



International Journal of Science, Architecture, Technology and Environment

Artificial Intelligence in Prostate Cancer Diagnosis and Early Screening: Ethical Challenges and Opportunities for Responsible Integration

Funmilayo Akinshawonu^{1*}

¹Science and Engineering Faculty, University of Hull, Cottingham Road, Hull, HU6 7RX.

*Corresponding author, F.AKINSHAWONU-2023@hull.ac.uk

DOI: <https://doi.org/10.63680/ijstate0925039.28>

Abstract

Ethical and responsible integration frameworks for artificial intelligence (AI) are debated within academic discourses. The rapid advancement of AI in prostate cancer diagnostics provides numerous medical benefits. However, concerns regarding bias and decision-making further complicate social, ethical, and legal aspects. There is a lack of empirical research on the views of diverse societal stakeholders. This study utilised a simulated dialogue forum with key stakeholders and ethicists to identify responsible integration strategies for AI in prostate cancer diagnostics. It examines the implications of developing AI solutions for diagnosis and screening, emphasising the need for public engagement and critical assessment of AI capabilities and responsibilities. Integrating social dimensions into AI remains underexplored, with a focus on the ethical and legal aspects of AI in the context of prostate cancer diagnosis. The dialogue forum's research design creates a unique environment that enables participants to engage with ethical, medico-legal, and social issues, fostering deeper involvement in policy design and public discourse.

Keywords: Artificial Intelligence; Prostate Cancer; Ethical Challenges; Responsible Integration

1. Introduction

Prostate cancer is the most common cancer among men in many countries [1]. However, existing methods for diagnosing prostate cancer are limited. The standard method of diagnosis, histopathological analysis of biopsies, is highly invasive and frequently fails to diagnose or exclude cancer in men with raised prostate-specific antigen levels [2]. As a result, most diagnostic biopsies are negative for cancer but are not risk-free, with 20–30% of men suffering serious harm such as sepsis and hospitalisation. Distributed diagnosis, the process by which cases are diagnosed by multiple different diagnosticians, consensus development, and then subsequent agreement or disagreement on the diagnosis, is a key feature of the single best biomarker for prostate cancer detection: second-opinion read-through of radiological images [3]. In this paper, we examine a topic that has received relatively little attention in the literature: the ethics of integrating and utilising artificial intelligence technologies to support human diagnosticians in prostate cancer diagnosis and the early detection of the condition in men. We consider the reasons why integrating artificial intelligence tools into

diagnostic and early screening pathways may be beneficial, the potential risks of using biased or overly trustworthy tools, and the responsibilities that health professionals who employ such tools in decisions affecting patients' lives may owe to their patients, to manufacturers, and their professional institutions. Figure 1 illustrates the progression of diagnostic advancements in prostate cancer, including digitised biopsies and AI systems that facilitate prognosis prediction and enhance treatment planning.

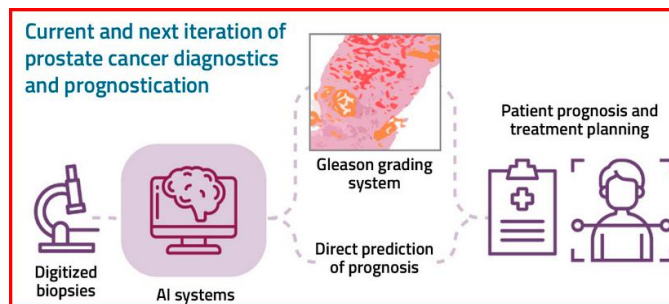


Figure 1: Current and Future Directions in Prostate Cancer Diagnostics and Prognostication.

