ISSN: 2755-0176

Journal of Cancer Research Reviews & Reports

SCIENTIFIC Research and Community

Review Article

Open Access

AI-Driven Advancements in Breast Cancer: Transforming Detection, Diagnosis, Treatment, and Monitoring

Enrique Díaz Cantón[1]*, Joaquín Fernández Sande[2], Vanesa Krakobsky[3] and Mario Rossi[4]

[1]Adjunct Professor of Oncology CEMIC Titular Professor of Artificial Intelligence in Medicine CEMIC University Institute, Argentina

[2]Teaching Assistant Artificial Intelligence in Medicine CEMIC University Institute

[3]Medical Director Radio Oncology Service Mevaterapia Italian Hospital, San Justo, Buenos Aires

[4]Translational Medicine (IIMT) - Universidad Austral-CONICET. Professor of Artificial Intelligence in Medicine (FCB| FI) Universidad Austral University

ABSTRACT

Artificial Intelligence (AI) is transforming the fight against breast cancer. It helps in early detection and accurate diagnosis through analysis of large volumes of medical data. It allows personalized treatments, optimizes radio-oncology, and contributes to the discovery of new drugs. AI-powered chatbots assist healthcare professionals with administrative tasks. Although it offers great promise, ethical challenges need to be addressed and ensure that it complements, not replaces, physicians. Multidisciplinary collaboration is key to harnessing its potential in today's medicine.

***Corresponding author's**

Enrique Díaz Cantón, Adjunct Professor of Oncology CEMIC Titular Professor of Artificial Intelligence in Medicine CEMIC University Institute, Argentina

Received: August 22, 2023; **Accepted:** September 25, 2023; **Published:** September 30, 2023

Keywords: Artificial Intelligence, Oncology, Radiotherapy, Natural Language Processing, Machine Learning

Introduction and Basic Concepts

Breast cancer is a devastating disease that affects millions of women around the world. Although advances in screening, diagnosis and treatment have improved survival rates, it remains essential to continue making progress in early detection, accurate diagnosis, personalized treatment, and effective monitoring of breast cancer. In this sense, Artificial Intelligence (AI) has been positioned as a revolutionary tool that has the potential to radically transform the way we approach this disease. We want to convey what is considered central when talking about AI in medicine. This helps increase access to medical services, such as bringing medical care to areas where the ratio of doctors to inhabitants is very low, we can, through devices placed on smartphones that only require basic models and a simple internet connection, take photos of skin lesions or chest x-rays and analyze these by AI algorithms that return a diagnosis with very high precision.

It is the concept developed by the WHO in 2019 of Augmented Intelligence, which arises from the sum of human intelligence PLUS artificial intelligence [1]. The scenarios where AI has and will play a key role are multiple and range from prevention, early detection, imaging diagnosis, histopathological diagnosis, especially through digital pathology, and treatment. AI currently has a role in surgery (with AI-assisted robots), radiotherapy, and in the guidance of various treatments, as we can see with the renowned IBM software "Watson for Oncology" [2].

It is surprising how through the so-called "Large Language Models" (LLMs), of which the most popular is Chat GPT from the company Open AI, which was presented in November 2022 and GPT4 in April 2023 and have caused a "Copernican Revolution¨ in all our understanding of reality, by observing how they can assist us not only in the diagnosis and treatment of complex cases, but also through the role of doctors' co-pilot in tedious tasks such as writing clinical histories, writing letters to justify orders. of procedures or treatments, etc.

Although it may seem like it, AI is not a new concept, but rather dates to 1956 when John Mc Carthy developed the concept at Dartmouth University, USA. Although it flourishes notably from 2000 onwards thanks to several things: the increase in processor power, the availability of massive amounts of data (also known as Big Data), the ability to analyze data, storage capacity, development of automatic learning (AA) or "machine learning (ML) and its most powerful version that emulates the human brain: Deep Learning" and, finally, the arrival in 2017 of the "Transformers" that pave the way for models such as Chat GPT, GPT-4, etc [3].

