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Systematic Review: Application of Artificial Intelligence in Breast Cancer Therapy

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ABSTRACT

Background and Objective: Gene therapy can be employed to treat several disorders, including cancer. Globally, women are more frequently diagnosed with breast cancer than any other cancer type, underscoring the necessity for innovative strategies. Algorithms driven by artificial intelligence can enhance the gene therapy process for breast cancer by analyzing vast data sets, identifying intricate patterns, and classifying those patterns. This project aims to perform a literature evaluation focusing on the therapeutic uses of artificial intelligence in gene therapy for breast cancer.

Materials and Methods: For the aim of this study, data was gathered by reading previously published articles and searching the PubMed database for phrases that were relevant to the question being investigated.

Findings: The AI-driven algorithm analyzes complex molecular pathways in the human body, replicates the knowledge of scientists and physicians in clinical research, and simulates biological processes related to gene regulation, thereby improving the effectiveness of gene vectors, managing gene and drug delivery parameters, and modeling cellular behavior. This method diminishes medical errors and promotes early disease identification and drug efficacy forecasting, thereby providing patients with optimal results from advanced treatments like gene therapy with minimal side effects.

Conclusion: Over the period of the past decade, a multitude of efforts have been made to deploy various gene therapy procedures for breast cancer patients, to achieve the highest possible level of efficacy while minimizing the risk of adverse consequences. As a result, artificial intelligence is considered to be a powerful tool for improving early diagnosis and efficient gene therapy for breast cancer.

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INTRODUCTION

Breast cancer ranks among the most prevalent cancers globally, and progress in its treatment and care is essential for enhancing patient outcomes (1-3). Artificial Intelligence (AI) has demonstrated considerable potential in multiple facets of breast cancer therapy, encompassing diagnosis, treatment optimization, and monitoring. This systematic review seeks to assess the present status of AI applications in breast cancer treatment, emphasizing global practices and developments in Iran. We evaluate the functions of AI in diagnosis, therapy customization, medication development, and monitoring, examining its obstacles, potential, and prospective trajectories (4). The findings demonstrate that AI is revolutionizing breast cancer management worldwide, with notable advancements in Iran; yet, challenges such as technological access, data constraints, and healthcare infrastructure persist (5).

The notion of gene therapy has existed for an extended period, predating the discovery of the first human coding sequence. RNA and DNA are two types of nucleic acids that can be delivered into host cells via gene therapy. This method is employed to address a variety of ailments (6). Gene therapy is beneficial in treating conditions such as Parkinson's disease and other cancers. Gene therapy is categorized into three types: immunotherapy, oncolytic viral therapy, and gene transfer (7, 8). Breast cancer is the most prevalent disease among women, and due to the inadequacy of current treatments, experts are exploring new therapeutic strategies, including gene therapy. The BRCA1 and BRCA2 genes, essential for DNA repair, are significantly associated with breast cancer (9). Women possessing these genes exhibit a markedly elevated chance of developing breast cancer. The predominant gene therapy methods for breast cancer treatment encompass gene editing, suicide genes, gene silencing, transcription factor targeting via decoy oligodeoxynucleotides, microRNA targeting, aptamer-mediated targeting of breast cancer cells, and DNA or RNA vaccination (10). Given that laboratory processes for identifying an effective and safe gene carrier are both labor-intensive and expensive, it would be advantageous to substitute existing methods with those grounded in artificial intelligence (11, 12). By merging machine learning and molecular biology with the concepts of gene therapy, this expertise can be employed through generative AI to create unique experimental methods for regulating gene expression (13). Artificial intelligence and its associated subfields can accurately simulate biological processes related to gene delivery, assess the efficacy of gene vectors, regulate the parameters of gene and drug administration, model cellular structures, and perform intricate analytical tasks (14). This study aimed to conduct a literature review on artificial intelligence in gene therapy, focusing specifically on its clinical applications for the precise and early identification of genes and gene therapy in breast cancer.

METHODOLOGY

A systematic review of published literature was conducted using databases such as PubMed, Google Scholar, Scopus, and IEEE Xplore. The search terms included "Artificial Intelligence in breast cancer," "AI breast cancer therapy," "machine learning in breast cancer treatment," and "AI in Iran breast cancer therapy." Studies published between 2010 and 2024 were considered for inclusion (Table 1).