1.1. Background

Efforts to harness the power of AI for early and accurate prostate cancer diagnosis are part of a growing trend in utilising AI for cancer detection and diagnosis [4]. The development and use of computer-aided detection or clinical decision support systems across various medical fields, although not without challenges, can potentially enhance clinical work [5]. The challenges associated with developing and integrating these intelligent systems are both technical and ethical in nature. Despite these promising aspects, significant hurdles remain in integrating AI into clinical pathways that may benefit from AI's potential. In the case of developing methods to detect prostate cancer based on imaging and other clinical parameters, for example, there remain significant clinical challenges concerning the trade-off between overdiagnosis and underdiagnosis of the disease, concerning the confinement of the diagnostic process to a specialised resource, and regarding the significant algorithmic variations and the lack of data-keeping centres [6]. These and other technical, ethical, and training challenges necessitate a thorough and ongoing examination of the host's needs and concerns, particularly for the ethical acceptance and responsible integration of AI and AI-like technologies in the clinical sector.

1.2. Methodology

We conducted a systematic literature review of articles from five research engines. Although the quality and quantity of the research are essential indices for evaluating effectiveness, the adoption of different websites has gained approval in studies based on similar previous findings. We analysed appropriate publications from 1975 to January 2021. This search received the matrix explicitly developed for review to guarantee that the essential manifestations of AI participation during diagnosis and early prostate cancer screening are addressed. The search string enables us to obtain the research results by submitting the acronym 'prostate +

2. Artificial Intelligence in Prostate Cancer Diagnosis

Prostate cancer is the most common solid cancer among European men, responsible for 375,000 new cases and 100,000 deaths in 2020 across Europe [1]. Cancer screening, through mammography for breast cancer,

cervical smears for cervical cancer, bowel tests for bowel cancer, and prostate-specific antigen tests, can help diagnose cancer early and is key to curing it. As such, considerable investment has been made to develop automated methods for detecting prostate cancer, including the use of artificial intelligence to analyse histological samples [7]. Several vendors have been awarded CE marks and FDA approval. At present, high rates of over-detection and low involvement of patients in determining whether they will be tested are limiting the expanded use of prostate cancer screening. These high rates of over-detection are driven by the relative insensitivity and lack of specificity of tests such as prostate-specific antigen, implying that tools to identify who would benefit from screening more accurately are fundamental to making it more useful. AI and machine learning methods may help in the identification of a small group of men at higher risk of death from prostate cancer among those with raised PSA, and this would be positive. However, the benefit of using these tools is linked to restrictions on prostate cancer over-treatment that, in turn, requires ethical reflection on the consequences, not only for the labelling of the advanced predictions as 'useful' or 'not useful' but also on the subsequent availability and use of them as practical tools for patient risk stratification[8].

2.1. Current Methods and Limitations

The current diagnostic methods for prostate cancer utilise various non-exclusive biomarkers or tests, which are associated with varying degrees of specificity and sensitivity for the disease and show limited effectiveness in cancer diagnosis [9]. Elevated levels of prostate-specific antigen typically lead to a prostate biopsy, which is the current gold standard for prostate cancer diagnosis. To date, prostate-specific antigen remains the most effective non-invasive test for diagnosing prostate cancer, with serum levels greater than 10 ng/ml being a predictor of tumour risk and disease recurrence[10]. A test with 90% specificity must be used to diagnose only 20 cancer cases, of which only 10 will be life-threatening diseases. Another diagnostic method is digital rectal examination, which, despite its association with adverse effects, remains an essential auxiliary tool for diagnosing prostate cancer. In preventive medicine, additional methods for detecting prostate cancer in patients with inconclusive tests or a pre-screening disease history include free-to-total prostate-specific antigen ratio, prostate-specific antigen velocity, and density.

Multipara metric magnetic resonance imaging (MRI) is proposed as a more accurate diagnostic tool for prostate cancer screening [11]. It has various clinical applications, including detection, lesion characterisation, biopsy, monitoring after negative biopsy, radiation therapy targeting, and detecting local recurrence and metastases. Currently, multipara metric MRI is the leading non-invasive imaging method for managing prostate cancer suspicion. However, it faces challenges: distinguishing benign from aggressive low-volume cancer, issues with prior biopsies, biopsy-related inflammation, cost-effectiveness, and limitations from comorbidities like bleeding or pacemaker insertion. Therefore, multiparametric MRI's normal ranges for benign cases are not always suitable, and further development is required for it to replace TRUS-guided biopsies as a prostate cancer reference.

