

REVIEW ARTICLE

COVID-19 and artificial intelligence: Experts and dermatologists perspective

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Abstract

Introduction: Artificial intelligence (AI) has an important role to play in future health-care offerings. Machine learning and artificial neural networks are subsets of AI that refer to the incorporation of human intelligence into computers to think and behave like humans.

Objective: The objective of this review article is to discuss perspectives on the AI in relation to Coronavirus disease (COVID-19).

Methods: Google Scholar and PubMed databases were searched to retrieve articles related to COVID-19 and AI. The current evidence is analysed and perspectives on the usefulness of AI in COVID-19 is discussed.

Results: The coronavirus pandemic has rendered the entire world immobile, crashing economies, industries, and health care. Telemedicine or tele-dermatology for dermatologists has become one of the most common solutions to tackle this crisis while adhering to social distancing for consultations. While it has not yet achieved its full potential, AI is being used to combat coronavirus disease on multiple fronts. AI has made its impact in predicting disease onset by issuing early warnings and alerts, monitoring, forecasting the spread of disease and supporting therapy. In addition, AI has helped us to build a model of a virtual protein structure and has played a role in teaching as well as social control.

Conclusion: Full potential of AI is yet to be realized. Expert data collection, analysis, and implementation are needed to improve this advancement.

KEYWORDS

artificial intelligence, COVID-19, dermatology, telemedicine

1 | INTRODUCTION

Artificial intelligence (AI) is a rapidly growing field in all areas of healthcare. It has an enormous potential in dermatology due to large image databases. Currently, has been researched in clinical diagnosis, dermatopathology, and therapeutics. Machine learning

(ML) has been widely studied in specialties that predominantly rely on visual diagnosis such as pathology, dermatology, and radiology. The success of AI in dermatology is dependent on two critical factors: high-resolution lesion images and large datasets. Most original studies in dermatology have been carried out to detect melanomas, differentiate cutaneous carcinomas from benign lesions, diagnose

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inflammatory skin diseases, and train AI in dermoscopic and dermatopathological images. Recently, a deep learning system diagnosing 26 common skin conditions from medical history, and clinical images was developed by Liu et al.¹ Smartphones with high-resolution cameras are harbingers of dermatology's digital future.² AI has been researched for its potential in diagnosis, assessment, prediction of long-term outcomes with treatment in different skin diseases including psoriasis,^{3,4} onychomycosis,⁵ acne,^{6,7} atopic dermatitis, and eczema.^{8,9} MI has the potential of being utilized for grading acne or acne scars, evaluating response to different laser treatments including lasers for hair reduction, scar management, and pigmentary conditions. Guimerez et al. in a study demonstrated that multiphoton tomography imaging can be combined with AI to successfully diagnose atopic dermatitis.¹⁰ MI-driven biomarkers can be used to differentiate between allergic and irritant contact dermatitis. AI-based apps are also used for comprehensive treatment of eczema. Chinese researchers have developed an AI dermatology diagnosis assistant (AIDDA) to diagnose psoriasis, eczema, atopic dermatitis, and recognize healthy skin.¹¹

2 | AI AND COVID-19 IN CONTEXT OF DERMATOLOGY CLINICAL PRACTICE

Analytic technologies such as AI and its use in healthcare can minimize the extent of damage caused by epidemics.¹² Pandemics are global health threats due to increasing world population and frequent international travel. Since its discovery, the severe acute respiratory syndrome coronavirus 2 (SARS CoV2) known as coronavirus disease 2019 (COVID-19), a pandemic has been a concern for healthcare professionals, patients, community, researchers, and policymakers in their own and different contexts. The disease spreads through droplets and aerosols. In this article, we discuss the potential of AI in COVID-19 management with focus on dermatological perspectives.