Inclusion criteria

Peer-reviewed studies, original research, clinical trials, systematic reviews, and studies that specifically focused on AI applications in breast cancer diagnosis, therapy, or treatment monitoring were included in this study.

Exclusion criteria

Studies not related to breast cancer, studies focusing only on general AI applications with no relevance to therapeutic outcomes and Non-peer-reviewed articles were excluded from this study.

For this article, we examined the abstracts of the publications and selected those we deemed the most relevant. Research is being focused on the promise of nucleic acid-based therapies for both inherited and acquired disorders. Such treatments aim to restore or replace genetic information that has been compromised. In 1991, Rosenberg and associates conducted the inaugural patient-specific gene transfer (15). They administered tumor-infiltrating cells harboring a neomycin resistance gene to five patients with metastatic melanoma utilizing a 3MLV vector (16). Gene expression in cells can be modified by administering nucleic acid-based agents, including DNA, CRISPR/Cas systems, messenger RNA (mRNA), and oligonucleotides. Gene editing facilitates the achievement of this objective (17, 18). Direct gene transfer into cells offers numerous advantages, including reduced immunogenicity; however, it also presents several disadvantages, such as the necessity of employing gene vectors to avert oncogene activation and the inadequate stability of nucleic acids in vivo (19, 20). Gene vectors are categorized into two primary groups: viral and non-viral (21). Virus generation can manifest in various forms, including adenoviruses, retroviruses, herpes simplex virus, and viruses associated with adenoviruses. Increasingly, non-viral vectors are employed for transmission to circumvent issues such as mutagenesis, adverse consequences, restricted gene size, and immunogenicity (22). Polymeric carriers, organic and inorganic nanoparticles, liposomal carriers, and DNA blast injection are non-viral techniques that exclude the use of viruses. Non-viral techniques may possess a distinct physical characteristic (23). Gene therapy has been extensively researched for its potential application in treating various diseases and conditions, including progressive disorders like Parkinson's.

Researchers have investigated gene editing, immune cell engineering, and antibody gene expression as potential gene therapy techniques to eliminate infection-related pathogen receptors (24). A further step in gene therapy is the utilization of viral vectors to develop vaccines for cancer and infectious diseases (25). Gene therapy research encompasses several categories, the most prevalent of which are cancer, genetic disorders (including both single-gene and multigene conditions), infections, and more areas (26).

This chart illustrates the number of publications on AI applications in gene therapy for breast cancer from 2010 to 2024. The bar chart depicts yearly publications, but the line chart demonstrates the cumulative trend

Table 1. The list of studies considered in this study.

Year	Number of Papers	Key Trends/Topics Highlighted
2010	5	Early exploration of AI in genomics
2011	8	Basic machine learning models for gene expression analysis
2012	12	Introduction of gene-editing AI tools
2013	18	AI-aided biomarker discovery
2014	25	Applications in CRISPR and genetic therapy models
2015	30	Growth in AI-driven personalized therapy
2016	45	Integration of AI with imaging and genomics data
2017	55	Advanced AI models for mutation prediction
2018	68	Use of AI for therapy outcome prediction
2019	82	Deep learning in breast cancer gene therapy
2020	95	AI applications during COVID-19 and cancer therapy
2021	110	Accelerated AI applications in precision medicine
2022	130	Large datasets enable more robust AI models
2023	145	Advanced natural language processing in gene therapy research
2024	160 (est.)	Predicted continued growth in research focus

over time.

Gene therapy in cancer

Hematological tumors are the ones that have been the subject of the most comprehensive investigation for gene therapy, followed by cancers that affect the digestive tract and the nervous system (25). It has been established that gene therapy in lung cancer can improve survival rates. This is accomplished through the creation of cancer vaccines, the utilization of viruses to target cancer cells, the induction of apoptosis in cancer cells, and the introduction of genes that either trigger cell death or restore a normal cellular phenotype (27). Breast, pancreatic, liver, and glioma tumors, along with a variety of other malignancies, have all been the subject of additional research studies (28).

