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EAACI POSITION PAPER

Telemedicine with special focus on allergic diseases and asthma—Status 2022: An EAACI position paper

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Abstract

Efficacious, effective and efficient communication between healthcare professionals (HCP) and patients is essential to achieve a successful therapeutic alliance. Telemedicine (TM) has been used for decades but during the COVID-19 pandemic its use has become widespread. This position paper aims to describe the terminology and most important forms of TM among HCP and patients and review the existing studies on the uses of TM for asthma and allergy. Besides, the advantages and risks of TM are discussed, concluding that TM application reduces costs and time for both, HCP and patients, but cannot completely replace face-to-face visits for physical examinations and certain tests that are critical in asthma and allergy. From an ethical point of view, it is important to identify those involved in the TM process, ensure confidentiality and use communication channels that fully guarantee the security of the information. Unmet needs and directions for the future regarding implementation, data protection, privacy regulations, methodology and efficacy are described.

Abbreviations: ADHD, attention deficit hyperactivity disorder; AI, artificial intelligence; ED, emergency department; e-health, electronic health; e-visits, electronic visits; FVV, facilitate virtual visit; GDPR, the general data protection regulation; HCPs, healthcare professionals; HCW, healthcare worker; HOHC, home online health consultation; ICTs, information and communication technologies; m-health, mobile health; PPE, personal protective equipment; PTSD, post-traumatic stress disorder; RPM, remote patient monitoring; S&F, store-and-forward; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; SMS, short message service; TM, telemedicine; US, United States; WHO, World Health Organization.

Methods: This position paper is a product of the EAACI Telemedicine Task Force, an expert panel of immunologists, allergists, physiologists, pulmonologists, ENT doctors, paediatricians and primary care professionals among others. The topic of the manuscript was identified at an online Group Meeting in January 2021 and a streamline of relevant subtopics was extensively revised and designated to individual members. Following workshops and using a circulation process, the final manuscript was released for review to all telemedicine group members, compiled and again recirculated for complete consensus on text, tables and figures. The final manuscript was read and approved by all authors.

Data sources, search strategy and study selection: Studies published in English within the 2000–2022 timeframe were identified from PubMed. The following keywords were used in the search strategy: telemedicine, e-Health, remote patient visits, digital healthcare, remote medicine, health informatics, information technologies, m-Health and mobile health. References published that had not been otherwise identified in the initial search were added where relevant.

For Affiliation refer page on 788

KEYWORDS
e-health, m-health, telecare, telehealth, telemedicine

1 | INTRODUCTION TO TELEMEDICINE

Telemedicine (TM) has been around in different forms since the end of the last century. The rise of telecommunications began in the late nineteenth century when tools for remote communications such as the telephone, radio and telegraph were invented. More recognizable elements of TM were seen by the 1950s when in two health centres in Pennsylvania in the United States (US), telephone technology was used to exchange radiologic images. One of the most famous examples of TM occurred in 1999 when a physician Jerri Nielsen found a lump in her breast while conducting research in Antarctica. The diagnosis and treatment of her breast cancer were carried out over a distance and the video equipment and chemotherapy were delivered by US Air Force pilots.[1–9] Patients' accessibility to remote medical services is easier today than it has ever been. The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic which exploded in 2020 drove the broad use of TM because of necessary contact restriction measures, affecting also health professionals. TM allowed for continuity of care including professional exchange with and between medical advisors. TM is rapidly gaining acceptance as a convenient way of accessing medical services worldwide.[10] There will be an increasing value in facilitating adoption of TM in the post-COVID era.[11]

1.1 | Definitions

TM as a term was first coined in the 1970s to describe 'remote healing' (literally means 'healing at a distance').[12] The World Health Organization (WHO) define TM as 'the provision of healthcare services, in which distance is a critical factor, by professionals who use information and communication technologies (ICTs) to exchange data to make diagnoses, recommend treatments and prevent diseases and accidents, as well as for the permanent training of healthcare professionals (HCPs) and in research and evaluation activities, in order to improve the health of people and the communities in which they live'.[13] In the European Union, TM is considered as the provision of healthcare services, through the use of ICTs, in situations where the health professional and the patient are not in the same location, and it involves secure transmission of medical data and information, through text, sound, images or other forms needed for the prevention, diagnosis, treatment and follow-up of patients.[14] As a leader in the promotion and support of TM and telehealth, the American Telemedicine Association promotes the use of guidelines that can be freely accessed and discussed.[15]

TM is a part of telehealth and they both are included in electronic health (e-Health) (Figure 1). According to the common definition of the WHO and the European Commission, e-Health refers to the combined use of electronic ICTs in the health sector to share, store and retrieve electronic health data for prevention, diagnosis, treatment, monitoring, educational and administrative purposes, both at the local site or at a distance.[16,17] The terms: TM and telehealth refer to care that is only given at a distance. TM refers specifically to remote clinical services. Telehealth is broader and can include not only remote non-clinical services, such as provider training, administrative meetings and medical education but also clinical services. Although the terms telehealth and TM are used interchangeably, they do not have the same meaning. TM refers specifically to the practice of medicine via remote means, with the help of technologies and telecommunication systems. Meanwhile, telehealth covers all components and activities of healthcare and the healthcare system that are conducted through telecommunications technology. Healthcare education, wearable devices that record and transmit vital signs and provider-to-provider remote communication are examples of telehealth activities and applications that extend beyond remote clinical care. As noted above, telehealth has evolved to integrate a broader variety of digital healthcare activities and services. A glossary of TM terms and related definitions which appear in the text are summarized in Table 1.

