Review Article

Different applications of telemedicine - assessing the challenges, barriers, and opportunities- a narrative review

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Abstract

Telemedicine (TLM) is a technique of telecommunication used to create, promote, or accelerate health services. Because of its societal significance, the current study attempted to demonstrate its essential applications in the health sector and the challenges, obstacles, and opportunities that lie ahead. Various studies and reports were received based on the subject of the current study, first using MeSH terms related to the subject in authentic and available international databases. After that, 30-related articles were selected based on the study criteria, and then the required results were extracted from the selected studies. The study results showed that TLM has a significant role in more than 13 major areas of health and treatment, and in most of these areas, it has made the relevant affairs easier for both patients and medical staff. Although TLM has many advantages, it still has obstacles and challenges requiring further studies to manage this technology better. Given the high importance of the TLM in the health sector in most countries worldwide, efforts are needed to promote this technology and remove the obstacles in front of it. Therefore, further evaluations of TLM efficiency in terms of economics, speed of action, effectiveness, and the provision of infrastructure are necessary to overcome the obstacles highlighted based on the results of these studies and improve the efficiency of using this technology.

Keywords: Barriers, challenges, health care, medical, telecare, telecommunications, telemedicine

Introduction

The term "telemedicine" first entered the medical glossary in 1920. National Aeronautics and Space Administration (NASA) was the first agency to provide medical advice to astronauts and their treatment remotely using satellites to establish communication between astronauts and physicians on the planet. Thus, this technology entered the field of medicine.[1,2]

Telemedicine (TLM) is the generic term for telecommunication technology to establish, promote, or accelerate health services. The general meaning of this term is the use of communication and

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information technology in medicine to provide TLM services without the need for routine communication (doctor–patient encounter). This service requires the transmission of text, images, audio, video, or converted electronic signals. Over the past 20 years, this technology has become more important and is used in various fields, including education, health monitoring, and even distance surgery. The term telemedicine is used to describe various aspects of telemedicine. The main purpose of TLM is to provide counseling, the transmission of information by electronic signals, the mechanization of clinical services, and electronic medical equipment.[3,4]

TLM refers to the application of telecommunications technology to provide and transmit medical services and knowledge. It can simply be a telephone conversation between two physicians about a patient or the complexity of using satellite technology for other purposes.[5,6]

One type of this technology is sending digital images (radiographs, computed tomography [CT] scans, magnetic resonance imaging [MRIs], and pathology slides or skin diseases) to reduce transmission costs and avoid wasting doctor-patient time.[7]

TLM employs a wide range of multimedia tools and modern technologies, including (live video, live sound, medical data and images, communication systems, texts, photos, and vital parameters) to provide temporal and spatial independence in the field of medical services.[8,9] The adoption of TLM's various uses in multiple health sectors is of special relevance, given the extensive usage of TLM in the public health sector. The main purpose of this study, which is a narrative review, is to express the different dimensions of the use of TLM in today's society to prevent or treat various diseases.

Materials and Methods

To review and extract the required results from published articles and reports related to the subject under study, systematically search through worldwide available databases such as Web of Science, Science Direct, Scopus, PubMed, and Google Scholar within the one time period, December 2000 to July 7, 2021. Narrative review using the Mesh terms "Telemedicine," "Telecommunications," "Definition," "Health care," "Opportunities," "Barriers," "Clinical," "Technical," "Challenges," "Medical," "Telecare," "Implementation," "Developing countries," "Information technology," "Stroke," "Surgery," "Mobile e-health," "Successful telemedicine," "Patient satisfaction," "Cancer care," "Operation," "Effectiveness," "Internet," "Internet of Things Services," "Emergency Medical Services," "Chronic Diseases," "Training program," "Healthcare Sector," "Online education," "Health information," "Learning" was performed. The same MeSH words were similarly used in other databases. The references of the studies obtained were checked (reference checking) to exclude the chance of missing research. Citation tracing was also reviewed. Moreover, unofficial reports, articles documented in the form of letters to the editor, and unpublished papers and information from websites were also deleted from the list of items that could be downloaded. Finally, for this review, the outcomes of 30 published publications were reviewed.