The ensuing material explains the three basic categories that represent gene therapy in the field of cancer (29). Immunotherapy, which is intended to improve the immune system's ability to remove cancer cells, has only achieved a limited level of success since cancer cells can avoid being detected by the immune system (29, 30). As a result, the exploitation of gene therapy in the process of developing recombinant cancer vaccines is an innovative approach in the field of immunotherapy (31). On the other hand, in contrast to vaccinations for infectious infections, which are designed to prevent recurrence, these vaccines are meant to cure or control cancer by teaching the immune system of the patient to recognize cancer cells by the presentation of cellular debris that stimulates the immune response (32). In the fields of gene therapy and immunotherapy, CAR T cells are among the most influential and widely recognized devices. It is possible to modify T cells so that they express chimeric receptors on their surface. This process results in CAR T cells, which can react to particular molecules, such as tumor-associated antigen proteins (33). Vectors for oncolytic gene therapy are often viruses that have been genetically manipulated to specifically target and eradicate cancer cells while remaining harmless to healthy cells (34). This has been accomplished through the use of genetic engineering. The vectors, which include vaccinia, adenovirus, herpes simplex virus type I, reovirus, and Newcastle disease virus, have been developed to specifically target cancer cells and cause cell death by viral release, the generation of cytotoxic proteins, and cell lysis (35, 36). A therapeutic strategy known as gene transfer involves inserting a foreign gene into a cancer cell or neighboring tissue (37).

This is done to treat the cancer. For this therapeutic method, several genes have been suggested, including genes that cause suicide, genes that inhibit angiogenesis, and genes that stasis cells (38). For this particular approach, the replication-deficient adenovirus is the primary viral vector that is utilized. Direct DNA transfer, oligodendromeric DNA envelopes, and electroporation are all examples of nonviral approaches that are as effective in the process of gene transfer (39). Even though the vast majority of cancer clinical trials make use of modified cells and ex vivo techniques, in vivo studies have also made significant progress, particularly in the utilization of human herpes simplex virus (HSV) as an oncolytic virus. Imlygic, also known as Talimogene Laherparepvec, is a genetically modified herpes simplex virus that was granted approval by the Food and Drug Administration (FDA) in 2015 as the first oncolytic virus utilized for the treatment of metastatic melanoma (40). There are currently several gene therapy products that have been granted permission for the treatment of cancer. These medicines include Oncorhin, Rexin-G, and CAR T cells (41).

