EURASIAN EXPERIMENT JOURNAL OF PUBLIC HEALTH (EEJPH)
ISSN: 2992-4081 **©EEJPH Publications**
Volume 5 Issue 2 2024

AI-Powered Diagnostics: Revolutionizing Pathology

Mugo Moses H.

School of Natural and Applied Sciences Kampala International University Uganda

ABSTRACT

The rapid integration of artificial intelligence (AI) into pathology is transforming diagnostic practices by enhancing accuracy, efficiency, and predictive capabilities. AI systems, particularly in image analysis and predictive analytics, have shown remarkable potential in identifying diseases such as liver steatosis, tumors, and kidney disease. This paper examines the advancements, challenges, and ethical considerations associated with AI-powered diagnostics in pathology. It discusses the benefits of automated image analysis and predictive analytics, while addressing concerns about AI's interpretability, bias, and the need for updated legislation. AI's role in enhancing pathology workflows, reducing discrepancies, and improving patient outcomes is explored, along with future directions for continued innovation.

Keywords: Artificial Intelligence (AI), Pathology, Diagnostic Imaging, Predictive Analytics, Machine Learning.

INTRODUCTION

The role of artificial intelligence in sharpening clinical diagnostics is currently one of the trending topics in the field of pathology. Most studies assert that an AI-powered system used for diagnostic purposes has the inherent advantage of not suffering from stress for longer working durations, rather than an incorporated deep and immunohistochemical assessment. As a subset of medical diagnostics, current studies on the potential pros and cons are secret to how this could transform the current traditional methods compared to praiseworthy innovations. Today, in diagnostics, do we need an AI integration that might skip an estimated percentage of advanced AI integration to focus on efficacious medico-economic parameters for its quantifiable efficiencies vis-à-vis its cost-effectiveness? Despite underlying discourse, AI is gaining attention to cross-check the accuracy rather than the precision in diagnostic procedures. The motivation for this discussion was to gain an expert's opinion on the current shift in structured pathology to AI-powered diagnostics in pathology. It outlines the perspectives of renowned experts who have conducted extensive research independently. A viewpoint to present this exciting, fast-emerging shift of AI in diagnostics in pathology has been taken. The overall impact that AI holds on diagnostics is multifold. It should also provide an answer to: (1) Why should AI and technologically sophisticated diagnostic equipment be implemented now? (2) Why will AI – if at all – be effective in minimizing discrepancies, and if indeed AI will, then how? [1, 2].

THE ROLE OF AI IN PATHOLOGY

The development of AI over the recent years has contributed to advancements in a range of fields, including pathology. Most of the AI developed for use in pathology focuses on image analysis to help with diagnosis or prognosis. Progress in this area has stemmed from factors such as the development of algorithms that can process large amounts of data quickly, as well as the availability of vast data sets that have been accumulated for various fields. Computer systems have numerous advantages over humans when processing visual data. Characteristics that a machine can detect at the cellular level can be used in combination with other factors to support diagnosis [3]. Many common pathogenetic factors, such as liver steatosis or inflammation, can be identified using cellular analysis in the liver. As a result, AI tools applied in the field are more numerous. Other areas with successful AI implementation include liver tumors, kidney disease, gynecological disease, urological disease, and duodenum and stomach disease. AI is commonly associated with automated image analysis. The progressive introduction of whole slide imaging systems into pathology laboratories in the last 10 years has made a more streamlined workflow for image acquisition and is allowing artificial intelligence to be utilized to aid and streamline the report model. Another potential use of AI currently being developed is in the area of predictive analytics. By combining data from a variety of sources, algorithms can be developed that have the potential to predict disease progression as well as patient prognosis and treatment responses. Further to this, AI has a potential role in supporting a histopathologist's diagnosis at a collegial level [4].

AUTOMATED IMAGE ANALYSIS

Automated image analysis in pathology is crucial for AI applications. It can analyze complex histopathological images with high correlation to expert pathologists. This technology reduces classification variability and allows pathologists to focus on challenging cases. Real-time microscopy image processing can prompt pathologists for optimal classifications. Tools for image processing and classification are available with a user-friendly interface and no programming knowledge required [5].

