Review Article

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Artificial Intelligence in Diagnostic Pathology

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Abstract

Pathology is the discipline of diagnosing a disease mostly through analysis of tissues cell and body fluid samples. Over the past few years, deep learning has created quite a hype about artificial intelligence in healthcare. The practice of diagnostic pathology has gone through a transformation wherein new tools such as digital imaging, advanced artificial intelligence algorithms and computer aided diagnostic techniques are being used for assisting, augmenting and empowering the computational histopathology and AI enabled diagnostics. This is paving the way for advancement in precision medicine in cancer. In this article, the milestones and landmark trials in computational pathology are discussed along with emphasis on future directions.[5]

Keywords: AI; WSI; Digital Pathology; ML.

INTRODUCTION

In the ever-evolving landscape of medicine, digital pathology (DP) has emerged as a powerful ally in the field of cancer diagnostics. Imagine a world where pathologists can harness cutting-edge technologies to enhance accuracy, speed, and precision in diagnosing diseases. This is precisely where AI steps onto the stage.[1]

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Artificial Intelligence is expected to have a profound effect on the practice of medicine in the next ten years. In particular medical imaging is already being transformed by the application of AI solutions. Such AI solutions can automate manual tasks in medical image analysis but can also be used to extract information that is not visible to human eye. Digitized histopathology images contain a wealth of clinically relevant information that AI can extract. For example, deep convolutional neural networks have been used to predict molecular alterations of cancer from routine pathology slides.

Artificial intelligence applications have enabled remarkable achievements in healthcare delivery. These AI tools are often aimed to improve accuracy and efficiency of histopathology assessment and diagnostic imaging interpretation, risk stratification (in prognostication) and prediction of therapeutic benefit for personalized treatment recommendation.

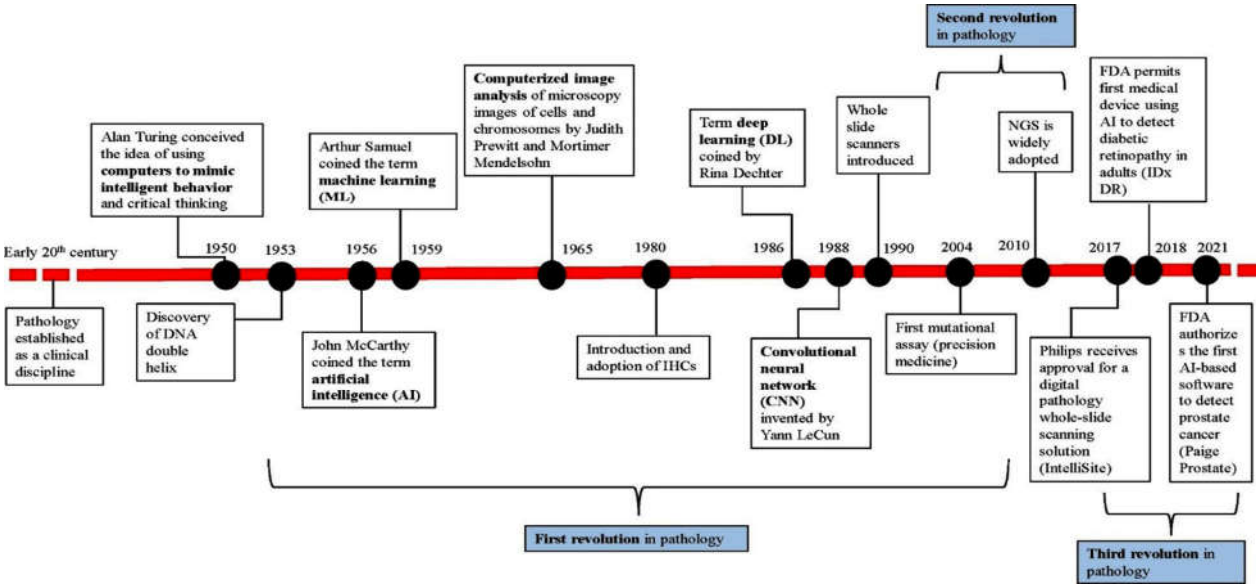
The Transformation of Diagnostic Pathology

