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(REVIEW ARTICLE)

# The role of telemedicine in modern health care

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## Abstract

With the continuous improvement and development of modern network information technology and the continuous improvement of people's demands for health care, the traditional health care model has evolved, giving birth to a new telemedicine health care model. Telemedicine refers to the comprehensive application of information technology for medical information transmission and long-distance communication between different places. And this is not cost effective, and in this telemedicine process there is both benefits and disadvantages. Urban medical centres have used telemedicine to expand access to specialist services by centralizing health care providers to assist patients seen by their primary care providers. This paper provides a what is telemedicine, how telemedicine works, telemedicine in India, the future of telemedicine, present scenario of telemedicine, Origin and development of telemedicine, Telecommunication standards, applied areas, Designing Telemedicine Approaches to Succeed, Types, challenges, goals, advantages and disadvantages of telemedicine and concludes with some importance of Telemedicine.

**Keywords:** Telemedicine; Telehealth; Telecommunication; Technology

## 1. Introduction

Father of telemedicine Dr Jay sanders MD, president and CEO of the global telemedicine group. first step of telemedicine Boston logan airport to Massachusetts general hospital in 1967.The term telemedicine literally means “healing at a distance” through the Latin “Medicus” and Greek “tele.” (1) Although there is no single commonly accepted definition of telemedicine, the use of technology to deliver health care services and information at a distance in order to improve access, quality, and cost is a common theme found throughout professional descriptions of these services. According to the American Telemedicine Association, “telemedicine is the use of medical information exchange from one site to another via electronic communications to improve a patient’s clinical health status.” (2) This includes “the use of telecommunications and information technology to provide access to health assessment, diagnosis, interventions, consultation, supervision and therapy and education information across distance.” The medical information may include images, live video and audio, video and sound files, patient medical records, and output data from medical devices. The transfer may involve interactive video and audio communication between patients and medical professionals, or between those professionals without patient participation. Alternatively, it may simply describe the transmission of patient data either from monitoring devices (telemetry) or from medical histories (electronic patient records). Those taking part in the transfer may be located in a GP surgery, a hospital clinic or some other environment if the occasion is an emergency. (3) Telemedicine and related healthcare technologies aim to provide efficient healthcare to improve the well-being of patients and bring medical expertise at a lower cost to the right people at the right time. The health expenditures as a share of Gross Domestic Product (GDP) have been rising in the United States and other member countries in the Organization of Economic Cooperation and Development (OECD) since 1960s. A study, conducted to justify the reasons of this increase, concluded that Information technology (IT) is playing an important role to reduce increasing costs. Telemedicine enables patients to receive medical attention at the convenience of both

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doctor and him, and at the same time, he is safe. This may imply that a person does not need to take time off from work or arrange childcare.

There are both benefits and disadvantages to the care that is provided through telemedicine. The benefits of telemedicine include providing access to specialty care services in underserved areas, a more efficient use of medical resources, and a way to reach patients living outside a hospital's normal service area. However, implementation of telemedicine services requires a number of new protocols and safety measures designed to protect the privacy and confidentiality of patients, as well as to ensure physicians having and maintaining appropriate licensure across state borders, and to allow patients and caregivers to receive adequate training on how to use the technology. Furthermore, providing medical care to patients using telemedicine technologies brings about important medical, ethical, and legal issues that must be addressed. Examples of telemedicine range from teleconsultations to telesurgery which have made diagnostic medicine and specialized care available to patients located in remote areas. These telecommunication technologies are changing the traditional doctor-patient relationship. Telecommunication technologies have made cost-effective treatment options available by reducing traveling expenses for patients, decreasing hospital readmission rates, and maximizing the number of patient-consults a physician can make (Brown, Buettner, & Canyon, 2012). (4)The great majority of existing research and practitioners' literature on telemedicine adopts a clinical, technical, and economic approach. The World Health Organization (WHO) announced the new coronavirus disease (COVID-19) in January 2020, which was declared a pandemic on 20 March 2020. The Polish government introduced the epidemic on 20 March 2020. The coronavirus epidemic made it necessary to introduce solutions that would enable the patient to obtain medical services at a distance, thus reducing the risk of infection through contact with patients, e.g., in the waiting rooms of the clinic. To prevent infection, regulations such as physical distance, wearing a mask, and hand disinfection were introduced. It was also recommended that the rooms be well ventilated and to avoid crowds. (5)