2.2. Role of AI in Improving Diagnosis Accuracy

Prostate cancer is the most commonly diagnosed cancer among men in the United States, with 12% of new cancers diagnosed in 2019 attributed to this particular type [12]. This equates to an estimated 1 in 9 men diagnosed with prostate cancer during their lifetime. However, the rate of mortality connected to prostate cancer is not as high as one would assume, given its relatively high rates of diagnosis. The 5-year survival rate in the United States is nearly 98%; globally, the rate has decreased to 95% [13]. These statistics become problematic, as a diagnosis of prostate cancer due to routine testing regimens does not guarantee the

usefulness of these data to inform patients' accurate decision-making regarding their particular diagnosed cancer, which can help identify dangerous cancers and subsequently point them towards the most beneficial treatment for their specific disease. To address this issue, recent research has focused on utilising AI to increase the accuracy of the PSA test, physical exam, and/or microscopic biopsy reading, providing more accurate information to prostate cancer patients.

3. Ethical Challenges in AI Integration

As AI technologies advance rapidly, research on their ethical and social implications has not kept pace. This has led to significant debate about the societal impacts of various AI applications, including those in healthcare [14]. While AI has the potential to enhance healthcare delivery by reducing costs and increasing efficiency, it also raises issues around privacy, transparency, accountability, and equity—factors crucial for gaining patient and public trust. Particular attention must be given to ethical considerations in AI applications, particularly in the context of prostate cancer screening and diagnostics. This project seeks to maximise the social benefits of AI in prostate cancer diagnosis while aligning with the values of relevant stakeholders. It utilises Responsible Research and Innovation (RRI) and Value Sensitive Design (VSD), which are recognised best practices aimed at enhancing social good and mitigating unintended consequences [15]. RRI and VSD involve societal actors as advisors in research activities. Key to this study is how AI innovations are communicated, fostering discussions about their role in prostate cancer diagnostics. Furthermore, respect for societal conditions in other countries is vital to avoid worsening global inequalities in prostate cancer treatment when pursuing financial or academic gains. Table 1 shows the Ethical and Social Implications of AI.

Table 1: Ethical Issues in AI and Social Implications.

Key	Issues Description
Advancement of AI technologies in healthcare	Rapid advancements in AI technology are outpacing the pace of research on the ethics and societal implications of these technologies.
Ethical and social implications of AI in healthcare	There is a significant debate over the societal impacts of AI applications in healthcare, particularly in prostate cancer diagnostics.
Potential benefits of AI in healthcare	AI can enhance healthcare delivery by reducing costs and increasing efficiency.
Challenges related to AI adoption (privacy, transparency, accountability, and equity)	Privacy, transparency, accountability, and equity issues must be addressed to build public trust.
Importance of ethical considerations in prostate cancer diagnostics	Ethical considerations are key in ensuring AI-based diagnostics benefit patients equitably.
Approach: Responsible Research and Innovation (RRI) and Value Sensitive Design (VSD)	Best practices that enhance social good and mitigate the negative consequences of AI integration.

3.1. Privacy and Data Security Concerns

Concerns regarding the protection of patient privacy and the potential abuse of gathered smart data are fueled by the commercial nature of many apps and the fundamental tension between life-logging technologies and traditional bio-medicine-inspired ethics [16]. This tension arises from the fact that, in the biomedical context, AI is usually used to handle extremely sensitive personal health data, which is afforded special legal and ethical protections. Exploratory research and development of these technologies are performed under strictly regulated data handling processes to ensure patient privacy, data security, and individuals' control over personal health data. These protections are usually experienced during and after the healthcare provider-patient relationship, in which the healthcare provider acts in the individual's best interests. Life-loggers are profit-driven companies; however, life-logging activities often occur outside of any healthcare provider-patient relationship and likely have divergent benefits and consequences [17].