Traditionally, pathologists have relied on manual examination of glass slides under microscopes. However, this practice has undergone a staggering transformation. New tools have emerged, including:

1. **Digital Imaging**: High-resolution images of entire glass slides are now captured using automated whole slide imaging (WSI) scanners. These images serve as the foundation for computational analysis.
2. **Advanced AI Algorithms**: Machine learning algorithms, particularly convolutional neural networks (CNNs), are revolutionizing diagnostic processes. They learn from vast datasets, recognize patterns, and assist pathologists in making accurate diagnoses.
3. **Computer-Aided Diagnostic Techniques**: AI tools go beyond human capabilities. They assess subjective features, quantify cellular characteristics, and even identify subtle patterns that elude human eyes.

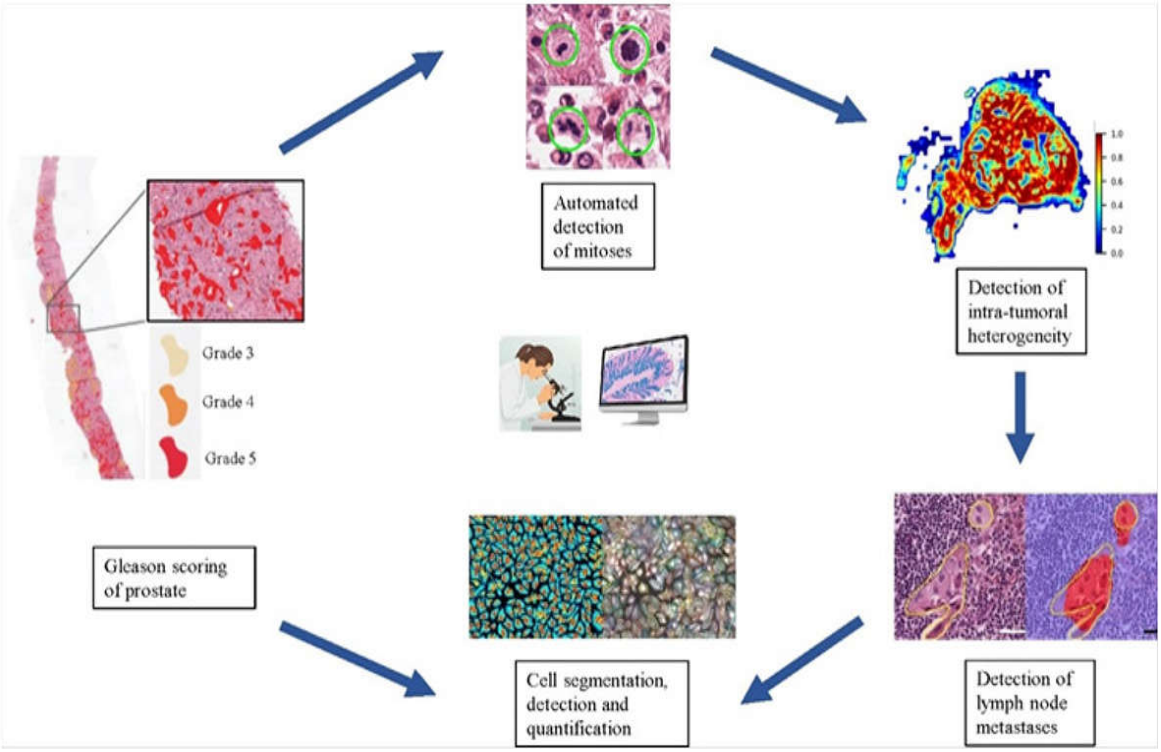
BACKGROUND

Pathology is the discipline of diagnosing a disease mostly through analysis of tissue, cell and body fluid samples. The examination starts with a biopsy. Some important milestones in computational pathology are as follows:



