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'Skin cancer and patients' use of Dermatology apps - a cause for concern or the future of healthcare provision?'

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1. Introduction

1.1 The Rise of Dermatology Applications ('Apps')

Could advancements in Artificial Intelligence start to revolutionise the management of skin cancer? In 2011, the Skin Scan application (later rebranded as SkinVision) for melanoma detection using the iPhone's camera was launched. It now serves 1.1 million users. [1]

Then in 2014 came DermoScreen with a $500 dermoscope said to detect 85 percent of melanoma cases. [2] Following that, First Derm launched a smartphone-connected dermatoscope that sends pictures of users' moles to a dermatologist for clinical evaluation. [3] More recently, Stanford's Artificial Intelligence Laboratory released a study describing a convolutional neural network that matched the performance of 21 board-certified dermatologists. [4]

Researchers are trying to determine the accuracy of these automated devices in detecting skin cancers. How viable is it to replace human dermatologists with image recognition technologies? This essay aims to examine the pitfalls and strengths of skin cancer applications and assess their place in standard of care. There is growing evidence that urges caution towards application use for automated diagnostic purposes but reveals potential for the supplementary use of other functions in some conditions.

1.2 Variety of App Functions

The functions of skin cancer-targeted apps can be categorised into the following: diagnosis, tele-dermatology/remote consultation, photo storage/monitoring change, education, sunscreen/UV recommendations and risk calculation. [5] For the purposes of this essay, the first four functions will be discussed in greater detail.

2. Current lack of regulatory oversight

Notably, most dermatology apps were not developed by medical professionals or did not state authorship clearly. There are a few, however, that were developed by academic institutions such as the Mayo Clinic. The apps available on the market are not subject to regulations and lack validation of governmental bodies such as the US Food and Drug Administration. [6] The need for rigorous validation of this sector became evident in 2015, when the American Federal Trade Commission (FTC) fined the melanoma detection apps MelApp and Mole Detective. The FTC remarked that the marketers "deceptively claimed the apps accurately analyzed melanoma risk," and had insufficient evidence to make these claims. [7]

3. Current practice

Skin cancer is diagnosed based on clinical assessment. It involves a full history, examination, dermoscopy and histopathology. A physical examination for clinical signs of metastases, such as lymph node palpation is done. Common diagnostic techniques include full-thickness excisional biopsy, Immunofluorescence and fluorescence in situ hybridization (FISH). This may be followed by staging by baseline imaging and sentinel lymph node biopsies. [8]

4. Diagnostic functions ('Tele-diagnosis')

Factors that contribute to a successful screening of skin cancer through applications include:

1. the accuracy of the diagnostic system. [9]

2. the patient. [10, 11]

3. image quality. [12]

4.1 Accuracy of diagnostic system: the technology is not perfect

Literature on the use of automated systems for diagnosis in clinical medicine has existed as far back as 1982. [13] Clinical diagnosis-making is a complex area of medicine requiring clinical acumen. [14] In clinical practice, if the lesions were found to be atypical or indeterminate, diagnostic techniques like biopsies may be used. Erroneous detection algorithms and false recommendations by an app may put users at risk of misdiagnosis and delayed treatment.

Studies on the accuracy of smartphone applications in the detection of skin cancers have given mixed reviews. Two recent studies determined that the accuracy of the system in detecting malignant melanomas and carcinomas substantially matched that of trained dermatologists.[4, 15] However, the University of Pittsburgh Medical Center studied four smartphone applications and found that the applications missed 30 percent or more of skin lesions. [16] This is a significant proportion of false negatives, showing that automated diagnoses can be inaccurate.

Furthermore, according to the study:

> "Sensitivity of the apps ranged from **6.8** percent to **98.1** percent. The app with the highest sensitivity for melanoma diagnosis was one that **sends the user-uploaded image directly to a board-certified dermatologist for analysis** ('tele-dermatology'). Those with the lowest sensitivity used **automated algorithms to assess** the downloaded images ('tele-diagnosis')."

These results demonstrate that input from trained professionals in diagnosis is still necessary and it is far superior compared to the automated systems currently available.