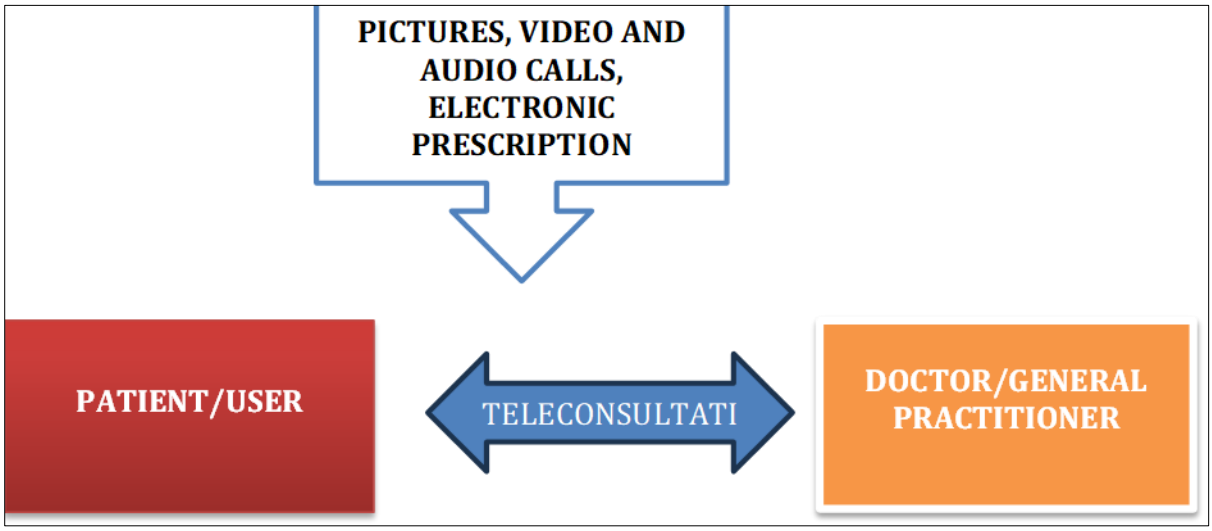


**Figure 1** Basic skeleton of telemedicine

## 2. How telemedicine works

Telemedicine is the use of telecommunication technologies and information sharing devices to deliver and support medical care when the patient and provider are separated by a distance. Distance can be understood in terms of geography, socioeconomic status as well as time constraints. (21) Telemedicine is also understood based on the information that is being transmitted such as radiographs or clinical data, as well as, how it is being transmitted. For example, what technologies and clinical applications are used? Now more than ever, there is a ubiquitous supply of digital bandwidth. With the ability to compress high resolution video conferencing and high-resolution images, the transmission of video, images and data over long distances has been made possible. The decreasing costs of hardware, software, and data transmission make setting up telemedicine equipment and networks more economical feasible, even for smaller medical clinics and offices.

Although video consultations have become the mainstay when one thinks of telemedicine, another important category of technology utilized is referred to as store and forward technologies. These include static images, data, and audio clips that are transmitted from remote locations to a database for later review by a medical provider. The advantage of the store and forward telemedicine is that both the provider and patient do not have to be available for consultation at the

same time. Dermatology, radiology, and pathology are examples of medical services that have utilized store and forward telemedicine technologies.

Services offered through telemedicine range from home care and psychiatry to radiology and neurology. Home care, or telehealth, programs that manage chronic diseases such as diabetes, chronic obstructive pulmonary disease, hypertension, etc. utilize devices that monitor and transmit patient symptoms and vital signs. Radiologists and pathologists, for example, utilize image transfers, while clinal specialists such as dermatologists can capture and remotely display their findings such as high-resolution images of skin conditions. Cardiologists can receive transmitted electrocardiograms (ECG) and psychiatrists can have interactive consultations with patients via video-teleconferencing. (22)

## 3. Telemedicine in India

Both, the public and private sectors have been involved in initiating several telemedicine programs in India. Interestingly, the initial telemedicine system in India was designed and pioneered by a private enterprise, Apollo hospitals, in collaboration with ISRO (Indian Space Research Organization) at a village called Aragonda in Andhra Pradesh. Consequently, with the support of the Department of Information Technology (DIT), ISRO, Department of Health and Family welfare, Ministry of External Affairs (MEA), National Informatics Centre (NIC) and respective state governments the network of telemedicine expanded across the country. The premier teaching institutes act as the central hubs, namely, AIIMS New Delhi, PGIMER Chandigarh and SGPGIMS Lucknow, TMH Mumbai, PBDSPGIMS Rohtak and CSMMU Lucknow. Several corporate medical institutions have also set up telemedicine centres to extend their services: Amrita Institute of Medical Sciences (Kochi), Narayana Hrudayalaya (Bangalore), AECS (Madurai), Apollo Hospitals (Hyderabad), Sankara Nethralaya (Chennai), and Sri Ramachandra Medical Centre (Chennai). Gradually, telemedicine network has extended across the country with more than 400 telemedicine platforms in India. ISRO's telemedicine program connects 245 hospitals- 205 district/ rural hospitals and 40 super-speciality hospitals. However, most of these initiatives remain confined to a 'pilot project' level and adoption of telemedicine into mainstream healthcare delivery system remains elusive (Mishra et al., 2012).(20)

## 4. The future of telemedicine

Moving telemedicine into the mainstream. Telemedicine will only move out of the pilot study phase and into the sustainable mainstream if it is seen to be cost effective. This means that it must demonstrably save money compared with equivalent, direct services or we must find new ways of quantifying elements such as expansion of access, quality of care, patient convenience etc.

