How Can We Use Artificial Intelligence to Predict Melanoma

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Abstract

Roughly 70% of metastatic melanoma cancer patients succumb to the 5-year survival rate. [1]. When compared to more commonly diagnosed skin cancers, such as Basal Cell Carcinoma (BCC) and Squamous Cell Carcinoma (SCC), the fatality rate for patients with melanoma is almost three times higher. Although there are several treatments available for patients, these therapies are accompanied by severe side effects and are often unable to cure higher stages of melanoma. This is why researchers have begun to combine therapeutic procedures with Artificial Intelligence (AI). The prediction abilities of AI have proven to be effective in detecting early symptoms of melanoma. Using various machine learning methods, AI can identify hidden melanoma cancer cells typically in the epidermis. This review aims to understand the AI techniques harnessed to predict the emergence of melanoma in a human body, as well as the possible benefits and risks of using computational models in medicine.

Introduction

The use of AI in cancer treatments, specifically melanoma, has significantly increased over the past couple of years. AI is a technology that uses machine learning and programming software to analyze medical data, improve patient outcomes, and possibly predict certain diseases and symptoms in individuals. AI can detect patterns and symptoms in cancers using certain designated data. It uses the data to train itself to detect the symptoms of the cancer, effectively reducing the chances of fatality. Unfortunately, every pattern and symptom for every cancer is different. Melanoma has proven to evade immunotherapy and build chemotherapeutic resistance, which the program is dependent on [2]. Therefore, understanding the basics of this skin cancer and constructing counter tools will help shape an adaptive artificial intelligence that can work its way around the defensive tools of the melanoma cell.

What is melanoma?

The development of melanoma cancer cells begins within a melanocyte, which is a melanin producing skin cell that provides pigmentation and protection from UV radiation. Prolonged exposure to radiation by UV light can damage the melanocyte's DNA, resulting in a DNA mutation, which if left untreated can accumulate through uncontrolled growth of the cells, eventually forming a malignant tumor. These tumors often become metastatic because they are not treated properly and can very easily grow undetected [3]. This makes melanoma extremely dangerous, and the risk of this cancer increases with age and people with lighter skin. An estimated 100,000 melanomas were diagnosed in 2023, and around 9,000 patients are expected to succumb to it [4].

Melanoma Subtypes

There are several subtypes of melanoma, including desmoplastic, mucosal, amelanotic, ocular, and spitzoid melanomas. Each cancer has its own unique characteristics, but they all attack certain skin tissues. The most common form is known as the superficial spreading melanoma, which accounts for close to 70% of all cases [5]. These variations of melanoma are all very dangerous, so the importance of finding a right treatment has become very clear.

Treatments

While there are options for melanoma treatments, they will differ based on the stage and severity of the tumor. The most common forms of treatments include surgical excision, immunotherapy with the help of interleukin 2 (IL-2), and chemotherapy [6]. However, chemotherapy does not work as efficiently due to the disease's tendency to develop drug resistance [7]. To counter this, a clinical trial conducted by the National Cancer Institute showed that combining the immunotherapeutic drug pembrolizumab (Keytruda) with surgical excision (neoadjuvant therapy) was very successful for patients with Stage I or II cancer [8]. Unfortunately, surgery alone is unlikely to render a patient with Stage III or IV melanoma disease-free [9]. To prevent advanced melanoma, early detection and prediction by AI still constitutes the best means to improve the outcome of the patient.

AI Proposition #1 ~ Melanoma Decision Support System

Proposing AI prediction as a possible way to remove melanoma cancer has been at the forefront of many research and clinical labs. The Melanoma Clinical Decision Support System (CDSS) is one of the low cost software programs that uses various dermoscopy imaging, machine learning, and prospective data to evaluate various proteins in the protein and predict whether or not it will form an eventual malignant tumor. Not only does the CDSS predict melanoma, but it can also predict the progression rate of the spreading of the tumor. The CDSS relies on epiluminescence dermatoscopy, which is a technique that uses data imaging analysis and microscopes to examine the skin's surface to evaluate skin and pigmented lesions [10]. With the images processed into the software, the AI uses the predisposed data to create a criteria and evaluation checklist for each cell it investigates. If the cell does not fill all the marks, this indicates it is not a normal cell, and could potentially form an abnormal skin tumor.

