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Artificial Intelligence in Bladder Cancer Diagnosis and Treatment

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Abstract

As medical science and technology advance toward the "big data" era, a multi-dimensional dataset pertaining to medical diagnosis and treatment becomes available for mathematical modelling. However, these datasets are frequently inconsistent, noisy, and have a high degree of redundancy. As a result, extensive data processing is widely recommended before feeding the dataset into the mathematical model. Artificial intelligence techniques, such as machine learning and deep learning algorithms based on artificial neural networks and their variants, are being used in this context to generate a precise and cross-sectional illustration of clinical data. Datasets derived from prostate-specific antigen, MRI-guided biopsies, genetic biomarkers, and the Gleason grading are primarily used for diagnosis, risk stratification, and patient monitoring in prostate cancer patients.

Keywords: Artificial intelligence • Clinical diagnosis • Diagnosis • Prostate cancer

Introduction

Prostate cancer is the second most common type of cancer in men and the most common cancer type in the United States. In 2020, WHO released cancer statistics and PC cases from the entire dataset. PC was also identified as the most common disease among Afro-American races. The mortality rate was discovered to increase with an individual's age, so it is most prevalent among people over the age of 66, accounting for more than 55% of all deaths. Prostatic hyperplasia is a condition in which the size of the prostate gland increases with age. BPH symptoms include frequent urination, which is caused by bladder compression caused by an enlarged prostate.

Description

Age and race were associated risk factors for PC, according to data from the surveillance, epidemiology, and end results population registry. Other factors that have been linked to the onset of PC include genetic mutations in the BRCA2 gene, family history, smoking, obesity, and eating high fat-containing foods. A history of prostatitis, inflammation of the prostate gland, and the use of drugs that inhibit 5 alpha-reductase, which is used to treat BPH, are also risk factors for PC. Patients with PC do not exhibit major symptoms during the initial stage, with the exception of common complaints about difficulty urinating, frequent urination, and nighttime urination, which are similar to those of BPH. Symptoms such as urinary retention and back pain are frequently indicators of the disease. Furthermore, back pain is an indicator of the metastatic stage of PC, indicating that it has spread to the bones [1].

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The needle biopsy Gleason score correlates with pathological variables such as radical prostatectomy margin status, prostate specific antigen levels, tumour volume, and related molecular markers. The human eye cannot easily detect scoring method errors due to ink on the slides, cutting artefacts, and the presence of rare cancer subtypes. Furthermore, in several cases, the Gleason score understates the severity of the disease. Nagpal et al. developed a DL-based model to improve the Gleason score for prostate cancer slides obtained during prostatectomies in this context. When the results were compared to the diagnostics and grading of 29 expert urologic pathologists, the reported accuracy on the validation dataset was 0.61 [2].

Convolution neural networks are used to improve the accuracy of the Gleason pattern and Gleason grading-based classification of prostate cancer histopathological samples. The algorithm was created to improve the accuracy of PC diagnosis after an expert pathologist reported numerous errors in the manual grading method. The algorithm was trained on 96 tissue specimens from digitised slides from 38 patients' biopsies. However, with fewer training datasets, the study overestimated the accuracy. The CNN method has been designated as the best algorithm for image classification. However, due to the slower calculation in the maxpool layer, the speed of the CNN-based training is a concern [3].

Deep learning methods must be widely used in the diagnosis and treatment of prostate cancer. Several DL implementations that aid urologists in diagnosing PC at various stages have recently been published in peer-reviewed journals. an overview of the various models used in recent research, as well as their evaluation matrix (area under curve score, AUC), which indicates their accuracy in detecting prostate cancer. The two major limitations of these computer-aided detection techniques were identified as a small dataset and the lack of a federated learning strategy. Federated learning models can help to improve the process of gathering and sharing data for research purposes.

Given the rise in prostate cancer cases, there is a need for computer-based methods that use AI to improve and speed up the assessment of prostate MRI data. For the enhanced detection and bi parametric classification of prostate MRIs, an AI algorithm based on cascade deep learning was developed and applied the Prostate Imaging Reporting and Data System score. For model training, testing, and validation, the algorithm used a dataset of 1390 samples obtained at 3 Tesla. A radiologist also examined all of the samples. In detecting cancer suspicious lesions, the algorithm was found to have good detection and classification performance [4].

Pathological examination of biopsies and surgically removed tissues is essential for disease diagnosis and characterization. This in-depth examination of the tissue's morphological and molecular properties is critical in determining which therapies are most appropriate for patients. For many cancers,the biopsy-determined grade of the disease is used to stratify patients for clinical care, which can result in vastly different treatment pathways.The recent proliferation of digital pathology approaches in oncology and other areas has resulted from the use of whole slide imaging scanners by a number of hospitals and healthcare institutions that have begun digitising their entire pathology workflows, combined with rapid increases in computational power [5].

Conclusion

To collect relevant reports, this review article used an organised search approach in PubMed, using a search string of multiple keywords. The methodology described in this study is based on the creation of keywords and their combination with a logical operator. PubMed allows you to customise your search by using multiple filter criteria. The search was focused on the use of AI in prostate cancer. The application of artificial intelligence in the medical/treatment domain has been the subject of ongoing rigorous debate and controversy. However, recent technological advances in AI algorithms and data generation have made significant progress, primarily in the diagnostic and treatment domains.

Furthermore, diagnostic and risk assessments are required for active surveillance studies and the early detection of prostate cancer. AI has reduced the subjectivity of the result and enabled tests to be conducted with fewer resources while improving overall competence and precision. The FDA has approved the use of artificial intelligence in the detection of prostate cancer. This method has a lower risk of false negatives because it is performed by doctors and pathologists who consider laboratory studies, patients' histories, and other relevant clinical information. AI-assisted diagnostics in PC biopsies can improve the outcome while lowering the cost and time involved. However, AI is used to reduce the likelihood of missing actual positive cases rather than to replace human expertise in detecting PC.

Acknowledgement

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Conflict of Interest

There are no conflicts of interest by author.

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