



# International Teledermatology Review

Karen McKoy<sup>1</sup> · Saul Halpern<sup>2</sup> · Kudakwashe Mutyambizi<sup>3</sup>

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## Abstract

**Purpose of Review** The use of teledermatology has been evolving slowly for the delivery of health care to remote and underserved populations. Improving technology and the recent COVID-19 pandemic have hastened its use internationally.

**Recent Findings** Some barriers to the use of teledermatology have fallen considerably in the last year.

**Summary** Teledermatology use has increased significantly in recent years in both government-sponsored and private health care systems and individual practices. There are no recognized international practice guidelines and variable use within countries. Many barriers remain to increasing the use of teledermatology.

**Keywords** International teledermatology · COVID dermatology · COVID teledermatology · COVID telemedicine · International telemedicine

## Introduction

In 2009, the eHealth survey of the World Health Organization (WHO) showed that a teledermatology service was established in 16% of the 114 responding countries [1]. This survey was repeated in 2015 with a response from 125 countries, showing a teledermatology service of some type, from pilot to established, in 46% of the responding countries [2].

Teledermatology (TD), involving consultation and management of patients with skin problems by remote health care providers, is increasingly recognized as an important component of health care delivery. The last reviews of international TD were in 2010 [3] and 2015 [4].

TD practice has evolved since then because of improvement in technology, especially in mobile devices [5], and particularly because of the current COVID-19 pandemic [6].

This updated review builds upon those previous articles as well as updating the literature in the last 5 years. In addition, a survey was constructed in an attempt to get a picture apart from the literature on the practice of TD internationally, outside of the USA (in which a review was done recently) [7].

Consultations in TD can be done asynchronously (store and forward) with digital images or synchronously (video real time) or a hybrid of the two methods to any location with Internet service or mobile phone service with an adequate bandwidth. The consultations can be direct to patients or provider to provider.

TD offers many advantages over in-person health care, including reductions in wait time for care, improved workflow efficiency, possible health care cost savings, and provision of care to underserved regions and populations. It can also be used as a triage tool to identify urgent and severe health problems and as a follow-up tool for established patients to save time and travel costs.

In terms of outcomes, the evidence to date supports both diagnostic and treatment accuracy and cost effectiveness of TD [8, 9]. Accessibility to health care and efficiency of practice in terms of “no shows” and appointment cancellations are improved with TD [10–12]. And TD has had a beneficial impact in improving dermatological access to rural areas. Other outcome studies confirm the usefulness of TD for geriatric patients, who often have trouble getting to appointments; TD helped to treat 67% of the dermatoses of older individuals in a large Brazilian study [13]. In addition, in-house

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✉ Karen McKoy  
thrlmcky@gmail.com

<sup>1</sup> Lahey Clinic Department of Dermatology, Harvard Medical School, Burlington, MA, USA

<sup>2</sup> Department of Dermatology, East Kent Hospitals University NHS Trust, Kent, UK

<sup>3</sup> Department of Dermatology, University of Texas McGovern Medical School, MD Anderson Cancer Center, Houston, TX, USA

dermatology consultation services for hospitalized patients can be instituted in a timely fashion to reliably and effectively bridge access gaps, improve diagnostic accuracy, and differentiate therapeutic approaches while maintaining patient satisfaction [14–16]. Follow-up for chronic disease with direct-access online care had an equivalent quality of life outcomes as those seen in person with the same or higher efficacy as well as reducing transportation and health care costs [17–21]. Certain conditions (acne, psoriasis, eczema, rashes, rosacea, and lesions of concern) were particularly amenable to TD, whereas other visit types (total body skin examinations) were not reliably accomplished through this modality [22]. Patients and physician users are generally satisfied with the use of TD, although most still prefer face to face [23–26].

Government initiatives to decrease health care costs and to increase specialty health care are one of the major factors for the adoption of telemedicine services. Such government initiatives can be found in Canada, the UK, and Saudi Arabia. For instance, Canada announced the investment of US\$500 million to bring high-speed internet in 300 rural and remote communities by 2021 [27].

### COVID-19 Pandemic Impact on TD Use

There has been a profound effect of the pandemic on dermatology practice due to social distancing measures and to concerns that examinations may be a vector of COVID-19 transmission.