Health policy and strategy. The benefits of telemedicine will be delayed and reduced unless governments see telemedicine as a strategic tool and consider how it should figure in their primary, secondary and tertiary healthcare delivery.

Telecare. Home telemedicine would appear to have a significant role to play given the ageing populations throughout the world. More work needs to be done on making equipment easy to use and unobtrusive, and the cultural aspects hold as many, if not more, problems as the technical ones.

The role of the Internet. The Internet offers almost endless possibilities for the delivery of information and education to both careers and patients and for the empowerment of the latter group. The technology will go some way to redressing the all too unequal balance between physician and patient, and, if used properly, can help patients to be more closely involved in managing their own care.

Enhancing healthcare in underdeveloped countries. Developed countries, commercial companies and non-profit organizations can make a real contribution by assisting underdeveloped countries to establish and improve basic healthcare. (3)

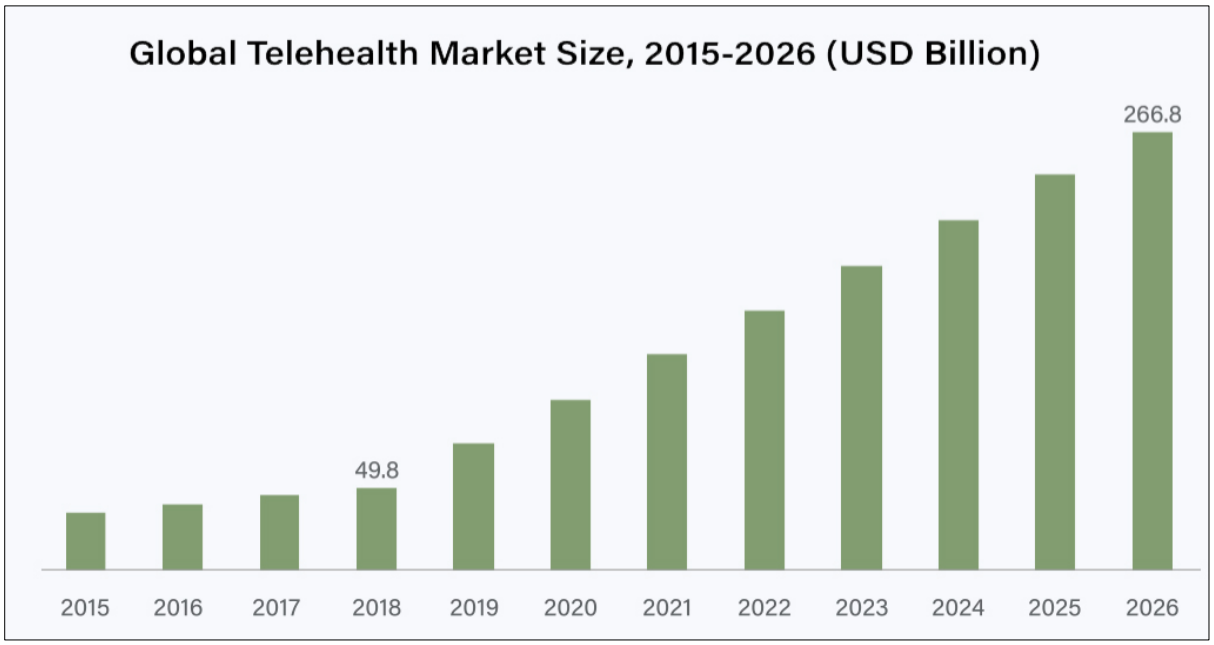


**Figure 2** Global Telehealth Market Size,2015-2026(USD Billion)

## 5. Present scenario of telemedicine

In current scenario of COVID-19 pandemic, telemedicine is emerging as a key technology for efficient communication and sustainable solution to provide essential health care services. Chronic pain management requires frequent visits to the physician for both non-pharmacological and pharmacological advice and adjustment of treatment. Due to lockdown, travel restrictions, social and physical distancing requirements or fear that health care facilities may be infected; patients may avoid visiting health care facilities in person. Telemedicine can help patient consult to physician.

In line with many guidelines, recommendation and best practices for management of CPPs during COVID-19, telemedicine should be considered for CPPs, wherever possible. Telemedicine can decrease the risk of exposure of the HCWs to SARS COV2 and can ease the overtly burdened health care system.

## 6. Origins and Developments of Telemedicine: From Beginnings to Modern Times

We can identify four phases of telemedicine development which shown in Table 1

**Table 1** Main phases of telemedicine development

| Development phase | Approximate time scale |
|---|---|
| Telegraphy and technology | 1840s-1920s |
| Radio | 1920s onwards [main technology untill1950s] |
| Television space technologies | 1950s onwards [main technology untill180s |
| Digital technologies | 1990 onwards |

## 7. Technological and Non-Technological Drivers

We can identify three main drivers under this heading:

- Computing and information technology
- Network and telecommunications infrastructure

- Technology-led society

Non-technological drivers can be just as important as those that harness technology. We can distinguish seven key factors that have helped, and are helping, the development of telemedicine (6):

