SHORT COMMUNICATION

Systematic Analysis of Artificial Intelligence in Pathology

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Abstract

Introduction: Artificial intelligence (AI) is an emerging modern technology within the health care sectors in the current era and it is the ability of computer software to mimic human judgment. Artificial intelligence (AI)-based modern image analysis methods have significant promise for enhancing the accuracy and efficacy of pathology diagnostic processes as well as for the discovery of new biomarkers.

Objectives: In this article, we will discuss Artificial Intelligence, its usage in pathology in various ways such as for screening of various diseases, detection of prognostic markers or biomarkers, and various treatment modalities.

Materials and Methods: Data were collected and analyzed from the recently published literature and electronic database searches of Cochrane and included the articles the year 2017 to 2021 by reading the title and the abstract. Artificial intelligence (AI), has a lot of potential for aiding in diagnosis with the advancement of information technology. For this purpose, few machine learning algorithms have been created to date. Given their capacity to evaluate complicated data in a quantitative and standardised manner to further improve the precision and scope of diagnoses, artificial intelligence (AI) or machine learning technologies hold great promise for the field of pathology.

Conclusion: The application of Artificial Intelligence tools in pathology has sharply increased in this era and it is anticipated to revolutionize the pathology field in the years ahead and can change the way the field of pathology is managed and make them not only more systematic but also effective in meeting the needs of the current age of precision medicine.

Keywords: Artificial Intelligence, Digital imaging, Machine learning, Whole slide imaging, Oral Cancer

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Introduction

An Artificial Intelligence (AI) system is a computer-based analysis that performs tasks that usually require human intelligence. The role of AI in various fields is constantly expanding. These systems are powered by various learning methods such as machine learning (ML) and deep learning (DL)[1]. Pathology is one such area in which AI impact will be seen. In this article, we discuss AI, and its usage in pathology in various ways such as screening of various diseases, detection of prognostic markers or biomarkers, and various treatment modalities.

Objectives

The main purpose is to emphasize that Artificial Intelligence is more effective than manual methods in mass screening of population, early detection of malignancies, biomarkers and thus helping in effective treatment modalities.

Materials and Methods

Systematic analysis (SA): We have analyzed the records systematically. The database searched was Cochrane. The title abstract keywords used were "Artificial intelligence in pathology" and "Digital histopathology". We have included as many articles as possible during the year 2017 to 2021. We have selected the articles by reading the title and the abstract.