- **1950**: Alan Turing conceived the idea of using computers to mimic intelligent behaviour and critical thinking.
- **1956**: John McCarthy coined the term artificial intelligence.
- **1959**: Arthur Samuel coined the term machine learning (ML) as the ability to learn without being explicitly programmed.
- **1960**: Prewitt and Mendelsohn scanned images from blood smear and reported a method to convert optical data into optical density values.
- **1965**: Computerized image analysis of microscopy images of cells and chromosomes by Judith Prewitt and Mortimer Mendelsohn.
- **1986**: Term deep learning (DL) coined by Rina Dechter
- **1988**: Conventional neural network (CNN) invented by YannLecun.
- **1990**: Whole slide scanners introduced.
- **1998**: Tripath becomes the first company with an automated PAP smear screening product to receive FDA approval.
- **2003**: Cytyc received FDA approval for their ThinPrep Imaging System.
- **2013**: Development of photoacoustic microscopy imaging technique.
- **2017**: Philip receives approval for a digital Pathology whole slide scanning solution.
- **2018**: FDA permits first medical device using AI to detect diabetic retinopathy in adults
- **2021**: FDA authorize the first AI based software to detect prostatic cancer.

Depiction of Artificial Intelligence and Machine Learning approaches currently used by Pathologists to analyze images from Tumors[2]



Role of AI in Pathology

AI methods are being increasingly used in pathology for a wide variety of image analysis and segmentation type of tasks. These include object recognition of cells etc as well as image pattern recognition for predicting disease diagnosis prognosis and therapeutics.

AI has helped with creating morphometric analysis methods which can facilitate quantitative histomorphometry (QH) analysis approaches for detailed spatial configuration (e.g. - capturing nuclear orientation, texture shape and architecture) of the entire tumour histologic landscape from a well stained H&E slide. These AI applications primarily aim to automate tasks that are time consuming for pathologists thereby aiding prompt and accurate diagnosis.

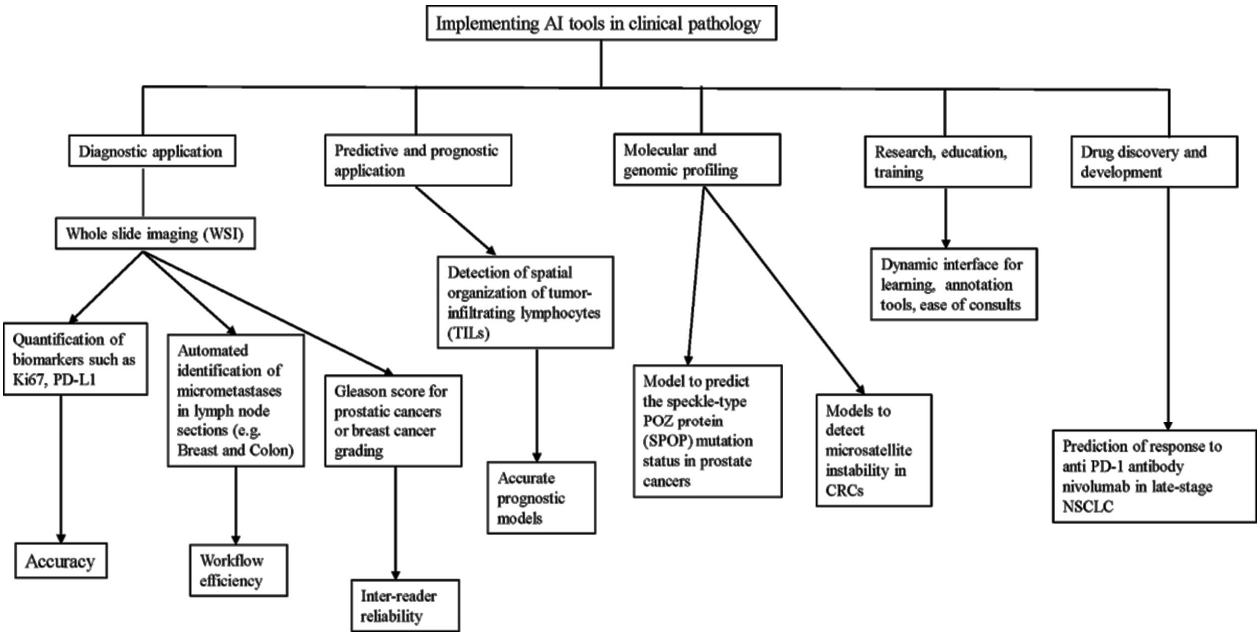
Automated Whole Slide Imaging (WSI)