- Extension of access to healthcare service
- Healthcare provision for travellers
- Military applications
- Home telecare;
- Cost reduction;
- Market development;
- 7.Health policy and strategy.
- Telecommunications Standards:

Clearly, for telemedicine to work, the units at both ends of the teleconferencing link must use the same codec algorithms and other transmission protocols. To ensure compatibility the United Nations International Telecommunications Union (ITU) has defined a range of standards to guarantee interoperability even if the videoconferencing equipment originates from different manufacturers. The most important standards are summarized in Table 2 .(7)

**Table 2** Important ITU videoconferencing standards

| Standard | Purpose |
|---|---|
| H.320 | The oldest (1993) videoconferencing standards for communication over ISDN |
| H.323 | An updated for videoconferencing over local area networks (LANs) and the internet |
| H.324 | A protocol for videoconferencing over the standard telephone network H.324 can also be used over ISDN so it may eventually supersede H.320 |
| H.261 | The code defined in H.320(for CIF images) |
| H.263 | The code defined in H.320(for QCIF images) |
| T.120 | A suite of protocols to allow concurrent users to use whiteboards and annotation etc |

## 8. Applied areas

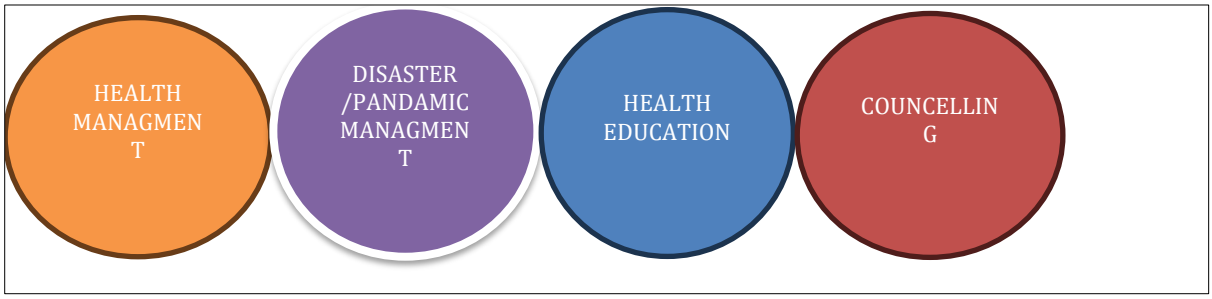


**Figure 3** Telemedicine applications in different areas

## 9. Technologies In Use Today

### 9.1. Telehealth For Congestive Heart Failure

For patients There are many examples of applications that illustrate connected health's potential for improving access, quality, and efficiency in health care. The following examples highlight a variety of technologies that are in use today.

with congestive heart failure (CHF), a number of studies have addressed the impact of home telemonitoring on health outcomes, with a decrease in both hospital readmissions and mortality having been reported.(8) In a program at Partners HealthCare, for example, more than 3,000 CHF patients received care using in-home monitoring of weight, blood pressure, heart rate, and pulse oximetry. These data were uploaded daily, and decision support software identified those patients who needed attention. With this approach, hospital readmissions dropped by 44 percent as compared to usual care, with three to four nurses caring for a daily panel of 250patients. The program generated cost savings of more than $10 million over a six-year period. (9) Considering that those same nurses, in a certified home care agency, would be caring for only four to six patients daily, the benefit of telemonitoring to extend the reach of providers to larger populations of patients becomes evident.

### 9.2. Home Health Program for Veterans

On a larger scale, over a four-year period the Veterans Health Administration (VHA) introduced a national home telehealth program called Care Coordination/Home Telehealth that integrated home telemonitoring and health informatics with disease management technologies. Data gathered from 17,025 participating patients having one or more of six chronic illnesses (ranging from diabetes to depression) demonstrated high patient satisfaction levels with the program, plus a 25 percent reduction in numbers of bed days of care and a 19 percent reduction in the number of hospital admissions as compared to usual care. (10)

The impact of the VHA's telehealth strategy has grown substantially. In 2012 the agency's national home telehealth program, designed to provide care for veterans via remote monitoring and videoconferencing, reached 119,535 veterans and generated annual savings of $1,999 per patient. The program also facilitated the independent living of 36 percent of these patients, who would have otherwise qualified for long-term residential care. Additionally, hospital admissions decreased by 38 percent compared to the previous year, inpatient bed days of care decreased by 58 percent, and patient satisfaction scores remained at a strong 85 percent.(11) The VHA example illustrates that as the prevalence of chronic disease grows in the United States, telemedicine can be an extremely promising solution for managing and reducing these illnesses.

