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Review Article

Role of telemedicine in dermatology

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ABSTRACT

Introduction: Telemedicine has revolutionized dermatology by enabling remote consultations, diagnosis, and management through digital platforms. Its integration supports improved access to care, especially in rural and underserved regions, aligning with global digital healthcare advancements.

Aim: This study aims to explore the applications, benefits, challenges, and future potential of telemedicine in dermatology, focusing on its technological tools, patient outcomes, and regulatory frameworks.

Methods: A comprehensive review of peer-reviewed literature and case studies was conducted, analyzing teledermatology's efficiency, cost-effectiveness, and technological innovations. The study highlights the role of store-and-forward (SAF) technology, live consultations, and artificial intelligence driven systems in dermatology.

Results: Teledermatology improves accessibility, reduces waiting times, and provides cost-effective care without significant differences in treatment outcomes compared to in-person visits. However, barriers include limited physical examinations, technical challenges, and privacy concerns. Advancements in AI and wearable technologies are enhancing diagnostic accuracy and patient engagement.

Conclusion: Telemedicine is a transformative force in dermatology, bridging gaps in care delivery and expanding access for underserved populations. With continuous innovation and adherence to regulatory standards, teledermatology holds the potential to revolutionize patient-centric healthcare.

Keywords: Telemedicine, teledermatology, dermatological care

INTRODUCTION

Telemedicine has transformed the practice of dermatology, allowing efficient visual consultations between patients and dermatologists.[1] Over the previous 20 or more years, there has been a steady increase in the number of dermatologists offering telemedicine.[2] The driving force behind this growth has been improved communications, first offering highly dependent telemedicine and then more standalone applications as technology has improved. Technological advances have allowed the use of digital dermoscopy and the ability to securely transmit photographic evidence.[3] The potential and

pitfalls of teledermatology are well described throughout the literature. Advantages include reduced waiting times, improvement in access to healthcare, and in some cases, higher patient satisfaction.[4]

There is little evidence that patient care is significantly worse than conventional methods, and more data is now being generated in this respect. Disadvantages include lack of full physical contact, especially important as dermatology is a highly visual specialty. Patients have also been known to seek other sources of opinion after being referred for specialist advice; for example, they may have been told that their lesion is of low concern and not given adequate reassurance that their skin cancer is not missed. The lack of direct contact can also impede the doctor-patient relationship, as well as provide technical problems that may affect the ability to communicate. As the internet and communication technology continue to improve, so do telemedicine and teledermatology.[5]

The virtual clinic is slowly becoming commonplace in dermatology, though a formal framework must be agreed upon to govern such practices. The adoption of virtual clinics is steadily becoming a standard practice in Saudi Arabia and other countries, driven by advancements in telemedicine and the nation's focus on digital transformation under Saudi Vision 2030.[6]

Virtual dermatology clinics offer numerous benefits, including improved accessibility for patients in remote or underserved areas, cost-effectiveness by reducing travel and operational expenses, and the convenience of timely consultations for non-emergency conditions.[7] However, challenges remain, such as limitations in conducting physical examinations or biopsies, concerns about data privacy and security, and the need for enhanced digital literacy among both patients and healthcare providers. Despite these obstacles, the integration of virtual clinics in dermatology demonstrates significant potential to enhance healthcare delivery and address access gaps, positioning Saudi Arabia as a leader in digital health innovation.[8]

1. Advantages and disadvantages of telemedicine in dermatology

Teledermatology has a number of advantages for both physicians and patients. Some limitations need to be taken into account. Because of that, although the technology used in teledermatology is already quite advanced, the method is not always right for every patient or every doctor. One of the main benefits of teledermatology is that patients get access to specialist dermatologists.[9,10] In rural or remote areas, there might be only one local doctor, and they might not be very knowledgeable about dermatology. Because teledermatology is remote, it can be carried out from the patient's home, which is convenient for older or disabled patients. Another advantage of teledermatology is that it can save the patient a long trip to see the specialist in person.[2,11]