The pandemic has substantially contributed to the increased use of TD, as it has limited traditional consultation and health care access. TD has come to the rescue in this situation by extending consultation for nonessential conditions to patient's homes. In many countries, teleconsultation platforms were launched after streamlining regulations to meet the demand and needs for patient care. However, elderly patients and those with language differences may be experiencing unequal access to remote care during the pandemic due to limited proficiency with technology, the administrative burden to mobilize an interpreter service, and the hesitancy of patients to receive medical care via virtual platforms.

A global survey of over 700 dermatologists showed a 3-fold increase in the number of dermatologists practicing TD during the pandemic compared to before, with North American responders indicating the highest use. There was a 53% reduction in the number of dermatologists in all practice settings providing face-to-face consultations and a 49.1% increase in TD consultations; 15.6% of dermatologists stopped delivering care during this pandemic. *WhatsApp* was the most common platform across all continents (Europe, 62.4%; Asia 62.6%; North America 39.4%; Central/South America, 36.7%) [28••].

European dermatologists shifted en masse to TD during the first wave of the COVID-19 pandemic, and most of them disliked the videoconferencing experience [29].

During this time of rapid change, dermatologists must simultaneously aim to protect and remain available to patients while preserving their own safety. The expansion of telehealth by payers acknowledges these needs. While challenges exist with TD, the pandemic has created the opportunity to explore and refine this technology, offering an opportunity to continually deliver care during the pandemic [30–36].

Asian telehealth platforms are reporting drastically increased usages, such as the Indonesian telehealth platforms Alodokter, Halodoc, and GrabHealth, driven by government support and recommendation. The Doctor Anywhere COVID-19 Medical Advisory Clinic has also been rolled out across several Asian countries such as Singapore, Thailand, and Vietnam, in which patients can undergo a video consultation through the app if they suspect they might have COVID-19 [38].

### Methods

A survey instrument was formatted in Google forms in English and distributed electronically to international personal contacts of the authors, to 85 international dermatology and teledermatology societies who are members of the International League of Dermatological Societies, and to members of the International Society of Teledermatology. Answers from US dermatologists were excluded. Participants accessed the survey via a provided link. This was an optionally anonymous survey. A Chinese version was sent directly to Chinese contacts as the Google platform is not permitted in China.

Survey questions asked about types of country-specific health care systems, devices used for remote consults, practice settings, method(s) of consultation (store-forward and/or live video), whether the consult was direct to the patient or to another health care provider, countries served, whether teledermoscopy and telepathology were done, estimated number of annual consults, providing unpaid volunteer service, methods of reimbursement, and the impact of COVID on teledermatology practice.

A literature review was done for 2015–2021 in PubMed with search terms international AND teledermatology and global AND teledermatology and with the name of individual countries contacted for the survey AND teledermatology. A search was also done with the terms COVID AND teledermatology and COVID AND dermatology.

In addition to the survey, authors personally communicated with international colleagues; their comments outside of the survey are referenced in the text.

## Survey Results (see Table 1)

One hundred twenty-two responses were received. Ten responses were excluded for the following reasons: No country was noted in 3 responses, one reply was from a commercial entity (which offered direct to patient consults for pigmented lesions), one entry was entered in duplicate, and 2 responses were from the USA. The majority of respondents experienced an increase in TD numbers during the pandemic, although some who perform store-forward consults to providers had decreased numbers as patients did not come into clinics. Responses are tabulated in Table 1.

## World Regions

Most TD programs are active in North and South America and Europe [37].

