformation has the potential to deliver contextualized education and awareness on quality accreditation, particularly tailored to small-scale remote laboratory segments.

Further, AI can help establish a connected and interoperable ecosystem for processing pathology orders and results. This is achieved by implementing machine learning algorithms focused on transformation maps of diagnostic orders and data for standardization. Interoperability-led digitalization of pathology is key to transformation and standardization at scale, ensuring quality and accessibility to all providers, regardless of the size of their operations. Let us now take a look at how technology and interoperability play a pivotal role in standardization.



The Role of Technology in Standardization

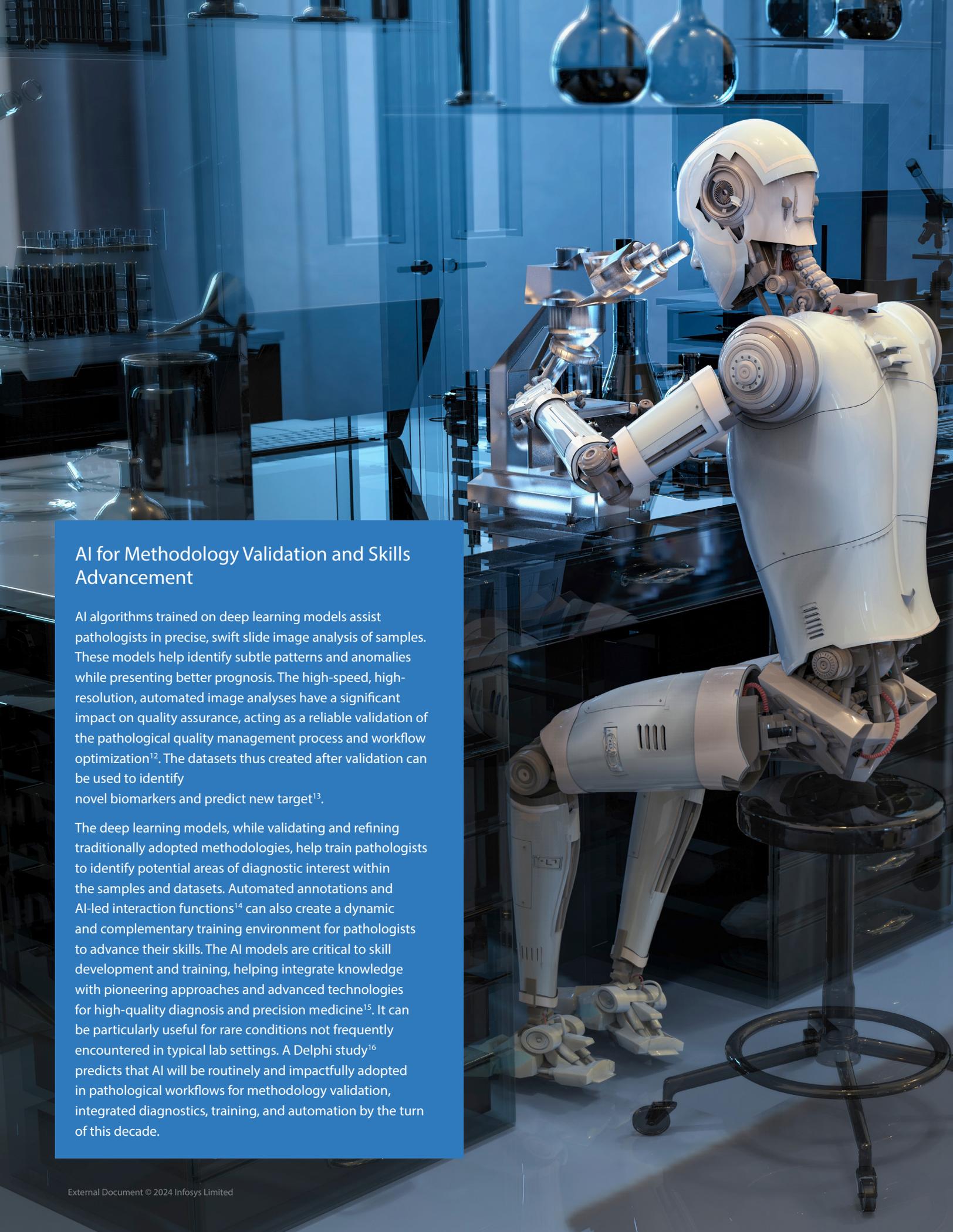
A recent study reveals that almost 60% healthcare executives⁷ believe that AI significantly enhances the quality of diagnosis. Further, interoperability and machine learning (ML) help regulate procedures, standardize reporting, and fast-track care. Interoperability also ensures that the benefits of standardized practices and AI/ML solutions are accessible to care providers country-wide.