### 9.3. Access To Specialty Physicians

Equally compelling is the idea that telehealth can be used as a tool to extend access to specialized knowledge across geographic boundaries. Two places where this vision is being realized are in the fields of diagnostic radiology and laboratory medicine. Innovations in digital imaging, the establishment of international global standards for the interoperability of health information technologies (Health Level Seven International, or HL7), and the Internet now allow specialty physicians to provide services in both a time and place-independent manner. For example, radiologic images are now routinely read by specialists at great distances from where they are taken, and reports are sent back to the primary care providers in a timely manner. Retinal images can be read remotely by ophthalmologists consulting with referring physicians on diabetic retinopathy. Given the success of these applications, the range of innovative uses of telemedicine for remote consultation will expand rapidly over the coming years. Many specialty physicians who are only comfortable with diagnosing conditions based on directly observing the patient have been slow to adopt telehealth technologies. Exceptions to this include dermatologists, who have become comfortable with two-dimensional imaging for performing diagnoses. Dermatologists have adopted tele-dermatology more rapidly than other specialty physicians have adopted diagnostic technologies.

Using dermatology as an example, specialist access can be enabled via two types of telehealth strategies. One strategy relies on the use of interactive videoconferencing, which has now become ubiquitous, is low in cost, and provides benefits to patients, especially when they live far from their physician or provider. Numerous studies have shown the quality of care resulting from interactive videoconferencing to be very high—streamlining care, reducing waste, and leading to faster problem resolution. (12)

The second strategy to provide remote specialty care is called "store and forward." For example, in this approach, a referring physician uploads images of skin lesions to a secure storage site along with the relevant patient history; a consulting dermatologist then accesses this information and responds. This strategy takes advantage of digital imaging, asynchronous communication, and robust communication networks. With the expansion of high-resolution cameras on smartphones and high-bandwidth mobile networks, all this can now also be accomplished using mHealth devices. (13)

As the "store and forward" approach is more widely adopted, it has the potential to create real gains in efficiency. Dermatologists at Kaiser Permanente in San Diego, California, treat approximately 800 such cases per month using this method, handling 50 percent more cases than they could through face-to-face visits (Jeffrey Benabio, Kaiser Permanente, personal communication, August 12, 2013). The most recent innovation in tele-dermatology is a novel

online service in which patients take mobile phone pictures of their lesions and send them to their dermatologist, who, in turn, sends them a diagnosis; therapeutic recommendation; and, if appropriate, a prescription for treatment. (14) Although these services are increasing in number, they need to be evaluated for their potential to provide convenient and efficient care for specialty services.

### 9.4. Remote Intensive Care

Intensive care units (ICUs) are a key component of hospital care, treating the most fragile and complex patients in the health care system. While many hospital inpatient units are being downsized with the shift to outpatient care, ICUs are expanding to the point that they now provide care for six million patients per year, at an annual cost of $107 billion. This number has remained constant over time, with the United States spending approximately 1 percent of GDP on ICU care annually. Meanwhile, as the population ages, the number and severity of critical care patients is growing just as the supply of critical care physicians is decreasing.

Several studies conducted by NEHI (Network for Excellence in Health Innovation) and the University of Massachusetts Memorial Medical center have shown that ICU care provided remotely by physicians trained as intensivists can decrease mortality by more than 20 percent, decrease ICU lengths-of-stay by up to 30 percent, and reduce the costs of care.(15) Additionally, the supply of intensivists is not adequate to meet the needs of the ICUs across the country, leaving critical care at many small community and rural hospitals to be provided primarily by community physicians and ICU nurses.

Tele-ICU technologies can leverage intensivist coverage over more ICU beds and increase productivity by providing direct consultation and management of ICU patients at a distant site through remote two-way audio, visual, and physiologic monitoring. Central tele-ICU units are typically staffed with one or more intensivists, critical care nurses, and other specialists, who observe patients in distant hospital units; provide proactive care by anticipating crises before they happen through sophisticated computerized physiologic, laboratory, and medication monitoring; and provide direct consultation to on-site nurses and physicians.

Approximately 13 percent of ICU beds in the United States are currently supported by tele-ICU technologies. (14) Given the positive system and financial improvements resulting from this remote monitoring, the expansion of effective implementation of tele-ICU care will substantially benefit patients and providers across the country.

### 9.5. Helping Patients Adhere to Medication Regimes

Patient medication adherence is another example of a pervasive problem that can benefit from telehealth support. Although millions of Americans suffer from chronic illnesses that could be effectively managed with prescription drugs, on average, patients take their medications as prescribed only about half the time.30 Yet compelling data show that patients who adhere to treatment regimens for chronic illnesses have fewer clinical problems and are less costly to care for over time compared with nonadherent patients. (16)

There are a number of technologies that help patients better adhere to their medication regimens, although these technologies have different mechanisms of action. For example, smartphone applications remind patients to take their pills and can help order refills. Internet connected pill caps alert patients (through music, ringtones, and flashing lights) to take their medications and often have the ability to send e-mail to remote caregivers, create adherence reports, and refill prescriptions. As another example, pharmaceutical packages designed to improve patient adherence have dated calendars printed on medication cards (or “blisters”) that help patients take their drugs as prescribed. In the future, technology-enabled medication reminders may be built into automatic pill dispensers, watches, and alarm clocks and potentially encapsulated in sensor-enhanced pills that can track when the patient swallows the medication.

The center for Connected Health, a division of Partners Healthcare, conducted a randomized clinical trial using a wireless electronic pill bottle to remind patients with high blood pressure to take their medication. Initial findings demonstrated a 68 percent higher rate of medication adherence in patients using the Internet connected medication packaging and feedback services compared to controls.