3.2. Bias and Fairness in AI Algorithms

The literature on AI and machine learning has highlighted issues of bias and unfairness, including the reinforcement of subtle biases, the amplification of human biases, and data imbalances [18]. In AI-based prostate cancer diagnosis and early screening, biased algorithm predictions interfere with the algorithm's fairness. Biased algorithms, underpinned by the input data and output and interwoven relationships with other types of bias, can create biased and unfair systems. Integrating AI-based prostate cancer diagnosis and early screening must ensure balance and fairness in model training data, take on social responsibility, and adopt fairness-aware learning approaches. The unbalanced data from research makes algorithm predictions prone to bias. In the phase of acquiring cancer-related data, only older men with higher serum prostate-specific antigen levels were enrolled in the biopsy group, which may lead to a biased selection of the training data. This biased data is also reflected in training the prediction model, with imbalances that may be inherent to the prostate cancer stage and might prevent clinical translation [19]. Providers currently recognise that recommendations lack evidence of the benefits of prostate cancer screening in medical care. However, some patients still hope to verify the examination value in the group at risk of missed diagnosis. The machine model, which only used the three pieces of information in biopsy indication, could not avoid ignoring some more severe diseases.

4. Opportunities for Responsible Integration

This analysis argues that instead of classifying AI solutions as high-risk healthcare products and then placing them in unmanageable regulatory bureaucracies or quickly clearing poorly understood AI solutions with insufficient legal oversight, the potential use of AI in prostate cancer should be seen as an opportunity to envision, design, and coordinate new and expanded models of regulatory collaboration and reform, with a scope that goes beyond traditional regulatory bodies and includes an international perspective[20]. While maintaining a pragmatic and focused stance about the various positive and negative consequences that this will entail, probability values could change the standard for regulatory approval, with an AI that could be further tested and approved to provide standard clinical care at age 30, decreasing its probability to a typical 40-year-old person who falls within the range of specialist recommendations [21]. Other changes could include new product and drug development incentives, such as tax credits for research and stimulus programs following significant outcomes, the integration of large data sets, and the design of predictive algorithms, as well as substantial funding and resources for independent agencies and institutions to monitor and evaluate outcomes and research.

Cities and health services can also be further integrated into the regulatory approval path for AI-driven prostate cancer solutions, given that they have a greater understanding of the broader demands, unmet health service needs, and patient populations. The potential role can bring about the revision and approval of payment mechanisms, the collection of more detailed and diverse data on health outcomes, and informal collaboration between the public and private sectors [22]. There is an opportunity to design a more ambitious ethical oversight approach, focusing on evaluating the actual consequences of a patient-centred lens and driven by intense, interdisciplinary collaboration to promote a more comprehensive assessment of privacy threats, biases, and structural injustices. Open science policy also has the potential to help maximise the benefits of AI in a redistributive and constructive sense.

4.1. Enhancing Healthcare Access and Efficiency

Modern clinical decision-making involves diagnosing diseases, predicting outcomes, and selecting interventions tailored to the patient's needs [23]. These tasks are becoming increasingly complex due to numerous variables that come into play, including clinical and genetic factors, as well as individual choices and preferences. In recent decades, decision support systems and expert systems have been developed in several areas of medicine. However, the recent progress in machine learning has led to a significant exponential growth in the development and application of automated data analysis in medicine. Especially in domains where large amounts of complex and unstructured data must be analysed, implementing deep learning and other artificial intelligence techniques in healthcare may support physicians and patients, and have great potential for reducing healthcare costs and improving the quality of care [24]. The advantages of using AI in the healthcare field extend not only to disseminating best clinical practices at unprecedented speed but also to enhancing patient adherence. Different kinds of interventions can be performed at the patient's bedside, thus providing advantages in personalising medicine, avoiding hospitalisation, and reducing economic disparities among the population.

4.2. Improving Patient Outcomes

The increasing number of men diagnosed with prostate cancer has led to numerous innovations in treatment technologies and methods [25]. However, controversies exist surrounding the clinical and economic outcomes, considering costs, benefits, complications, and success rates associated with current standard treatment options using radical prostatectomy, radiation therapy, or other techniques. Most of the diagnosed prostate cancer cases are either indolent and do not require definitive treatment or active surveillance or present as advanced disease with poor prospects for cure, thus necessitating palliative care [26]. Advanced cancers, solitary medical problems with limited survival prospects, generally lead to more decisions to discontinue anticancer treatments. In such scenarios, a substantial percentage of individuals with advanced or aggressive prostate cancer reach the point of having more limitations in the appropriate use of life-saving treatments, thus calling for clinicians who support their decisions and manage their expectations.