**Table 1** Survey responses

Regional responses (of 33 countries represented)	Caribbean — 1 Central and South America — 29 Canada — 2 Western Europe — 12 Eastern Europe — 7 Africa — 4 Middle East — 10 Indian subcontinent — 10 Far East — 32 Pacific region — 4
Practice types (many respondents had multiple practice roles)	Academic — 58% Group practice — 39% Private practice — 73% Commercial employment — 9%
Reimbursement sources (note many had multiple sources)	National health care system — 59% Private insurance — 85% Self-pay — 73% Unpaid volunteer work — 36%
TD methods used	Video synchronous — 55% Store-forward asynchronous — 48% Hybrid store-forward video — 43%
Devices used	Telephone — 33% Mobile devices — 79% Desktop computer — 76% Unencrypted email — 31%
Consult source	Other health care providers — 57% Direct to patient — 89% Consultation to patients or providers in other countries — 14%
Teledermoscopy provided	15% of responses
Teledermatopathology provided	9% of responses
Number of referral sites served	From none to 300 (10 mean/4 median)
Number of annual consults per respondent	From none to 27,926 (984 mean/110 median)

## Canada

Policy surrounding telemedicine differs according to provinces. Government support of telehealth initiatives promises continued development [40]. TD is available, with some restrictions, in 6 of the 10 provinces (British Columbia, Alberta, Manitoba, Ontario, Quebec, and Nova Scotia) [41]. Shared Care is a provincial “not for profit” program in which dermatologists are reimbursed for their participation in the project on a per consult basis; it is being used in Alberta, British Columbia, Northwest Territories, and Prince Edward Island [42]. TD is also a service of the Ontario eConsult Program, available at no cost as part of Ontario’s publicly funded health care system [43].

A recent task force found that half of primary care providers and specialists offer no interactive electronic services to patients [44]. In this gap, virtual private care has developed. There are several Canadian-based websites which offer health services directly to paying patients. During the pandemic, virtual care went from being extremely rare to “the default.” After the start of COVID, according to a Canada Health Infoway survey, more than half of Canadians in spring 2020 said their most recent health encounters in 2020 were virtual [45].

## English Speaking Caribbean

Some in Trinidad and Tobago provide TD using WebEx or a hybrid model (Dr. Jeffrey Edwards, personal communication, February 2021). Another practitioner uses photographs, telephone, and video consultation in Antigua, Montserrat, St Kitts and Nevis, and the UK (Dr. Ronnie Cooper, personal communication, February 2021).

## Central and South America

A total of 29 survey responses were from 9 countries in this area. Brazilian dermatologists are the busiest with 5 dermatologists reporting a total of over 29,000 annual consults, primarily to other providers. Chile was next in numbers at 2000 annual consults, again to other providers. Eight Argentinian dermatologists reported almost 2500 total consults, both to providers and patients. All other countries reported low numbers of consults.

With limited education, economic constraints, poor broadband service, and political issues affecting health care, TD is not widely practiced and few commercial platforms are available. Many institutions have tried TD, but most stopped within a few years. WhatsApp and Zoom allowed an increase in TD during the pandemic for some in private practice [46]. The 2015 WHO eHealth survey noted TD practice of some type in 6 out of 12 South American countries [47•].

Brazil has the most developed TD practice in Latin America. Large-scale public TD programs have been developed in much of the country and some work with artificial intelligence (AI) incorporated [48, 49].

In 2018 in São Paulo, Brazil, 57,832 patients had been waiting for an appointment with a dermatologist through the public health system for almost a year. City Hall decided to create a program in conjunction with Hospital Israelita Albert Einstein, a private hospital, to assist using TD; 30,916 patients participated in the project, with 55,012 lesions photographed, resulting in nearly 165,000 images evaluated by 13 dermatologists over 12 months [50]. The same authors showed teletriage of pediatric patients addressed 63% of the lesions without the need for an in-presence visit [51].

In another state, the Telehealth Network of the state Minas Gerais is a public telehealth service supporting primary care practitioners in 660 of the 853 municipalities in the state in the southeast of Brazil. The most frequently requested specialty is dermatology [52].

In Chile, with a national telehealth program, TD consults composed over a quarter of consults with 37,424 TD consults from 2014 to 2016 [53].

In 2001, the French public health service launched a successful project delivering TD to remote health centers in French Guiana to tackle health care access inequalities [54].

Other countries are still slow on the uptake of telemedicine [55].

## Europe

Nineteen survey responses came from this region. Seven were from Eastern Europe, indicating the use of TD.