Interoperability is the ability of various information systems to access, exchange, integrate, and collaborate over data within and across physical and geographical boundaries⁸. Interoperability in the form of health information exchange (HIE) enables data sharing by electronically moving data across disparate healthcare systems. HIE facilitates easy and secure access to clinical data in a timely and equitable manner, setting the expectations to responsibly gather and safely analyze clinical data for improved patient outcomes. There has been a global adoption of interoperability through Health Level Seven (HL7), and more recently, Fast Healthcare Interoperability Resources (FHIR). FHIR provides a more robust mechanism to securely manage lab

test orders and exchange test results data with accuracy.

When integrated with AI/ML solutions, interoperability standards can enhance the impact of digitalization. While digitalization can be expensive⁹, standardization using interoperability can help bring down costs in the long run. Further, laboratories that embrace interoperable digitalization see up to 21% gains in quality and efficiency¹⁰, with improved ability to balance workloads, streamline collaborations, and broaden their access to expertise. AI helps in swiftly unifying the diverse formats used by laboratories into a standardized data structure. This accelerates the formation of a connected ecosystem involving clinics, hospitals, and laboratories.

AI also helps laboratories with subspecialty and super-specialty solutions that seamlessly connect data with diverse platforms. For an efficient AI-powered laboratory workflow, it is critical that all health data is connected to the source¹¹. While discussions on connected and interoperable data in healthcare often spotlights electronic health records (EHRs), the evolving pathology ecosystem is broader.



AI for Methodology Validation and Skills Advancement

AI algorithms trained on deep learning models assist pathologists in precise, swift slide image analysis of samples. These models help identify subtle patterns and anomalies while presenting better prognosis. The high-speed, high-resolution, automated image analyses have a significant impact on quality assurance, acting as a reliable validation of the pathological quality management process and workflow optimization¹². The datasets thus created after validation can be used to identify novel biomarkers and predict new target¹³.

The deep learning models, while validating and refining traditionally adopted methodologies, help train pathologists to identify potential areas of diagnostic interest within the samples and datasets. Automated annotations and AI-led interaction functions¹⁴ can also create a dynamic and complementary training environment for pathologists to advance their skills. The AI models are critical to skill development and training, helping integrate knowledge with pioneering approaches and advanced technologies for high-quality diagnosis and precision medicine¹⁵. It can be particularly useful for rare conditions not frequently encountered in typical lab settings. A Delphi study¹⁶ predicts that AI will be routinely and impactfully adopted in pathological workflows for methodology validation, integrated diagnostics, training, and automation by the turn of this decade.

The Evolving AI-led Pathology Ecosystem in India

AI-powered pathology is about data-driven, integrated diagnostics with a significant reliance on EHRs. However, on a larger scale, AI in pathology results in making the healthcare ecosystem smarter, enabling remote diagnosis, and easing clinical workflows.

The AI-led diagnostics ecosystem in India is rapidly evolving. A 2022 Edelman report indicates it is among the fastest growing markets in the healthcare industry, projected to grow at a rate of 10% by 2025¹⁷. Research also shows that AI-driven pathology, often referred to as the 'third revolution of pathology,' is "on the verge of becoming a mainstream option for routine diagnostics."¹⁸

Emerging Trends and Advancements

EHRs, telemedicine, diagnostic slide archival, whole slide imaging (WSI), and image analysis and automation, among others, are some of the trends that are opening new doors through digitalization. Consider the integration of AI-led predictive analytics with EHRs. It helps create accurate and comprehensive patient profiles that enable informed decisions and accurate predictions around health concerns. On a larger scale, insights from these analytics can aid in identifying health trends and potential disease outbreaks, thereby safeguarding public health. This is possible if India's INR 700 billion¹⁹ fragmented medical diagnostics industry is unified. Under the National Digital Health

Mission (NDHM) and the Unified Health Interface (UHI) project, India seems to be on track toward an integrated and interoperable healthcare and diagnostics platform²⁰.

Besides routine test diagnostics, AI-powered pathology in India is also seeing disruption in genomics, oncology, ophthalmology, medical imaging, cardiology, and in general care facilities. A spate of Indian start-ups in the super-specialized diagnostics space is providing the much-needed tailwind to the healthcare industry. However, within the fast-evolving landscape, pathology in India presents several gaps.