WSI is a game-changing technology that digitizes entire glass slides, revolutionizing how pathologists analyze tissue samples. There are the essential points to consider:

1. ***Definition and Purpose:***
   a. WSI involves scanning entire glass slides at high resolution to create digital representations.
   b. The goal is to replace traditional microscopy with digital images for diagnostic purposes.
2. ***Implementation Considerations:***
   a. Technical and Cost Factors: Implementing WSI requires careful planning. Consider factors like scanner compatibility, informatics infrastructure, and costs.
   b. Pathologist Oversight: Pathologists' input during planning is crucial. They ensure that scanned slides meet diagnostic standards.
   c. Validation and Documentation: Follow guidelines (e.g., College of American Pathologists) to validate WSI systems for clinical use.
3. ***Clinical Applications:***
   a. Digital Archival: WSI enables long-term storage of digital slides.
   b. Collaboration: Pathologists can share and discuss cases remotely.
   c. Telepathology: Real-time consultation across geographical boundaries.
   d. Primary Diagnosis: FDA-approved

WSI scanners are now used for primary diagnosis.

e. Image Quantification: AI-powered tools quantify features like immunohistochemical biomarkers and tissue characteristics.



An overview of the challenges and Roadblocks Encountered during various steps of using Artificial Intelligence tools in Pathology[1]