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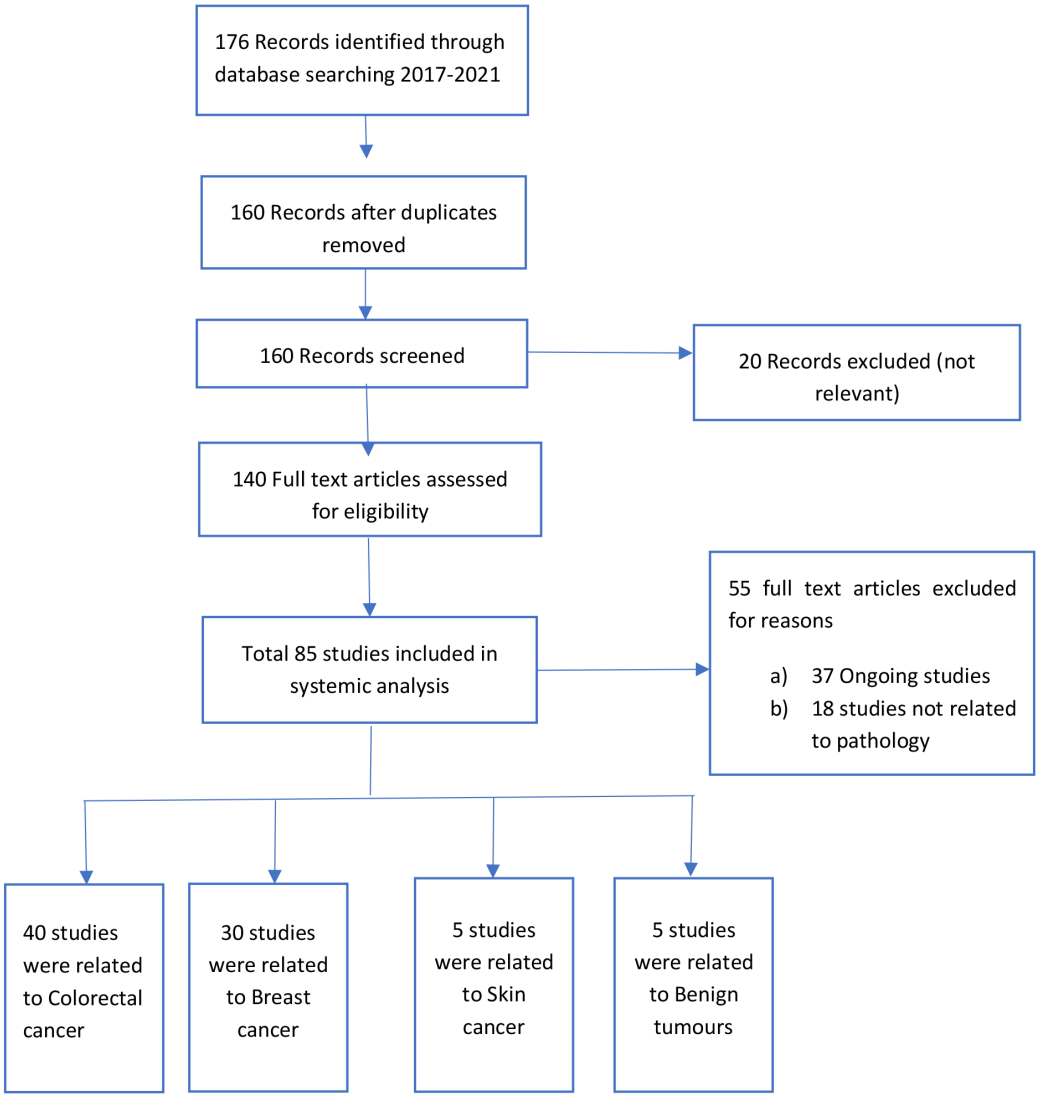
Results

In our analysis of records, the AI has wide application in colonoscopy, a diagnostic procedure of diseases involving the colon and colorectal areas (Table 1). Few other areas of AI usage are AI-mediated endoscopy in the diagnosis of gastric cancer and identifying the diagnostic markers in benign tumors like adenomas, melanoma, etc., In oral pathology whole slide imaging is one of the methods of AI which will help in overcoming limitations of a manual method such as inter-observer bias, errors in diagnosis, excessive time consumption, etc.

Discussion

Artificial intelligence (AI) is the most recent advance in the medical field and it has the potential to revolutionize pathology. AI is divided into two learning methods such as machine learning (ML) and deep learning (DL).[1] In our systematic analysis we have found that computer-based decision-making has the potential to revolutionize the medical field by performing multiple tasks that are usually assigned to specialists by increasing diagnostic accuracy, the efficiency of thorough inputs, better-streamlining workflow clinically, decreasing human resources, and improving treatment modalities. Clinically AI can be used to apply modern machine learning techniques to digital imaging which helps in capturing cells or tissue structures, also has its way of usage in radiology which will eventually help in diagnosing various diseases.[2,3] In our analysis of records, AI has its wide application in colonoscopy, a diagnostic procedure for diseases involving the colon and colorectal areas. Few other areas of AI usage are AI-mediated endoscopy in the diagnosis of gastric cancer and identifying the diagnostic markers in benign tumors like adenomas, melanoma, etc.[4]

