**GENOMIC DATA ANALYSIS: CONCEPTUAL FRAMEWORK FOR THE APPLICATION OF ARTIFICIAL INTELLIGENCE IN PERSONALIZED TREATMENT OF ONCOLOGY PATIENTS**

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**ABSTRACT**

Oncology is one of the most dynamic branches of medicine. As a result of numerous oncology studies, there has been a significant increase in scientific and clinical data that the human brain cannot store. Advances in artificial intelligence (AI) technology have led to its rapid clinical application. In this paper, we wanted to see the role of the use of artificial intelligence (AI) in oncology. We conducted an unsystematic search of databases (Pub Med, MEDLINE, and Google Scholar) using the keywords: artificial intelligence, deep learning, machine learning, oncology, personalized medicine. From a large number of articles available to us, we singled out review articles and clinical trial results according to their clarity and innovation regarding the use of artificial intelligence in oncology. Of particular importance to us was the ability to apply their results in everyday clinical work. The possibilities of using artificial intelligence in oncology are innumerable. Thus, AI can be used for diagnostic purposes (malignant screening, histopathology, and molecular diagnostics), therapeutic purposes (personalized treatment, prediction of treatment side effects and response to therapy, treatment decisions) as well as for prognostic purposes (risk stratification, 5-year survival, monitoring). The implementation of AI in clinical practice presents new challenges for clinicians. Namely, in the era of evidence-based and patient-centered medicine, they will have to master statistical as well as computer skills in addition to clinical ones. Therefore, it is necessary to start educating future doctors about the importance of AI in medicine as soon as possible.

**KEYWORDS**

Data Analytics, Artificial Intelligence, Oncology, Personalized Medicine

1. **INTRODUCTION**

Oncology, a field of medicine that deals with the prevention, diagnosis, and treatment of cancer, is one of the most dynamic branches of medicine (National Cancer Institute, 2021). In recent years we have witnessed a rapid increase in scientific and clinical data in oncology to better understand cancer and develop personalized and effective oncology care. But to effectively use the handful of available data, which an individual cannot absorb due to the amount of information, we need the help of artificial intelligence, not only in the field of oncology research but also in everyday clinical practice (Nagy et al., 2020). Artificial intelligence (AI) is defined as the ability of a machine to perform tasks typically associated with intelligent human behaviour. In the mid-20th century, Turing and McCarthy laid the foundations of artificial intelligence, which began to be studied more and more. But wider use required advances in technology (Turing, 1950; McCarthy, 2021). Machine learning (ML) is part of artificial intelligence that uses mathematical and statistical models to improve computer characteristics, and deep learning is part of machine learning (ML). It is based on the operation of complex interconnected artificial neural networks (ANNs) and processes information like neurons in the human brain.

There are different types of neural networks. Thus, convolutional neural networks (CNN) are intended for image processing, recurrent neural networks (RNN) are intended for handling sequential data (data from time series) and are used to exploit data from electronic health records while transformer networks are intended for processing textual data contained in medical records. Each neural network specializes in its specific data...
structure, and their combinations could interpret more complex phenomena. But in addition to neural networks, other methods are used, such as regression methods, tree algorithms, and other algorithms (Nagy et al., 2020).

The application of deep learning requires large data sets, but it is equally necessary that medical professionals have a basic knowledge of deep learning, including its application, but also potential shortcomings. The main disadvantage of AI is the possible violation of an individual's privacy due to potential access to personal data (Shimizu & Nakayama, 2020). On the other hand, in-depth learning can based on the use of radiological and pathological images, help us diagnose disease in a way that exceeds the clinician's performance (Teare et al., 2017; Ehteshami Bejnordi et al., 2017). The focus of our interest is to see where artificial intelligence can help us in oncology.

2. METHODS

We conducted an unsystematic search of databases (Pub Med, MEDLINE, and Google Scholar) using the desk research method and using the keywords: artificial intelligence, deep learning, machine learning, oncology, personalized medicine. From a large number of articles available to us, we singled out review articles and clinical trial results according to their clarity and innovation regarding the use of artificial intelligence in oncology. Of particular importance to us was the ability to apply their results in everyday clinical work.

3. RESULTS AND DISCUSSION

The possibilities of using artificial intelligence in oncology are innumerable. It can be used for diagnostic purposes (screening programs, histopathology, and molecular diagnostics), therapeutic purposes (personalized treatment, prediction of treatment side effects and response to therapy, treatment decisions), as well as for prognostic purposes (risk stratification, survival prediction, monitoring).

Thus, for example, the use of stored mammograms can help us identify breast cancer, while the use of stored digital pathology images can help us diagnose prostate cancer (determination of Gleason score) or breast cancer (determination of Her2 status or tumour-infiltrating lymphocytes (TIL)). AI is expected to be an important tool soon to significantly assist pathologists in their daily work (Niazi et al., 2019; Nagpal et al., 2019; Saltz et al., 2018; Vandenberghe et al., 2017; Chang et al., 2019). The application of AI has also found its place in dermatology where the recognition of skin lesions, such as melanoma, by analysis of stored dermoscopy images, is as effective as and the recognition of skin lesions by a dermatologist (Esteva et al., 2017). But for this, a large amount of imaging data is needed which still needs to be worked on. In general, we can say that AI is already used to perform various tasks in oncology at a level equal to or sometimes greater than the level of clinicians (Rodriguez-Ruiz et al., 2019; Litjens et al., 2016).