Gene Therapy and Breast Cancer

Breast cancer is the most common form of cancer and

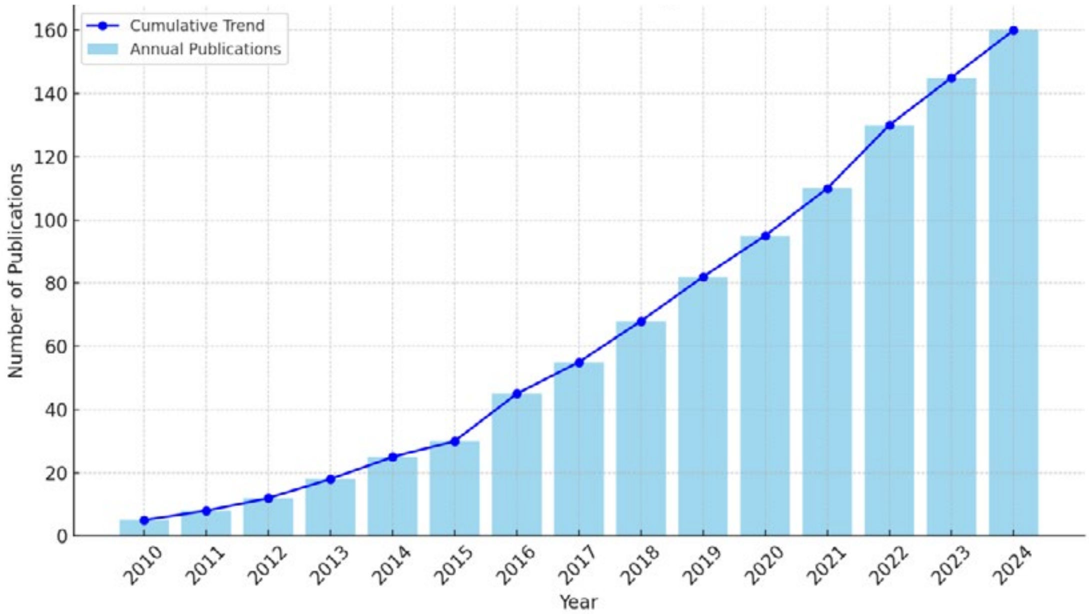

Fig 1. Number of Pepers Published on Al in Gene Therapy for Breast Cancer (2010-2024).

the second leading cause of death among women as a whole across the world. According to the most recent data from the national level, the incidence rate of breast cancer, when adjusted for age, is 21.33 per 100,000 people (42). Treatment approaches that are considered to be typical for breast cancer include surgical procedures, radiation therapy, chemotherapy, and hormone therapy. Both drug resistance and considerable adverse effects contribute to the limited success of these treatments, which is further aggravated by the low selectivity of pharmacological therapy (43). Consequently, because inherited changes in these genes are a contributing factor in the progression of this disease, gene therapy was considered as a potential treatment for it. Given that they are involved in the process of repairing damaged DNA, the BRCA1 and BRCA2 genes have been shown to have a significant association with breast cancer (44, 45). It is estimated that women who have a positive BRCA1 test have a probability of developing breast cancer by the age of 17 which ranges from 41 to 78 percent (46). By the year 2008, a prospective cohort study projected that those who carried the BRCA1 mutation had a cumulative breast cancer risk of 72%, while those who carried the BRCA2 mutation had a risk of 69% (20). There are around 2,000 variants that have been found in these two genes, and some variants in particular areas of both genes have been associated with an elevated risk (47, 48). In addition to these two genes, several other genes, including STK113, PTEN2, TP, and 14NF, have also been known to be associated with this type of illness (49). The processes involved in gene therapy for breast cancer are described in this document. Gene modification is a procedure that includes replacing a normal gene with a mutant gene. This technique, when combined with other cancer treatments such as chemotherapy or radiotherapy, has the potential to eliminate cancer (50, 51). Within the revolutionary methodology known as the gene transfer method, the equipment that is responsible for gene transfer directly penetrates the target cell without making use of a vector (52). This strategy makes use of nuclease enzymes, which, upon binding to the target DNA, cause double-strand breaks to occur (53). As was mentioned earlier, one of the methods for gene transfer is the utilization of genes that are responsible for suicide. Using this method, genes such as cytosine deaminase and herpes simplex virus thymidine kinase are introduced into cancer cells. These genes then cause the cancer cells to create enzymes that convert safe prodrugs into harmful metabolites, which ultimately results in the death of cancer cells (54). Inhibiting gene transcription and translation is the goal of the gene suppression approach, which ultimately results in the suppression of oncogenes associated with cancer. This technique makes use of antisense oligodeoxynucleotides, which are primarily concerned with transcription, in conjunction with specific 5-SiRNAs (42). To target transcription factors using decoy oligodeoxynucleotides, double-stranded oligodeoxynucleotides are utilized. These oligodeoxynucleotides encode transcription factors and completely suppress gene transcription (55). By either accelerating metastasis or blocking the roles of tumor suppressors, certain microRNAs, which are referred to as onco-microRNAs (for example, miR-21 and miR-92), act as tumor promoters. On the other hand, other microRNAs, such as miR-34, act as tumor suppressors (56, 57). Breast cancer can be caused by either of the two groups of microRNAs. In light of this, targeting microRNAs is considered to be a gene therapy technique for treating this variety of cancer. Aptamers are single-stranded DNA or RNA oligonucleotides that are relatively short and possess a high level of sensitivity for genetic targeting. Aptamers can specifically target cancer cells and promote gene transfer by acting as vectors that are not the result of viral infection (58).