In oral pathology whole slide imaging is one of the methods of AI which will help in overcoming limitations of a manual method such as inter-observer bias, errors in diagnosis, excessive time consumption, etc. In countries like the USA, the biopsies performed in the prostate cancer were approximately one million, only 20% of them are found to be positive for prostate cancer.[5,6] This tells us that pathologists are spending ample time diagnosing benign tissue that can be easily differentiated from malignancy. This implies the need for Artificial intelligence which is the computer-aided diagnosis that helps in focusing more on difficult-to-diagnose cases. Das et al. in 2015, developed an AI method, i.e., an automated segmentation method to identify keratinization and keratin pearl from oral histopathological digital images.[7] They have found 95.08% accuracy in comparison with the conventional method. This necessitates the further need for an AI classification system for the analysis of histological features for consistent, rapid, and quantitative cancer diagnosis.[8] There is also an ongoing project on the Mobile Mouth Screening



Anywhere (MeMoSA) app from Kingston University (U. K.) and the University of Malay (Malaysia).[2,3] This app captures images of the oral cavity and the trained Deep Learning system differentiates the thousands of photos with and without the signs of oral cancer which will help in the early detection of oral cancer.

In oral pathology, AI helps to accurately diagnose Oral Cancer (OC) by thoroughly examining a vast array of pictures (fluorescent, hyperspectral, cytology, CT imaging, etc.). The two stages of AI's operation are "training" in the first stage and "testing" in the second. The parameters of the model set are determined by the training data. Retrospectively, the model makes use of data from earlier examples, such as patient data or data with other examples. The test sets are then subjected to these criteria. AI can identify many biomarkers from studies that have outlined the prognostic aspects of OC. The patient survival rate and appropriate treatment treatments are improved by early detection of the malignant lesion. Numerous experiments have been done utilizing image analysis to develop AI-based OC detectors for smartphones. The diagnosis, treatment, and management of patients with OC are made easier by AI technology. Workload, complex data, and tiredness are all decreased by AI.[9]

AI technology has primarily been used to distinguish between normal, premalignant, and malignant conditions, predict oral cancer incidence likelihood, prognosis, early detection of pre-cancerous and cancerous lesions, predict the risk of recurrence, predict the possibility of disease development from the potential malignant lesion, and predict patient survival.[10]

Convolutional neural networks (CNNs) and artificial neural networks (ANNs) were used in a few investigations described in this systematic review (ANNs). The primary purposes of these neural networks were to evaluate patient records, high-resolution cytology pictures, hyperspectral images, autofluorescence images (AFI), and white light imaging (WLI).[11]

Sunny et al. conducted a study by ANN for the early detection of OC, using tele cytology (TC), which is a digitization of the cytology slides. The efficacy of AI was compared with conventional cytology and histology; 11,981 prepossessed images were loaded for AI analysis, based on the risk stratification model. Results showed an accuracy of 80–84% in diagnosis, with no difference in tele cytology and conventional cytology detection, however, potentially malignant oral lesions were detected with low sensitivity, using tele cytology. The ANN-based model showed improved malignant detection accuracy to 93%, and a potentially malignant lesion to 73%. The study used the brush biopsy method for sample collection, which is less invasive, and this factor should also be considered while detecting cancer.[12]

In our systematic analysis, many records have shown that AI can also be applied in the treatment of diseases involving joints and also in determining the prognosis by detecting the prognostic biomarkers.

Conclusion

The application of AI tools in pathology has sharply increased in this era and it is anticipated to revolutionize the pathology field in the years ahead. AI tools can be recognized as an exemplary shift that can change the way the field of pathology is managed and make them not only more systematic but also effective in meeting the needs of the current age of precision medicine. Pathologists and AI tool users should have ample training and great input to enhance the adoption of these technology-driven applications. AI and pathologists' collaboration can yield results that are timely, consistent, and useful beyond a human's ability. AI applications will also emerge as an advanced diagnostic approach to life-debilitating diseases like cancer. The integration of AI will help in advancing the future of precision oncology which results in personalized treatment planning. Yet one should never forget that pathologists who can provide feedback and assess the system's performance and their advice, knowledge, and supervision are essentially more important and can be the best equipped to interpret the histopathological findings with the help of AI.

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