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AI in Dermatology: Bridging the Gap Between Potential and Practice

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Abstract

Artificial intelligence has been rapidly penetrating every element of our lives for quite some time. However, its presence in health care has remained elusive. This is particularly apparent in the field of dermatology, where, given the characteristics of this discipline of medicine, it would seems that its presence should be abundant. Malignant skin lesions are still high in the statistics in terms of cancer mortality while being one of the easiest to treat when diagnosed early. There are many reasons why artificial intelligence is not used in daily practice as an aid for cancers detection. However the most important one is the ongoing insufficient quality of the algorithms, which, despite great results in laboratory settings, do not produce good enough outcomes in clinical settings. Other important reasons are that people still distrust and fear artificial intelligence and simply the legal lack of adaptation of countries to its lawful and safe use. Despite the work of scientists and legislators the road to seeing artificial intelligence as a helping tool for dermatologists on a daily basis is still very long and requires the attention of scientists and the whole medical community.

Keywords: artificial intelligence, dermatology, melanoma, skin, cancer

Introduction

What is Artificial Intelligence?

Phrase Artificial Intelligence (AI) was first defined by american computer scientist John McCarthy in year 1955. The definition he has used: *"The goal of AI is to develop machines that behave as though they were intelligent."* [1]. These days computing power of computers and in particular the ability to process huge amounts of data, the so-called Big Data using sophisticated algorithms has made it possible to create programs and applications that by learning specific information can later produce precise results. The scientific branch that focuses on these algorithms is Machine Learning (ML). For this reason, the two terms, Machine Learning and Artficial Intelligence are used interchangeably in colloquial language. Less frequently, but also vicariously, we can also encounter the term Deep Learning, which stands for a subcategory of ML in which a large number of layers of neurons are used in the so-called neural network of which the algorithm is composed. A special type of algorithm is Convolutional Neural Network it is the most common type of algorithm used for image analysis. An important feature of it is the ease of finding similarities in images with a relatively low need for computing power as well as the invariability of results when images are distorted [2]. The correlation of the concepts is shown in Figure 1.

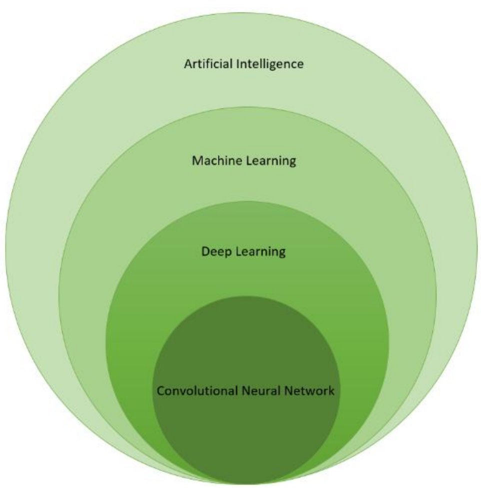

Figure 1. The correlation of the concepts

In medicine, we can divide AI into two branches: virtual and physical. The physical branch consists of robots and devices. For example there are a device used to assist surgeons in performing procedures, and others to help the elderly and disabled in their daily functions (so-called carebots). Another interesting example of this type of devices are robots whose purpose is to communicate and teach children with autism [3]. The virtual branch consists programs and software used in diagnosis, treatment and research. The fields in which AI is most commonly used today are genetics, molecular medicine, radiology, pathomorphology, oncology and cardiology. Recent studies also show the potential use of AI in diabetology and ophthalmology [4]. Dermatology is a field in which the evaluation of the appearance and nature of skin lesions plays an important role so it seems clear that it can benefit greatly from using AI to classify lesions and in making it easier for doctors to diagnose dermatological diseases. Malignant skin tumors are among the most dangerous diseases so increasing their detection and thus further chance of curing them is one of the priorities in the development of this branch of medicine.

Malignant tumors of the skin

Skin malignant lesions are usually divided into melanoma and non-melanoma skin cancers in which the most common are basal cell carcinoma (BCC) and squamous cell carcinoma [5,6]. In Poland in 2019 the incidence of melanoma and other malignant skin cancers per 100,000 people was 46.8. They represent about 11% of all malignant tumors. Which puts them in fifth place in terms of morbidity. According to statistics, their detection rate has remained at a similar level in recent years [7].

Well-known and renowned specialists in dermatology recommend that skin lesions should be examined using a dermatoscope. When there is uncertainty as to whether the examined lesion is benign or when it shows features indicating a chance of becoming malignant the basic procedure is to excise it with the margin of healthy tissue and then transfer it to the laboratory for histopathological examination. During these steps two unfavorable situations may occur. The doctor due to lack of knowledge or confidence in his judgment in diagnosing the lesion recommends removal and examination of lesions with a very low probability of malignancy which puts the patient under unnecessary stress caused by waiting for the result and also leads to increased the overall cost of medical care. The second situation is the opposite pole when a doctor out of inexperience or lack of knowledge ignores skin lesions that by their appearance should have been examined more thoroughly. An unwillingness to widen the examination may also simply be due to concern to save expenses for the patient or the healthcare facility. It is also a fact that despite recommendations to use dermatoscopes a large proportion of GPs meaning those to whom patients first reportdo not have such devices and/or do not know how to use them effectively [8].