The method of vaccination involves injecting DNA directly into the body of the patient, which results in the production of antigens that are associated with tumors. Considering that breast cancer is a systemic condition that has the potential to spread to other parts of the body, this method is effective (59). According to research published by the International Agency for Research on Cancer in the year 2020, breast cancer has quickly become the most prevalent form of cancer worldwide (60). Around 2.62 million new cases of breast cancer were diagnosed around the world, and around 685,000 people lost their lives as a result of the disease (61). Despite the multitude of breakthroughs that have been made in treatment approaches for breast cancer, the prevalence of breast cancer increased by 24.3% in the year 2020 in comparison to the year 2012 (62). Even though certain studies have shown that Burley gene therapy in breast cancer treatment has the potential to produce positive results, the evidence that is now available regarding its usefulness is still inconclusive. As a result, additional clinical trials are required to improve both its safety and its performance. According to a recent article, the recurrence rates of breast cancer after five years were: seven percent, eleven percent, and thirty-one percent for patients in stages one, two, and three, respectively (63). There are variations in the life expectancy rates of breast cancer patients around the world, with survival rates being higher in more developed countries compared to less developed countries (64). These statistics unequivocally illustrate the imperative for revolutionary approaches, including the application of artificial intelligence in innovative treatment methods such as gene therapy (65).

Overview of AI Application in Cancer

This enables the difference between healthy and unhealthy individuals, as well as the prediction of treatment efficacy in patients. Artificial intelligence algorithms have the potential to evaluate enormous data sets and uncover subtle patterns (74). The capabilities of this field in terms of analysis are especially useful in the field of oncology. For instance, if an algorithm that is supported by artificial intelligence can predict how a patient will react to chemotherapy before the treatment is administered, this could make it possible for doctors to personalize treatment plans for patients (75). Dose modification may be one of the powers of artificial intelligence, which would allow medical professionals to provide systemic medicines with increasing doses that are based on AI predictive models (76, 77). A study that was conducted in 2012 suggests that artificial intelligence has the potential to revolutionize the production of nanofactors for gene therapy and mRNA vaccines, which could have a positive impact on the treatment of cancer (78).

More effective treatments for a variety of cancers could likely be developed through the utilization of artificial intelligence to optimize the design and delivery of these medicines. It has been suggested by research that the combination of artificial intelligence with multifunctional magnetic nanostructures could potentially improve the effectiveness of cancer treatment (79). The findings of this study demonstrate that nanostructures can be injected with medications and then supplied directly to cancer cells. This process makes it possible to develop a more individualized treatment plan that has fewer negative side effects (80). Moreover, they have the potential to be exploited in imaging modalities, which can assist medical professionals in the early diagnosis of cancer. The study, on the other hand, advocates for the application of artificial intelligence to enhance the utilization of these nanostructures (81). This is because the nanostructures have the potential to be toxic to healthy cells when they are present in high concentrations, and their effectiveness is influenced by parameters such as size and morphology (82). There are several applications for artificial intelligence, including the prediction of the efficacy of particular treatment modalities, the enhancement of dosage levels, and even the development of more effective nanostructures (83).

Application of Artificial Intelligence in Breast Cancer Gene Therapy

It is primarily due to genetic and molecular anomalies that result in varied tumor morphologies, which ultimately influence tumor responses to cytotoxic medications, that the heterogeneity of breast cancer provides a substantial barrier to the treatment process (84). As of right now, a great number of genetic and molecular factors that influence oncogenes have been identified (85). These factors include genes that control proliferation, the cell cycle, invasion, and metastasis. The field of breast cancer research is beginning to recognize the potential benefits of (AI). The application of artificial intelligence techniques is allowing researchers to make progress in the areas of breast cancer risk assessment, gene therapy, and personalized medicine (86). Emerging fields of medical imaging that make use of artificial intelligence algorithms for the noninvasive study of breast cancer tumors are making it possible to provide patients with treatment options that are more individualized and effective (87). It has been demonstrated that several artificial intelligence models, such as artificial neural networks and decision trees, are capable of accurately predicting the risk and probability of developing breast cancer based on the presence of BRCA gene mutations (88). According to thirty, these models can be of use in determining the treatment method that is most suitable for a specific genetic profile (89).

