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Intelligent Detection for Pancreatic Cancer Diagnosis: Future Directions

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Abstract

Introduction: Artificial intelligence is one of the most modern information systems that bases its operation on analogous functioning to the human mind. Particular hopes are placed in the treatment of diseases considered incurable. One such disease is pancreatic cancer, which has an extremely poor prognosis. Thanks to the use of machine learning and deep learning, artificial intelligence analyzes the available images taken during computed tomography and

compares them with the introduced changes characteristic of pancreatic cancer. The advantage of the machines is the ability to analyze data, scans and images in a fraction of a second.
Material and methods: The authors reviewed the peer-reviewed international literature describing the application of artificial intelligence in oncology. Databases such as PubMed, SCOPUS and Web of were searched with the keywords "artificial intelligence", "oncology" and "pancreatic cancer". The review included articles from 2004-2023.
Discussion: Pancreatic cancer is an important topic of research due to unsatisfactory treatment results and the lack of screening tests allowing for quick detection of people at risk. Artificial intelligence is becoming a promising solution for asymptomatic patients, who can be classified into risk groups much faster than traditional methods. Unlike humans, intelligent machines can work faster and continuously, delivering content and results much faster.
Conclusions: Artificial intelligence is a promising tool in the diagnosis of pancreatic cancer. Research results indicate that it is the most widely used in the field of oncological radiology, thanks to which imaging of early stages of cancer is becoming easier to detect. There is a need to verify machine methods and avoid bias when privatizing smart machines. The good of the patient should always come first, especially in a disease with an unfavorable prognosis, such as pancreatic cancer.

Keywords: oncology, pancreatic cancer, artificial intelligence

Introduction

Artificial intelligence is one of the most modern software systems, which bases its operation on analogous functioning to that of the human mind. There are many definitions of this system, but the general idea is that artificial intelligence implies the ability to interpret received data and create conclusions and explanations based on their analysis [1]. The premise of the developers of artificial intelligence was a system that would be able to learn, remember and solve the problems encountered without direct human supervision [2]. Because of its abilities, this system has revolutionized medicine and related sciences. Intelligent machines have been programmed to autonomously diagnose patients and suggest possible treatment options based on the system's data analysis [3].

Particular hopes are pinned on modern methods such as artificial intelligence for diseases considered incurable, which have been a nuisance to doctors and patients for many years. Such diseases include cancer, especially pancreatic cancer characterized by an outstandingly poor prognosis. Artificial intelligence is expected to improve the diagnostic and therapeutic process and make a breakthrough in the management of this cancer.

The purpose of this article is to present the latest developments in the diagnosis and early detection of pancreatic cancer based on artificial intelligence methods on the basis of a review of the international literature.

Material and Methods:

For the purpose of this review, the authors reviewed the peer-reviewed international literature describing applications of artificial intelligence in oncology. Databases such as PubMed, SCOPUS and Web of were searched using the keywords: "artificial intelligence," "oncology" and "pancreatic cancer." The review included articles written in English and dating from 2004 to 2023. Articles were classified based on abstracts. After excluding non-compliant publications, 97 articles remained. In this work, 42 publications were finally included.