Relative uptake and enthusiasm for TD in Europe appear to be related to national health care systems and ratios of dermatologists to the population. Countries such as Spain, the Netherlands, and the UK, which have among the lowest number of dermatologists per million inhabitants and whose dermatologists are mostly based in the public sector rather than in private practice, have far greater experience of TD and have significant mature mass digital services [56–58].

In the UK, national surveys revealed an increase in active participation in TD from 17% in 2006 to 48% in 2016, and dermatologists with any experience of TD rose from 27 to 82% over the same period [57]. The UK National Health Service (NHS) from 2018 has mandated digital referrals to secondary care with an “advice and guidance” facility that allows the attachment of digital images for virtual triage. Many localities have developed their own strategies utilizing adapted public sector IT systems or private provider platforms to manage primary care outpatient and, in some cases, secondary care inpatient demand.

In the Netherlands, one major telemedicine provider, KSYOS, established in 2005, links almost 5000 GPs with

285 Dutch dermatologists, with an average of 300 teleconsultations per week. Telecare is approved and embedded in the health care establishment [60].

Several areas in Spain have well-established TD services; the skin cancer screening program for Andalusia managed 8000 digital cases in 2018, with additional TD used for inflammatory skin disease, including monitoring of psoriasis patients using a mobile app (D. Moreno-Ramirez, personal communication, Oct 2020 & World Congress of Dermatology, Milan, June 15, 2019).

In many other Western European countries, there have been local or regional TD services both for primary and secondary care support [61–65]. Publications show its use in geographically challenged and niche areas such as to the Faroe Islands from Denmark [66], specialist opinion for prisons in France [67], and to emergency care departments in Germany [68]. There is also evidence of experimentation and usage of mobile-based TD in several countries [69, 70] including monitoring and management of patients with chronic inflammatory conditions such as psoriasis [71].

There appears to be a paucity of published evidence of TD usage from Eastern European countries although no doubt there has been a degree of uptake for the same reasons as elsewhere [72]. In Russia, with a state-run health care insurance which is without charge, Alexey Sergeev, Professor, Sechenov University, Moscow Russia, states that “thousands of us consult online for free and for reward” through TD. In addition, there are “fully networking Russian-made dermatoscopes that offer cloud diagnosis and automatic cancer recognition for free instantly - inside a social network of all dermatologists in Russia” (A. Sergeev MD, personal communication, October 2020).

## Middle East and North Africa

Ten survey responses came from this region. TD has come to the rescue in this situation by extending consultation for non-essential conditions to patient’s homes, most from Iran, which indicated active informal TD use.

Less than half of respondents in this region to a WHO 2015 survey have any type of TD program. Jordan and Ethiopia were the only countries with an established program [73].

In Turkey, a recent study surveyed 107 dermatologists regarding informal teledermatology use before and after the COVID-19 pandemic began.

Before the pandemic, 40% of responding dermatologists used live video consults with patients, and 85% used store-forward via mobile device or email; 95% used WhatsApp as a platform. During the pandemic, 63% used video, and 72% used store-forward methods to consult with patients; 57.9% of participating dermatologists stated that they had a moderate level of knowledge about teledermatology, and 64.4% wanted teledermatology methods to be established officially [74].



The use of TD in Egypt is uncommon outside of large academic centers for remote consults to distant rural areas [75]. Teledermatopathology and teledermoscopy are not practiced (Pakinam Nabil Ibrahim MD, personal communication, December 2021).

### Sub-Saharan Africa

A contemporary informal survey estimates < 1 dermatologist per million population across the continent. In this area, mHealth, which relies on mobile phones and wireless networks, is preferred, being portable, accessible, and cheaper than broadband. The African Union and World Bank have set the goal of increasing internet connectivity from the current 22% to every person on the continent by 2030 [76], which would provide infrastructure support for the expansion of teledermatology. Teledermali is a program in Mali, supporting 67 community health centers. A 2-year pilot conducted in Mali from 2015 to 2017, using the system Bogou, showed a vast improvement in the dermatologic knowledge of health care workers who triaged cases to consulting teledermatologists and improvement in the management of dermatologic conditions [77]. Similar programs are being built in Togo and Mauritania [78].

In South Africa, a 2016 critique of teledermatology indicated that 4 of 8 original programs remained active at that time [79••].