Teledermatology is often cost-effective. In particular, if the patient lives far away from the doctor, it can save the patient several hours of travel time. It can also save time for the doctor, who can look at a number of images quickly.[12-15] Teledermatology has limitations, including its limited examination of the skin surface, potential technical issues, potential safety concerns due to potential misdiagnosis, and concerns about patient confidentiality. However, these limitations can be addressed by adjusting to internet-based communication and embracing the internet and other communication methods.[4,9,16]

2. Technological tools and platforms for teledermatology

The role of technology in teledermatology is to support quick, effective, and good communication between healthcare providers and patients. Several key technological tools have been widely used for teledermatology. Essentially, when choosing which technology to adopt, criteria such as user-friendliness, security, and interoperability need to be considered.[17]

2.1 Store-and-forward technology

The incorporation of telemedicine into dermatology, particularly through Store-and-Forward (SAF) teledermatology, has transformed patient care by enabling remote diagnosis, treatment, and monitoring. SAF teledermatology is highly efficient in dermatology, as it allows for asynchronous sharing of high-resolution images and patient data for evaluation. This flexibility, combined with dermatology's dependence on visual assessment, has significantly improved diagnostic accuracy and access to care, especially in underserved regions.[18]

SAF teledermatology facilitates remote consultations by allowing patients or referring physicians to upload skin condition images and medical histories. Dermatologists can assess these asynchronously, providing timely care without in-person visits. This approach is particularly useful for follow-up care and in connecting patients from remote areas to specialists, bridging geographic barriers. Studies, such as those by Pasadyn et al., show that SAF technology has the potential to reduce face-to-face visits by 79%, increasing efficiency and convenience.[19]

This technology offers convenience and cost-effectiveness for both patients and healthcare systems. Patients benefit from remote care without travel or appointments, while dermatologists can review cases flexibly during non-clinical hours. Its ability to provide care in rural and underserved communities highlights its transformative potential in ensuring equitable healthcare access. However, not all skin conditions can be fully managed through telemedicine, necessitating occasional in-person visits.[20]

While effective, SAF teledermatology faces challenges such as dependence on the quality of submitted images, which can impact diagnostic accuracy. The lack of real-time interaction may limit the ability to gather comprehensive clinical details. Privacy concerns and potential data breaches necessitate strong encryption and secure data storage protocols. Regulatory issues, such as inconsistent telemedicine laws and reimbursement policies, pose additional barriers to widespread adoption.[21]

Advances in artificial intelligence (AI) and mobile technologies are set to enhance SAF teledermatology. AI-powered tools can assist in case prioritization and risk assessment, while standardized protocols and user-friendly apps for image capture will improve accessibility and accuracy. Teledermoscopy, a specialized extension using dermoscopic images, is further refining diagnostic capabilities, particularly for early detection of skin cancers like melanoma. By addressing limitations and embracing innovations, SAF teledermatology is poised to remain a cornerstone of equitable and effective dermatological care globally.[22,23]

2.2 Live interactive teledermatology

Live interactive teledermatology uses videoconferencing to provide real-time consultations for dermatologists to assess skin conditions, using patient history and visual inputs. This approach ensures comprehensive and timely diagnosis.[24]

Live teledermatology offers a dynamic, patient-centered approach, utilizing non-verbal cues to understand and address concerns, blending technological innovation with traditional care principles, and ensuring immediate feedback and tailored responses.[25]

Despite its advantages, live teledermatology can face technical challenges that may disrupt consultations. Ensuring patients are comfortable with the required technology and adequately prepared for the session is essential for a smooth experience. Training for medical staff on video techniques and pre-visit preparations enhances efficiency and patient satisfaction. By addressing these logistical considerations, live teledermatology can provide a seamless and effective alternative to in-person dermatological care, improving access while preserving high-quality outcomes.[26]

3. Regulatory and legal considerations in teledermatology

Regulatory and legal considerations in teledermatology are critical to ensuring the safe, effective, and compliant delivery of remote dermatological care. One of the primary concerns is licensing and credentialing. Providers must hold valid medical licenses for the jurisdictions where their patients reside, which may involve additional requirements for cross-state or international consultations. Teledermatologists must also navigate credentialing processes within healthcare networks or insurance panels to ensure they meet the qualifications necessary to offer telemedicine services. Failure to adhere to these licensing rules can result in legal and financial penalties.[27]