Although these technologies are relatively new, initial evaluations suggest that connected health technologies can prove useful in the context of well-managed medication care, increasing patient self-management, improving outcomes, and lowering costs.

### 9.6. Reducing Referral Wait Times

Referral is a service model for referrals and consultations through which primary care providers can exchange privacy-protected, templated e-mail messages with specialists. The program was developed at San Francisco General Hospital in 2005, when wait times for specialty appointments ranged from seven to eleven months. The program now covers more than forty specialties and services. Similar programs have since been established at the Los Angeles County Department of Health Services, the Mayo Clinic, and at UCSF and UCLA. In each implementation, use of this telemedicine technology has produced shorter wait times, reduced the number of in-person specialty visits by 20 percent or more, improved preparation of patients for specialty visits when required, and strengthened primary care provider-specialist collaboration and satisfaction. Because the rate of outpatient specialist referrals has almost doubled in the United States over the past decade, this application may become an important means of leveraging specialist capacity.

## 10. Designing Telemedicine Approaches to Succeed

Each of the above examples shows how telemedicine tools can allow providers to extend care to a wider population of patients, improve the quality of care, reduce costs, and increase patient and provider satisfaction. For telemedicine to reach its full potential, three criteria must be met. First, enough evidence must be compiled to assure that the new model does not sacrifice quality or cause harm to patients. To date, good progress has been made, and, as many of the articles in this issue of Health Affairs demonstrate, there are enough studies of the net benefits of telehealth to patients, providers, and payers for the connected health model to meet this criterion. Second, early progress is being made in aligning providers' financial incentives so that they produce desired outcomes. For example, health reforms such as the expansion of ACOs are realigning financial incentives to encourage the use of telehealth to leverage the skills of providers across a broader population of patients. In addition, CMS recently published for comment a proposal that would allow physicians to be paid for non-face-to-face encounters in the management of chronically ill Medicare patients, following similar legislation regarding Medicaid reimbursement for remote monitoring in eighteen states. (17)

Finally, more health policy research that evaluates the quality and cost impacts of connected health is essential. To demonstrate its value, providers will need to devote more dedicated leadership, expertise, and time to the implementation of connected health innovations. This includes changing the provider culture and workflow systems in order to allow the full incorporation of telemedicine into traditional care. Because clinicians have historically resisted changes in how care is delivered, physician and nurse champions will need to take the lead in ensuring that providers embrace these emerging models of care management.

## 11. Types of telemedicine

The scope and categorization of telemedicine (and telecare) practice have changed as the technology has developed. Currently, we can identify four different types as follows:

- Interactive Telemedicine services
- Speciality and primary care consultation
- Store-and-forward telemedicine
- Remote monitoring
- Image monitoring

### 11.1. Interactive telemedicine services:

Interactive services can provide immediate advice to patients who require medical attention. There are several different mediums utilized for this purpose, including phone, online, and home visits. A medical history and consultation about presenting symptoms can be undertaken, followed by an assessment similar to that which is usually conducted during face-to-face appointments.

These are following types;

*11.1.1. Teleneuropsychology:*

Teleneuropsychology is an example of this type of telemedicine that includes neuropsychological consultation and assessment over the phone with patients who have or are suspected to have a cognitive disorder. Standard evaluation techniques are implemented to assess the patient via video technology. A study from 2014 found that this form of telemedicine provides a feasible and reliable alternative to traditional in-person consultations, although it was noted that quality standards and administration must be upheld.

*11.1.2. Telenursing*

Telenursing refers to the utilization of communicative technologies to provide remote nursing services. Consultations can be made over the phone to reach a diagnosis and monitor health conditions and symptoms.

This form of telemedicine is growing in favor due to the low cost and high accessibility of the services to patients, particularly for those in rural regions. It also has the potential to lessen the burden of patients in hospitals because it is possible to address minor ailments earlier and patients can receive advice about whether hospital admission is required.

*11.1.3. Telepharmacy*

Telepharmacy provides pharmaceutical advice to patients when direct contact with a pharmacist is not possible. This allows medications to be monitored and patients can be offered advice over the phone.

Depending on regulations, refill authorization may be given to allow patients to receive regular medications when required.

*11.1.4. Telerehabilitation:*

Telerehabilitation utilizes technology to communicate and perform clinical assessment and therapy for rehabilitation patients. This usually has a strong visual element with video conferences and webcams commonly used to assist in communicating symptoms and clinical progress.

### 11.2. Specialist and primary care consultation

Primary care providers can access a virtual medical consultation to provide specialty care for their patients using an e-consult or online medical consultation. This is an asynchronous, physician-to-physician communication about a patient's chief complaint or current condition that leverages the expertise of a virtual specialist. Electronic consultations, or e Consults, are requested by a PCP seeking a specialist's expert opinion about the appropriate diagnosis or treatment for a patient.