Artificial intelligence in detecting pancreatic cancer

Cancers are cited as the second most common cause of death in our country. According to estimates, they lead to the deaths of about 25% of the population [4]. With the introduction of new diagnostic methods, the increase in people's awareness and universal access to medical services, the percentage of detectable malignancies is increasing every year. This results in an ever-increasing number of patients, which is inevitably combined with an increase in the cost of managing the oncology system. In 2009, more than PLN 4 billion was allocated to oncology, and 11 years later, more than PLN 9 billion. In 2020, spending was estimated at PLN 11.2 billion. Taking into account the analysis of the development of the system and the growing demand, a program called the National Oncology Strategy developed for 2020-2030 was adopted. The project envisages subsidizing medical services related to cancer treatment in 2020-2023 [5]. The main goal of the program is to improve long-term outcomes, the primary goal of which is the percentage of patients surviving 5 years in good health after treatment [6]. The program also involves the implementation of prevention campaigns, as the cost of cancer treatment increases with the stage of the disease at the time of diagnosis. Therapy is lengthy and expensive, and many cancers still fail to achieve satisfactory results. Such an example is pancreatic cancer [7], 80% of whose cases are detected at the inoperable stage, which inevitably means patients can only receive palliative therapy [8]. Most patients with this disease die, and satisfactory treatments have still not been developed [9]. Cure rates for other cancers are increasing, but not for pancreatic cancer [10]. The main problem with pancreatic cancer is that it is detected too late, so research is currently being conducted to improve diagnostic methods and to create publicly available screening tests [11] that would allow treatment to be initiated more quickly [12]. Currently, screening is not cost-effective due to too high a rate of false positives and the high cost of screening [13]. Imaging methods are the primary method of cancer diagnosis, and in the case of pancreatic cancer, computed tomography is used [14]. Due to the rapid development of artificial intelligence methods in radiology, specialists see an opportunity for a breakthrough in the diagnosis of pancreatic cancer. Artificial intelligence methods have been known since the 1960s, but only in recent years have they gained prominence in oncology [15]. Through the use of machine learning and deep learning methods, artificial intelligence can analyze available images taken during CT scans and compare them with inputted changes specific to pancreatic cancer. The advantage of machines over humans is the ability to analyze millions of data, scans and images in a fraction of a second and verify the data quickly [16]. Diagnostic successes achieved through the use of intelligent machines have already been made available in the literature [17,18]. Experts report that the branch of artificial intelligence known as deep learning has had the most success in oncology [19,20]. Machines have been shown to be able to recognize pancreatic lesions less than 2 cm in size, which has been considered a success in this field [21].

Another type of artificial intelligence called Transfer learning has been applied to predict the development of pancreatic cancer in precancerous conditions, as reported in international studies [22,23]. Artificial intelligence is able to analyze the infinite amounts of data contained in medical systems and mark cancerous lesions as abnormal. This process is crucial for detecting cancer at an undeveloped stage and achieving satisfactory treatment results. Studies have shown that deep learning is most widely applicable to oncology diagnosis. It gains a significant advantage over other artificial processes for detecting abnormalities [24]. Analyzing such good results in diagnosing cancerous lesions, researchers are now focusing on the detection and development of novel biological markers that, together with rapid imaging, will allow the development of effective therapy for pancreatic cancer. The cure rate in this disease remains low, reaching less than 10% [25]. Risk factors for pancreatic cancer have been well known for many years and include smoking, advanced age, obesity, family history and genetic factors [26,27]. Despite this knowledge, methods that are effective in cancer diagnosis have not yet been developed, but the above factors can be aids to artificial intelligence methods in estimating the risk of cancer development [28]. Thus, researchers assuming that an important factor leading to cancer is newly detected diabetes [29,30] have developed a state-of-the-art model that, based on intelligent machines, can predict the development of cancer with a sensitivity and specificity of 80%. Sharma et al [31] took into account parameters such as change in body weight, change in blood glucose levels and age of discovery of diabetes in the patient. Similar conclusions were reached by Chen et al. Who used smart machines in their project based on glycated hemoglobin studies [32]. After taking into account the basic parameters, the predictive value of expected risk was 60% and 80%, respectively.

Researchers are also using genetic factors and markers to improve rapid cancer detection methods. Kleina et al. created a state-of-the-art logistic regression model to estimate the risk of developing pancreatic cancer. The study looked at the European population, taking into account family history and genetics. The researchers achieved results of 61% prediction when assuming DNA chain polymorphism values [33]. Klein's research served as a foundation for the development of more modern methods, and so Chen et al. created an improved model for cancer detection based on biological, environmental and genetic parameters [34].