Artificial intelligence holds an immense potential to assist in combating the COVID-19 pandemic.¹³ AI has been effective in predicting, tracking, diagnosing, and promoting research on COVID-19 management strategies.¹⁴ On December 30, 2019, Health Map, an AI-based model at Boston Children's Hospital in the United States, first predicted a possible outbreak in China. BlueDot, a Canadian-based AI, released a similar alert on December 31, 2019. The data that BlueDot uses is gathered every 15 min, 24 h a day, from official public health statements recognized in 65 different languages, animal health and disease reports, digital media, global air travel tickets data, and demographics, which is then reviewed by physicians, epidemiologists, and computer programmers. The Allen institute for AI in collaboration with 33 research groups has issued a weekly updated COVID-19 open research dataset, continuously documenting COVID-19-related articles to accelerate novel research projects.

Giovanni Genovese et al. reported that there are six clinical proposed patterns in COVID-19-related dermatological conditions (1) urticarial rash (2) confluent erythematous/maculopapular/morbilloform rash (3) papulovesicular exanthem (4) chilblain like acral

pattern (5) livedo reticularis racemosa-like pattern (6) purpuric "vasculitic pattern."¹⁵ It is also essential to rule out cutaneous eruptions caused by viruses other than SARS-CoV-2 or drugs used to treat this infection. The exact pathophysiology, as well as diagnostic and prognostic value of COVID-19-associated dermatological symptoms, is at present evolving. The American Academy of Dermatology (AAD), in collaboration with the International League of Dermatologic Societies (ILDS) has launched an online COVID-19 dermatology registry to compile cases of dermatoses in both COVID-19-positive and suspected patients.¹⁶ Since it is not clear if the lesions are specifically caused by the virus, diagnosing COVID-19-related skin manifestations is confusing even for dermatologists.¹⁷ Where skin lesions appear before systemic features of COVID-19, or reverse transcription-polymerase chain reaction (RT-PCR) results are awaited, AI may be a useful diagnostic clue and help in timely quarantine of patients. Another AI study found that pseudo-chilblain lesions appeared late in COVID-19 while vesicular eruptions appeared early in the course of the disease.¹⁸ Pseudo-chilblains (COVID-19-associated pernio) has been found to affect a greater proportion of younger patients¹⁹ and could be useful in disease prognosis as pernio is not commonly associated with severe disease. Cutaneous features being of short duration, self-limiting, and non-emergency unlike systemic symptoms of COVID-19 have not been prioritized as screening policies till date. Previous works have proposed documenting cutaneous abnormalities using smart phone imagery and AI algorithms integrated into smartphone apps.^{20,21} Additionally ML techniques for diagnosing urticarial lesions by junior physicians have been studied.²² Frequent hand washing, use of alcohol-based sanitizers and gloves have been advocated to combat transmission of COVID-19. These practices have led to a new range of dermatological problems including hand eczema, contact dermatitis, and glove latex allergy. The use of protective goggles, facemasks, and face shields are frequently leading to device-related pressure injuries. Long-standing use of personal protective equipment kits and stressful working hours has been reported to aggravate the incidence of acne, rosacea, seborrheic dermatitis, and psoriasis.

Artificial intelligence can aid early detection, identify high-risk patients, estimate the future trajectory of the disease, forecast the number of cases, and predict mortality. The Centre for disease control and prevention (CDC) launched the "coronavirus self-checker," an assessment tool for deciding when to seek medical care for a suspected case of COVID-19.

Artificial intelligence can be leveraged by the patients, clinicians, or both. The lockdowns during COVID-19 pandemic posed considerable challenges for dermatologists and their patients. There have been significant delays in the management of cutaneous cancers, inflammatory skin diseases, and acute dermatological conditions requiring immediate intervention. AI seems to be a positive step to tide over this crisis. AI may help patient to self-assess the skin condition, understand possible diagnosis until they avail specialized dermatology services. It is possible to create a fully automated smartphone app that integrates AI with a tele-dermatology system. Once the patient photographs their lesions, an AI application may indicate top three

predictive diagnosis and a dermatologist referral can be generated, if applicable. AI encourages patient engagement and adherence—patients proactively participate in their own well-being and care. This leads to better outcomes—utilization, financial outcomes, and member experience. Overall, amidst the quarantine and movement slowdown, this may be a close to an ideal solution. However, performance improvements in these innovations will take time.