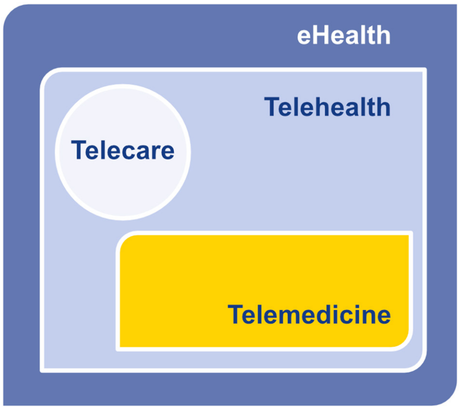

FIGURE 1 The relations between e-health, telehealth, telecare and telemedicine.

The additional definitions of TM forms, services and medical acts are presented below according to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the EU member states legislation.[14,18–21]

1.2 | TM forms

1.2.1 | Teleconsultation

Teleconsultation is the most frequent example of medical services provided at a distance between two or more geographically

TABLE 1 Glossary of telemedicine terms and related definitions.

Term	Definition
Telemedicine	Remote clinical services including the diagnosis and treatment of patients via telecommunications technology
Telehealth	Remote clinical and non-clinical services including all components and activities of healthcare and the healthcare system that are conducted through telecommunications technology
Telecare	Care afforded to patients remotely via telecommunications technology, either through synchronous (live video) or asynchronous means (store-and-forward, remote patient monitoring)
Information and communication technologies	Technological tools and resources used to transmit, store, create, share or exchange information
e-Health	Electronic information and communication technologies used to share, store, and retrieve electronic health data for prevention, diagnosis, treatment, monitoring, educational and administrative purposes
m-health	Applications installed on mobile devices (or handheld computers) such as smartphones, phablets, tablets to track health measurements (e.g. set medication and appointment reminders and share information with clinicians, etc.)
Teleconsultation	Synchronous or asynchronous delivery model of telemedicine between two or more geographically separated healthcare providers
Telediagnosis	Determining the nature of a patient's disease, at a remote location, based on the clinical data and information (i.e. data, images and video records) transmitted via information and communication technologies
Tele-education	Online educational lectures, programs, scientific libraries and databases, educational websites or virtual hospitals
Teleexpertise	Remotely requesting medical advice from another health professional regarding a certain medical condition or clinical scenario
Teletriage	Technology used to supplement or replace elements of the patient interaction. Involves screening patients remotely to determine the patient's condition and required care
Telesurgery	Use of telemedicine equipment and information and communication technologies to support and monitor surgical procedures at a distance or to perform remote surgery with robotized computerized machines and devices
Telescreening	Use of information and communication technology between patients and healthcare professionals to remotely identify a previously undiagnosed disease in individuals without signs of symptoms, or with pre-symptomatic or unrecognized symptomatic disease, via medical tests conducted remotely
Teleassistance	Healthcare professional providing remote support or assistance to another professional in the context of medical care
Telefacilitator	Healthcare professional that gathers objective measures using equipment (i.e. digital stethoscope, thermometer, pulse oximeter, etc.) and transmits data to the provider
Telemonitoring	Remote control of various individual parameters through wearables and biosensors (also referred to as telesurveillance)
Telerehabilitation	Remote delivery of rehabilitation services to the home or place of choice of the patient (also referred to as e-rehabilitation)

separated healthcare providers (remote requests medical advice from another professional regarding a certain medical issue is known as *teleexpertise*) or between healthcare providers and patients with the use of ICTs to communicate at a distance. The purpose of teleconsultation is to diagnose or treat a patient at a remote site, to obtain a specialist's second opinion and to develop innovative care pathways. Teleconsultation is a good option for those who live in rural and remote areas, where there is a lack of healthcare professionals and for people with physical disabilities, who have increased difficulties attending physical consultations. Teleconsultations help save patients' time and transportation costs and can be done from patient-friendly environment like home.[14,18–21]

1.2.2 | Teletriage

Teletriage refers to the process of identifying a patient's problem, assessing the level of urgency and recommending advice via phone by trained professionals, to guarantee a safe, timely and appropriate disposition of patient symptoms. Rather than diagnosing symptoms it has sense to estimate the urgency of care to safely direct the patient in need (home or on-site treatment). Medical advisors are trained and need to follow a list of predefined questions in order to determine whether symptoms are life-threatening, emergent, urgent, acute or non-acute. Teletriage contributes to reducing healthcare system costs through a reduction in inappropriate emergency visits and is beneficial to patients as a tool to use under conditions of urgency or uncertainty.[14,18,19]

1.2.3 | Telemonitoring

Medical telemonitoring is the remote control of various individual parameters through wearables and biosensors, also referred to as *telesurveillance*, when a healthcare professional makes remote interpretations of medical data with or without medical decisions for follow-up on the treatment of a patient. Telemonitoring-type services are utilized in the context of the provision of medical care and provide health professionals with the physiological parameters of the patient/citizen by using ICTs. Telemonitoring offers various benefits: it can improve the quality of life of chronically ill patients through self-management solutions; reducing hospitalization costs; and saving on unnecessary emergency visits. Telemonitoring services, as opposed to medical act-type services, usually do not involve physicians in the first line of the service provision. Many telemonitoring services are primarily managed by the nursing profession. Physicians must be involved when vital signs indicate a deterioration of the patient's condition. In this case, it becomes a medical act. Telemonitoring services involve the management of alarms and comprise rule-based surveillance schemes. Automated filtering of the primary data by computational algorithms may avoid false alarms and sensory overload of the health professionals in charge. Telemonitoring improves the quality of medical care provided to chronically ill patients and reduces the frequency and duration of hospital stays.[14,18–21]