3.1 Personalized Treatment

The goal of modern oncology is personalized treatment. Given the large amount of data to which oncologists are exposed daily, if we want to personalize oncology, or choose the best treatment for each patient individually, we need the help of AI.

Namely, the precondition for personalized treatment is knowledge of the genomic data of the tumour, whether there are possible genomic mutations in the tumour as target points of oncology treatment. Hundreds of thousands of articles are published annually on genomic mutations and cancer. Therefore, databases are being created that aim to help clinicians. An example of a database linking genomic variation and disease is COSMIC. Thus, in 2019, COSMIC isolated almost 10 million genomic mutations related to cancer (Forbes, 2017). This database also helped to link genomic mutations to drug susceptibility, which can then be used in clinical practice (Lee et al., 2018).
ExPecto also works on this principle, using all publicly available genome-related studies to help find a link between genomic mutations, cancer, and drug sensitivity, and there are more and more such examples (Shimizu & Nakayama, 2020).

### 3.2 Analysis of Genomic Data

At the centre of oncology interest is the connection between genomic mutations and disease. This is supported by the fact that only in 2017, FDA approved several genomic tests in oncology (Oncotype Dx, Praxis Extended RAS Panel, MSK-IMPACT, and FoundationOne CDx) to personalize medicine (Shimizu & Nakayama, 2020).

Namely, currently, the diagnosis, as well as the classification of oncology disease, is based on histopathological examination and the expression of molecular markers of the tumour cell (biological information about the tumour).

If we use gene analysis we can predict the prognosis of cancer without other biological information about the tumour. By implementing tools that allow us to do this in clinical practice, such as the molecular prognostic result (mPS), we can avoid over-treatment of cancer patients (Shimizu & Nakayama, 2019).

The role of artificial intelligence in healthcare is growing and more and more artificial intelligence-based tools have been approved by the FDA, such as Arteryx, an imaging platform that uses magnetic resonance and computed tomography to help physicians follow-up lung and liver cancer patients (2018) or the PAIGE.AI platform (Digital Pathology Platform) that uses AI for the diagnosis and prognosis of certain types of cancer (2019).

### 3.3 Conceptual Framework for the Application of Artificial Intelligence in Oncology

A prerequisite for the wider use of artificial intelligence in oncology is the creation of large databases, such as The Cancer Imaging Archive [http://www.cancerimagingarchive.net] and the Genomic Data Commons Data Portal [https://portal.gdc.rak.gov].

It is also important to use AI when analysing the data obtained. Given the dynamics of AI development and the speed of AI implementation in medicine, and thus in oncology, soon we can certainly expect radical changes (Shimizu & Nakayama, 2020).

So although the application of AI in oncology seems very complex and still inaccessible to all oncology centres, given the required infrastructure and skills of clinicians, some segments of AI can already be used in everyday clinical practice. Thus, AI can help us make decisions about oncology treatment. Namely, decisions on oncology treatment are based on the assessment of the patient's clinical condition (PS = performance status). It is a subjective assessment made by the clinician by observing the patient's condition and based on data obtained in conversation with the patient (Pirl et al., 2015).

However, a prospective study by Gresham et al (2018) showed that monitoring patient activity (steps, distance, stairs) can help us not only to assess the clinical condition of patients with metastatic cancer but also to assess clinical outcomes (side effects, hospitalization, survival). A correlation was observed between the number of average daily steps and the clinical condition of the patient (p <0.01) and possible adverse events (OR: 0.34, 95% CI 0.13, 0.94), hospitalization (OR: 0.21 95% CI 0.56, 0.79) and risk of death (HR: 0.48 95% CI 0.28–0.83). All of this points to the feasibility of using activity monitor carriers to assess PS in patients with metastatic cancer and suggests their potential use for predicting clinical outcomes such as hospitalization and patient-reported outcomes. These findings should be confirmed in larger, randomized trials (Gresham et al., 2018).

The results of a study by Pirl et al. (2015) are on the same track. It included 41 patients with metastatic non-small cell lung cancer (NSCLC). The patient activity was measured using an actigraph (ACTIWATCH 2) over 72 hours and compared with the performance status (PS) determined by the oncologist. This study concludes that measuring patient activity using an actigraph may be useful in determining a patient’s PS (Pirl et al., 2015).
4. CONCLUSION

Objective assessment of patients' clinical condition (PS = performance status) is difficult because patients spend most of their time outside the hospital. But objective real-time activity data that we can collect with physical activity monitoring devices, such as smartphones or smartwatches, can help. In this way, the subjectivity and bias associated with current assessments during the clinical examination itself can be avoided. The active introduction of AI technology is considered an inevitable trend in the future of medicine. The implementation of AI in clinical practice presents new challenges for clinicians. Namely, in the era of evidence-based and patient-centered medicine, they will have to master statistical as well as computer skills in addition to clinical ones. Therefore, it is necessary to start educating future doctors about the importance of AI in medicine as soon as possible.

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