Thus, it seems that increasing the availability of programs that describe and classify skin lesions which would assist primary care physicians and inexperienced dermatologists would make the diagnosis of dermatological skin lesions much more efficient and effective. AI could also help extract a lesion from a photo to enhance rapidly growing teledermatology. Having a smartphone with a built-in camera and using an appropriate AI program would enable any patient to obtain an initial diagnosis of the lesion of concern.

Artificial intelligence in detecting malignant skin lesions

Diagnosis of skin lesions involves a detailed history in which the doctor asks, among other things, about the symptoms, the circumstances under which the lesion appeared and other chronic diseases the patient suffers from or has suffered from. In addition, an essential criterion for the doctor is the appearance of the lesion itself. This is where the use of AI, which is able to propose a diagnosis based on thousands of previously analyzed images can be of great importance. The specialist usually uses a dermatoscope to analyze the lesion which is a specialised device that magnifies and illuminates the lesion, thus making more details visible. However, it is not uncommon for a patient or general practitioner to not have access to such a device. Therefore, AI training in skin lesion analysis is mostly done on images taken with the omnipresent smartphones or traditional cameras.

Taken into account in this work the original papers from recent years, in which the effectiveness of AI in detecting malignant skin lesions was determined we could state that the effectiveness of AI can be comparable to dermatology specialists. And compared to non-specialist physicians even outperform them [9,10,11,12,13,14]. A meta-analysis examining papers from earlier years (2002-2018) concludes that computer-assisted melanoma diagnosis has similar efficacy to dermatologists but also notes that of the 70 papers it analyzes, only four were free of risk of bias [15].

Disadvantages and difficulties of using AI in dermatology

Academic and clinical papers have been showing the effectiveness of AI in skin cancers detection for more than a decade [16] and many AI-based devices and programs to aid in disease diagnosis and treatment have been systematically approved by the FDA for more than a dozen years including those related to dermatology [17,18,19]. The development of one of these devices however after about 5 years of FDA approval and entry into the market has been canceled. Moreover, it is not seen that in daily clinical practice dermatologists or general practitioners use AI to help diagnose skin diseases. What is the reason for this?

The use of AI - ethics and the law

In the general understanding of AI the most important and basic feature of how AI should be characterized is its primary purpose - to "serve" humans and any activity that may harm human should not be performed. In addition, using AI in a legal, legitimate way creates a number of problems.

Algorithms that create AI can turn it into a so-called "Black Box". That means such a level of complexity in AI that even its creators are unable to understand how it performs computations on the given variables and gets a particular result. This, in turn means that it is impossible to reliably predict what data will be obtained when specific input values are entered [20]. It is therefore not obvious how one would treat a medical error in treatment or diagnosis if its occurrence was influenced by the use of "non-transparent" AI [21]. A similar problem could arise with leaked patient or health care worker data. It is then impossible to say with certainty whose fault it would be. The employee's, the AI creator's or no one's?

Another problem with AI is its tendency to produce biased results. This can lead to unfair or even discriminatory decisions about the type or method of treatment. This type of situation is most often based on what type of date AI was taught on. In dermatology, an important feature is the color of the patient's skin that surrounds the lesion being diagnosed. Using AI trained on images of skin lesions of light-skinned people in a patient's "skin of color" can affect the AI's response, and this further affects diagnosis and treatment [22].

Patients' and doctors' confidence in using AI is also an important issue. Unfortunately this topic is very often neglected and there are few works that analyze this [23]. Studies show that only 37%

of questioned people would be willing to trust AI in the healthcare system. As the researchers noted, at present, it is the appropriate regulations that are the most important factor that could increase consumer trust in AI [24]. It is also crucial to remember how important it is to have the ability to explain and communicate the diagnosis to the patient, something that only a living doctor can do.

Currently, the European Union (EU) is working on introducing the first AI regulations. The idea is that AI systems used in the EU ougth to be "safe, transparent, traceable, non-discriminatory and environmentally friendly." Depending on the degree of AI risk, different rules would apply for the AI manufacturer and user [25]. Those regulations, at the time of writing this paper, are under negotiation with the EU council. Assuming that these regulations take effect in near future we can expect an acceleration in the adoption of AI in daily healthcare.

In recent years, the increased access to robotics and AI in industry has had a major impact on workers previously occupying robot's workplaces. Demand for human workers has declined, salaries for existing positions have decreased, while new job positions that were required to operate AI and the devices have been created [24]. The rapid introduction of AI into systematic use in healthcare is also likely to affect the quality of work of its employees, most likely negatively. Therefore, it should be kept in mind that breakthrough AI technologies should be introduced gradually to avoid or at least minimize their harmful effects [26].

