Chapter 3
Revolutionizing Early Cancer Diagnosis Using Artificial Intelligence: A Systematic Review

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ABSTRACT

Early cancer diagnosis significantly improves treatment outcomes and survival rates. While traditional diagnostic methods face challenges in accuracy, speed, and accessibility, artificial intelligence (AI) offers transformative solutions. AI models, particularly machine learning (ML) and deep learning (DL), excel at learning complex data patterns to predict early-stage cancer, enhancing existing diagnostics. This review examines the scope of AI in early cancer detection, analysing studies categorised by cancer type, diagnostic modality, AI methodology, and performance. AI consistently demonstrates superior sensitivity and specificity compared to conventional methods, especially in radiology, pathology, and genomics. Despite promising advancements, further exploration and collaborative efforts between clinicians, researchers, and technologists are crucial to address limitations and ensure effective clinical implementation.

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1. INTRODUCTION

Early detection of cancer has acquired immense exposure among other researchers, clinicians and oncologists to enhance the survival rate and cure. Due to the development of oncology, along with the introduction of advanced methods, the procedure of cancer diagnosis has been dramatically changed. As stressed in many pieces of evidence, screening can be used to detect cancer at early stages and decrease mortality (Crosby et al., 2022). Nevertheless, despite successful screening, a doubt about the accuracy of diagnostics persists. Majority of the existing screening procedures use a single proven model which usually collides with the concepts of personalised medicine (Maroni et al., 2021). One of the challenges is the identification of the right patients to screen using relevant risk factors. The diagnosis process has also been automated under conditions of artificial intelligence (AI) techniques, which have led to the precise diagnosis of cancer tumours (Houssami et al., 2019) . Artificial intelligence (AI) approaches of ML and DL have been demonstrated to be effective to address complicated medical problems, such as cancer detection and diagnosis. These models can become a significant contribution to the enhancement of these processes in the near future (Dembrower et al., 2020; Tharwat et al., 2022; Hirsch et al., 2025) . Also, AI may enhance the diagnosis of cancer through automation of clinical practices founded on clinical data of individuals who undergo screening, especially in case of limited resources (Bi et al., 2019).

Previously, a number of studies have surveyed the role of AI in early detection of different types of cancer (Cheung and Rubin, 2021; Jones et al., 2022). AI models have better potential of classification of cancer into various types with the highest accuracy. The usefulness of these models was confirmed in a number of studies, and the utilization of AI should be properly studied to make it more useful in the healthcare systems. Given the eminence of AI, the current review paper discusses the role played by these models in enhancing the process of early cancer diagnosis.

1.1 Importance of Early Cancer Diagnosis and Challenges

Early cancer detection is of utmost importance in enhancing the outcome of patients by boosting their survival chances and facilitating its timely and less expensive treatment while minimizing the risks of the disease (Fitzgerald et al., 2022). Some studies have suggested that the early detection of cancer greatly enhances the prognosis of cancer. Irrespective of its importance, there are certain critical issues associated with early cancer diagnosis. Given the difficulty of detecting cancer in its initial stages, it is necessary to consider new methods, including AI in oncology, to address the problem and improve the efficiency of early diagnosis. To set the