Resident's Page

Artificial intelligence in dermatology

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ABSTRACT

Artificial intelligence (AI) refers to the ability of a machine to communicate, reason, and operate independently. There is a need to understand this technology's progress for future medical care. AI has many applications in the field of medicine, but its use in dermatology is comparatively new. Applications that commonly analyse and classify images and tools like risk assessment calculators are available. Even though many applications exist, the important implementation barriers inclue difficulty in standardization, interpretability, and acceptance by patient and doctor.

Keywords: Artificial intelligence, Machine learning, Melanoma, Tele-dermatology

INTRODUCTION

Artificial intelligence (AI) can be defined as the branch of computer science dealing with the simulation of intelligent human behavior in computers. It is done by creating algorithms that can solve problems and are programmed for all the specificities of the problem. The term AI is credited to John McCarthy. Dermatology has taken the leading position for the implementation of AI in the medical field because of its large clinical, dermoscopical, and dermatopathological image database.

PRINCIPLES AND TYPES

AI is continuously evolving from

Conventional AI (100% humans)

↓

Machine learning (50% humans and 50% computers)

↓

Deep learning (10% humans and 90% computers)

Machine learning

Machine learning process involves
- Input – in the form of data
- Algorithms consume the training data
- Output – a machine learning model is the output generated.

MACHINE LEARNING PROCESS

Most commonly used learning processes are:

1. Supervised learning
   We train the machine to match a set of inputs (e.g., images) to their correct output (diagnosis).
2. Unsupervised learning
   After training the machine by supervised learning, the machine is made to analyze new/novel patterns from the data and to give output.

TYPES OF AI

1. Narrow AI – Capable of handling one particular task. For example: Identification of consolidation in lungs.
2. General AI – Capable of handling a wide range of tasks. For example: Identification of consolidation/pleural effusion/cardiomegaly.

Two learning methods of AI are:
1. Shallow learning
   Based on predefined engineered features as per expert knowledge.
2. Deep learning
   Based on deep features processed by convolutional neural network (CNN). Imitates the working of the human brain in processing the data. Deep learning algorithm does not require explicit feature definition by human experts.

CNN

It is the most prevalent deep learning architecture. Computational models comprise series of layers and successively match inputs to desired end points.

AI IN MEDICINE

The main applications of AI are in radiology, pathology, and dermatology. AI ranges from simple automated blood pressure monitors to robot-assisted surgery. In 2018, FDA approved unguided AI tool (IDx-DR) for the diagnosis of diabetic retinopathy, based on retina images. Furthermore, there are FDA approved mobile applications that help to treat opioid addiction and aid with contraception (2018), further enhancing the digital human partnership.

AI IN DERMATOLOGY

Dermatology is a field with a growing interplay of digitalization, tele-health, and informatics. Hence, AI can be used for dermatological applications as well.

Distinguishing between benign and malignant lesions

The main principle behind this application is that dermoscopic or non-dermoscopic images of lesions can be broken down into individual pixels for analysis. These applications are typically validated by comparing their ability to correctly diagnose lesions with the ability of a certified dermatologist. Jafari *et al.* described 60 features based on images to classify them.[1] In 2017, Stanford university published a study on deep learning of skin tumors. They trained CNN, using more than 1 lakh images of around 2000 different diseases and tested its performance against that of 21 board-certified dermatologists on biopsy-proven clinical images. It was found that machine had a competence, comparable to that of board-certified dermatologists in identifying and classifying skin cancers.[2]

For example: Benign nevi versus malignant melanoma, non-melanoma skin cancers versus benign and premalignant lesions.

Although most of the research on AI is based on photorecognition algorithms, numerical values can also be applied.

For example: To predict the complexity of Mohs micrographic surgery based on variables assessed at the initial evaluation visit such as tumor size and patient age. These can be used to triage patients and prioritize Mohs referrals. Hence, risk factor assessment is possible with AI. These applications were described by Tan *et al.*[3]

In recent years, smartphone applications are available and easily accessible for diagnosis of melanoma. Actually, they offer an instant risk assessment of likelihood of malignancy so that the patients can seek medical advice at an early stage. Disadvantage is the possibility of missing melanomas or giving a false sense of security to the user. Sensitivities and specificities for this applications range from 7% to 73% and 37% to 94%, respectively.[4]

Furthermore, AI can assist in histopathological diagnosis of malignancies. CNN is trained with a data set of histopathological and corresponding clinical images to generate diagnosis. Studies by Hekler *et al.* showed promising results on the role of CNN in the definite diagnosis of melanoma.[5]

Ulcer assessment

AI is mainly employed for diabetic and pressure ulcer assessment at present. Applications are capable of measuring precise wound boundaries and are able to differentiate

between the types of tissue involved. They can classify granulation, slough, and necrotic tissue. Mukerjee *et al.* described an AI application for classification of wound tissues.[6] Risk prediction tools also exist, for example, to predict the tendency for the development of pressure ulcers.