4.2 The patient: the users are not perfect

The patient is integral in the chain of care. Early detection of skin cancer is linked to improved survival outcomes. [17] As mentioned above, applications that send the user-uploaded image directly to a dermatologist seem to hold the most promise. Trials show these apps may not be maximally utilised in the hands of persons medically untrained in identifying suspicious lesions.[10] This potentially delays early detection of skin cancer. For example, one trial showed that 22% of participants did not photograph 14 pigmented lesions that the dermatologist considered worth photographing or monitoring. Participants sent photos of many nonpigmented lesions in another study. This illustrates the value of full-body checkups by a dermatologist in person.

4.3 Image quality: the picture is satisfactory

Studies so far demonstrate that handheld devices produced high quality images and could be a substitute for computer screens for remote consultation (Emerg Med J 2017).[10] More large-scale research is needed to validate the imaging functions of these apps.

5. Dermatologist access functions ('Tele-dermatology')

Studies have shown some promise for other sectors in healthcare that could potentially benefit from use of dermatology apps.

5.1 Smartphone Tele-dermoscopy for Facilitating Triage

Patients in Emergency departments across the UK and Ireland are facing long waiting times [18], and institutions have looked at various interventions aimed at alleviating this issue over the years. [19, 20]

In an open, controlled, multicentre and prospective observational study, smartphone teledermoscopy referrals were sent from 20 primary healthcare centres to 2 dermatology departments for triage of skin lesions of concern using a smartphone application and a compatible digital dermoscope. The outcome for 816 patients referred via smartphone teledermoscopy was compared with 746 patients referred via the traditional paper-based system. When surgical treatment was required, the waiting time was significantly shorter using teledermoscopy. Triage decisions were also more reliable with teledermoscopy and over 40% of the teledermoscopy patients could potentially have avoided face-to-face visits. Only 0.4% of teledermoscopy referrals had to be excluded due to poor image quality.

This study suggests that smartphone teledermoscopy referrals allow for faster and more efficient management of patients as compared to traditional paper referrals. This benefits patients who have months until the next appointment to have faster access to a dermatologist for evaluation, diagnosis, and treatment.

5.2 Bringing early screening to rural populations

Theoretically tele-dermatology could potentially help people in remote locations who may be miles from an available dermatologist. Tele-dermatology with a dermatoscope performed in the context of occupational medicine and targeted to agricultural populations has be shown to be feasible. Skin cancer screening was improved in such at-risk populations in 53% of cases. [21] More large scale research needs to be done to evaluate the medium- and long-term feasibility of implementing such a system.

6. Lesion tracking functions

An archive of a patient's lesion history may be a useful idea to supplement specialist consultations. An example is UMSkinCheck by The University of Michigan which helps users store a full body photographic library and track detected moles/lesions. [22, 23] Healthcare authorities appear to be increasingly supportive of personalized medicine and “big health data”. [24 ,25] However, big health data poses big privacy risks. The harvesting of large sets of personal data and the use of state of the art analytics implicate growing privacy concerns. Data harvesting for profit by developers of electronic platforms including healthcare apps is certainly a reality. [26] The anonymity of user data could raise future legal issues concerning data security, protection and patient privacy. [27]

7. Educational functions

Another useful function available is access to informational videos and literature. [22] Patient education has always been advocated by practitioners with the hope of patients presenting earlier in the course of their disease. [28] Patient information improves survival rates and patient satisfaction (*JAMA Dermatology* 2018). [25, 29]

8. Conclusion

The use of apps should not replace clinical judgment or physician interaction. Apps for the purposes of skin cancer detection require further validation of their utility and safety. Laws and regulatory systems are required if the use of dermatology apps is to be sustained.

The apps have potential usefulness for other purposes. Tele-dermatology may facilitate early screening in triage and remote places but are still less accurate than in-person examinations. tele Healthcare providers may be able to disseminate educational information.

Overall evidence suggests that the key may be picking out useful and safe functions for optimal use. App developers may also wish to focus on meeting more unmet needs and gaps in the healthcare system, rather than replacing well-functioning methods.

(Word Count: 1500)

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