Selecting the best genes with AI

Different molecular characteristics are possessed by each patient, which results in a wide range of responses to treatment (90). Because of the accumulation of unique mutations, which leads to heterogeneity, which makes diagnosis and therapy more difficult, the variation among patients is especially obvious in the various forms of cancer (91). With the use of several genetic and epigenetic markers, personalized medicine aims to tailor treatment plans to the specific needs of individual patients. To examine a patient's various markers, researchers in the field of tailored medicine use complex algorithms that make use of machine learning and artificial intelligence (43).

This research finds several genes that are potentially responsible for the development of breast cancer in an individual. Through the use of this knowledge, researchers can develop gene therapies that are substantially more accurate and effective than the approaches that have been traditionally used. One advantage of AI-driven tailored medicine is the mitigation of risks, such as off-target effects, which could result in severe consequences. This renders gene therapy potentially safer and more efficacious than it would have been otherwise (92). Through the examination of gene expression patterns derived from breast cancer tumor samples, a study conducted in 2020 indicated that out of the 34 genes and 43 transcription factors that were presented to artificial intelligence, 17 genes, including AMELX1 and FREM12, were identified as prognostic biomarkers for breast cancer (93). A 2020 study analyzing gene expression patterns from breast cancer tumor samples revealed that, among 34 genes and 43 transcription factors evaluated by artificial intelligence, 17 genes, including AMELX1 and FREM12, were recognized as prognostic biomarkers for breast cancer. Artificial intelligence often identifies a greater number of biomarkers, resulting in enhanced personalized medicine outcomes. Furthermore, it can identify intricate patterns and correlations between certain genetic modifications and clinical results (94).

Targeted therapy based on personalized medicine with the help of artificial intelligence

In a study that was conducted in 2013, three pathologists evaluated patients using immunohistochemistry to determine whether or not they had HER2 status. Following this, the researchers utilized thematic algorithms and trained an artificial intelligence model on a dataset consisting of breast cancer cases to determine the HER2 status of primary and metastatic tumors (95). A comparison was made between the results of the AI and the evaluations of the pathologists, which revealed that the AI model successfully and properly diagnosed the HER2 status of all types of breast tumors (96). This study's findings indicate that artificial intelligence enhances the precision and efficiency of HER2 status assessments, resulting in more effective therapy alternatives for these patients. A separate study found that artificial intelligence models can accurately forecast the risk of breast cancer in patients with BRCA mutations (97). This study indicates that artificial intelligence can improve the accuracy of breast cancer treatment by enabling therapeutic targeting based on an individual's genetic profile in customized medicine. Furthermore, the amalgamation of AI with person-centered oncology has demonstrated enhanced precision in therapeutic efficacy (98).

The algorithms that are used for machine learning can analyze vast amounts of patient data and identify groups of people who share similar genomic patterns. This classification of genomic information allows medical professionals to design treatments for specific patients depending on the genetic traits of those patients, which ultimately results in a treatment plan that is more personalized and effective (98). In light of this, person-centered oncology and artificial intelligence have the potential to revolutionize the treatment of breast cancer. The identification of biomarkers and the accuracy of treatment planning may lead to the development of more effective medicines and for patients to experience more positive clinical outcomes (99).

DISCUSSION

The purpose of this review is to provide an overview of gene therapy and its various approaches in the treatment of breast cancer patients. These approaches include gene modification, gene editing, the use of suicide genes, gene silencing, the targeting of transcription factors through the use of decoy oligodeoxynucleotides, the targeting of microRNA, the targeting of breast cancer cells through the use of aptamers, and vaccination with DNA or RNA (100).

Performance level in the world

In this study, a research pathway is shown, which was accomplished through the utilization of Google Scholar and a general search of pertinent phrases. The results of the search have been compiled into Table 1, which contains an illustration of the significance of this subject matter due to the considerable volume of publications from around the world (101). In oncology research, applications include identifying predictive biomarkers by analyzing gene expression patterns in breast cancer samples, accurately classifying HER2 status across different breast tumor types, and developing advanced medical imaging techniques that utilize artificial intelligence algorithms to analyze and interpret breast cancer tumors (103). Nonetheless, there are other constraints related to the application of artificial intelligence. These constraints encompass ethical challenges (such as obtaining informed consent for data consumption), potential data loss, substantial maintenance costs, and the necessity for regular software updates (104). The implementation of artificial intelligence may enhance societal health; nevertheless, due to existing limitations, its application must be approached with prudence. Artificial intelligence is employed for the accurate and timely diagnosis of genetic disorders, in addition to gene therapy for breast cancer (105, 106).