PREDICTIVE ANALYTICS

Predictive analytics uses AI to predict future outcomes based on current or past data. In pathology, it can forecast disease states, treatment responses, complications, and suggest treatment options. Genomic data integration allows for more accurate predictive models. Predictive tools are being developed for various diseases. However, accuracy and data quality are limitations. Predictive models can guide pathologists in improving assessment and reporting. Data completeness is crucial for reliable models. Privacy concerns and biases can also limit implementation. Verification sets can check model accuracy. The benefits include personalized treatments and improved testing accuracy [6].

CHALLENGES AND LIMITATIONS

The potential of AI in digital pathology for disease diagnosis has initiated exciting conversations across multiple disciplines. As a result, high-quality whole-slide images have been made available to train robust AI models in the past decade. However, several complex issues must be addressed for the wider adoption of AI in pathology. For instance, there are requirements for training AI systems with high-quality samples and data for development and validation, as well as an established protocol to train algorithms robustly. Additionally, concerns have been raised about the inability of current AI systems to interpret some image features to provide molecular and cellular context, which are very subtle and complex at times [7, 8]. Furthermore, there is a challenge regarding the interpretation of AI-generated conclusions given the 'black box' nature of AI. Also, traditional pathologists might feel threatened about losing their roles and positions to deep learning algorithms, which is perceived as a challenge to the successful integration of AI into clinical practice. Moreover, one should not ignore the issue of job displacement, efficiency, and the added value of deep learning systems or any AI solutions and the cost of investment that are associated with deploying these technologies in clinical practice versus the risks to patients. More importantly, legislation and standards must be reviewed and updated to support the integration of AI diagnostic tools with continuous advancements. These challenges and limitations articulate the pressing need to address them for the realization of the full potential of AI in revolutionizing the field of pathology [9].

ETHICAL AND LEGAL IMPLICATIONS

AI decision-making frameworks are decided based on the input data they are trained on, and if the data itself holds biases, it is highly likely that the final decision-making prompts will also adopt biases. This is a major concern in pathology, as the training data is composed of previously diagnosed clinical cases and is thus likely to contain biases related to, for example, racial or age factors that exist in the healthcare system. Furthermore, it is possible that the use of AI in diagnostic procedures, such as patient consent and prognosis, could limit patient care or worsen patient outcomes, as AI could be justified as simply following the data, removing the clinical need for precise prognostication or diagnosis based on new or novel patient presentations. Patient autonomy is also a major area of concern, as AI interventions in pathology do not require patient consent, although it is a key role in the patient interaction with healthcare. The duty for transparency also applies to healthcare professionals, who will require training in AI technologies to understand the strengths and limitations of the device, especially in the event of an error in diagnostic analysis or output; albeit this could be a weakness of the result. Patient-related data is particularly protected within the healthcare sector, and as such, companies and healthcare professionals must adhere to the Data Protection Act and General Data Protection Regulation when storing and using patient-derived data. The extent to which AI constitutes a 'data controller' is currently undecided within the UK, unless under instruction via NHS Digital or UKRI, which is also a further aspect that needs to be addressed for compliance with working within the legal frameworks. AI technologies will also need to be monitored similarly to other healthcare technologies following post-marketing surveillance and adverse event reporting. But as well as the technical and legal aspects of AI implementation, there is a pressing need to establish guidelines concerning when and how such technologies should be used and integrated into patient care. Medical ethical guidelines that govern expectable uses for AI technologies are possibly of equal, if not greater, importance in governing the safety and trustworthiness of such devices in clinical implementation. A lack of public trust in AI technologies would lead to limited use and adoption of such devices within pathology, limiting opportunities on a path towards personalized medicine [10, 11].

FUTURE DIRECTIONS

Ibas et al. summarize the current and potential use of AI tools for pathologic diagnoses in various organs, and the different computational tools used to develop these algorithms. Comparing experience from different research groups reveals a general accuracy of above 90% for tumor detection, grading, and subtyping across different organ systems, demonstrating real-world applications of developments in the field. This section looks ahead to the future, examining the next steps of where this field will go [12, 13]. It is clear at this stage that AI algorithms are developing at a rapid rate, and that gradually it will become normal for pathologists to integrate them into their practice. Indeed, the AI-diagnostic development pipeline with a particular clinical application has been a popular approach in the field, demonstrating a degree of statistical sophistication and interest in the design of the diagnostic tools themselves. Indeed, algorithm improvement has been a core theme in AI-enabled diagnostics in surgical and molecular pathology, and current research is investigating improving digital diagnostics using novel data sources and algorithms. Additionally, interpretation of MSI status using CNNs of histopathologic images is significantly superior to image-based and HE macroscopic-based subjective evaluation of tumor tissue preparations in colorectal surgery. Similarly, the integration of deep learning and computational methods with epigenomic and transcriptomic data is a widely discussed research area in major journals. Thus, while AI-histopathology collaborations may not be "newly forged fields" or "paradigm shifting" in and of themselves, these again are examples of insightful works that bring in contributions from other disciplines in a highly useful manner. A section linking more specifically to the broader theme of how pathology and AI promote synergistic innovation would be apt, because these cutting-edge approaches, which are motivated by computational improvements, underline the future of the field [3].