The teaching hospitals in the Western Cape Province provide TD through an online application VULA, which allows provider-to-provider referrals to dermatology using store and forward teledermatology. Referrals are addressed in real time, with treatment and triage decisions concluded while the patient waits with the referring provider. In addition to providing needed services, the teledermatology application has been a robust dermatology teaching tool. A direct-to-patient private-sector program, Dr. Derma, was launched in March 2020 in response to the COVID-19 pandemic, providing approximately 2000 consultations to date, and is available across South Africa and some Southern African Development Community countries. This store and forward mobile phone app has the added functionality for providers to send voicemails reinforcing treatment recommendations and for scheduling a video call in complex scenarios. Dr. Derma operates as a virtual practice, where patients have the option to seek further treatment in person from the selected dermatologists (Dr. W. Visser, personal communication, February 2021).

### Central Asia (No Survey Responses)

Central Asian countries could follow the example set by Kazakhstan which is in the adoption stage of telemedicine [80]. Kazakhstan implemented a national telemedicine network in 2004 to eliminate the gap in the availability of specialized medical care for the urban and rural populations. This

network combines 199 districts, regions, and organizations. More than 500,000 telehealth consultations have been provided via video conferencing over the last 15 years [81]. Turkmenistan and Uzbekistan have informal local TD [82].

### South Asia and Indian Subcontinent (10 Survey Responses from This Region, All of Which Reported an Increase in TD with the Pandemic)

**India** India is in the adoption stage of telemedicine, with governance bodies and guidelines in place, indicating the willingness of the government to implement telemedicine programs. However, ongoing issues such as limited infrastructure and lack of comprehensive regulation inhibit this process [83]. One of the major issues in India is the technology illiteracy of the masses and having appropriate devices in spite of having access to high-speed internet. There are several commercially available teleconsultation portals [84].

There is informal TD practiced in Pakistan [85]. Currently, no national telemedicine framework in Bangladesh exists; current systems suffer from a lack of technological infrastructure, health care inequities, and poor treatment quality [86].

Afghanistan and Bangladesh have been reported on a WHO international survey to have TD at a national level [87].

**Far East** Most of the 31 responses from this region came from the Philippines (16) and Vietnam (13).

Singapore is a front-runner in Asia in terms of telemedicine adoption and health care system efficiency [88] with an intermediate established TD program [89].

**China** China has varied degrees of implementation across telehealth realms. It demonstrates invention in novel technologies and population health management; however, some telemedicine regulations and implementation are still entry-level and require further clarification [90]. Local pilot TD projects exist. Companies supplying direct-to-patient telehealth subscriptions such as Good Doctor, Alibaba, and Tencent are experiencing growth.

Dr. Yong Cui, chair of the National Telemedicine and Connected Health Center dermatology committee, stated that TD is practiced at the Anhui Province Cloud Hospital in both real-time and asynchronous modes, covering 5 million patients. Development of AI software for TD started in 2018 with the China Skin Imaging Database; 4000 hospitals are projected to be connected to this TD project. To date 300,000 image data sets are included [91].

AIDERMA is the first comprehensive platform for AI-assisted diagnosis and treatment of skin patients in China. AIDERMA includes three sections: assisted diagnosis and treatment, continuing education, and consultation. In the assisted diagnosis and treatment, more than 90 kinds of common skin diseases are supported. This purports to be a simple operation

which provides a diagnosis and treatment ideas [92]. Another application to diagnose psoriasis, eczema, and atopic dermatitis, AIDDA, is available to all doctors in China, and more than 7000 doctors have registered for this application [93].

An overwhelming majority of Chinese dermatologists are favorably disposed to AI and think the role of AI will be in “assisting the daily diagnosis and treatment activities for dermatologists” [94].

**Taiwan** Only 2 publications on TD have come out of Taiwan. Weekly live-interactive consultation services for dermatology have been done since 2018 [95]. A successful TD pilot was done in Mongolia in 2013 [96].

**Korea** No information is available in North Korea. South Korea has used live-interactive teledermatology for prisoners [97]. TD using smart phones has been used in the military [98].

