http://medicaleducation-bulletin.ir
Review Article (Pages: 153-192)

Investigating the Use of Telemedicine during the COVID-19 Pandemic

Mohammad Saeedi[1], Mostafa Mahvelati Feyzabadi[2], Zohre Tohidipour[2], Behrooz Mohammadi[2], Somayeh Nazari[3], Zari Dolatabadi[4], *Mahdieh Sharifzadeh Kermani[5]

[1] MS of Software Engineering, Information and Communication Technology Unit, Mashhad Municipality Fire and Safety Services Organization, Mashhad, Iran.
[2] BSN, Bachelor of Science in Nursing, Mashhad University of Medical Sciences, Mashhad, Iran.
[3] PhD Student of Neuroscience, School of Advanced Technologies in Medical Sciences, Mazandaran University of Medical Science, Sari, Iran.
[4] Student Research Committee, Kerman University of Medical Sciences, Kerman, Iran.
[5] Assistant professor of Anesthesiology, Clinical Research Development Unit, Shafa Hospital, Kerman University of Medical Sciences, Kerman, Iran.

Abstract

The COVID-2019 pandemic has had a devastating impact on the global population, claiming the lives of more than 3.7 million worldwide. The biggest difference between COVID-19 and other common infectious diseases such as the flu, MERS, and SARS is that COVID-19 can be deadly even in young people without a chronic disease. The only preventing measure for COVID-19 is to observe social distancing and reduce the number of visits to hospitals and medical centers. Telemedicine technology in medical science is a useful tool to achieve this goal. Remote counseling and video conference via mobile phones are safe and effective methods to assess suspected COVID-19 cases and guide patients in diagnosis and treatment to minimize the risk of disease transmission. Although telemedicine was effectively used before the COVID-19 pandemic, its use was limited to situations when proper facilities and infrastructure were unavailable. However, with the onset of the COVID-19 crisis, the prevalence of online medical services is increasing rapidly. Remote medical solutions can monitor and treat patients in emergency situations without physical presence in the hospital. In general, the benefits of using telemedicine services can be divided into two groups: 1) providing assistance in the diagnosis, treatment, and follow-up of patients suspected with COVID-19 and 2) providing assistance to non-COVID-19 patients who need regular visits and follow-ups, like diabetic patients.

Key Words: COVID-19, Information technology, Healthcare, Telemedicine.

*Please cite this article as: Saeedi M, Mahvelati Feyzabadi M, Tohidipour Z, Mohammadi B, Nazari S, Dolatabadi Z, et al. Investigating the Use of Telemedicine during the COVID-19 Pandemic. Med Edu Bull 2021; 2(2): 185-92. DOI: **10.22034/MEB.2021.293696.1009**

Corresponding Author:

Mahdieh Sharifzadeh Kermani, MD, Clinical Research Development Unit, Shafa Hospital, Kerman University of Medical Sciences, Kerman, Iran.

Email: msharifzade78@gmail.com

Received date: Mar. 10, 2021; Accepted date: Jun.22, 2021

1- INTRODUCTION

Coronavirus disease 2019 (COVID-19) is a contagious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The first known case was identified in Wuhan, China in December 2019. The disease has since spread worldwide, leading to an ongoing pandemic (1-4). The rapidly spreading coronavirus has posed enormous health, economic, and social challenges to communities. This pandemic, in addition to imposing a lot of stress on health care providers, has also increased health care costs. Therefore, if the outbreak is not managed and controlled as soon as possible, health systems will face serious problems due to the lack of medical staff and medical equipment. On the other hand, coronavirus epidemic has drastically changed the patient examination and treatment and health care access (5, 6).

Today, most sciences are dependent on information technology (IT), and medical science is no exception to this rule. These two fields are completely separate from each other and must be connected in some way. Technology management as an interdisciplinary science plays a connecting role. Telecommunication and information technology are widely used in medicine and related sciences. Physicians can provide daily counseling for patients on a landline or mobile phone and experts can give important advice to general practitioners or students through video conferencing systems or websites. Physicians store patient records on personal computers and, when necessary, send them to other physicians (7, 8).