Biosensors are devices that detect the existence of biological substances and are being used in COVID-19. Chat boxes, audio, and video messages aid in keeping track of people infected and forecasting the path of spread of the disease. Smartphone apps such as Aarogyasetu in India, COVIDSafe in Australia, and COVIDALERT in Canada immediately notify people if they test positive for COVID-19. AI helps in symptom monitoring, early identification of warning signs, and disease prognosis. In Taiwan Smart Quarantine Station AI trilogy is used to redirect patients from crowded emergency rooms to quarantine tents, allowing isolation of patients with COVID-19 features.²³ BlueDot published the first scientific paper on COVID-19, accurately predicting eight of the first 10 cities to import the novel coronavirus using global airline ticketing data. India and Brazil were listed as potential epicenters in Blue Dot's regular focus reports, months before the number of cases in those areas started to rise. The COVID-19 data dashboard of WHO provides information related to the number of confirmed cases, deaths, and vaccine doses administered in all countries.

Canadian start-up DarwinAI released COVID-Net, an open-sourced neural network for COVID-19 detection using chest radiography.²⁴ Chest imaging, especially CT, can reveal early lung lesions. COVID-19 manifests in a way similar to a variety of pneumonias. Harmon et al, in a study said that "AI-based algorithms can readily identify CT scans with COVID-19 associated pneumonia, as well as distinguish non-COVID related pneumonias with high specificity in diverse patient populations."²⁵

DeepMind, a Google AI subsidiary based in London, developed an AI framework called AlphaFold that could predict the virus's protein structure based on genome sequencing which is being used in research to develop new drugs.

AI is used for drug testing for COVID-19. Baricitinib was identified as a potential drug against COVID-19 by using ML methods developed by BenevolentAI,^{26,27} Several other molecules targeted against COVID-19 have also been studied by Insilico Medicine.²⁸ Other AI-based projects like IDentify.AI (identifying infectious disease combination therapy with artificial intelligence)²⁹ and PolypharmDB³⁰ have also contributed to discovering effective candidates against COVID-19. Ong et al. predicted possible vaccine candidates for COVID-19 using the Vaxign reverse vaccinology-ML platform.³¹ AI can help healthcare organizations plan vaccinations, streamline patient interactions, and prioritize access. The Viterbi School of Engineering at the University of Southern California (USC) has set out to create a new artificial intelligence method to combat COVID-19 emergent mutations. Utility of AI applications studied in COVID-19 is summarized in Table 1.

AI allows doctors to treat patients virtually using telemedicine. Telemedicine can be synchronous, in which the patient and clinician communicate in real time, or asynchronous, in which the patient's information is processed and reviewed later.

The pandemic has replaced traditional classroom teaching with multimedia instructions through audio recordings, video lectures, and simulators. For honing clinical assessment skills, virtual patients and simulators are used. The COVID-19 Open Research Dataset (CORD 19) created by the White House in collaboration with a group of leading researchers covers COVID-19, and associated coronaviruses and contains over 400 000 free access scholarly articles with more than 150 000 full texts that may help in further research against the disease. Cameras using infrared light and thermal imaging have been used to monitor public areas for individuals who could be compromised and help maintain social distance. For

TABLE 1 AI applications and COVID-19

AI Application	Utility	Researchers
Canadian-based Blue DoT ^{32,33}	Predicted the outbreak of the infection at the end of 2019, issuing a warning on 31st of December 2019, before the WHO did so Also listed the top 20 destination cities where passengers from Wuhan would arrive in the wake of the outbreak	Kreuzhuber K Bogoch I, A. Watts, Thomas-Bachli A, Huber C, Kraemer M, and Khan K
Algorithms trained at Carnegie Mellon University, to predict the seasonal flu, are now being re-trained for COVID-19 ³⁴	At Carnegie Mellon University, algorithms trained to predict the seasonal flu, are now being re-trained for COVID-19	Hao K
Mapping the Landscape of Artificial Intelligence Applications against COVID-19 ¹³	AI application in radiology performed a faster and cheaper diagnosis compared to the standard tests for COVID-19. Both X-rays and Computed Tomography (CT) scans can be used	Bullock J, Luccioni A, Pham K. H, Lam, C. S. N, and Luengo-Oroz M
Detecting COVID-19 in X-ray images with Keras, TensorFlow, and deep learning ³⁵	Offers a tutorial on how to use deep learning to diagnose COVID-19 using X-ray images	Rosebrock A
A Novel AI-enabled framework to diagnose coronavirus COVID-19 using smartphone embedded sensors ³⁶	Proposed a technique using mobile phones to scan CT images	Maghdid H, Ghafoor K, Sadiq A, Curran K, and Rabie K