**Vietnam** Vietnam in 2015 had intermediately established the use of TD [99]. In 2018, there were 20 mHealth initiatives in Vietnam. Most of the initiatives were funded by external donors, while the rest were government funded or self-funded. A majority of the initiatives targeted vulnerable and hard-to-reach populations, aimed to prevent the occurrence of disease, and used text messaging as part of their intervention. Vietnamese mHealth implementation has been challenged by factors including features unique to the Vietnamese language and sociocultural factors [100]. Thirteen survey responses indicated that the number of consults is generally low.

**Malaysia** Since COVID, a teledermatology service has been provided from Kuala Lumpur to remote Sabah [101].

**Philippines** In 2015, WHO reported an intermediate established TD service in the Philippines [102]. With COVID, there are several providers of TD without charge [103]. Currently, the Philippines lacks national legislation, rules, and regulations specific to telemedicine, but during the pandemic, the Department of Health permitted the use of telemedicine [104]. Fee for service TD is offered by many dermatologists.

Sixteen survey results came from this country. The number of annual consults ranged from 30 to 2000, many provided to the military. All reported an increase in consults with the pandemic. One respondent commented that although teleconsultation has existed for the past decade, it is only during the pandemic that its worth has been realized as an important means for accepting consultations from patients.

## Oceania

Survey responses were only from Australia and New Zealand.

**Australia** Despite the potential of teledermatology to increase access to dermatology services and improve patient care, it is not widely practiced in Australia. In an effort to increase uptake of teledermatology by dermatologists and support best practices, guidelines for teledermatology have been developed by the University of Queensland’s Centre for Online Health [105].

Tele-Derm National is provided to registered medical practitioners who are members of the Australian College of Rural and Remote Medicine through its Rural and Remote Medical Education Online (RRMEO) platform. The service has been active since 2003, utilizing a store-and-forward format to provide a specialist dermatologist opinion within 24 h [106, 107].

A survey of Australian dermatologists and dermatology trainees found that mobile teledermatology was common, with more than 50% saying they sent or received clinical images using a smartphone at least weekly (rising to 89% of junior practitioners). However, it was also poorly regulated, with limited security measures, documentation of patient consent, or transfer of images to a patient’s permanent medical record. Dermatologists reported taking mobile phone images to obtain advice from a colleague, monitor patient progress, communicate with the patient’s other doctors, and for educational purposes [108]. Respondents from this country also provided military consult services.

**New Zealand** According to WHO, New Zealand had a local pilot in 2015 [109]. In order to combat the access gap and prioritize skin cancer diagnosis and treatment, Waikato public dermatologists launched the Suspected Skin Cancer (SSC) service in 2017, a free store-and-forward teledermatology system for Waikato GPs to receive specialist advice within 4 days of referral [110].

Teledermatology applications for consultations using mobile devices for a fee are increasingly prevalent. Other commercial platforms operating (internationally) are DermEngine and MetaOptima [111]. Major health insurers in New Zealand have agreed to fund virtual consultations during COVID [112, 113]. One survey responder from this country does 7000 annual consults. The military is also served.

## Volunteer TD

Teledermatology has been delivered on a charitable basis in developing countries, particularly Africa, where there are few qualified dermatologists. The African Teledermatology Project, coordinated by Stephen Kaddu, based in Graz, Austria, and Carrie Kovarik at the University of Pennsylvania, USA, has established links with Uganda, Botswana, Malawi, Swaziland, Burkina Faso, and Lesotho, giving clinical and educational support to local health workers [114, 115].

Based in the UK, the Swinfen Charitable Trust offers teledermatology advice to many countries in Africa, as well

as in the Middle East and Asia, including Pakistan and Iraq. In 2019, there were 400 Telemedical Links in 84 developing countries, with 692 referring doctors being advised on diagnosis and recommended medical treatment for their patients by some 500 volunteer medical specialists [116].

Médecins Sans Frontières (MSF), a medical humanitarian organization, began using store-and-forward telemedicine in 2010. In 2016, MSF had 271 operational sites in Africa, 74 in the Middle East, 56 in Asia, 37 in Europe, 26 in the Americas, and 4 in the Pacific. By 2017, over 6000 cases have been managed by this telemedicine system. Specialists are volunteers from hospitals or private practice all over the world. Among the medical specialties, dermatology was one of the most frequent subspecialties requested. Experts not available within MSF, such as dermatologists, were based primarily in Europe or the Americas [117].