Results

History of telemedicine (TLM)

Historically, the NASA agency regulated the astronauts' health in various situations using TLM technology in the 1920s, which was regarded as the beginning of such a change in TLM. Cecil Whitson established the first practical TLM program in 1959. This program aimed to give mental health treatment as well as medical education. The idea of TLM was proposed to guide the "group therapy" program for the mentally ill, and in 1960 telemedicine was used by the military.[8,10]

The term telemedicine was coined by Thomas Bird in 1970 and referred to healing at a distance. It is derived from the Latin word "Medicus," meaning cure, and the Greek word "tele," meaning far away, which implies the use of information and communication technologies to improve patient outcomes by increasing access to medical care and health information.[11] In 1978, a satellite network was established in rural Queensland, Australia, to offer medical coverage. Medical consultants used telephone, radio, or helicopter medical services to reach patients before creating this network. The project's major objective was to improve access to medical treatment in remote locations. On September 7, 2001, it was also performed for the first time using robotic surgery. A surgical team from New York operated on a 68-year-old woman with a gallbladder illness at CIVIL in eastern France with the help of a robot. The surgical team and the patient were distanced by roughly 8,000 km, which New York physicians were able to successfully perform with the help of a high-speed fiber-optic line and a robotic surgical system.

TLM's most important applications

Teleconsultation

One of the applications of TLM is remote health counseling. Currently, the main application of this technology is medical, psychiatric, and psychological consultations, which are easily done in other parts of the world. A remote consultation is usually held between two or more physicians, a psychiatrist and a psychologist, or between the patient and the treating physician. Remote consulting allows you to use any communication method you choose, including the phone, fax, email, Internet chats, and message page. It should be noted that remote consulting can lead to obtaining both valuable and inaccurate information and fraudulent physicians and websites with no medical qualifications.[12]

Remote psychotherapy

Remote psychotherapy is another application of the TLM. Patients with mental illnesses often refuse to visit a doctor or, in many cases, refuse to talk to a doctor about their private lives despite seeing a doctor, which can lead to serious disorders. Remote psychotherapy is another application of the TLM. Patients with mental disorders often refuse to see a doctor. In

many cases, despite seeing a doctor, they refuse to talk to their doctor about their life issues, leading to serious disorders. The use of remote psychotherapy is an effective solution in this regard. Because a person can be confident of remaining anonymous and providing all the information needed to treat their illness to a psychiatrist or psychologist, it is possible to treat mental illnesses and disorders through remote psychotherapy.[13]

Remote imaging

Remote imaging is an important application of TLM for the diagnosis or treatment of patients. Digital telecommunications and computer technology progressions have had a significant impact on radiology. For example, you may manually modify an image on a computer or use digital processing algorithms to extract special and important parts of an image. With different imaging methods, you can increase the detection power and finally save time and money. Imaging technologies play a major role in diagnosis, treatment, and recovery. Ultrasound scanners, small cameras used in joint surgery and diagnostic equipment, radiology and pathological examinations, and brain scans are just some of the leading imaging technologies used by medicine. They can be done remotely.[14]

Telepathology

TLM can also be used to diagnose damage in a variety of patients remotely. The study of changes in cells and tissues that occur during disease is known as pathology. The process of identifying damage in a patient far is known as remote pathology. The pathologist performs the same thing by looking at the tissues on the screen as if he were directly looking at the tissues under a microscope and seeing the sample. A video camera is installed on a microscope, or a digital video microscope is used to send a slide image to the desired centers in remote pathology.[15]

Remote skin treatment (Teledermatology)

TLM can be used to help individuals with skin diseases. The medical history, examination, and biopsy are used to diagnose skin disorders. Color images with high resolution should be prepared from the site of the complication in telemedicine for the treatment of skin disorders. The biopsy can be sent to a specialist center by post. Moreover, real-time contact between specialists and patients is not required in these diseases.[16]

Remote home medical care

Due to the growth of the elderly population and the shortage of specialist physicians, home care through TLM has great growth potential. This type of treatment is required for the majority of patients with cardiovascular disease and chronic respiratory diseases. In addition, when a patient is admitted to the hospital following surgery or for any other reason, the hospital loses a valuable bed. Moreover, some patients do not feel well after being hospitalized and feel more relaxed at home. In this method, some required devices such as vital signs recorders, video communication devices with the patient are installed in the patient's home, and changes in heart rate, blood pressure, respiration and other vital signs of the patient and the patient image has been sent to the nurse.[17]

Remote patient monitoring

TLM can be used to monitor a variety of patients remotely. Patients' information can be transferred from their homes to a specialist cardiologist via remote monitoring, which has replaced Holter monitoring, or in remote areas where there is no resident psychiatrist, patients can be recorded by video conference and treated and followed up by a psychiatrist living in another area.[18]