Limitations of AI in dermatology

It is worth noting that currently available studies on the use of AI in medicine are largely retrospective and there are just a few prospective studies in dermatology alone. Yet these are the ones that can show the true clinical application of AI and its reliability.

The effectiveness of AI in evaluating skin lesions largely depends on the quality of the images provided to it. The images should be standarized to the system in use. This results in the fact that "non-ideal" images that have noises, are rotated, have manipulated contrast or have been resized may give different results. As example Figure 2 shows how small changes of picture characteristics may produce different results.

Figure 2. A Image and prediction (used online analyzer: skin.test.woza.work) of a skin lesion of a 25-year-old male taken with Iphone SE 2020.
B Same image but rotated, with changed brigthness and color saturation.

It has also been noted that AI models unintentionally take into account and learn certain features of images that a physician would not, correctly, pay attention to. As an example, due to the fact that in the usually used databases which the algorithm had been learning on, the presence of rulers or ink markers was far more common in photos of malignant lesions. The AI learned that this allegedly favors the malignancy of the lesion. Such algorithm biases occur if the databases used for learning are not carefully selected and properly standardized [27,28].
However, doing such a thing is not easy because due to the nature of the algorithms, which behave like a "Black Box," it is difficult to determine the appropriate limits and boundaries of image manipulation like dimming or spatial orientation.
Studies also show that intentional, human-made, targeted image perturbations can change the AI's response by 180 degrees at the same time remaining indistinguishable for humans to see the difference. For example, a benign lesion previously recognized correctly by AI after performing an image modification will be recognized by AI as malignant, at the same time claiming a high confidence of prediction [29].
In addition, depending on where on the body the lesion is located, the presence of hair or scabs, the effectiveness of AI can also vary [30,31]. This shows the limitations of AI that a living person does not have. The doctor can adapt his diagnosis taking into account the patient's history and data not available on the image, such as his race or gender.
Most of the studies comparing physicians to AI do so under highly artificial conditions, which are not similar to real clinical situations where the clinician can look at the lesion from different

angles and compare it to surrounding lesions using, among other things, the so-called "Ugly duckling Sign" (a clear distinction of a certain lesion against surrounding other lesions) or "Predominant pattern"(an individually characteristic pattern of pigmented lesions found in most of the patient's skin lesions). That conditions of an experiment diminish the capabilities of physicians in their examinations [32,33,34].

It is also important to consider whether the availability of technology will not result in notorious, unnecessary diagnosis of lesions, leading to a situation where lesions that have a low risk of becoming malignant, or lesions of unknown origin, but benign or very early stages, will be repeatedly operated on. Such situations may cause adverse psychological and even physical effects in patients, especially in the elderly people and those who have been previously diagnosed with melanoma or other skin cancers, at the same time not reducing the mortality of the disease itself [35,36,37].

Summary

It is undeniable that Artificial Intelligence will have an important position in dermatology in the near future. This is indicated by research results and examples from other areas of medicine and other branches of science. Unfortunately, only a few of these studies show its clinical application. They tend to focus more on testing it under heavily laboratory conditions in a kind of bubble made of database. Some studies have highlighted these limitations and problems of AI in detecting skin lesions. Often, these constraints naturally do not apply to a human. For example a doctor will not change his diagnosis because of the presence of a ruler or ink near a lesion. Most often, the limitation of artificial intelligence algorithms is that they only focus on the presented image of the lesion while the clinician approaches the patient in a holistic manner. With a well-gathered history and a thorough medical examination the chance of an accurate diagnosis increases significantly. Another disadvantage of AI is the lack of emotional understanding of a patient and the lack of developing interpersonal contacts accompanying the patient-doctor relationship which is an important factor in the diagnosis and successful treatment of the disease [38]. A matter of equal importance is legislation and law which these days is unprepared for the large-scale introduction of AI into medicine. Without the creation of appropriate laws and procedures the use of AI legally will be highly risky.

Efforts toward solving the problems of implementing AI in deramtology are already underway. Researchers are improving algorithms to automatically standardize images of skin lesions to avoid errors in diagnosis due to perturbations and imperfect images [39,40].

Lawmakers are introducing new regulations to lay the groundwork for the proper and safe use of AI in dermatology and health care in general. The most important thing, however, seems to be that despite AI's undeniable progress, it cannot be treated as competition for doctors. And, as research shows, it is the collaboration between a doctor and AI that yields the best results in the diagnosis and treatment of skin lesions [41,42].

In recent years, artificial intelligence has been thriving in practically every area of life, and medicine is one of the most important one. AI in dermatology could be a breakthrough, but not as a standalone machine, but as an improvement of the doctor's work. Allowing to make more accurate diagnoses and make the right decisions. But to achieve this, further research and work of scientists is needed to make this possible in a safe and well thought out manner.

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