### 11.3. Store-and-forward telemedicine

Store-and-forward telemedicine surpasses the need for the medical practitioner to meet in person with a patient. Instead, patient information such as medical images or biosignals can be sent to the specialist as needed when it has been acquired from the patient. This practice is common in the medical fields of dermatology, radiology, and pathology.

With proper structure and care, store-and-forward telemedicine can save time and allow medical practitioners to serve the public with their services more fully. However, this form of telemedicine relies on a history report and documented information or images, rather than a physical examination, which has the potential to cause complications such as misdiagnosis.

Remote monitoring

Also known as self-monitoring or self-testing, remote monitoring uses a range of technological devices to monitor the health and clinical signs of a patient remotely. This is extensively used in the management of chronic diseases such as cardiovascular disease, diabetes mellitus, and asthma.

Some of the benefits associated with remote monitoring include cost-effectiveness, more frequent monitoring, and greater patient satisfaction. There is some risk that tests conducted by the patients themselves may be inaccurate; however, the outcomes are generally thought to be similar to professional-patient tests.

### 11.4. Image monitoring

Tele-imaging is an important part of telemedicine: it includes the transmission of medical digital images and plays a role in all fields of telemedicine, such as expertise, consultation, teaching and research. Tele-imaging has been made possible through the digitalization of medical imaging. There are two possibilities: either digitalization of conventional radiological film or direct acquisition of digital images. The transmission of medical imaging requires a high data rate so as to obtain a good quality transmission of the initial images in a reasonable delay. In order to deal with the great amount of information to be stocked and transmitted, a compression of the data, without loss of information, is usually necessary. Interactivity is very important in all these types of transmissions. These tele-transmission techniques are

already used worldwide, especially in Japan and in the United States, to help in therapeutic or diagnostic decisions. In France, we have been performing real time interactive tele-imaging sessions between radiology and endocrinology departments of Hotel Dieu in Montréal and Hospital Cochin in Paris. This experimental device includes a visual-conference link between the medical teams and a real time link between two CT scanners. The CT scanner slices appear simultaneously both CT scanner screens; it is even possible to guide a CT scanner examination using remote control from the other hospital. We have successfully repeated the experiment between Cochin and a private hospital in Paris. In the case of the "Prison de la Santé", we have been using telemedicine in order to reduce problematic transfers of prison inmates. Moreover, access to doctors in the prison is sometimes difficult. The system ensures the daily transmission of X-rays, which are immediately read by radiologists at Cochin. In the past, 50 to 70 X-rays had to be read during one weekly visit. Medical tele-imaging raises certain legal, ethical and economic issues, such as problems concerning confidentiality, the right to compensation, patient information. It would be interesting in this context to open a discussion on the possible dangers of telemedicine, its value for the patients and the physicians, its role in emergency care, and the possibility of creating imaging data storage that may help radiologists in making diagnoses, especially for unusual images. Drawbacks not to be ignored: Poor digital images could lead to difficulties in their reading and interpretation. There is still a debate as to whether tele-diagnosis is reliable or not. Further evaluations must be made to ascertain the effectiveness of these techniques. A certain dehumanization of medicine due to an increase in the distance between the physician and patient is another difficult issue. The great number of people involved in the process of tele-imaging could confuse the issue of determining individual responsibility. Such consultations of experts may reduce the freedom of patients to choose their doctor. Tele-consultation must not be performed without the patient's consent. If consent was not obtained before tele-transmission, the patient should be informed after the procedure; and the use of tele-consultation should be mentioned in the report. The utilization of public networks could lead to the manipulation of data as well as undermine confidentiality. These pitfalls must be avoided. Lastly, the financial ramifications of these new technologies must not be overlooked.

## 12. Challenges

High cost of telemedicine systems and solutions, especially for rural areas. Low budgets are affecting all the projects of developing countries, also outside the strict health care sector. Maintenance costs for keeping the system alive after the original experimentation and enthusiasm, are even higher in developing countries if compared to the similar costs in developed countries. In order to achieve a good final result, some initial funds could be devoted to continuing the use of the system. Such considerations are confirmed by our taxonomy and by the survey based on it.

Resistance to change and slow clinical acceptance of telemedicine. A not project has to face when entering the application domain. This is particularly negligible effort should be devoted to overtake the entrance barriers every new evident – and must be properly managed – in the health care sector. General practitioners as well as specialized physicians are used to maintaining their traditional investigation and diagnostic methods, rather that experimenting with new ones even if supported by the most recent technological discoveries.

Unavailability of the required ICT infrastructure for telemedicine (e.g., Internet connection, bandwidth for highspeed telecommunications, etc.). In most rural areas the required ICT infrastructure can be below minimal acceptable levels, thus impairing any type of connection with remote centres and facilities. Lack of ICT infrastructure is one of the most evident causes of failure in telemedicine systems.

Lack of standards. Adoption of standards helps a lot in enabling easy communication between different health care centers. Standards relate to data exchange security, safety, and privacy, too. The adoption of a common standard removes many barriers in developing mid-to-big size projects. Such aspects have been highlighted in the classification proposed for design issues: opensource code, interoperable tools, and flexibility are all oriented and would benefit of common standards for message exchange, electronic medical record structure, and so on.