Patient care in emergencies

Emergency patients are examined by experienced physicians assigned at medical centers at this level of service. If required, communicate with a TLM system physician via audio, voice, and visual communication, and send vital signs (such as heart sound, lung sound, and patient's heartbeat). While reviewing the patient's history and condition and assessing his vital signs, the TLM system's physician immediately provides the necessary treatment suggestions to preserve the patient's life and monitors the patient's recovery steps.[19]

Patient care at the first level of health care

In this TLM system, a doctor positioned at a distance from the medical center concurrently locates various patients suffering from level one medical illnesses, such as colds and hypertension disorders. While examining and negotiating with the patient, the physician collects the patient's vital signs and conditions simultaneously, and after diagnosing the disease, gives the required consultations for the patient's treatment. This section contains a variety of activities related to education and primary health care.[20]

Specialized counseling system

In the TLM system, several general practitioner visits at the first level of medical service require specialized medical services. This technology can establish a three-way communication between a technical center's physician or specialists, the general practitioner, and patients from various medical centers. Using audio and video transmission technologies and related medical equipment, the specialist physician presents the patient to the general practitioner while negotiating directly with the patient and the general practitioner. At the same time, the expert physician provides vital signs and other information needed to diagnose the disease. Using a medical center's specialist physician, it is possible to provide expert medical services to a large population dispersed throughout various areas of residence under this system. This system can reduce the number of patients sent to specialized centers from different cities and thus save a lot of time and money.[21]

Remote surgery

Robots and modern medical systems are used to perform remote surgery; however, due to the high expense of this technology, it has been limited to industrialized countries. There are several major issues with remote surgery: There are several major

problems in telemedicine: One of these problems is the lack of confidence of patients in the methods of remote surgery, which should be solved with proper training. The second problem is not touching the doctor directly with the patient, which is expected to soon improve the quality of touching physician robots and this problem will be solved. In addition, when the distance between the doctor and the patient increases, the speed of communication with equipment and monitors decreases, and doctors may notice a 25-second delay on the monitors in such circumstances and thus, it will be a death or life punishment for the patient in special circumstances.[22]

Robotic surgery uses robotic arms to transfer the movement of the surgeon's hand very precisely into the patient's body and provides the surgeon with images during the operation clearly and transparently. What enables the physician to control surgery is a strong internet connection used to communicate with physicians, surgical instruments, monitors, and experienced physicians.[23]

Because the doctor also deals with the patient's life in this method, it is impossible to perform medical action with the disconnected and connected internet. Remote surgery is not only used when the surgeon and the patient are far apart, but may also be used at close distance. One of the biggest problems for surgeons is the involuntary shaking of their hands. Special gloves are now being developed that detect the surgeon's hand movements in three dimensions. The periodic vibration of the hand is filtered out, and the rest of the movements are transferred to the precise arm that is used to perform the surgery on the patient's body. Surgery is conducted on an artificial model larger than the patient's limb for more precise operations, whereas smaller-scale movements are performed on the real limb.[24]

Telemedicine in pediatrics

In children's mental health, telemedicine, which uses electronic technology and telecommunications to enhance access to care and outcomes for children worldwide and other medical disciplines, is well developed and active. It uses cognitive-behavioral therapy (CBT) to treat several psychological issues in children, including depression and hyperactivity, and provides school-based treatment. By extending the use of remote care to children, parents can be assured that their children's health care needs will be met without compromising their income or employment situation, as most children are at risk. Therefore, health care is required to quickly, and telemedicine in children is effective for care and treatment.[25]

The use of telemedicine in crises and unforeseen events

In telemedicine, two main methods are most used:

- Storage and transfer method: Digital images are sent to another location after preparation, and the response is received again after a while.
- Compressed video images are transformed into digital format and delivered in two directions using a two-way TV technology: This method necessitates high-bandwidth connections, such as fiber optic cables or satellite systems, as well as medical and non-medical accessories.