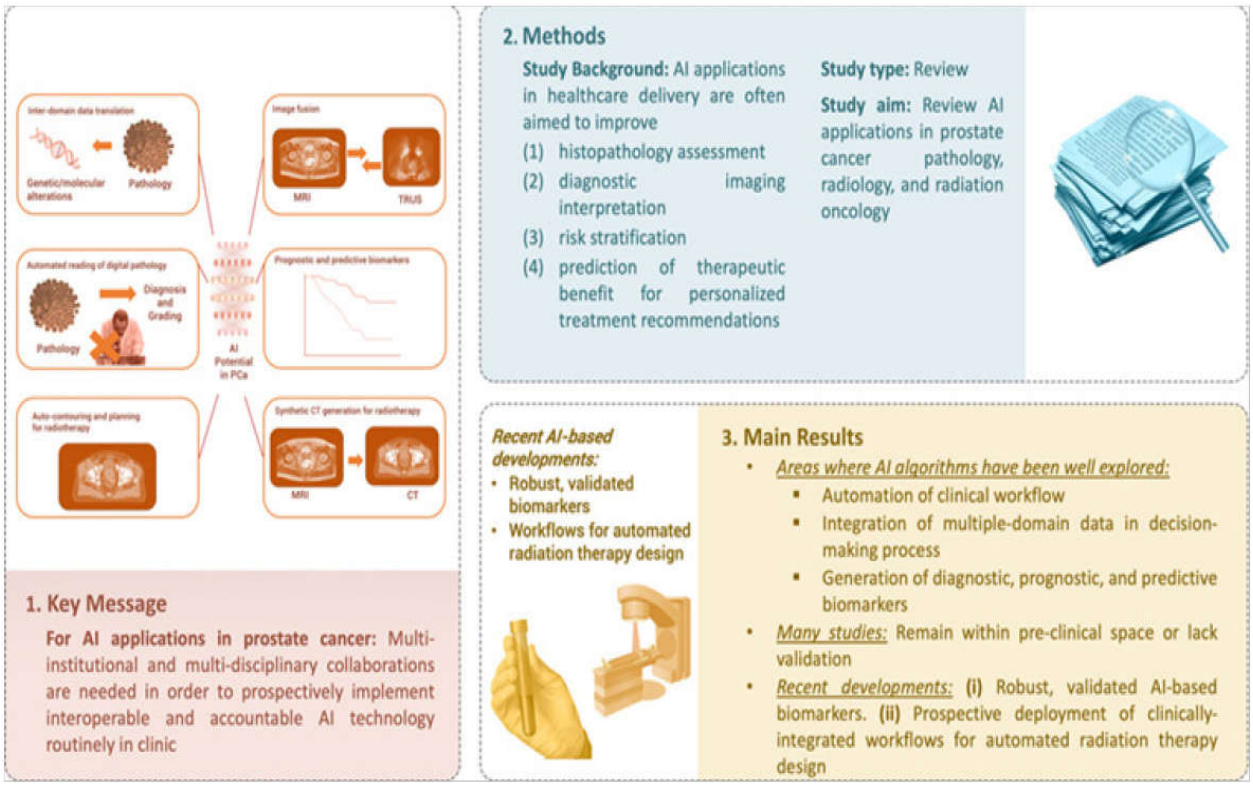
Process involved in interpretation of AI tools in Pathology	Challenges and roadblocks
Identification of needs	Incorrection assessment of endorser and demands, small market size of AI usage, lack of awareness of possibilities of use
Collaborative interdisciplinary efforts	Lack of coordination between different players, discordance in goals of participants
Study concept design	Scientific background /rationale, funding, ethical approval
Development of algorithmic models	Preanalytical &analytical factors, lack of objective ground truth
Optimization, validation and standardization	Lack of appropriate validation dataset, overfitting
Interpretability	Lack of interpretability &generalizability, black box tissue
Data curation	Difficulty in obtaining well curated annotated data
Regulation/approval	Lack of clearcut regulatory guidelines
Installation	Pathologists' resistance to changes in old workflow, IT Infrastructure investment and overhead costs
Accreditation	No external quality assurance scheme, unestablished audit cycles.
Reimbursement	Lack of dedicated procedure codes
Clinical Adoption	Lack of FDA approval for use of AI, skepticism among Pathologists and Oncologists
Computation System and data storage	Need for powerful high specification hardware Cost benefit ratio consideration

CONCLUSION

Digital Pathology is very promising in cancer diagnostics providing additional tools for faster, high quality accurate diagnosis. The practice of diagnostic pathology has gone through a staggering advancement via artificial intelligence (AI) algorithms, and computer aided diagnostic techniques which are being used for assisting,

augmenting and empowering the computational histopathology and AI enabled diagnostics. Automated whole slide imaging (WSI) scanners are now providing high resolution images of entire glass slides and combining these images with innovative digital Pathology tools is making it possible to integrate imaging into all aspects of Pathology reporting including anatomical, clinical, and molecular Pathology. The recent approvals of WSI scanners for primary diagnosis by the FDA as well as the approval of Prostate AI algorithm has paved the way for starting to incorporate this exciting technology for use in primary diagnosis.

AI tools can provide a unique platform for innovations and advances in anatomical and clinical Pathology workflow.



Future Directions[4]

By integrating digital imaging, AI algorithms, and clinical data, we're paving the way for precision medicine. Imagine a future where AI assists in standardizing histological scoring criteria, handles rare and complex cases, and augments pathologists' expertise.

REFERENCES

1. Shafi, S., & Parwani, A. V. (2023). Artificial intelligence in diagnostic pathology. Diagnostic Pathology, 18(109).
2. Artificial intelligence (AI) in medicine: Transforming the practice of surgical pathology. (2021). Diagnostic Pathology.
3. AI-Enhanced Digital Pathology and Radiogenomics in Precision Medicine. (2023).
4. Current and future applications of artificial intelligence in pathology diagnosis. (2021). Journal of Clinical Pathology.
5. Pathology AI {Artificial Intelligence} Reference Guide by Holger Lange and Cris Luengo , Flagship Biosciences Inc.