Telemonitoring is not included in the curative scope of TM, but in the telecare scope, focusing on the preventive aspect of healthcare. According to Nangalia,[18] the telemonitoring chain is composed of five stages: (1) data acquisition using an appropriate sensor; (2) transmission of these data from the patient to clinician; (3) integration of the data with other data describing the state of the patient; (4) synthesis of appropriate action, or response or escalation in the care of the patient and associated decision support; and (5) data storage. Telemonitoring services empower patients to actively manage their diseases, and at the same time enhance continuity of care and prevention of future occurrences in the context of chronic disease management.[19]

1.2.4 | Tele-education

Medical tele-education for patients, general population or HCP includes online educational lectures, programs, scientific libraries and databases, educational websites and virtual hospitals.[19–21]

1.2.5 | Teleassistance

Medical teleassistance is used when a healthcare professional provides remote support or assistance to another professional in the context of a medical act.[18–21]

1.2.6 | Telesurgery

Telesurgery refers to the use of TM equipment and ICTs to support and monitor surgical procedures at a distance, or to perform remote surgery with robotized computerized machines and devices, for instance, patients with permanent rhinosinusitis with nasal polyps may undergo functional endoscopic sinus surgery or a balloon sinuplasty.[22] This means that telesurgery can be performed using two methods: telementoring or telepresence surgery/teleintervention. The former consists of the remote interactive assistance given by a specialist to a surgeon during a surgical procedure, through the use of video and audio connection. The latter uses robotized and computerized technologies to actively perform remote surgeries, by linking surgeon's movements to a scale-down and very precise movement produced by a small robot machine.[18,19,21]

1.2.7 | Telediagnosis

Telediagnosis is the determination of the nature of a patient's disease, at a remote location, based on the clinical data and information (i.e. data, images and video records) transmitted through ICTs.[18,19,21]

1.2.8 | Telerehabilitation

Telerehabilitation is the remote delivery of rehabilitation services to the home or place of choice of the patient (also referred to as e-rehabilitation).[19]

1.2.9 | Telescreening

Telescreening consists of the use of ICTs between patients and healthcare providers to remotely identify a possible disease that was not previously recognized in individuals without any signs or symptoms, or with pre-symptomatic or unrecognized symptomatic disease, through the use of medical tests that can also be provided remotely. Automated analysis, coupled with digital stethoscopes, can play a crucial role in enabling telescreening of severe lung diseases.[23]

Understanding the different forms of TM and related services, using the appropriate ones, and obtaining informed consent, documented either as a written or verbal one, are important rules for the implementation of a TM program for patients with allergies and asthma.[21] Specific forms of TM are summarized in Figure 2.

1.3 | Use of TM across disciplines

In the publication of Shigekawa,[24] the authors researched systematic reviews and meta-analyses published between January 2004 and May 2018 trying to answer two relevant questions: (1) does the evidence indicate whether services delivered via telehealth are equivalent to in-person services? and (2) does the evidence indicate whether the use of telehealth services (remote monitoring, mobile applications, structured phone disease management by nurses and fully automated website interventions) affects the use of other services? Both paediatric and adult populations receiving a telehealth intervention for any disease or condition were included. The authors concluded that in most cases, telehealth appeared to be equivalent to in-person care, but it is unclear whether the use of telehealth services reduces the use of other services, duplicates services or improves access to beneficial services.

FIGURE 2 Types of telemedicine services.

The diagnostic accuracy of in-person clinic dermatology is better than teledermatology, as the researchers showed. Diagnostic concordance of store-and-forward (S&F) and clinic dermatology was 'acceptable'/'good', but concordance rates were better for live video and clinic dermatology although based on fewer patients. Overall accuracy was equivalent between teledermatology and clinic dermatology. Evidence consistently supported teledermatology's effectiveness in diagnostic and treatment concordance with in-person dermatology.[25] Some studies reported significant improvement in physical functioning for telerehabilitation compared to usual care, significant improvements in pain for telerehabilitation or no significant differences between telerehabilitation and control groups. Similarly, a systematic review and meta-analysis by Michelle Cottrell and co-authors found that both real-time telerehabilitation and usual care reduced pain and improved quality of life and physical, psychological and social functioning, with a slight effect in favour of telerehabilitation over usual care alone.[26,27] Generally, when teleconsultation was used some studies found a significant decrease in visits to general practitioners, but some found an increase in return consultations following telephone consultation (the authors did not report an increase in adverse events or emergency visits associated with telephone consultation).[28,29] The authors reported that teleconsultations resulted in more repeated visits but required providers to spend less total time with patients.[30]

1.4 | Use of TM in allergic and asthma patients´ treatment

In chronic diseases such as asthma and allergy, TM offers value in both treatment and monitoring, as it is detailed subsequently in the manuscript. In summary, TM has shown valuable cost-effectiveness, suitability, convenient synchronous and asynchronous monitoring of the diagnosis and or treatment of allergic conditions, especially in vulnerable and remote patients. The study by Waibel et al. reported that 76% of allergic patients seen initially in person were subsequently referred for a TM visit while 93.5% of patients seen initially by TM continued being seen by TM via follow-up phone calls. Prescriptions were the same regardless of how the patients were seen.[31] Both new and follow-up visits to the allergist/immunologist were well received by patients and demonstrated significant indirect cost savings, with less than one-fourth of the patients recommended for an in-person visit. Moreover, the authors estimated that of 112 TM visits, 200 work days or school days were saved and $58,000 in travel-related costs and 80,000 km in driving was avoided. In a different publication by Portnoy et al.,[32] the researchers compared asthma control in 100 children seen in person with 69 who were seen via TM—asthma control (measured by the Asthma Control Test™) improved in both groups. The clinical differences were not present for patients seen in these two ways and therefore asthma care over distance is comparable to care delivered in person. Asthma management in the school setting, which included administration of preventive medications and TM encounters with primary care providers, produced significantly better outcomes than asthma management via traditional in-person methods.