This increase in computing power made it possible to effectively analyze big data, producing what we are currently experiencing with the rise of AI. Briefly, Machine Learning is the field of AI focused on developing algorithms that allow computers to learn and make decisions or make predictions without being previously programmed, which distinguishes it from classical computing. Therefore, they learn from examples and data, through different learning techniques.

Early detection and diagnosis

Early detection is crucial to improving outcomes in breast cancer, and AI can play a critical role in this. AI algorithms can identify subtle patterns and anomalies that might go unnoticed by human eyes, leading to earlier detection and more accurate diagnosis. This provides doctors the opportunity to intervene in the early stages of the disease, improving the chances of successful treatment and longer survival.

A study from the Massachusetts Institute of Technology (MIT) analyzed 60,000 people who had been performed 90,000 screening mammograms. The algorithm detected an elevated risk of breast cancer in 32% of patients versus 18% if it had been analyzed by traditional clinical risk methods [4]. Google researchers have developed an artificial intelligence algorithm called LYNA that uses deep learning to analyze mammogram images and identify signs of breast cancer up to five years before they are visible on traditional mammograms [5] More recently , the MASAI study was published, which is the first prospective study in this regard, which attempted to compare the reading of mammograms by 2 specialist doctors versus double reading assisted by an AI algorithm called "Transpara v1.7.0" (Screenpoint Medical) 80,000 mammograms were analyzed. In group 1, two doctors were studied with AI and in group 2, two doctors were analyzed. The study showed that AI assistance reduces work time by 44%, increases detection by 20%, with no increase in false positives [6].

If we go more general, Alpha Fold 2, a Deep Learning algorithm based on Transformers, managed to predict the three-dimensional structure of most human proteins from amino acid sequences. This constitutes the most complete database for predicting the human proteome [7].

In 2018, another study showed that deep learning could predict driver mutations and tumor subtypes from digital histological images [8] It is very important that we understand that AI is NOT medicine of the future, in fact as of writing this article the FDA has 521 medical devices based on AI [9].

Treatment and Follow-up

Breast cancer is a highly heterogeneous and very complex disease with a speed and volume of new data that surpasses us as human beings. According to a report by consulting firm Frost and Sullivan (Big Data Analytics in Healthcare, Forecast to 2025), it is expected to double every 73 days by 2025.

AI can play a crucial role in personalizing treatment IBM's Watson for Oncology (WFO) software was designed to diagnose and recommend treatments based on AI, achieving surprising agreements with boards of clinical oncologists from centers of excellence. Specifically in breast cancer, a recent publication revealed a concordance of 93% [10]. WFO continues to operate in several countries around the world, although it was deactivated in the United States because they wanted to put it to work in referral centers when it should be used in peripheral centers. WFO is and will be very useful when a primary care doctor without the possibility of consulting in a specialized center must decide regarding an oncology patient, with WFO acting as a co-pilot.

In addition to diagnosis, AI can also play a crucial role in personalized treatment planning for breast cancer patients. By analyzing genomic data, clinical records, and other relevant factors, machine learning algorithms can help identify the most effective treatment approaches for individual patients. This type of personalized approach can improve treatment outcomes and minimize adverse effects for patients.

AI also has a very important role in radiation oncology. To understand the magnitude of this fact, AI played a leading role in the last ASTRO (American Society of Radiation Oncology) congress at the end of 2022. Its motto was: "AI and Emotional Intelligence: Caring for the Patient in a Wireless World": emphasizing scientific advances in AI and biology [11]. AI is expected to become an invaluable tool in the era of precision and personalization of RT. The applications are very varied: with radio genomics it could be predicted: radiosensitivity and radiotoxicity, optimizing the response and minimizing adverse effects. We could also identify the type of particle to be used (protons, photons, etc.) [12] Dosiomics, a substitute for radiomics integrated into the DVH (dose volume histogram), could constitute an advanced tool to evaluate the quality of the treatment plan RT [13]. In summary, AI could play a crucial role in improving the precision and effectiveness of RT in breast cancer and in optimizing the specialist's work strategy, always focusing on the quality of patient care.