Telemedicine was introduced in the 1970s by Thomas Bird. There are many definitions of this word. According to the International Telecommunication Union (ITU), telemedicine is the practice of medical care using audio-visual communications (9).

Telemedicine is an interesting, efficient, and cost-effective option for dealing with coronavirus. Studies have shown that the use of telemedicine has previously had a positive effect on many COVID-like epidemic diseases, including Ebola, SARS, and the flu (10). Dashrat et al. proposed that caring for a vulnerable population is one of the most important measures against threats from infectious diseases. Telemedicine is a proven method of providing palliative care for the most vulnerable members of the society.

When travelling is forbidden and quarantine is in place in entire cities, the affected populations will be under increased pressure from daily life, unpredicted economic pressures, contagious and non-contagious diseases, and various mental health complications. In these circumstances, telemedicine services develop into important assets with important and beneficial outcomes for the whole range of health care delivery (10). The aim of the present study was to investigate the role of telemedicine and to review the advantages, disadvantages, and applications of telemedicine services during the COVID-19 pandemic period.

2- MATERIALS AND METHODS

2-1. Data sources

In this review study, a systemic search of electronic databases of Medline (via PubMed), SCOPUS, Web of Science, ProQuest, Cochrane Library, SID, Magiran, CIVILICA, and Google Scholar search engine was performed with no time limit up to March 2021, using the following keywords alone or in combination: "Telemedicine", "Benefits", "Advantage", "Disadvantage", "Usage", and "Applying". The search was done independently and in duplicate by two reviewers, and any disagreement between the reviews was resolved by the supervisor.

2-2. Study selection

Database search was done for suitable studies, abstracts of the studies were screened for identification of eligible studies, full text articles were obtained and assessed, and a final list of eligible studies was made. This process was done independently and in duplication by two reviewers, and any disagreement was resolved by a third reviewer. References were organized and managed using EndNote software (version X8).

3- RESULTS

Telemedicine is emerging as an important technology for providing medical care to patients, aiming to reduce the transmission of COVID-19 among patients, families, and physicians at present. The World Health Organization (WHO) has also stated that telemedicine can reduce the direct interaction between patients and healthcare providers and protect healthcare providers, thus minimizing the risk of COVID-19 transmission. Telemedicine also helps protect high-risk individuals (e.g., the elderly, individuals with underlying diseases, pregnant women, children) by reducing referrals to hospitals and other healthcare facilities where people with acute COVID-19 infection may be present (8-10).

3-1. A telemedicine system consists of the following four parts:

1) Technology; including communication devices and peripherals;

2) Communication networks;

3) Users (patients and medical staff); and

4) Rules and regulations.

3-2. The application of telemedicine can be investigated in three different areas:

1) Assisting in decision making: Telemedicine allows specialists to use medical centers database to make the right decisions. This is the oldest application of telemedicine, which provides the results of research and treatments for physicians at workplace with the help of search engines.

2) Sense transfer: Sense transfer means sending patient information from one medical center to another. Information such as the patient's vital signals, especially digital radiographs and even the patient's appearance, can be sent via telemedicine.

3) Real time collaboration in patient management: The most important and newest application of telemedicine is the use of video transmission technology, which assists physicians manage the treatment status in treatment processes such as surgeries or long-term treatments. In addition to sending video images of the patient's apparent conditions, information on various imaging equipment such as ophthalmoscopes, otoscopes, and dermatoscopes can also be sent (8-10).