Patient privacy and data security are equally crucial. Teledermatology platforms must comply with stringent privacy laws, such as the Health Insurance Portability and Accountability Act (HIPAA) in the United States or the General Data Protection Regulation (GDPR) in the European Union. These frameworks mandate the use of secure systems that encrypt patient data, including high-resolution images, videos, and consultation records, to prevent unauthorized access or breaches. The selection of telemedicine platforms with robust security features is essential to meet these requirements and maintain patient trust.[28]

Informed consent is another key legal requirement in teledermatology. Before consultations begin, patients must be informed about the nature of telemedicine, including its benefits, limitations, and the technology being used. This process ensures patients understand that teledermatology may not completely replace in-person evaluations and that it comes with certain constraints, such as limited physical examinations. Documenting informed consent is vital for both legal protection and compliance with ethical standards.[29]

Reimbursement policies add another layer of complexity. These policies vary significantly by region, payer, and healthcare system. Providers must understand the billing requirements for different types of teledermatology services, such as live interactive video consultations, SAF evaluations, and follow-up visits. Staying updated on insurance coverage changes and reimbursement codes is critical to avoid denied claims and financial losses.[30]

The standard of care in teledermatology must be equivalent to that of in-person consultations. Dermatologists are responsible for ensuring that remote assessments are accurate and that the limitations of telemedicine do not compromise patient outcomes. This often involves the use of high-quality imaging technology, clear communication, and adherence to established clinical guidelines for remote care. In cases where teledermatology cannot provide sufficient diagnostic confidence, patients should be referred for in-person evaluations.[31]

Malpractice and liability are also significant considerations. Teledermatologists must ensure they have appropriate malpractice insurance coverage that includes telemedicine services. Legal risks, such as missed or delayed diagnoses, are heightened in remote care due to the lack of physical examination. Providers must take measures to mitigate these risks by using high-resolution imaging, maintaining thorough documentation, and communicating diagnostic uncertainties to patients.[32]

By addressing these regulatory and legal considerations comprehensively, teledermatology providers can enhance patient trust, reduce liability risks, and deliver high-quality care that meets the standards of modern healthcare systems.[33]

4. Impact of telemedicine on access to dermatological care

Teledermatology, a subset of telemedicine, has shown significant promise in improving access to dermatological care for the underserved. Teledermatology utilizes telemedicine to render dermatological care and education to individuals and patients who may not have ready access to specialized expertise.

Teledermatology services can be delivered between sites of varying distances, providing a platform for the expansion of dermatological care to individuals located in rural or remote areas. Teledermatology can minimize barriers to dermatologic care that primary care physicians face, including a limited number of dermatologic specialists in rural areas.[34]

Telemedicine can also provide financial and time-related savings for patients and families. For those living in rural areas, seeking a consultation at a distant medical center usually means traveling, often at significant expense. Telemedicine provides remote consultations without the need or expense of travel. For individuals with chronic disorders such as severe skin disease, conditions such as atopic dermatitis, psoriasis, and hidradenitis often require years of management and follow-up.[35,36]

Telemedicine can facilitate frequent and timely follow-up visits and assessments where necessary to reduce the incidence of intermittent or longer-term exacerbations inherent in episodic follow-up care alone. However, certain challenges in implementing teledermatology have been documented, with access to a computer, mobile device, or other hardware and a reliable broadband internet connection presenting two such barriers. This healthcare access disparity due to technology access is known as the "digital divide." Working towards targeted strategies and approaches for reducing barriers is necessary, rather than the superficial modification and implementation of such digital health tools.[37]

Telemedicine has offered various advantages in increasing access to dermatologic care, particularly within underserved communities and states. Numerous case studies and programs have reported positive clinical impacts and time savings, as well as specialty training opportunities. As such, leveraging telemedicine to improve access to dermatologic care represents an important aspect of ongoing changes to health systems currently engaging health systems across North America and many other parts of the world.[38]