In another study enrolling 400 children, those in the intervention group had more symptom-free days per 2 weeks (11.6 vs. 10.97; difference, 0.69; 95% CI, 0.15–1.22; $p = .01$) and showed to have lower probability to visit an emergency department (ED) or hospitalization (7 vs. 15% odds ratio, 0.52; 95% CI, 0.32–0.84) for asthma.[33] The study suggested that TM was an efficient way to link children to primary care and facilitate asthma assessment and treatment. Moreover, clinical and cost-effectiveness of mobile phone-supported self-monitoring of asthma with a multicentre randomized controlled trial on 288 adolescents and adults with poorly controlled asthma was assessed. In this study, patients in the control (paper) group were asked to keep a paper diary, recording the same data as the intervention (mobile monitoring) group (symptoms, drug use and peak flow readings) twice daily. Both groups were provided with the same clinical care. The researchers found no significant difference between mobile technology asthma control and paper monitoring based on clinical guidelines. Also, cost-effectiveness was assessed with regards TM for the delivery of outpatient pulmonary care to a rural population, which one study demonstrated that can be more cost-effective ($335 per patient/year) compared with usual care (about $585 per patient/year) and on-site care ($1166 per patient/year).s.[34,35] In the same line of remote monitoring, Australian researchers studied an asynchronous form of TM using remote monitoring of symptoms and the use of an asthma action plan in 72 pregnant women. The intervention group used a handheld device connected to a smartphone to measure lung function along with a written asthma action plan while the other group received usual care. After 6 months, the TM group experienced improved asthma control and improved asthma-related quality of life when compared to the control group. The two groups did not differ in lung function, number of acute healthcare visits, missed work/school or amount of oral corticosteroid used.[36]

Although skin prick testing with aeroallergens and food extracts are not recommended to be performed at distance in TM visits, the usefulness of TM with digitized grid reconstruction was very recently discussed to improve the value of photo assessment in late patch test readings.[37] Moreover, a 2018 study concluded that TM can be used to remove penicillin allergy suspicion ('delabelling'),[38] saving the patient time and monetary expenses (over $30,000). The money saved was calculated by the authors by reducing the use of vancomycin, metronidazole, aztreonam, aminoglycosides and clindamycin. Besides, the authors showed that the average total time to complete an in-person consultation was 128 min (standard deviation [SD] ± 33). Of this, the average physician assistant travel time was 46 min (36%) with the remaining time spent on clinical services (82 min, 64%). The average physician telemedicine time per patient was 5 min (SD ± 2).

2 | TELEMEDICINE SERVICE DELIVERY MODELS

There are few main delivery models used for TM service[39] (Figure 3).

2.1 | Store-and-forward (asynchronous)

Store-and-forward (S&F) TM is also called asynchronous TM and allows the exchange of pre-recorded healthcare data between two or more individuals at different times. It also permits deferred communication between patients and health professionals. Computerized tomography, magnetic resonance imaging, x-rays, photos, videos and text-based patient data are gathered and sent to specialists and other members of a care team to evaluate patients and assist in their treatment. Technologies used for the S&F TM include secure servers and routers that temporarily house incoming packets of information and then route them to the appropriate end users. Secure e-mail platforms are also often used for S&F TM, as it is an inexpensive and easy to set up choice.[40] In the field of allergy, this model could be used for sending photos of skin lesions with a relevant clinical history to a healthcare professional working in a remote health facility.

2.2 | Live videoconferencing (real-time or synchronous)

Real-time (or synchronous) TM requires the immediate transmission of information through a communication device to allow real-time interaction between a patient/healthcare professional and a healthcare provider/specialist, who are simultaneously present, but remotely. Synchronous TM is considered interactive and live. It includes videoconference tools for audio and visual examination. Devices for remote physical examination, such as electronic stethoscopes, can be used. Usually, it is done through video-conference equipment, but a phone call or an online chat forum are also interactive forms of synchronous communication. Live videoconferencing is a good choice for controlling the status of asthma through patients' regular short remote visits with the physician.

Another type of a live (synchronous) TM visit is a facilitated virtual visit (FVV). An example of FVV occurs when the patient is located at an accessible site (i.e. clinic) where diagnostic equipment is available and the medical provider is at a distant site. A telefacilitator (i.e. medical assistant, nurse) gathers objective measures using equipment (i.e. digital stethoscope, thermometer, pulse oximeter, other) and transmits this data to the provider.[39,41,42]

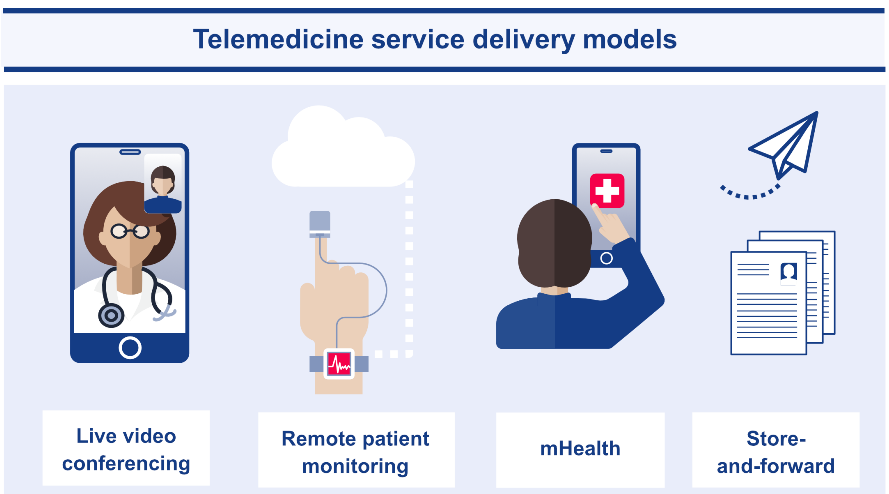

FIGURE 3 Telemedicine service delivery models.