3-3. Types of telemedicine services:

The services provided by telemedicine are divided into three groups of data, audio, and video information:

1) Information and voice services: This category of services is provided based on information provided by telephone lines. The least expensive type of medical information service is provided via telephone, which is also used in Iran as a home doctor. This service is divided into two types:

a) Offline: for example, a patient's echocardiography is sent to the doctor and recorded by the device to be analyzed and the output is sometimes drawn using curves and the result is announced to the patient.

b) Online: for example, the patient talks to the doctor via a direct telephone line, the

doctor decides on it, and announces the result.

2) Information and video services: These services include video conferencing, image transmission and radiography. These services are expensive but have many applications. Sometimes this information reaches the physician using scanners, and sometimes through digital radiography. The images are directly converted and sent digitally. This method is common in radiography centers today (11).

3) Information and data services: This type of information is divided into three groups:

a) Online access to databases that makes it easy for physicians and other users to be informed of the patient's latest conditions, prescribe quickly, and give immediate feedback.

b) It is the Internet that is used to update medical information and makes doctors aware of the latest news in the medical world or even exchange information from one corner to another and provide medical care.

c) Remote sensing, which means studying and showing the physiological functions of humans or animals from distant or mobile centers. The first Remote sensing experiment was performed by NASA, which was aware of the physiological conditions of its astronauts (12).

3-4. Telemedicine applications:

1) Tele-consultation: which takes place via a variety of tools such as telephone, email, or video conferencing.

2) Tele-education: It has now been proven that the development of any science requires the training of specialized groups of that science. Tele-education is presented in three areas: Remote learning and access to remote information. Tele-education has many benefits, including reduced costs due to the fewer visits, increased trust in health centers, and better exchange of information between medical centers.

3) Medical emergencies and assistance to the injured: Since it can be difficult to access medical emergencies in urgent and sensitive cases of unexpected disasters, telemedicine can provide a shortcut and relief operations can be accelerated.

4) Remote surgery: Remote surgery is performed by robots and advanced medical systems, but it has not yet been properly applied in developing countries, and is limited to developed countries due to its costs (13).

3-5. Telemedicine advantages:

• Faster access to doctors and the possibility of visits at shorter intervals;

• Eliminating long waiting for visits;

• No need for physical movement and commuting;

• Reducing the cost of visits to hospitals and medical centers; and

• Using the patient's electronic profile, creating a database of the progress of disease, using the experiences of doctors and specialists in other parts of the world, and using artificial intelligence and advanced diagnostic tools (14).

3-6. Telemedicine during Covid-19 outbreak:

Telemedicine is useful for maintaining social distancing during the COVID-19 pandemic. Physicians can make an initial diagnosis by assessing symptoms, including fever, cough, the patient's movements, and communication with others. The laboratory confirmation of an infection can also be sent electronically to minimize contact during the epidemic (15).

1) Telemedicine services and COVID-19

• Tele-consultation between physicians working in remote areas with specialized and sub-specialized centers to discuss and

exchange views on the condition of COVID-19 patients or suspected patients.
• Consulting and asking questions from people who have disease symptoms and need tele-consultation with a doctor.

• Consulting for diagnostic and treatment protocols between specialists about the disease and decision to continue the treatment process.

• Following up patients after discharge with no referral needed.

Telemedicine can also be helpful for other patients who need regular visits to clinics and hospitals as the presence of patients, especially patients with immune system problems, can be dangerous.

The advantages of using telemedicine services can be divided into two general groups: Assisting in the diagnosis, treatment, and follow-up of COVID-19 patients and suspected cases; and assisting non-COVID-19 patients who need regular visits and follow-up, such as diabetic patients (16, 17).

2) Use of telemedicine technology during COVID-19 outbreak

Considering that, depending on the situation, several unique needs can be remotely met during the outbreak of COVID-19, centers for disease control, many public health agencies, and several industrial associations have supported the prospect incorporating telemedicine as part of their COVID-19 response systems. Telemedicine allows healthcare providers to perform safe and effective remote medical examination, check-up, and triage. This allows providers to reduce human exposure while achieving quality care (18-21). Examples of telemedicine applications during the COVID-19 pandemic are as follows:

1. In an article titled "the Importance of Telemedicine during the COVID-19 Pandemic with Focus on Diabetic Retinopathy in 2020", the use of this technology is mentioned to periodically manage glycemic levels (22).