Machine learning is also being developed based on radiological imaging, as Quareshi et al [35] did in their analysis. Their method involves identifying at-risk patients based on imaging scans. The scans came from medical records up to three years before the cancer was detected. Artificial intelligence was able to analyze the imaging results with up to 86% accuracy by control and prediagnostic groups. However, these results were conducted on a narrow group of patients and need to be replicated in a multidisciplinary study on a large population. Of all the fields of medicine, artificial intelligence is making the most progress in radiology, hence this is where the latest research by clinicians is focused. Chakraborty et al [36], using machine learning, were able to quickly classify identified cysts in patients as potentially cancerous and without dysplasia capacity. The artificial intelligence tools showed a sensitivity of 68% and specificity of 84%, which was confirmed histopathologically. Chu et al [37] in a similar study described the results of cancer detection using artificial intelligence. The result was 89% compared to the traditional method. Here, in addition to CT imaging, demographic parameters such as the patient's age and gender were taken into account.

Computerized imaging combined with artificial intelligence was also presented in the studies of Matsyuama et al [38] and Yamasita et al [39].

Discussion

Numerous international studies have highlighted the role and opportunities offered by intelligent machines in oncology. Researchers are focusing not only on improved treatment, which has direct benefits, but especially on fast and effective diagnosis of cancer. Pancreatic cancer is an important topic of research, due to unsatisfactory treatment results and the lack of screening tests to quickly detect those at risk. Artificial intelligence, thanks to its diversity, is becoming a promising solution for asymptomatic patients, whom it can classify into risk groups much faster than traditional methods. Unlike humans, intelligent machines can work faster and without interruption, delivering the desired content and results much faster [40].

Machine learning, deep learning and other types indicate that in the future, through their use, it will be possible to develop screening tests for pancreatic cancer and predict the development of the disease. The speed at which machines can analyze radiology databases is yielding promising results in cancer detection. Early detection of lesions gives hope to patients for possible therapy of early stages without the use of surgical organ resections. Early-stage lesions are associated with less complex therapy, which is an opportunity for treatment units to reduce costs in oncology. In many countries, health care is underfunded, with increasing financial demands. Artificial intelligence can reduce medical costs. Certainly, in the coming years, artificial intelligence will become a common tool in the diagnostic and therapeutic process not only in oncology, but in all areas of oncology. However, studies conducted on broad groups are needed so that the results can be verified.Experts point out that the sensitivity and specificity parameters obtained with artificial intelligence tests should be tested for possible differences depending on the patient groups studied or institutional characteristics such as the software and testing methods used. It should be kept in mind that artificial intelligence platforms may be commercialized, which may result in biased results for financial purposes [41]. Therefore, despite promising results, artificial intelligence needs improvement and verification [42].

SUMMARY

Artificial intelligence is a promising tool for pancreatic cancer diagnosis. Research results indicate that it is most widely used in the field of radiation oncology, making imaging of early stages of cancer increasingly easy to discover. In addition, artificial intelligence can contribute to the creation of effective and simple screening tests for pancreatic cancer. Despite the positive prognosis for the development of modern technology, there is a need to verify machine methods and avoid bias when smart machines are privatized. The patient's welfare should always come first, especially in a disease with such an unfavorable prognosis as pancreatic cancer.

Author's contribution:

Conceptualization: Magdalena M., Klaudia K. Jakub L.; Methodology: Magdalena M., Klaudia K.; Software: Jakub L.; Check: Aleksandra M., Natalia R.; Formal analysis: Klaudia K., Paulina B.; Investigation: Anna S.; Resources: Magdalena M. Jakub L.; Data curation: Magdalena M.; Writing - rough preparation: Magdalena M., Julia C.; Writing - review and editing: Magdalena M., Lidia R. Jakub L; Visualization: Monika Z.; Supervision: Klaudia K., Magdalena M.; Project administration: Magdalena M., Jakub L., Klaudia K.

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