5. Quality of care and patient satisfaction in teledermatology

The quality of care in teledermatology has been the subject of various studies evaluating the outcome of disease treatment. These studies showed no significant difference in disease clearance and/or relapse rate between in-person and teledermatology consultations. One study of burn injury treatment showed that those patients presenting in the clinic without a prior teledermatology consultation had significantly higher rates of non-adherence to the outpatient burn management plan compared to those with a prior teledermatology consultation. Evidence strongly suggests that patients are satisfied with teledermatology. High user satisfaction levels are considered important as the satisfaction level with the teledermatology service is a proxy for the quality of teledermatology services.[39]

Several factors in the literature can cause patient dissatisfaction with teledermatology services. Of note was the substandard care that some patients perceived from an off-site clinic, either because it was not staffed with a physician or not in a regional clinic setup, leading them to question whether steroids prescribed by a community nurse, following teledermatology specialist consult, were appropriate. Patients also wanted timely communication from the district nurse involved in their consult results. Patients have expressed the need for access to well-trained telemedicine or teledermatology personnel.[40]

Patient outcomes and satisfaction are pivotal metrics in evaluating the effectiveness of healthcare services, including teledermatology. Research consistently demonstrates that teledermatology delivers comparable treatment outcomes to traditional in-person consultations, particularly in managing chronic dermatological conditions such as atopic dermatitis and psoriasis. Timely diagnosis, enhanced accessibility, and frequent follow-ups via telemedicine platforms contribute significantly to patient adherence to treatment regimens, reducing the risk of complications and relapse. Additionally,

teledermatology has proven effective in underserved areas, ensuring that patients receive specialized care without geographical constraints.[41]

Patient satisfaction with teledermatology is notably high, driven by convenience, cost-effectiveness, and reduced travel time. Many patients appreciate the flexibility and ease of accessing dermatological expertise remotely, especially for follow-ups and non-emergency conditions. However, dissatisfaction can arise from technical challenges, data privacy concerns, and the inability to perform physical examinations. Ensuring high-quality imaging, real-time communication, and comprehensive patient education can mitigate these issues, fostering trust and satisfaction. Ultimately, teledermatology's patient-centered approach enhances the overall healthcare experience, addressing gaps in accessibility while maintaining quality care.[42]

There was a high level of satisfaction among patients using teledermatology: 88% of 258 respondents said that they were satisfied with their telemedicine session. In terms of the eight questions on the questionnaire, 84% of the responses were in the top two positive categories on a seven-point Likert scale. In addition, access to dermatology appeared to increase with the availability of the telemedicine service.[43]

In summary, patient satisfaction levels are an effective measure of the degree of patient trust in and confidence in their adherence to the teledermatology service. Adequate provision of teledermatology follow-up services helps in fostering patient engagement and provider satisfaction. In two studies, patient satisfaction levels were determined subjectively, indicating that telemedicine follow-up was beneficial irrespective of the travel costs avoided and the hardships endured, such as time off work and school. In Denmark, using automated technology to support virtual follow-up yielded a high degree of reliability in the diagnosis of a range of dermatologic conditions comparable with traditional in-person follow-up.[44,45]

However, a qualitative study, including individuals with congenital skin disorders or their parents, found that in 75% of eligible or attended telehealth care consultations, concerns and questions were missed. A report suggests a number of parameters based on existing literature that should be assessed to ensure the quality and effectiveness of a follow-up care system. While it is generally agreed that the most important indicator of the quality of care rendered is the feedback or outcome from established pilot projects, the parameters listed as being necessary to evaluate a system are useful to prompt a discussion on the quality of the service; the parameters are also discerning. The literature explains the teledermatology literature in which feedback or indicators of quality include case reviews, outcomes of hospital-based or general practitioner referral dermatology clinics in which the patients were referred as teledermatology cases, GP and patient surveys, and randomized control trials.[46-49]

6. Statistical perspectives in modern healthcare

Teledermatology has demonstrated significant benefits in enhancing patient outcomes and satisfaction, supported by robust statistical evidence. Studies reveal that teledermatology can reduce the need for in-person consultations by up to 79%, especially in follow-up cases or routine management of chronic skin conditions such as psoriasis and eczema. This statistic highlights the efficiency of telemedicine in streamlining healthcare delivery.[50]