The management of aggressive metastatic prostate cancer is a multidisciplinary effort focused on addressing emotional and physical concerns to enhance health outcomes. Following integrated care principles boosts care quality, patient understanding, satisfaction, psychological well-being, service utilisation, and longevity. Advanced prostate cancer can be treated with non-curative intent through radiation therapy, androgen deprivation therapy, or palliative care. Significant advancements in tumour biology and prostate cancer's natural history have led to new treatment developments. In microsatellite instability-high advanced prostate cancer, the use of drugs targeting mismatch repair deficiency represents a revolutionary approach [27]. This

confirmation has spurred regulatory decisions that benefit patients, particularly those with rapidly progressing cancers, while enabling professionals to champion improvements in patient care.

5. Conclusion and Future Directions

Despite AI's advancements in prostate cancer diagnosis and early screening, ethical concerns related to its integration into clinical practice demand careful consideration. We discussed the responsibilities of stakeholders in developing AI solutions that incorporate clinical, organisational, and social values. Recommendations were provided, emphasising sector-specific challenges and the necessity for broader public engagement about AI's role in healthcare. This includes enhancing AI literacy among healthcare professionals and the public, ensuring transparent communication about AI's capabilities and limitations, and maintaining human oversight to ensure the responsible deployment of AI in healthcare settings. The focus was on the ethical implications of AI in prostate cancer diagnosis, with an eye toward future research in AI applications in treatment allocation and healthcare decision-making. There are also potential ethical considerations around justice and fairness, ensuring no one is discouraged from seeking care. While our concentrated effort was on prostate cancer and its associated data for training AI algorithms, it is also essential to recognise the broader potential of AI tools that can be adapted for different settings and populations. As federated learning and on-device data processing become more prevalent, discussions about data sharing and ownership should be incorporated into debates about AI in healthcare, fostering a more inclusive approach to governance in healthcare innovation.

Declaration of Conflicting Interests

The authors declare no potential conflicts of interest with respect to the research, authorship and publication of this article.

Funding

The author received no financial support for the research, authorship and publication of this article.

References

- [1] G. Gandaglia, R. Leni, F. Bray, and N. Fleshner, "Epidemiology and prevention of prostate cancer," **European Urology**, Elsevier, 2021. europeanurology.com
- [2] L. Wang, B. Lu, M. He, Y. Wang, and Z. Wang, "Prostate cancer incidence and mortality: global status and temporal trends in 89 countries from 2000 to 2019," *Frontiers in Public Health*, 2022. frontiersin.org
- [3] S. Giona, "The epidemiology of prostate cancer," Exon Publications, 2021. exonpublications.com
- [4] IB Riaz, S. Harmon, Z. Chen, and S.A.A. Naqvi, "Applications of artificial intelligence in prostate cancer care: a path to enhanced efficiency and outcomes," in *Society of Clinical*, 2024. ascopubs.org
- [5] S. Perincheri, A. W. Levi, R. Celli, P. Gershkovich, and D. Rimm, "An independent assessment of an artificial intelligence system for prostate cancer detection shows strong diagnostic accuracy," *Modern Pathology*, Elsevier, 2021. sciencedirect.com
- [6] O. S. Tătaru, M. D. Bartolomei, J. J. Rassweiler, and O. Virgil, "Artificial intelligence and machine learning in prostate