TLM uses cable communications, including telephone and fiber optic lines, wireless technology, infrared, radio and television, microwave and satellite communications, to transmit data and information. In times of crisis, these systems can provide a dependable and accessible means of fully functional communication, despite the severity of accidents and infrastructure damage. Mobile communications and information transmission in times of crisis are among the advantages of wireless technology, and so are cost reductions. The Alabama National Guard employed digital lubricating radiography scanners at its Mobile Military Surgery Hospital in the aftermath of Hurricane Hugo in 1990 and transferred images via satellite to Satinmar to Walterrid Military Medical Center in Washington; during the 1991 Gulf War, images of CT scans were transmitted via satellite and international telephone lines to military medical centers for consultation at a movable military hospital in the Saudi desert. In Somalia in 1992 and 1993, the same thing happened. Video conferencing was also used in the US military in 1994. Other military conflicts in Croatia, Bosnia, Afghanistan, and Iraq have used this technology in various forms. TLM's applications in the field of military medicine are also quite important. Soldiers deployed in peacetime and remote locations can benefit from the expertise of the top experts. The same is true for those who have been injured in combat. When paramedics and emergency personnel arrive on the scene, they contact a professional physician and follow their orders.[26]

Investigating the dimensions of TLM implementation

Even though TLM is constantly expanding and improving daily, this comprehensive and complex technology still faces various challenges. As a result, whenever any technology in the field of health care, including TLM, is used, the following issues must be considered.[27]

Information security and confidentiality

Although remote access to medical information is one of the benefits of this system and in the medical community's interest, the confidentiality of patient information may be lost.

Responsibility and commitment

The responsibility for medical records was traditionally split between the doctor or referral organization and the doctor or institution being consulted. The legal scope of medical liability and TLM medical records should be decided because additional personnel have been added to the TLM system, such as technical staff and sending staff.

Permission and credit

Due to the different rules in different places, the relevant authorities must identify the people who have a license to operate in TLM.

Possibility of abuse

Because TLM services are made with the assurance of the accuracy and precision of the information sent by the

information-sending center, this increases the incidence of abuse or error in providing information.

Costs

Given that many insurance companies have refused to cover the cost of a TLM system, and given the expanding reach of this approach, it is important to address the payment concerns. Although the adoption of this plan may reduce the demand for medical team members, it is important to pay attention to the plan's advantages, particularly in locations remote from medical centers.[28]

Barriers to using TLM[29]

High technical costs that may include the following:

- High cost of equipment
- High cost of preparing a suitable telecommunication infrastructure
- High ongoing costs to pay for information exchange.

Legal restrictions and legal issues were proposed.

- Internal permits must be obtained from the authorities of the respective countries to implement this technology.
- Physician activity license: Physicians can use this treatment method if they have obtained the necessary license. Only doctors who have received their degrees from the same countries are allowed to work in some countries.
- Responsibility for carelessness in treatment: In this treatment method, it should be identified who is responsible.

Confidentiality and security

- Privacy policy in this technology: It is better for all people who work with this method of treatment to agree to the use of security and privacy laws.
- The use of identity systems to work with this treatment seems necessary.
- Concealment of information transmitted over the internet should be considered (convert information to code for transfer).
- Cultural factors of society.

Physicians' resistance

Some physicians believe in the patient's presence, but they are afraid of giving the wrong therapy; therefore, they avoid utilizing this approach.

Healthcare providers' resistance

The group cannot act due to concerns such as the quality of therapy offered and the dependability of the treatment method.

Patient resistance

Fear of incorrect treatment with this method and the belief of some other patients in face-to-face examination prevent them from using this method.

Development and promotion solutions for the use of TLM

- Increase public awareness of TLM
- Eliminate legal restrictions on TLM implementation
- Teaching physicians and specialists the necessary skills to use TLM
- Establishing a medical communication channel with neighboring countries due to the lack of some specialties or the high cost of treatment and the use of experienced specialists in their own country to earn income
- Establish a TLM network for veterans and the disabled to reduce transportation problems

Discussion

One of the influential processes in today's aeon, which has had a serious and significant growth and increase, is communication and information facilities in the society. With the creation of new technology in the present aeon, it is possible to access information.[1] Nowadays, physicians can provide medical tests and diagnoses of disease to other physicians worldwide via the internet or online, or even send a simple email about the condition of the disease and consult other practitioners for available solutions.[2]

TLM is a skill set that utilizes multimedia tools and utilizes a wide range of day-to-day technologies, including live image, live sound, medical data and images, communication systems, texts, photographs and vital parameters related to medicine; medical services can be delivered remotely to another place using the internet.[5-7]

Information and communication technology (ICT) has become an everyday occurrence in different sectors of life throughout the world in recent years. Most people are familiar with terms such as e-learning, e-government, e-commerce, TLM, and others. Internal specialists may have a major effect on keeping society up to date on technical advancements. TLM is an environment that is expanding rapidly. Electrical/computer technologies are used in a wide variety of medical and healthcare areas. TLM applies ICT, such as computers and information systems, to deliver medical and health care over long distances.[4-6]