Burshtein et al in 2023 in a systematic review highlighted the effectiveness of pediatric teledermatology in diagnosing and managing common conditions like atopic dermatitis, acne, and infantile hemangiomas, with diagnostic concordance rates ranging from 70.1% to 89%. It has successfully reduced wait times and missed appointments when in-person follow-up rates dropped from pre-pandemic levels (12%-51.9%) to 13.5%-28.1%. Both patients and providers expressed high satisfaction (70%-98% and

~95%, respectively), citing improved access and convenience. However, challenges such as limited technology access, digital literacy gaps, and concerns about care quality remain, particularly in underserved communities. Globally, teledermatology has increased access to care in regions with few specialists, but issues like reimbursement policies and infrastructure limitations need resolution to enhance its adoption and effectiveness.[51]

Additionally, research comparing teledermatology to in-person visits found a significant difference in treatment success rates, with over 90% of patients achieving similar outcomes regardless of the consultation mode.[52]

From a healthcare system perspective, teledermatology also yields considerable cost savings. Studies indicate that implementing teledermatology can reduce overall healthcare expenditures by up to 30%, mainly by minimizing unnecessary referrals and optimizing specialist time through asynchronous review methods like Store-and-Forward technology. This approach not only reduces costs but also shortens patient wait times, with studies reporting a 40% decrease in waiting periods for dermatology consultations. These statistics underscore teledermatology's role in improving both economic efficiency and healthcare delivery outcomes.[53]

7. Integration of artificial intelligence in teledermatology

In just a few years, AI has been widely explored for its possible applications in dermatology. From smartphones to complex software solutions, dermatologists can take advantage of a computer-aided diagnosis based on algorithms fed by databases of thousands of skin pictures. These systems can not only recognize specific patterns of one given disease but also analyze different characteristics in a single picture, merging the concepts of clinical and dermoscopic images with added diagnostic precision.[54]

Consequently, AI in dermatology reaches a level of performance that ensures notional equivalence with medical judgment.[55,56] Most importantly, it guides the physician in highlighting the urgent cases requiring immediate medical attention, as well as the prognosis of cases and the suitability for treatments, dispensing further specialist evaluation.[57]

Despite the performance and the advantages presented, some ethical considerations should be raised when integrating AI into the clinical decision process. Primarily: the clarity and understanding of categorization made by the algorithmic decision; the use of data must have an accurate and clear validation process; the physician must be aware and trained on how to work and interpret the data given by AI during the entire consultation process.[58]

The future developments of these technologies will be the integration of AI's possible explicit suggestions into dermoscopy software devices and apps in multidisciplinary clinical settings. Indeed, the future of teledermatology lies in the augmentation, rather than replacement, of clinical skills. AI, in particular, is expected to support the physician in diagnosis, targeted therapy selection, and monitoring treatment responses.[59]

8. Teledermatology in the diagnosis and management of skin cancer

Teledermatology has become an integral tool in diagnosing skin cancer, leveraging technology to enhance early detection and management. Through SAF and live interactive modalities, dermatologists can remotely evaluate high-resolution images of skin lesions and conduct real-time video consultations. Teledermoscopy, a specialized branch of teledermatology, further refines diagnostic accuracy by utilizing dermoscopic imaging to distinguish benign from malignant lesions, such as melanoma, basal cell carcinoma, and squamous cell carcinoma.[60]

Teledermatology bridges gaps in access to dermatological care, particularly for patients in remote or underserved areas. By allowing timely evaluations without the need for physical travel, it facilitates early detection, enabling prompt intervention that is crucial for effective skin cancer treatment. This approach also reduces unnecessary face-to-face visits, streamlining the healthcare process while maintaining high diagnostic standards. Studies show that teledermatology can effectively triage cases, ensuring that high-risk patients receive expedited in-person care when necessary.[61]

9. Teledermatology in rural and underserved areas

Rural and underserved areas face significant barriers to providing healthcare, particularly specialty services like dermatology, due to geographical isolation and limited resources. These challenges are magnified for the growing elderly population, who often struggle with access to advanced technologies while managing chronic conditions and multiple medications. Recruiting specialists to these regions is difficult, making telemedicine a crucial solution for delivering essential dermatological care to these populations.[62]