2.3 | Remote patient monitoring

Remote patient monitoring (RPM) involves the reporting, collection, transmission and evaluation of patient health data through electronic devices such as wearables, mobile devices, smartphone apps and internet-enabled computers (Figure 4). RPM technologies remind patients to weigh themselves, check vital signs like blood pressure, oxygen levels and transmit the measurements to their physicians. RPM helps with continuous evaluation of a patient's clinical status via review of parameters, tests and images collected remotely. The transmission of collected data can be done on a regular basis every few days for example. Newer technologies, such as mobile applications on devices, allow for a wider breadth of telehealth possibilities. In allergic patients, this could possibly work for registration of daily allergic symptoms in patients' e-diaries.[32,39,41]

2.4 | m-Health

Applications designed to be installed on mobile devices (or handheld computers) such as smartphones or tablets which allow patients to get in touch with a medical advisor anytime and anywhere are an integrated function in mobile health (m-Health). These applications allow patients to track health measurements, set medication and appointment reminders and share information with clinicians. Users can access hundreds of m-Health applications including asthma and diabetes management tools as well as weight loss or smoking cessation applications. Digital inhaler devices could become an integral part of the management of asthma via telemedicine. These devices are equipped with wifi and/or bluetooth capabilities to upload inhaler use and other data to a cloud accessible to the patient's healthcare provider.[43] This would provide real time assessment of a patient's adherence and inhaler technique. Additionally, mobile devices allow users to schedule appointments and communicate with providers via video conference and text message.[32,39,41]

3 | ADVANTAGES AND DISADVANTAGES OF TELEMEDICINE

The list of benefits and disadvantages of TM are shown in Table 2.

3.1 | Advantages of TM for patients and HCP

TM can successfully help patients with a range of medical conditions. Providing safe care during the COVID-19 pandemic was challenging, but beneficial from many points of view.[44–46] TM allows easier and faster access to care for people who are geographically isolated, those who are incarcerated, patients with disabilities and other groups, including elderly populations. TM services need to be creative and active in promoting equality, non-discrimination and human rights. Some research revealed that TM reduces healthcare disparities for patients in remote locations.[21,47,48] The use of TM allows the patient to contact the preferred HCP regardless of geographical distance, thus allowing specialist opinion consultations in a simple manner, without having to face (sometimes long) journeys. TM allows patients to access healthcare from the

FIGURE 4 Wearables (adapted from Alvarez-Perea A et al.[59]).

TABLE 2 Advantages and disadvantages of telemedicine (TM).

Advantages	Disadvantages
• Increases the chance for proper diagnosis or treatment option. • Saves patients and healthcare providers time (less absences from school, work, home). • Helps patients to get access to specialists. • The home environment might be more comfortable for patients and help to build a closer relationship with their doctor. • Lower cost of visits. • Faster access to medical help/advice. • Reduces spread of illness (necessity in pandemic!) • Reduced number of cancellations/no-shows. • Reaches more patients (higher punctuality, less travels between work places—extended time for visits). • Opportunity for a clinician to learn about patient's home environment (help from family, information shared by relatives or caregivers who assist the patient during visit). • Better compliance. • Easy follow-up. • Timely access to appropriate intervention in emergency. • Convenient (especially for patients with mobility problems).	• Relies on technology and internet accessibility. • Security of sensitive data is not guaranteed. • Geographical barriers not always possible to overcome. • Reimbursement problems. • Requires technology—devices. • Requires staff training in TM system implemented in the clinic. • Technical assistance/support might be needed on site. • Differences in health law or legislation between countries – no equal quality of service. • Insurance difficulties. • A lack of standardization of guidelines and procedures on TM implementation across countries (influence the quality of service and accessibility). • Differences in systems used by healthcare providers (quality). • Patient's concentration can be distracted at home environment, as well as honesty with a doctor can be influenced by other people assisting the call (intentionally or not). Nonverbal clues can be missed if no video. • High costs of technical support and system maintenance. • Personal attitude to technology (not positive).

safety, comfort and privacy of their own homes and this can also lead to reduced healthcare costs.[42] Some researchers suggested that patients using TM spend less time in the hospital, with cost savings.[34,49,50] E-visits (electronic visits) have significantly lowered costs compared with face-to-face visits, reducing trips to hospitals, time off-work and childcare costs.[39,51] Recently researchers suggested a role for TM in preventing unnecessary emergency and hospital utilization following disasters, such as natural disasters, war and extreme remote sites.[52–54]