Search for New Drugs

AI can help in the discovery of new drugs and targeted therapies. By analyzing large genomic and molecular databases, it can identify potential therapeutic targets and predict the effectiveness of different drugs based on the genetic and molecular profiles of patients. These speeds up the drug development process and offers new therapeutic options for patients with breast cancer. We must highlight that 4% of oncology patients are enrolled in clinical studies. This is very serious, given that progress will come hand in hand with research trials and a molecule takes between 10 to 15 years from its discovery to approval by regulatory systems (e.g. FDA, EMA), and then many years will pass more until the national regulator approves it. To this we must add a cost of approximately 1.5 to 2 billion US dollars per drug [14]. Watson for Clinical Trial Matching is an AI algorithm that reviews the electronic health record (EHR), then extracts key patient data and analyzes it using ML models to see if it matches study inclusion and exclusion criteria. clinics available.

Research Transformation: Artificial Intelligence Generating New Paradigms and Concepts

The integration of artificial intelligence (AI) into scientific research is transforming the discovery process by streamlining hypothesis formulation, experimental design, and data analysis. Notable advances include self-supervised learning and geometric deep learning, both of which optimize the accuracy of scientific models. Generative AI also excels in enabling the design of molecules and proteins through multimodal analysis. These innovations are redefining the acquisition and understanding of scientific knowledge through AI. In this sense, it is plausible that AI not only improves the application of current scientific knowledge in medical practices, but also, and perhaps even more importantly, encourages the emergence of new knowledge paradigms. These new paradigms are expected to trigger the development of emerging areas that complement and expand the current understanding of tumor biology at the molecular level and therefore expand and improve the possible points of intervention in the treatment and control of breast cancer.

The Role of Chat Bots: The new best friend of the medical doctor
The immediate future of medical practice, powered by artificial intelligence, transcends conventional strategies for implementing

Machine Learning (ML) for the diagnosis or treatment of diseases. Instead, it will be defined by the integration of the interfaces of generative artificial intelligence models with patients' personal information. This subtype of artificial intelligence, designed specifically for the creation of content in various formats such as text, images and audio, will be a crucial component in the evolution of medicine. This advance will mark the beginning of a new era of communication between doctors and machines, where we will share patient data, our decisions, their complementary studies and the management of appointments and prescriptions inherent to medical treatment.

In the field of generative artificial intelligence, Large Language Models (LLMs) will be the first to interact with doctors through chatbots. In the most recent literature, Google stands out as a pioneer in research with artificial intelligence, actively participating for several years in publications in numerous areas of health and evaluating the disruptive potential of artificial intelligence in the world of medicine. In one of their articles, "Deep learning models for histological classification of breast cancer and their association with disease prognosis," [15] they raise the important challenge of accurate and useful histological classification, given the inherent subjectivity and inter-variability associated pathology. In this article, they demonstrate how an automated deep learning system (DLS) for histological classification could provide internal consistency and reliability for classifying any given tumor. In another panorama, Topazium presented similar research, "A Machine Learning (ML) approach to identify genetic biomarkers and new molecular targets associated with impaired survival of breast cancer patients," demonstrating great advances in the implementation of ML to identify genes involved in cell adhesion and migration pathways, critically related to impaired survival. Raising the possibility of investigating several of these genes as possible targets for the discovery of new drugs [16].