For example, cutaneous larva migrans (CLM) is a zoonotic parasite disease found in hot, sunny tropical and subtropical areas; nonetheless, cases of allocated resources have been reported in Saudi Arabia. There is little data on the prevalence of CLM as a work-related ailment among personnel who are exposed to possibly polluted soil or have close contact with dogs. In this work, we provide an ancestral case of CLM in Saudi Arabia and discuss the risks of CLM infection. CLM may present a challenge to physicians in non-endemic areas in terms of assessment, therapeutic measures, and protection, particularly at work. The protocol of management was carried out through teledermatology.[63]

Teledermatology initiatives, including remote consultations, one-day clinics, and collaborations with correctional facilities, showcase innovative strategies to extend specialty care to underserved populations. Training and technological advancements are critical to ensuring that remote diagnoses are as reliable as in-person assessments, thereby building trust in telehealth services. Sustained efforts to raise awareness and promote community acceptance of telemedicine can improve equity and foster strong relationships with rural communities, making specialized care more accessible and sustainable over time.[64]

10. Training and education in teledermatology

The teledermatology implementation needs healthcare professionals proficient in using technological tools as well as in understanding the teleconsultation protocol. The primary professionals involved are predominantly dermatologists who must improve their competencies in teledermatology. Well-elaborated educational programs exist but are not widely available.[65]

Although there are currently many practical applications and educational resources about telemedicine usage and dermatological knowledge, most of them refer to familiarity with this vast topic. Relevant programs that exist include various portals about projects in information and communication technology (ICT) for health and telemedicine. Our level of familiarity with ethical and legal aspects, medicolegal regulations, and privacy, security, and data protection is not explored.[66]

Education and training in teledermatology should be a continuing education because of the increasingly rapid advancement of medical technology and the constant changes in administrative and procedural enactments and regulations. The introduction of adequate programs is needed to facilitate clinicians as well as administrative and other staff in integrating teledermatology into their work. It seems necessary to create an interdisciplinary education area for different work categories along with care pathways. Patients must be educated if telemedicine is to be effective and efficient in service delivery and care. Sub-

specialization and specialization of leading service providers in-house, along with the conclusion of contracts for specialist services by trained in-house physicians, initially appeared to be the principal determinants of success for a telemedicine project.[67-69]

11. Future trends and innovations in telemedicine for dermatology

Looking to the Future Overall, the key findings from the examination of teledermatology trends are promising. The skin remains the most successful application of telemedicine, and several ongoing technological advances have been proposed or are on the cusp of development in a bid to improve efficacy and patient satisfaction in teledermatology. These advances include augmented reality for 3D skin lesion visualization, specialized imaging tools for molecular and subcellular features of the skin, and personal wearables for the remote monitoring of skin diseases.[70]

Moreover, as data flow into teledermatological databases from around the world, predictive analytics and assisted diagnosis systems can be expected to become significant knowledge sources for risk assessment and disease prediction in dermatology. With machine learning, the daily developments in such databases will enable the delivery of increasingly precise, personalized skin disease prediction and support patients and professionals in risk assessment. Developments like these are the cutting edge of teledermatology and could be game changers in the delivery of primary care settings, translating the experience of experts to the point of need. Considering the developments in fields close to teledermatology and the increasing amount of dedicated research, integration, and miniaturization may be expected to make such technologies increasingly accessible in the next few years. Indeed, successful regulatory pathways and clinical trials in progress may permit the commercialization of such technical advances sooner rather than later. These technologies have the potential to revolutionize teledermatology and may benefit patients around the world by bringing healthcare to meet them in their context.[71-74]

CONCLUSION

Teledermatology has revolutionized access to dermatological care, particularly for underserved and rural populations, by providing timely and efficient diagnosis and treatment through technologies like Store-and-Forward systems, live interactive consultations, and teledermoscopy. It addresses geographical and logistical barriers while ensuring comparable outcomes to in-person care. Despite challenges such as technical limitations, regulatory hurdles, and the need for quality imaging, advancements in artificial intelligence, user-friendly platforms, and innovative tools are enhancing its effectiveness and accessibility. By bridging gaps in care and fostering equitable healthcare delivery, teledermatology is poised to remain a cornerstone of modern dermatological practice, offering specialized care to diverse populations worldwide.

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Conflicts of interest

The author declares no conflict of interest relevant to this article.

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