For instance, take the Granulocyte macrophage colony-stimulating factor (GM-CSF). If this serum, which is a cytokine that helps produce white blood cells, is found to have decreased in a collective area of cells, it is a marker of possibly being cancerous as well as poor prognosis. Other examples include Breslow thickness, IL-4 and IL-6 serum levels, and many other factors (figure 1). Therefore, instead of the researchers spending hours evaluating the levels of certain serums and proteins, AI can do it for them, whilst also predicting if a cancerous cell is present. This effectively reduces the time it takes for evaluation, and it decreases the chances for the cell to rapidly grow [11].

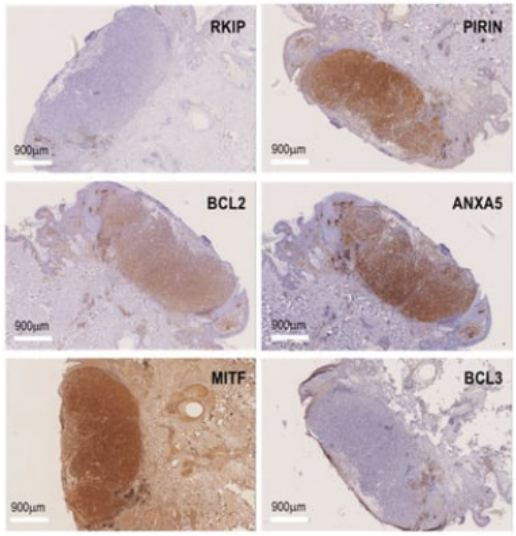

Figure 1. Biomarker expressions, and checkpoints, representing serum levels and evaluating for melanoma biopsy[11]

On the contrary the data used by the AI to fact check (ML) every cell brings a risky element because the clinically researched data is the only source of information AI relies on. The researchers must gather data on the characteristics and genes of normal cells, as well as melanoma cells. AI only compares these two variables and then implicates it on the cell [12]. This means AI does not modify or adjust data as it cannot adapt to a foreign substance, which may be found in melanoma cancer cells. This potential error requires constant data review and updates to ensure accurate evaluation criteria, which is why CDSS may not be the best method for predicting melanoma [13]. The risk of a non-researched protein or substance present in the cell being diagnosed incorrectly by the AI may be a reason why there are other suggested methods for integrating and using AI to predict melanoma.

AI Proposition #2 ~ Morphological Footprint Detection

Another proposed AI method involves adaptation and detection, rather than examination and evaluation. This involves searching for early morphological footprints of melanoma tumors, which are fairly simple to detect when given the prospective training and data [14]. The most common morphological footprints are immunohistochemical (IHC) markers like S-100 Protein, HMB-45, Melan-A, and various other markers. These are regular proteins found in melanocytes and melanoma cells. With proper training,AI can detect these certain proteins by familiarizing themselves with it. Often, by finding these protein footprints, the cell that was found with them can then be examined, and necessary therapies will then remove all types of those cells if needed. This process involves AI actually finding the cell, rather than evaluating one like the CDSS [15].

This adaptive AI technique can narrow down the suspects for possible tumor growth in melanoma because of the melanocytic nevi (mole on the skin). Since these nevi are unable to undergo mitosis, common mutations like CDKN2A (cell cycle control) and TP53 (apoptosis) can be easily found. AI undergoes training in which it practices collecting data, analyzing it, and perfecting any defects the program may have. Once AI has undergone the proper training, it can use its data software to not only detect the variables it has been given, but also fuse multiple elements to evaluate whether or not the morphological footprint is cancerous or not [15].

Conclusion

Newly developed AI techniques can advance the field of medicine and melanoma cancer cell prediction. While there is currently no guarantee AI will be able to accurately predict the emergence of melanoma in a patient, with enough research and clinical trials, these proposed tools can help save thousands of lives each year. From a forward-looking perspective, with adequate funding, this field has the potential to harness AI for comprehensive cancer analysis, enabling the development of tailored treatment plans and optimizing prescription recommendations.

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