Psoriasis and other inflammatory skin diseases

In psoriasis, AI mainly focuses on improving psoriasis classification methods using image recognition. Emam *et al.* demonstrated systems' ability to predict response to biologic therapy in psoriasis patients, using parameters gauged at initial visit, so as to optimize treatment.[7]

Other applications

Other dermatological conditions where AI has found a role are acne, lichen planus, pityriasis lichenoides, dermatomyositis, and seborrheic dermatitis.

For example: smartphone application that grades and classifies acne lesions.

Atopic dermatitis

There are artificial neural networks for differentiating atopic dermatitis from unaffected skin using information derived directly from images. This was designed by De Guzman *et al.*[8]

Onychomycosis

Diagnostic accuracy for onychomycosis is increased using deep learning AI with a reference set comprising all possible images. Han *et al.* used more than 49,000 images in their data set.[9]

Predicting skin sensitization substances

There are applications capable of analyzing the physiochemical properties of substances. They can determine whether the substance could be a sensitizer or not. Studies were conducted by Zang *et al.* They described an application, capable of determining the melting point of a substance and deciding whether it could be a sensitizer or not.[10]

Dermatopathology

Applications that can automate histopathology image processing and classification (mainly for skin malignancies) have been described.

Tele-dermatology

It is one of the fast growing fields of dermatology, especially in areas where access to a dermatologist is difficult. AI can be integrated into smartphone applications to photograph skin lesions, collect relevant clinical information, and generate referral when needed. At present, tele-dermatology is an integral part of clinical practice due to the ongoing COVID pandemic.

Augmenting face-to-face assessment

Rather than functioning alone, AI and humans (dermatologist) working together can achieve better results in diagnosing and managing skin conditions.

AI as an educational tool

AI is as excellent educational resource for training dermatologists, researchers, students, and skin cancer specialists. After going through visually similar images, medical experts are able to gain deeper insights into their cases which help them to make a more accurate diagnosis.

AI in the field of dermoscopy

This technology uses AI algorithms and content-based image retrieval to provide medical professionals dermoscopic images that are visually similar to their submitted cases.

Limitations

Generalizability

Most of the studies available are from Western world and from developed nations. The findings may not be applicable to the rest of the world. Each population should have their own data based on the local prevalence of the disease and should develop individual algorithm. Although difficult in developing countries at present, it will definitely become a part of clinical practice in future.

At present, image data of different skin diseases are insufficient, and the quality of images is not uniform.[11] This leads to lack of standardization.

Image quality

Technical variation, difference in image acquisition, and image quality can all affect interpretation.

Data requirement

One large barrier is the pre-requisite of large quantity of data of appropriate quality to process AI algorithms.

Interpretability

AI is flexible, it forms algorithms, re-evaluates, and constantly brings changes without human input by means of neural networks. Therefore at times, the logic behind the decision-making may not be interpretable.

Acceptance by patients

A proper history, followed by examination, eliciting specific signs complemented by additional investigations or biopsy, is a standard way of diagnosis in dermatology. This holistic approach cannot be fully replaced by any methods including AI.

Liability/ethical issues

If there is an adverse outcome from AI, who should be made liable, is another question.

Multidisciplinary approach

AI researchers come from different fields of science such as computer science and biomedical, and medical science. Hence, it is a difficult task to coordinate the group.

CONCLUSION

While AI is helpful in diagnosing disease into broad categories, dermatological expertise and clinical correlation will still be needed for accurate diagnosis and for decision-making, at present. Currently, most of the data are based on Western studies; hence, studies from this part of the world are essential. AI is a rapidly advancing field, hence, a basic knowledge about the fundamental principles, potential uses, and limitations becomes all the more important.

Declaration of patient consent

Not required as there are no patients in this article.

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Conflicts of interest

Dr. Sobhanakumari K is on the editorial board of the Journal.

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