Regulatory bodies. Telemedicine services across the country and between different countries must be suitably regulated by regulatory bodies. This also may help in the adoption of a common standard or of a common care protocol. Both reusability and technology acceptance, discussed in Section 4, are related to such aspect.

Accreditation of telemedicine service providers. Many telemedicine service providers are starting to enter the market. The need of evaluate, validate, and certify the services is arising. To the best of our knowledge, no organization is currently taking care of such accreditation procedures.

Licensed health care professionals. In order to avoid malpractice in telemedicine, which can be as common as malpractice in traditional medicine, professionals should be specifically trained for telemedicine, as they do for traditional medicine.

Business models. At present, no well identified business model has been defined yet to ensure the sustainability of telemedicine. From a pure economic and business management point of view, such models are relevant also in order to estimate costs, revenues, and return of investments.

Reimbursement. Such a discrimination occurs very seldom in developing countries, where generally no health care insurance exists: however, such an aspect must be considered when developing telemedicine systems and services. Would a patient be taken care of by using a telemedicine system, insurance claims may not cover such circumstances as the delivered healthcare service does not follow traditional techniques. That is, a limited or even null reimbursement is provided to insured people if they resort to telemedicine services. These last four aspects all relate to the complex issue of "Technology acceptance" we introduced and discussed in the classification proposed for design issues. (18)

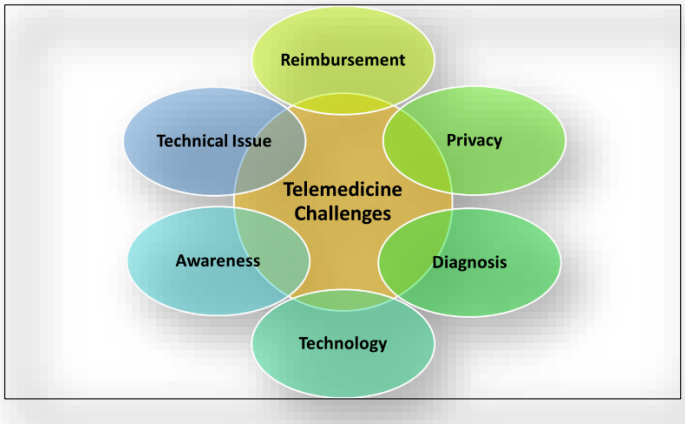


**Figure 4** Challenges of telemedicine

## 13. Goals of telemedicine

There are four main goals for using telemedicine to collect, transmit, analyze, discuss, and automatically respond to medical data. These reasons all relate to promoting greater effectiveness in the interaction between the patient and the health care provider team. Telemedicine can facilitate the achievement of individualized treatment goals by

Training patients to manage their own disease;

Introducing population-based tools for health care, such as individually tailored education modules and registries;

Providing access to electronic decision support tools with oversight from physicians; and Delivering timely information and directions based on individual data and population data. (19)

## 14. Advantages and disadvantages

**Table 3** Advantages and Disadvantages of Telemedicine

| Advantages | Disadvantages |
|---|---|
| Easy access to remote areas | Technological glitches when using devices |
| Using Telemedicine can significantly reduce the time and cost of patients | Inability to physically examine people |

| | |
|---|---|
| Monitoring home care and ambulatory monitoring | Lack of access to the necessary infrastructure, such as high-speed internet |
| Improve communications between health providers separated by distance | Diagnosis hindrance due to the poor -quality camera, images, or lighting |
| Continuing medical education and clinical research | Medicare only covers people in some rural regions |
| A tool for public awareness | Individuals should meet with practitioners licenced in the state where they are in at the time of the visit |
| Reduces spread of illness and convenient to the patient and doctors | Challenges ensuring electronic health records remain protected |

## 15. Conclusion

It is concluded with that from the above study Telemedicine has the potential to reduce the health care costs for both patients and doctors or hospitals. Telemedicine can improve access, quality, quantity, and continuity of medical care for patients as well as reduce health care costs. Telemedicine also provides a solution to help reduce the physician shortages in rural areas and the overuse of emergency room visits. Preventative medicine is a key to the future success of the U.S. healthcare system. Telemedicine has the potential to significantly benefit preventative medicine efforts, which will ultimately reduce costs and improve population health. Telemedicine is appreciated by patients but also has some limitations. The COVID-19 pandemic is creating a challenge for doctors, patients, and pharmacists. Telemedicine has the chance to transform from implementations to a routine healthcare system structure. However, some patients still need face-to-face contact with the doctor or pharmacist. Pharmacists are essential contributors to public health and played a key role during the COVID-19 pandemic. Integration of pharmaceutical care with public health care and a strong increase in the professional group of pharmacists may have optimized patient care and impact the budget. Telemedicine puts the specialist where the specialist is needed, when the specialist is needed. It brings the medical educator and primary health care provider together at the electronic examining table, and it enlivens continuing medical education with beside teaching.

## Compliance with ethical standards

### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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