Some countries now employ TLM facilities to treat patients even in rural and remote locations. This is especially true for accident victims, as most respectable accident clinics are located far away. Because many traditional hospitals lack the resources to care for and treat serious accidents and severe injuries, TLM has become a part of all-inclusive medicine and is very important in operational areas.[26]

With a focus on diagnosis and clinical treatment, teleradiology, telepathology, and teledermatology are frequently given in industrial regions such as the United Kingdom, Northern Ireland, Scandinavia, Northern America, and Australia.[8] TLM is a tiny portion of e-health, but it is ideal for big geographic regions with sparse populations, such as Canada, India, and Norway.[30-32]

TLM can reduce diagnostic time, improve clinical management, and provide healthcare services globally while enhancing quality and efficiency.[8,9]

Debnath (2004) reported the most use of TLM from 1991 to 2003 in education, emergency medicine, general medicine, and related fields in a TLM analysis study in the UK. The study found that barriers to using TLM in the UK included financial constraints, lack of infrastructure, concerns about forensic medicine, and resistance to change. This study considered the lack of close interaction with the patient as a barrier to the active participation of some specialists.[33]

Other barriers to widespread use of TLM, according to Kife *et al.*[34] (2006) in a study titled "A telemedicine transfer model for Sub-Saharan Africa," include a lack of resources, poor infrastructure, telecommunications, and human resources, as well as the previously mentioned socio-economic policies and issues. According to this study, TLM cannot be effective and continue to function without infrastructure.

Traditional system inconsistency and TLM inpatient referrals, changes in TLM coordinators, limited bandwidth, and network instability were among the causes for the failure of a TLM pilot system in Malaysia, according to Tahir and Wooten (2004).[35] According to some research results, one of the biggest challenges in implementing remote counseling in the United States is a lack of promotion and management of changes related to TLM and licensing concerns.[35,36]

Various studies point to several barriers to the use of TLM. Severe resistance from local health care providers and fear of losing a job, insufficient insurance coverage, poor quality of diagnosis or care, purchase costs, etc., are among the most important barriers associated with TLM.[29,37] A study by Jennett *et al.*[38] (2003) reported that medical staff compliance is an important factor in the success of TLM.

Professionals in the field of involvement must be convinced of the use and viability of new methods because it is critical for them to actively participate in TLM services to increase their interest and support for the project.[39] Other studies have found that initial reservations and concerns about TLM have evolved into interest and desire following its effective deployment.[40]

According to Kennedy and Yellowlees (2000) research on two rural health facilities that employed TLM services, expenses were decreased from a societal standpoint but increased fourfold from a provider one. Although the provider's perspective is essential, it is only one of the variables that go into making a choice, and the usage of teledermatology is justified from a societal standpoint. Choosing a social viewpoint rather than a cost-cutting one is the desired strategy that needs political and administrative support like other areas of health care.[41]

Investing in TLM depends on the positive features of TLM compared to other forms of service delivery. Discussions about the cost of TLM are more limited to budget-related issues and do not have a comprehensive economic perspective. Cost decision-making for such extended programs should include different views of patients, health care professionals, and investing organizations in health care.[39]

Thus, in particular, TLM can help low-income, remote, and rural communities where access to specialist physicians is not readily available. Also, the distance and time between healthcare practitioners and patients can be reduced, and there is evidence that these strategies have significant economic and social benefits. TLM enables patients to seek therapy more quickly and effectively.[42] and improves the quality of life of chronic disease patients.[43] Moreover, the TLM program can motivate and improve performance in physicians in remote areas.[44]

Conclusion

Due to the numerous applications of telemedicine and the documentation of telemedicine medical records, this process requires the creation of a suitable platform and structure for the provision of health services in care organizations. Using this technology, the speed, accuracy and quality of patient care can be improved. And guaranteed patients. In the last decade, much progress has been made in the development of TLM technology supported by modern digital media communications. However, there are still obstacles and problems in the way of this technology around the world. One of the most important obstacles can be the lack of software and hardware infrastructure, lack of trust of doctors and other medical staff, and patients' resistance and lack of confidence in providing services. Therefore, further studies on the efficiency of TLM in terms of economics, speed of action, effectiveness, and infrastructure provision are needed to remove obstacles based on the results of these studies and increase the efficiency of using this technology.

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Conflicts of interest

There are no conflicts of interest.

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