However, the complex world of technology and data analytics often isolates healthcare professionals from the intersection of artificial intelligence and medicine. Google Vertex AI, a relatively new release in the world of technology offers the opportunity to perform "Model Tuning" to pre-trained generative AI models, without the need for great programming skills. With the launch of PaLM2, Google's new next-generation natural language model with similar features to Open AI's Chat GPT, it also provides a friendly interface for those who want to take the use of AI in their daily lives to a more sophisticated level. Through Google Cloud's "Google Vertex AI" platform, you can train your version of PaLM2 to obtain a personalized chatbot according to your tastes and preferences [17].

Without going any further, Google has already created its own specialized chatbot for the medical world, called Google Med PaLM2, which is estimated to be trained on more than one hundred million medical documents and can process information from textbooks, trials, and clinical histories. and obtained 95% correct answers in the official USMLE exams, highly recognized worldwide [18].

Challenges and ethical considerations

Although AI offers great promise in the field of breast cancer, there are also challenges and ethical considerations that must be addressed. The confidentiality and privacy of patient data is fundamental and must be always protected. Clear guidelines need to be established to ensure the responsible use of AI in clinical practice, avoiding discrimination or bias when making treatment decisions based on algorithms. AI should complement and enhance healthcare, rather than replace healthcare professionals. This major concern about job losses should not be minimized. It is essential to train the medical student so that they are familiar with the basic concepts of AI and can work with it and avoid being displaced by AI.

The combination of human clinical experience, the emotional intelligence that doctors have that positions us favorably over machines, with the capabilities of AI can achieve optimal results and provide a comprehensive and patient-centered approach.

Conclusion

Artificial Intelligence is revolutionizing the way we approach breast cancer, from early detection and accurate diagnosis to personalized treatment and effective follow-up. Its ability to analyze large amounts of data and provide precise recommendations is providing new hope in the fight against this devastating disease. These advances are just a few examples of what AI can bring to oncology. However, we must also consider the challenges and limitations involved in its implementation in clinical practice. Some of these challenges include the quality and quantity of data available to train and validate the algorithms. The interpretation and explanation of the results obtained by the algorithms. It is also necessary to evaluate the clinical and economic impact of their use, as well as the possible biases or errors that they may introduce. The integration and interoperability of algorithms with existing systems. It is essential to guarantee the security, privacy, and protection of patient data, as well as compliance with current ethical and legal regulations. The training and acceptance of health professionals. It is essential that doctors know the advantages and limitations of AI, and that they know how to correctly use it as a complementary tool to their clinical judgment. There is also a need to foster trust and collaboration between AI experts and oncology experts.

To face these challenges, a multidisciplinary and integrative vision is required, involving researchers, doctors, patients, administrations, industries, and scientific societies. In this sense, there are European initiatives such as "EuCanImage", a project of the Horizon 2020 program that will create a cancer scanning platform that will contribute to improving the potential of AI and precision medicine in oncology. The project has the participation of twenty internationally recognized institutions and will focus on breast cancer and colorectal cancer.

In conclusion, AI in oncology is a revolution underway, offering great opportunities to improve the care and prognosis of cancer patients. However, it also poses important challenges that must be addressed with rigor, transparency, and responsibility. Only in this way can the full potential of this technology be harnessed for the benefit of society [19].

AI promises a significant transformation of healthcare across all medical areas, potentially representing the "Gutenberg moment" for medicine. The future of medical specialties will depend largely on human interaction and creativity, forcing doctors to evolve and employ AI as a tool in patient care. AI will offer patients security, autonomy, and the possibility of m-care Timely medical care in hard-to-reach areas. It will also reduce the frequency of medical errors and improve diagnostic accuracy through the integration, analysis, and interpretation of information by algorithms and software. However, it is important to highlight that it is still necessary to standardize research in the area, which

allows improving the quality of scientific evidence by knowing its advantages and risks and accelerating its implementation in current medical practice.