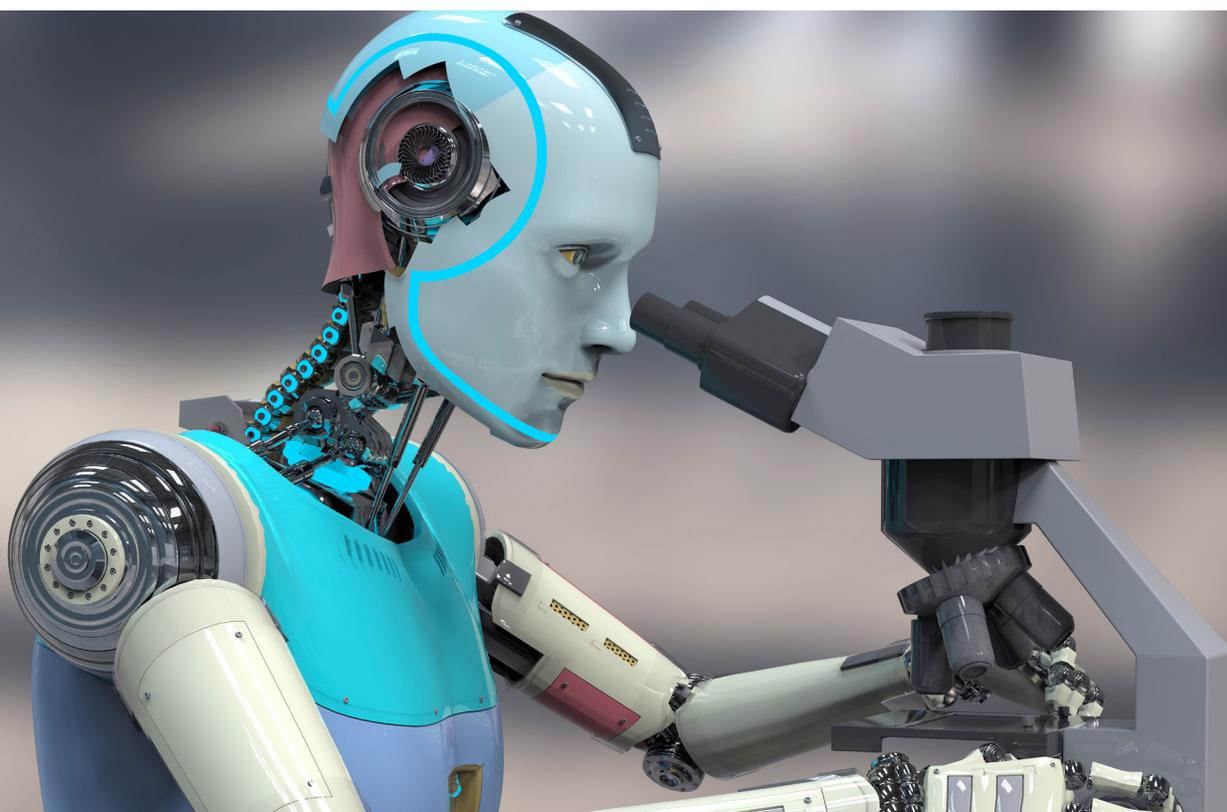
Addressing White Spaces and Filling Gaps

EHRs and other patient data face security risks and privacy concerns if they do not follow storage protocol. While the availability of massive data to pathologists, clinical statisticians, bio-informatics professionals, and other decision-makers can enable precision healthcare²¹, security vulnerabilities should not be overlooked. The NDHM and UHI projects must enforce regulations for the safe management of sensitive data. Besides, solutions for cost-effective, on-premises data storage, and affordable cloud infrastructure must be explored.

Along with regulations for data security, there is a greater need to implement CAP-recommended guidelines for WSI and other analyses for accurate data validation and reporting. Integrating

computational pathology (based on deep-learning AI algorithms)²² can enhance clinical and research outcomes, providing novel opportunities for precision diagnosis. This would have the potential to improve sensitivity and accuracy of diagnoses, reduce turnaround time, analyze complex clinical data, and detect sub-variants of a broad spectrum of diseases²³.

Adequate training and relevant upskilling for pathologists can help address the issue of resource scarcity and minimize reporting errors. The 2022 Survey Healthcare Global report finds that 34% providers worldwide²⁴ have observed increased errors due to shortage of skilled resources. The statistics could be starker in India.



A Holistic Healthcare Transformation through Digitalization

As we explore the emerging trends and the white spaces in AI-led pathology, it is clear that digitalization and AI hold the promise of revolutionizing this critical industry. Digitalization is expected to have a positive impact on overall healthcare with data banking, cloud laboratories, and deep-learning assisted pathology fast becoming a part of AI-led pathology. These trends are expected to lead to the increased adoption of teleconsultation, prevalence of predictive healthcare, and growth of smart medical wearables. Big data will play a significant role in healthcare by reducing medical errors and optimizing care. AI will also play a key role in personalized treatments, while providers could take to virtual reality for near-real consultations and health management.

The future of healthcare requires a holistic approach. Infosys has always championed the cause of improved healthcare and believes that care organizations can grow through unification and digitalization. In delivering harmony in healthcare through the power of connectivity, interoperability, and digitalization, our vision is to help create a future-ready one-world laboratory. Infosys Helix, the cutting-edge AI-powered suite of healthcare platforms solves specific problems, evolving with the needs and challenges of the industry.

Conclusion

The trajectory of AI in pathology demands collaboration between technology experts and healthcare providers. It is the combination of human expertise and technological innovation that can make healthcare holistic, patient-centric, and preventive. As we venture into a promising future, we must remember that setting the stage for a secure, standardized, efficient, and affordable healthcare system is important. With pathology significantly impacting the overall healthcare landscape, AI and its allied technologies must be used ethically and responsibly.

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