Adaptations and challenges in current methods

The real-world clinical validation of AI models is a critical challenge. Despite the exceptional efficacy of AI algorithms in many studies, these algorithms need to undergo clinical validation with extensive datasets before their incorporation into clinical practice. Recent endeavors in clinical validation, especially those concentrating on treatment outcomes, sometimes face limitations due to retrospective designs that may bring unforeseen biases, highlighting the necessity for prospective research (107). These prospective studies are essential for thoroughly understanding the effects of AI implementation on clinical practice and ensuring that AI tools are useful and dependable in a clinical environment (108).

Secondly, the incorporation of AI models into practical clinical environments entails issues that extend beyond validation, including utility and usability. To ensure utility, AI models must undergo thorough validation using randomized controlled trials that evaluate several clinical objectives (109). These outcomes must encompass overall survival, illness control, toxin mitigation, enhanced quality of life, and reduced healthcare resource consumption. AI models must undergo evaluation in practical environments to assess time efficiency, user satisfaction, and the acceptance of AI recommendations (110). The incorporation of a feedback mechanism through post-market surveillance is essential for detecting potential shortcomings and avenues for improvement, thereby ensuring the continuous advancement of these models. Real-time monitoring tools for healthcare professionals and AI algorithm developers are crucial to ensure the safe delivery of services. Moreover, the smooth integration of AI technologies with existing workflows, such as PACS, is essential for their efficient utilization (111).

A third problem is the generalizability or robustness of the AI model, which pertains to its consistent performance across diverse datasets, including the training dataset. Various techniques to tackle this issue involve utilizing datasets encompassing a diverse range of preanalytic and analytic parameters to improve model resilience; however, obtaining large-scale datasets with manual annotations poses obstacles in the creation of AI algorithms (112). To resolve this issue, various methodologies, like unsupervised learning and Generative Adversarial Networks, are being employed. Another obstacle that emerges is the potential misrepresentation of health issues in minority communities, due to the development of AI models predominantly based on data from majority populations. This circumstance may intensify health disparities (113, 114).

Fourth, many AI algorithms are frequently regarded as black boxes because of the ambiguity around the identifiable features within them. The development of explainable AI systems could foster trust among clinicians, enhance transparency in decision-making, and mitigate various biases (115). Conversely, Ghassemi et al. proposed that fervent internal and external validation of AI systems may provide a direct method for attaining objectives related to explainability (116).

Ultimately, reimbursement difficulties must be addressed, especially if AI systems begin to supplant specific functions previously executed by physicians. Discussions regarding reimbursement and the influence of AI on healthcare systems should occur at the national or screening program levels to guarantee equitable and successful implementation (117). To foster discourse and engagement among physicians, the wider medical team, pertinent governmental authorities, and hospitals regarding the integration of AI in healthcare, it is crucial to analyze the primary issues (118).

CONCLUSION

Consequently, in light of the data and the increasing prevalence of this cancer, along with the anticipation that breast cancer will emerge as the most common cancer type in 2024, the imperative for the use of fresh technologies and methodologies in treatment strategies was underscored. Gene therapy is profoundly impacted by artificial intelligence, a relatively emerging field of study. The field of artificial intelligence focuses on developing intelligent machines that can replicate human behavior through diverse learning and decision-making processes with limited external input. This research is applicable in differentiating between healthy and diseased persons, forecasting drug efficacy in patients, formulating personalized medicines, executing gene therapy, and evaluating breast cancer risk, all of which may improve community health outcomes. The advantages of engaging in a profession in intelligence science Artificial intelligence can distinguish between healthy and unwell persons, forecast drug efficacy in patients, facilitate individualized therapies, aid in gene therapy, and evaluate breast cancer risk, potentially improving the overall health of the population.

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