## Conclusions

Telemedicine increases access to general and specialized health care services, delivers care to rural areas, offers providers greater flexibility in scheduling, and saves patients' time and money in seeking care.

Barriers to telemedicine remain in both developed and developing countries and unnecessarily slow its diffusion. A recent review of global telemedicine barriers cited organizational barriers of cost, reimbursement, liability, privacy, data security, outdated equipment, workflow efficiency, a rural location, and profit, teaching status, and size of organizations. Patient-related barriers were increased age, educational and digital literacy levels, access to enough bandwidth and to a telephone, unawareness of telemedicine, unreasonable expectations of telemedicine, socioeconomic status, unwillingness to be photographed, language barriers, and the perception that telemedicine is impersonal. There are also barriers related to staff and programmers such as technology literacy, resistance to change, poor design, interoperability, and language [118].

When the consult is between the care provider and a specialist, poor uptake of teledermatology may be due to fact that the existence of these services is not widely known to medical practitioners or patients. In addition, a far greater workload and responsibility are placed on the referring doctor [119–121].

When the visit is direct to the patient, barriers to the use of live video include negative attitudes to video; unfamiliarity with video; the perception that the time taken to set up a video consultation will encroach on the time available to attend to the patient; interruption and/or disruption to workflows in the clinic; low competence and/or low confidence with the technology, equipment, and software; and “it's easier to pick up the phone” [122].

When telemedicine adoption came after COVID in Australia, only 3% of GP telehealth consultations were conducted by video, the rest by telephone, despite the two Australian GP colleges and the National Health Service stating a preference for the use of video rather than phone as a substitute for in-person consultation [123]. Other challenges in implementing outpatient teledermatology in the pandemic are poor image quality, particularly when evaluating pigmented lesions, medico-legal liabilities, and privacy issues during COVID.

The pandemic decreased barriers to TD care in many countries, particularly those with developed technology. Access to care for those with the proper technology tools improved enormously. Coverage for physician services via government or insurance systems was made available in many countries for the first time. Both patients and health care delivery institutions, private and otherwise, rapidly adopted TD to deliver care and became familiar with the possibilities and perils of TD. Reasons for reluctance and acceptance of patients and health care providers to using TD were explored.

By utilizing a survey and personal contacts, we identified that the published literature does not reveal the extent of the ingenuity of applications of teledermatology, particularly in the developing world. Novel mechanisms for knowledge sharing and lessons learned which may be unique to each region would facilitate the growth and utility of teledermatology globally.

Teledermatology growth and application in the future may be possible through the rapid development of AI (augmented or artificial) intelligence, with the potential to alter the way dermatology is practiced. Studies comparing dermatologists to machine-learning computers showed computer algorithms were superior to clinicians in diagnostic accuracy [124, 125]. AI in dermatology might be used in the education of patients and health care trainees, lesion tracking, triage, and treatment response. Teledermatology in combination with AI can allow the use of dermatologist vetted images to be used as a database for machine learning [126].

Although telemedicine shows promise in its ability to increase access and efficiency, ease and acceptance of this modality of care are necessary for its diffusion. Public policy could compensate for barriers common in several countries, but it becomes difficult for many nations to act in accord, particularly when monetary incentives can differ between countries. Future research could start with the assembly of a Delphi team to identify possible common ground for international public policy. From the results of the Delphi team, surveys could go out to an international community inviting standards for interoperability and universal acceptance of telemedicine as a means to expand access to care [127].

**Abbreviations** *AI*, artificial intelligence; *COVID-19*, coronavirus disease 2019; *WHO*, World Health Organization; *TD*, teledermatology; *MSF*, Médecins Sans Frontières

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## Declarations

**Conflicts of Interest** The authors declare that they have no conflict of interest.

**Human and Animal Rights and Informed Consent** This article does not contain any studies with human or animal subjects performed by any of the authors.

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Papers of particular interest, published recently, have been highlighted as:

- Of importance
- Of major importance

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