References

1. Joaquín Fernández Sande y Enrique Diaz Cantón (2023) Artificial Intelligence and Medicine Treatise on Artificial Intelligence and Law. Juan Corvalan. Editorial Thompson Reuters, (en impresión)
2. Jie Z, Zhiying Z, Li L (2021) A meta-analysis of Watson for Oncology in clinical application Sci Rep 11: 5792.
3. Vaswani S, Shazeer N, Parmar N, Uszkoreit J, Jones L, et al. (2017) Attention is all you need. Google, 20174 https://proceedings.neurips.cc/paper_files/paper/2017/file/3f5ee243547dee91fbd053c1c4a845aa-Paper.pdf
4. Adam Conner-Simons, Rachel Gordon (2019) Using AI to predict breast cancer and personalize care https://news.mit.edu/2019/using-ai-predict-breast-cancer-and-personalize-care-0507
5. Google Research Blog (2020) https://blog.research.google/2020/?m=1
6. Lang K, Josefsson V, Larsson AM, Larsson S, Högberg C, et al. (2023) The safety of an artificial intelligence supported screen Reading procedure versus standard double reading in the mammography screening with artificial intelligence (MASAI) trial: A randomized controlled, screening accuracy study. SSRN, Posted 1-24.
7. Zhenyu Yang, Xiaoxi Zeng, Yi Zhao, Runsheng Chen (2023) Alpha Fold2 and its applications in the field of biology and medicine. Nature 8: 115.
8. Coudray N, Ocampo PS, Sakellaropoulos T, Narula N, Snuderl M, et al. (2018) Classification and mutation prediction from non–small cell lung cancer histopathology images using deep learning. Nat Med 24: 1559-1567.
9. Andrea Koncz (2023) The Medical Futurist, Junio https://medicalfuturist.com/7-medical-technologies-we-are-looking-forward-to-seeing-more-in-2023/
10. Somashekhar S, Sepúlveda MJ, Puglielli S, Norden AD, Shortliffe EH, et al. (2018) Watson for Oncology and breast cancer treatment recommendations: agreement with an expert multidisciplinary tumor board. Ann Oncol 29: 418-423.
11. https://www.astro.org/Meetings-and-Education/Micro-Sites/2022/Annual-Meeting/Learn/Meeting-Highlights/Presidential-Symposium
12. Arimura H, Soufi M, Kamezawa H, Ninomiya K, Yamada M (2018) Radiomics with AI for Precision medicine in Radiation Therapy. IJROBP 60: 150-157.
13. Placidi L, Gioscio E, Garibaldi C, Rancati T, Fanizzi A, et al. (2021) A Multicentre Evaluation of Dosiomics Features Reproducibility, Stability and Sensitivity. Cancers 13: 3835.
14. Harrer S, Shah P, Antony B, Hu J (2019) Artificial Intelligence for Clinical Trial Design. Trends in Pharmacological Sciences 40: 577-591.
15. Jaroensri R, Wulczyn E, Hegde N, Brown T, Flament-Auvigne I, et al. (2022) Deep learning models for histologic grading of breast cancer and association with disease prognosis. npj Breast Cancer 8: 113.
16. Sanz G, Doldán V, Castillo J, Gómez P, Galmarini CM, et al. (2022) A machine learning (ML) approach for identifying genetic biomarkers and new molecular targets associated with impaired survival of breast cancer patients. https://topazium.com/a-machine-learning-ml-approach-for-identifying-genetic-biomarkers-and-new-molecular-targets-associated-with-impaired-survival-of-breast-cancer-patients/
17. Priyanka Vergadia, Jaime Farinos (2023) Generative AI on Google Cloud: New training content, from introductory to advanced. https://cloud.google.com/blog/topics/training-certifications/new-generative-ai-trainings-from-google-cloud
18. Singhal K, Azizi S, Tu T, Mahdavi SS, Wei J, et al. (2023) Large language models encode clinical knowledge. Nature 620: 172-180.
19. Kather JN, Heij LR, Grabsch HI, Loeffler C, Echle A, et al. (2020) Pan-cancer image-based detection of clinically actionable genetic alterations. Nat Cancer 1: 789-799.