3.2 | Advantages of TM for allergic patients

TM interventions may apply to different allergic and immune diseases, including allergic rhinitis and asthma, drug and food allergies or atopic dermatitis.[55,56] Besides conducting new and control visits remotely, TM allows risk assessments, avoidance of hospitalization, patient and family education and improved therapeutical support.[46,57] Moreover, TM is useful for allergy services in rural and regional locations lacking specialty services.[58] By facilitating access to specialists, TM is valuable especially for allergic patients whose condition requires prompt assessment, a need often hindered by long waiting lists.[3] TM has been used mostly in patients with asthma.[59] The first report was published two decades ago and revealed improvement in asthma symptoms and quality of life in paediatric patients through specialty care delivered via TM.[60] Several studies subsequently demonstrated how using short message service (SMS),[61] internet-based systems[62] and providing patient education to patients using real-time TM[63] improve asthma outcomes, with comparable results to in-person visits.[32] TM may be also used to de-label previously considered penicillin-allergic patients, providing high satisfaction rates in patients,[59] by skin testing performed by a trained allergy/immunology physician assistant with subsequent TM video consultation performed by an allergist.[38] TM may be used to evaluate seasonal allergy symptoms, especially at the beginning of the spring pollination season, which may resemble the common cold and sometimes COVID-19. Children are at lower risk for COVID-19 and have a less severe course of the disease, but vulnerable patients with immunodeficiency, representing a potential at-risk group, are recommended to be consulted via TM.[64] Given the actual rates of vaccine hesitancy, TM is also used to address vaccination barriers by providing accurate information about vaccine efficacy, schedule and timing and safety profile.[65–67]

3.3 | Advantages of TM for healthcare professionals

An important use of TM is in triaging patients with a referral to the allergist to determine the need for in vivo and/or in vitro allergy tests, for pre-assessment of specialized treatments such as allergen immunotherapy or biologics, for pharmacotherapeutic education and follow-up to monitor treatment response and adverse effects.[68] It is possible also to pay less for front desk support and/or reduced office spaces. Thus, HCP who offer TM services may incur fewer overhead costs. Through TM, HCP can expand their catchment area regardless of geographic distance and save time and money which normally would be used for travels between workplaces. TM can lead to decreased HCPs burnout, improved compensation and flexibility in patient management.[21] By consulting patients remotely, HCPs are not at risk of exposure to airborne pathogens from these subjects. TM visits reduce the need for personal protective equipment (PPE) use.[69,70] The majority of specialists with qualifications in allergology perceive TM implementation as positive during a pandemic and can imagine integrating TM services into their daily clinical routine in the future.[71]

As TM is more and more accepted, it is necessary to incorporate a standardized telehealth curriculum in Allergy/Immunology fellowship training.[72]

3.4 | Disadvantages of TM for patients

When using TM, there are several disadvantages and potential concerns both for patients and HCPs. TM was not a convenient fit for all patients or circumstances. An increase in TM consultations was insufficient to fully replace the reduction in face-to-face consultations during the COVID-19 pandemic.[67] Moreover, there is concern that the use of certain technologies depersonalizes the patient–clinician relationship.[39] Another issue previously reported consists of overprescribed antibiotics in patients assessed by TM consultations for respiratory tract infections.[59,73]

TM requires technology and an adequate internet connection. Some disadvantages are related to the so-called 'digital divide' representing the disparate access to and utilization of technology and the Internet among communities and populations of diverse race/ethnicity and socioeconomic demographics due to social, language, financial and other barriers.[74]

TM is particularly beneficial in rural and underserved communities, but ensuring reliable access to ethnic minority groups in rural areas is necessary. Fortunately, broadband online access is still needed only in a few regions.[55]

Additionally, patients speaking less-represented languages or experiencing intersecting literacy barriers are underserved with TM. Existing TM platforms need language interpreter services, sometimes as a third party, in order to be optimized for diverse patient support.[75]

Being unable to have a physical examination completed is a major disadvantage of TM. Moreover, when a patient needs emergency care, accessing TM first may delay treatment, particularly as a doctor cannot provide lifesaving care. In addition, the fact that in vivo allergy procedures such as skin tests, immunotherapy injections and oral challenges cannot be done by TM, and the lack of in-person communication/inability to optimize physician/patient relationship represent other important disadvantages.[76]

Older age, greater limitations in physical capacity and cognitive/sensory impairments are other disadvantageous factors for TM, along with low socioeconomic status and the lack of technology access or comfort.[77]

Some researchers suggested that an aggravation of inequities may be an unintended consequence due to factors having roots in different forms of discrimination, such as racism, ageism and ableism, and their intersections.[78,79] According to the American Geriatrics Society, we all are able to identify communities where not only ageism but also ableism and other forms of discrimination impact different means of healthcare access.[63] Moreover, a recent observational cohort study during a COVID-19 pandemic peak in New York City, found that there are multiple groups that experience disparities in TM access and subsequent aspects of care. For instance, African Americans and those with a lower mean income and higher average household size were less likely to use TM to seek care. The multilevel nature of observed disparities indicates that complex interventions at different levels are needed.[64]

3.5 | Disadvantages of TM for allergic patients

Although general recommendations suggest the continuation of allergen immunotherapy and biological therapy, the discontinuation rate is significant in some countries.[9,80–83] Websites offering episodic on-demand care may disrupt the continuity of healthcare between the patient and the allergist and undermine care coordination. In-person consultations are a preferred option for severe allergic conditions. It is possible to proactively discuss modified management of anaphylaxis via TM,[66] but emergency department care is needed if a patient has had severe anaphylaxis episodes in the past.[84] Although TM evaluations rely on patient self-reports and comprehensive health history taken by the healthcare provider, limitations regarding the lack of physical evaluation are obvious[59] and of importance in many allergic diseases. Some specific cases where in-person appointment is irreplaceable include skin prick tests, blood tests, contact dermatitis epicutaneous tests and allergen challenges. Large-scale studies of patient outcomes comparing in-person versus TM visits are needed.[42] The management of asthma patients requires regular lung function testing, importantly spirometry. The diagnostic and prognostic value of these tests is well established, and they are recommended by all existing guidelines to diagnose and monitor asthma patients (adults and children). The initial diagnosis of asthma requires a face-to-face visit of the patient to the clinic to perform a bronchodilator test, FeNO measurement, methacholine challenge, etc. The subsequent monitoring can be done through TM, as long as the patient is instructed and uses regular ambulatory PEF measurement. In case of worsening, TM can help triage patients who need to come to the clinic for further functional evaluation.[81]