- cancer patient management: current trends and future perspectives," *Diagnostics*, 2021. mdpi.com
- [7] A. Wang, J. Shen, A. A. Rodriguez, E. J. Saunders, F. Chen, "Characterising prostate cancer risk through multi-ancestry genome-wide discovery of 187 novel risk variants," **Nature**, 2023. nih.gov
- [8] W. Rayford, A. T. Beksac, J. Alger, and M. Alshalalfa, "Comparative analysis of 1152 African-American and European-American men with prostate cancer identifies distinct genomic and immunological differences," *Communications*, 2021.
- [9] D. K. Dwivedi and N. R. Jagannathan, "Emerging MR methods for improved diagnosis of prostate cancer by multiparametric MRI," *Magnetic Resonance Materials in Physics*, 2022. researchgate.net
- [10] F. Midiri, F. Vernuccio, P. Purpura, P. Alongi et al., "Multiparametric MRI and radiomics in prostate cancer: a review of the current literature," *Diagnostics*, 2021. mdpi.com
- [11] F. Ditonno, A. Franco, C. Manfredi, and A. Vecchia, "Novel non-MRI imaging techniques for primary diagnosis of prostate cancer: micro-ultrasound, contrast-enhanced ultrasound, electrography, multiparametric," *Cancer and Prostatic ...*, 2024.
- [12] M. M. Desai, G. E. Cacciamani, K. Gill, and J. Zhang, "Trends in incidence of metastatic prostate cancer in the US," *JAMA Network*, 2022. jamanetwork.com
- [13] A. Jemal, M.B.B. Culp, J. Ma, and F. Islami, "Prostate cancer incidence 5 years after US Preventive Services Task Force recommendations against screening," **Journal of the National Cancer Institute**, 2021. nih.gov
- [14] S. M. Williamson and V. Prybutok, "Balancing privacy and progress: a review of privacy challenges, systemic oversight, and patient perceptions in AI-driven healthcare," *Applied Sciences*, 2024. mdpi.com
- [15] O. Akinrinola, C. C. Okoye, and O. C. Ofodile, "Navigating and reviewing ethical dilemmas in AI development: Strategies for transparency, fairness, and accountability," *GSC Advanced*, 2024. gsconlinepress.com
- [16] K. Singh, "Artificial Intelligence & Cloud in Healthcare: Analysing Challenges and Solutions within Regulatory Boundaries," *SSRG International Journal of Computer Science*, 2023. researchgate.net
- [17] N. Khalid, A. Qayyum, M. Bilal, and A. Al-Fuqaha, "Privacy-preserving artificial intelligence in healthcare: Techniques and applications," **Computers in Biology and**, 2023. sciencedirect.com
- [18] R. J. Chen, J. J. Wang, D. F. K. Williamson, and T. Y. Chen, "Algorithmic fairness in artificial intelligence for medicine and healthcare," **Nature Biomedical**, 2023. nih.gov
- [19] A. Nair, "Artificial intelligence in the diagnosis and prevention of multi-stage colorectal cancer: potential algorithmic bias and systematic mitigation," *Journal of Medical Artificial Intelligence*, 2024. researchgate.net
- [20] A. S. Purysko, "Invited Commentary: Prostate Cancer Diagnosis—Challenges and Opportunities for Artificial Intelligence," *Radiographics*, 2021. rsna.org
- [21] B. Turkbey and M. A. Haider, "Artificial Intelligence for Automated Cancer Detection on Prostate MRI: Opportunities and Ongoing Challenges, From the AJR Special Series on AI Applications," *American Journal of Roentgenology*, 2022. ajronline.org
- [22] H. Kim, S. W. Kang, J. H. Kim, H. Nagar, and M. Sabuncu, "The role of AI in prostate MRI quality and interpretation: Opportunities and challenges," *European Journal of ...*, 2023.
- [23] L. Yang and A. Shami, "IoT data analytics in dynamic environments: From an automated machine learning perspective," *Engineering Applications of Artificial Intelligence*, 2022.
- [24] S. Tufail, H. Riggs, M. Tariq, and A. I. Sarwat, "Advancements and challenges in machine learning: A comprehensive review of models, libraries, applications, and algorithms," *Electronics*, 2023. mdpi.com
- [25] M. Sakellakis, L. Jacqueline Flores, "Patterns of indolence in prostate cancer," *Experimental and ...*, 2022. Spandidos-publications.com
- [26] S. Wasim, S. Y. Lee, and J. Kim, "Complexities of prostate cancer," *International Journal of Molecular Sciences*, 2022.
- [27] L. Klotz, "Overdiagnosis in urologic cancer: For World Journal of Urology Symposium on active surveillance in prostate and renal cancer," *World Journal of Urology*, 2022.