anyone under a 14-day quarantine, closed-circuit television (CCTV) cameras are used for surveillance. Drones are being used to remind people to wear masks and for disinfection of public spaces.

3 | LIMITATIONS

With all the promises offered, AI is not free from limitations. One of the existing limitations is low diagnostic accuracy when compared to direct consultations. Diagnosis in dermatology like other medical specialties is formed after adequate patient history, clinical examination, investigations, and histopathological correlation. Despite years of research, computers still lack human common sense hence making even the most advanced technology inferior to the diagnostic ability of physicians.³⁷ It may enable individuals to assess their skin lesions; however, it may not provide accountability on diagnosis/treatment advice and is susceptible to providing false reassurances or generating unnecessary referrals. Despite the fact that AI applications are technologically feasible, significant implementation obstacles have been found, including data training deficits, standardization difficulties, interpretability, legal concerns, privacy issues, lack of tactile perception in diseases requiring palpation, and physician and patient acceptance.

Algorithms are dependent on accurate and unbiased data. Applications trained with images from one skin type may not be relevant when applied on another skin type. A study found that performance of algorithms improves when trained with multiple images from different ethnic populations.³⁸ Lesions manifest differently in dark skin. Psoriasis and eczema may be less erythematous in type 4 than type 1 skin. Similarly, data trained on skin of color showed suboptimal performance in Caucasian populations. Another study also concluded that datasets containing images from a wider demographic resulted in more accurate AI algorithms.³⁹

Image angles, lighting condition, background, distance from camera are all variables that require standardization. Unstandardized photographs are a constant reason that reduce an AI application's performance. An enormous volume of high-quality images is needed for AI applications to diagnose and outperform dermatologists.⁴⁰ However, predicting the number of training images required is a crucial decision for app developers. Facing a medicolegal issue or litigation from patients in an event of treatment complications or inaccurate diagnosis is feared by most physician and dermatologists.⁴¹ In the current scenario, the safest use of AI would be as a supportive tool for dermatologists or patients in diagnosis and decision making. Improving sensitivity and specificity of diagnosis by integrating relevant medical history, using multiple images of the same patient, and adding of dermoscopic images is the need of the hour.

4 | CONCLUSION

Artificial intelligence can be of assistance in reducing workload of frontline staff by playing a role in diagnosis, monitoring, teaching, and patient care. Many studies on different dermatological conditions

including melanoma, inflammatory skin diseases, and dermatopathology have established AI as a potential tool to empower dermatologists and patients. With COVID-19, it has become clearer that the world is moving toward digital channels and virtualization. Although AI has a great potential to assist dermatologists, its existing limitations in dermatology, as well as COVID-19, need to be addressed with more studies. Training systems with clinical presentations and images from different skin types and anatomic locations as well as standardization of photographs will improve the performance of algorithms in future. Overall, at this point in time, AI is a no regret choice for dermatologists, the technology industry and society at large.

AUTHOR CONTRIBUTIONS

Yaser Goldust, Farah Sameem, Samia Mearaj, Atula Gupta, and Anant Patil contributed to writing and revising the manuscript. Mohamad Goldust contributed to conception, writing, review, and revising the manuscript.

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CONFLICT OF INTEREST

None.

ETHICAL APPROVAL

Authors declare human ethics approval was not needed for this study.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

DISCLAIMER

We confirm that the manuscript has been read and approved by all the authors, that the requirements for authorship as stated earlier in this document have been met, and each author believes that the manuscript represents honest work.

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