A home-monitoring mHealth system was used in asthmatic patients in research settings, consisting of a portable mini-spirometer, together with a fraction of exhaled nitric oxide (FeNO) home-measuring device with audiovisual control of correct performance, a wearable device to measure the respiratory rate (RR), a physical activity tracker, a smart inhaler adapter, an indoor air-quality monitor and a smartphone app, used along with asthma control and quality of life questionnaires and outdoor air quality online maps. The smart inhaler device recorded information on compliance with regular treatment and the need for reliever medications.[85,86]

A smartwatch/smartphone combination serving as a hub for personal/wearable sensing devices collecting data on health, such as mobile spirometry and asthma medications and personal exposures was also recently used within a biomedical evaluation platform.[87]

Moreover, a new speech-based spirometry has the potential to eliminate the need for an additional device to carry out lung function assessment outside clinical settings.[88]

3.6 | Disadvantages of TM for healthcare professionals

Those who offer TM services may also face some associated drawbacks. Choosing the optimal digital platform for TM can be challenging. Allergists must ensure that the TM platform used is secure and compliant with privacy laws. In some countries, other concerns regarding the quality of TM services are related to outdated technology systems, computer viruses or hardware failures, network crashes linked to power outages and online access/wireless issues such as limited high-speed broadband internet connectivity in some medical establishments, poor audio and/or video quality.[21,89]

Important disadvantages of TM for HCP are represented by liability issues and the need to be licensed in the state where the patient is located, and possibly to be credentialed in a local hospital. Significant disadvantages are the concerns about reimbursement, including the fact that the reimbursement may be not adequate in some jurisdictions or TM services are performed while patients are overseas, and the lack of in-person communication/inability to optimize physician/patient relationship.[76]

Some of the key medicolegal implications of TM include licensing and jurisdiction, failure to provide an appropriate standard of care, documentation and not adhering to privacy and security regulations. Patients who engage in TM while at work or multitasking, while driving, exercising or having concomitant childcare responsibilities may not be able to provide their full attention or accurate medical information. Therefore, clinicians should assess the patient's ability to engage in a meaningful medical discussion and provide informed consent.[90,91]

3.7 | TM impact on doctor–patient relationship

In the face-to-face HCP-patients relationship, communication is strategic and is based on the professional's situation awareness or rather on his or her degree of awareness of the communicative scenario. This competence is particularly relevant in the relationship mediated by technology, characterized by important nuances with respect to the face-to-face relationship. Table 3 details the main differences between face-to-face communication and online communication.[92]

4 | SUMMARY: UNMET NEEDS AND DIRECTIONS FOR FUTURE

4.1 | Unmet needs regarding TM implementation in Europe

Despite the gradual global implementation of TM for more than a decade, restrictive administrative regulations and the lack of solid legal frameworks slowed down the growth of this remote clinical service. In Europe, TM is considered both a health service (Directive 2011/24/EU) and an information service (Directive 95/46/EU, Directive 2000/31/EC, and Directive 2002/58/EC), but due to lack of pan-European uniform medical liability and medical legislative regulations, a Europe-wide TM framework is not realized. There is not sufficient governmental support for TM innovation and cooperation between European countries to implement TM models.[93] There is a great need for a standardized lexicon, methods and guidelines for TM in Europe. There are still many barriers for TM to become accessible to every European patient and to be fully covered by all social security systems. Many different legal and regulatory aspects regarding TM across Europe are associated with various other difficulties in defining a European standard of care for TM.[90,94]

4.2 | Unmet needs regarding data protection and privacy regulations for telemedicine

With the introduction of the EU General Data Protection Regulation (GDPR), effective data protection in TM became critical. There is a need for more preventing data protection failure mechanisms by better managing the risk of unauthorized access, establishing cyber-hygiene routines in practice, managing the risk of device theft, loss and sharing, building more trust with patients and reducing data protection concerns. Secure and legally compliant exchange of data in TM can be achieved if the legal basis for data protection is clear and known, the creation and structure of the data protection policy are achieved and the data protection concept is audited and regularly evaluated to ensure the security of patient data and to regulate data flows, data storage and data processing.[95,96]

4.3 | Unmet needs regarding TM methodology and efficacy

Large-scale studies of patient outcomes assessing TM versus in-person visits are needed. In addition, the methods by which TM visits can most effectively be integrated into a clinical practice must be clearly defined, along with guidelines developed for individual specialties. Moreover, there is still a need to convince payers and legislators that TM services should be reimbursed just like any other medical encounter and without excessive regulations. This is sometimes not easy, the long-term effects of TM on healthcare costs and patient outcomes are not currently precisely established.[15,42] Box 1 presents the barriers for TM development.

5 | CONCLUSIONS AND FUTURE DIRECTION IN TM

Specific TM guidelines, concrete legal and regulatory aspects, vendors who provide standardized and legally compliant systems as well as insurance and governance support are on the actual list of needs for proper and further TM development. Mobile technologies are increasingly used by more and more patients, and TM will evolve. The new generation of wireless telecommunication

TABLE 3 Main differences between face-to-face communication and online communication (adapted from Secci et al.[92]).