CONCLUSION

AI-powered diagnostics represent a pivotal advancement in the field of pathology, offering significant improvements in accuracy and workflow efficiency. Automated image analysis and predictive analytics are key areas where AI demonstrates high utility, supporting pathologists in handling complex cases and predicting disease outcomes. However, ethical and legal challenges, including issues related to bias, data privacy, and transparency, must be addressed for AI to fully integrate into clinical practice. With continued development and refinement, AI has the potential to revolutionize pathology, providing personalized diagnostics and ultimately improving patient care. The future lies in synergizing AI with traditional pathology for more precise, cost-effective, and comprehensive diagnostic solutions.

REFERENCES

1. Palok TA, Ahmed S, Anim GK, Ratul SSB et al. Medical image reader powered by artificial intelligence. 2023. bracu.ac.bd

2. Wang L, Liu B, Xu S, Pan J et al. Ai auxiliary labeling and classification of breast ultrasound images. Journal of Image and Graphics. 2021. joig.net

3. Rakha EA, Toss M, Shiino S, Gamble P, Jaroensri R, Mermel CH, Chen PH. Current and future applications of artificial intelligence in pathology: a clinical perspective. Journal of clinical pathology. 2021 Jul 1;74(7):409-14. bmj.com

4. Ahmad Z, Rahim S, Zubair M, Abdul-Ghafar J. Artificial intelligence (AI) in medicine, current applications and future role with special emphasis on its potential and promise in pathology: present and future impact …. Diagnostic pathology. 2021. springer.com

5. Bankhead P. Developing image analysis methods for digital pathology. The Journal of pathology. 2022. wiley.com

6. Nam D, Chapiro J, Paradis V, Seraphin TP et al. Artificial intelligence in liver diseases: Improving diagnostics, prognostics and response prediction. Jhep Reports. 2022. sciencedirect.com

7. Baxi V, Edwards R, Montalto M, Saha S. Digital pathology and artificial intelligence in translational medicine and clinical practice. Modern Pathology. 2022. sciencedirect.com

8. Cui M, Zhang DY. Artificial intelligence and computational pathology. Laboratory Investigation. 2021. sciencedirect.com

9. Huang J, Neill L, Wittbrodt M, Melnick D, Klug M, Thompson M, Bailitz J, Loftus T, Malik S, Phull A, Weston V. Generative artificial intelligence for chest radiograph interpretation in the emergency department. JAMA network open. 2023 Oct 2;6(10):e2336100-. jamanetwork.com
10. Belenguer L. AI bias: exploring discriminatory algorithmic decision-making models and the application of possible machine-centric solutions adapted from the pharmaceutical .... AI and Ethics. 2022. springer.com
11. Landers RN, Behrend TS. Auditing the AI auditors: A framework for evaluating fairness and bias in high stakes AI predictive models.. American Psychologist. 2023. apa.org
12. Assarzadegan N, Montgomery E. What is new in the 2019 World Health Organization (WHO) classification of tumors of the digestive system: review of selected updates on neuroendocrine neoplasms, appendiceal tumors, and molecular testing. Archives of pathology & laboratory medicine. 2021 Jun 1;145(6):664-77. allenpress.com
13. Saba T. Recent advancement in cancer detection using machine learning: Systematic survey of decades, comparisons and challenges. Journal of infection and public health. 2020. sciencedirect.com

CITE AS: Mugo Moses H. (2024). AI-Powered Diagnostics: Revolutionizing Pathology. EURASIAN EXPERIMENT JOURNAL OF PUBLIC HEALTH, 5(2):13-16