Communication	Face-to-face	On-line
Communication tools	Words, voice, gaze, facial expressions, gestures, interpersonal distance, posture, space and environmental characteristics	Words, voice and facial expressions
Emotionality communication pathway	The body and the voice contact and corporeality	The face and the voice dialogue and cognitive processing
Perceptual and cognitive processing channel	Visual, auditory, proprioceptive, somatosensory, olfactory	Visual, auditory
Speech shifts managed	Pauses, gaze, gestures and posture	Breaks
Importance of the ability to	Welcome	Respond
Relational responsibility	High	Low
Communicative	Flexibility	Pragmatism
Control by the patient	Low	High
Control by the professional	High	low
Intimacy of	The body	The word
Availability and accessibility	Challenging	Less demanding
Reciprocity	Direct: less difficulty in giving/receiving feedback	Mediated: greater difficulty in giving/receiving feedback
Evaluation focused on	Doctor–patient relationship	The result
Primary outcome	Effectiveness	Efficiency
Impact of the digital skills of the patient and the professional	Low	High

BOX 1 Barriers for TM development (adapted from Gioia G. et al.[101])

- Lack of funding mechanisms to develop TM.
- Lack of reimbursement procedures for TM services.
- Absence of TM services sustainability.
- Lack of specific legislation/regulation on reimbursement procedure/guidelines.
- Absence of a national strategy towards TM development.
- Lack of technical standards that ensure interoperability.
- Inability to evaluate and monitor the quality of TM services.
- Little government support to prioritize TM in health services delivery.
- Little demand/acceptance of healthcare providers towards TM services.
- Lack of defined ethical standards and regulations limitation in use (performing comprehensive physical examinations not always possible).

technologies also opens new possibilities as well as demands. 5G is technology characterized mainly by Gigabits per second, speed of enhanced mobile broadband, ultra-reliable low-latency communications and massive machine-type communications with a huge impact on TM. 5G is not a single technology, rather it is a combination of cutting-edge technologies, including big data, cloud computing and artificial intelligence.[97–100] Despite many arguments supporting TM as a healthcare tool, it still should not replace fully face-to-face models but, rather, continue to be used in parallel, depending on need.

AUTHOR CONTRIBUTIONS

SS and TC coordinated the project and contributed to specific parts. Sylwia Smolinska edited and compiled texts into the final article. Abstract: was written by: OJP, SS, TC, EI. Section 1: was written by: AA-P, ADG, CB, DAA, EA, EI, F-DP, FF, FH, JAF, KH-S, MB, IEG, NGP, OJP, OP, ÖK, SD, SS, TC. Section 2: was written by: EI, F-DP, IA, PG, SS, TC. Section 3: was written by: AA-P, DAA, EI, F-DP, FH, FF, HAB, IA, IEG, MJ, RG, RK, SS, TC. Section 4: was written by: F-DP, LK, MJ, PM, SS, TC. Table 1: was created by OJP, SS. Table 2: was created by EI, KH-S, SS. Table 3: was created by SS. Figure 1: was created by AG, SS. Figure 2: was created by AG, SS. Figure 3: was created by AG, SS. Figure 4: was created by AG. Box 1: was created by SS.

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CONFLICT OF INTEREST STATEMENT

All authors have read and approved the position paper. Any potential conflicts of interest indicated by the authors are listed here: Peter Gibson reports being a speaker and/or research grant recipient AstraZeneca, Chiesi, GSK, Novartis, Sanofi. Dr. Jutel reports personal fees from ALK-Abello, personal fees from Allergopharma, personal fees from Stallergenes, personal fees from Anergis, personal fees from Allergy Therapeutics, personal fees from Leti, personal fees from HAL, personal fees from GSK, personal fees from Novartis, personal fees from Teva, personal fees from Takeda, personal fees from Chiesi; outside the submitted work. Nikolaos G. Papadopoulos reports being a speaker and/or advisory board member for Abbott, Abbvie, ALK, Asit Biotech, AstraZeneca, Biomay, Boehringer Ingelheim, GSK, HAL, Faes Farma, Medscape, Menarini, MSD, Novartis, Nutricia, OM Pharma, Regeneron, Sanofi, Takeda, Viatris. Oliver Pfaar reports grants and/or personal fees from ALK-Abelló, Allergopharma, Stallergenes Greer, HAL Allergy Holding B.V./HAL Allergie GmbH, Bencard Allergie GmbH/Allergy Therapeutics, Lofarma, ASIT Biotech Tools S.A., Laboratorios LETI/LETI Pharma, GlaxoSmithKline, ROXALL Medizin, Novartis, Sanofi-Aventis und Sanofi-Genzyme, Med Update Europe GmbH, streamedup! GmbH, Pohl-Boskamp, Inmunotek S.L., John Wiley and Sons, AS, Paul-Martini-Stiftung (PMS), Regeneron Pharmaceuticals Inc., RG Aerztefortbildung, Institut für Disease Management, Springer GmbH, AstraZeneca, IQVIA Commercial, Ingress Health, Wort&Bild Verlag, Verlag ME, Procter&Gamble, ALTAMIRA, Meinhardt Congress GmbH, Deutsche Forschungsgemeinschaft, Thieme, Deutsche AllergieLiga e.V., AeDA, Alfried-Krupp Krankenhaus, Red Maple Trials Inc., Königlich Dänisches Generalkonsulat, Medizinische Hochschule Hannover, ECM Expro&Conference Management, Technische Universität Dresden, Lilly, Paul Ehrlich Institut (PEI), all outside the submitted work and within the last 36 months; and he is member of EAACI Excom, member of ext. board of directors DGAKI; coordinator, main or co-author of different position papers and guidelines in rhinology, allergology and allergen-immunotherapy. The remaining authors do not declare any potential and real conflicts of interest to this publication.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

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