2. In an article titled "the Use of Telemedicine during the COVID-19 Pandemic," the beneficial effect of this technology in protecting the mental health of the elderly population during the COVID-19 pandemic is emphasized (23).

3. In an article titled "Telemedicine during the COVID-19 Pandemic in Western China," a 5G network, a special telephone line, and a smart device COVID-19, which allows online consultation and remote medication for chronic patients as well as the use of remote CT scans with acceptable diagnostic accuracy, were established and the telemedicine services reduced the number of outpatient visits to hospitals and the concerns regarding chronic patients (24).

4. A study titled "Monitoring and Managing COVID-19 patients with the WeChat-Based Telemedicine System in 2020" was carried out on 188 patients. A total of 74 patients were reported to be COVID-19-positive and a medical team specializing in communicating with patients and receiving their histories was formed. This telemedicine model minimized the risk of infection among caregivers by reducing direct physical contact between the medical staff and the patients (25).

5. In an article titled "Telemedicine Framework for Reducing the Impact of the COVID-19 Pandemic in 2021," a conceptual model for remote monitoring of suspected COVID-19 patients is developed. Social Internet of Things and artificial intelligence technologies, text processing and deep learning methods, and other digital devices have been used to record and evaluate patients' symptoms. This model divides patients into three groups: asymptomatic, mild, and severe cases. They communicate with the patient with mild/moderate symptoms through video conferencing (26).

6. In an article titled "COVID-19 Self-test Based on Smartphones Using Breathing Sounds in 2020", researchers conducted a careful examination of respiratory sounds through a smartphone microphone and their outcomes for identifying respiratory complications. The resulting respiratory sounds can be divided into healthy and unhealthy categories by using advanced signal processing and analysis combined with new deep machine-learning techniques and pattern recognition to separate breathing steps, estimate lung volume, perform oxygenation, and further classify respiratory data input (27).

3-7. Reasons to adopt telemedicine:

Telemedicine will be more widely used in countries like Iran with regard to its geographical area in the following cases:

1) Population dispersion in some regions and mountainous and remote areas of the country;

2) Lack of access to specialized medical centers in some regions;

3) Increasing elderly population in need of intensive medical care;

4) Facilitating the diagnose of diseases;

5) Adopting up-to-date treatment strategies; and

6) Time-efficiency for acute diseases and emergency cases.

Telemedicine services can help people receive their diagnostic tests for preventative medicine on time. With the help of telemedicine, people can be informed about methods of prevention in a timely manner and take appropriate measures. Telemedicine is a suitable alternative to acute, chronic, and routine care and prevention and can improve clinical outcomes. In the industrial world, telemedicine is likely to continue to transfer health care from a hospital or clinic to the patient's home (28).

3-8. The difference between telemedicine and telehealth:

Although the terms telemedicine and tele-health are often used interchangeably, there is a distinction between the two. The term tele-health encompasses a wide range of technologies and services for patient care and improvement of the overall health system, whereas telemedicine specifically refers to clinical telemedicine services. Tele-health can be related to non-clinical services such as care provider training, office sessions, and continuing medical education in addition to clinical services. According to the World Health Organization, tele-health includes the following: monitoring, health promotion, and general health performance. Telemedicine involves the use of electronic and software communication to provide clinical services to patients without personal visiting. Telemedicine technology is often used to examine patient health status, chronic disease management, drug management, specialist counseling, and many other clinical services that can be provided remotely. Today, the spread of the COVID-19 pandemic has imposed additional pressure and costs on the healthcare system and the patients. Therefore, telemedicine technology can be an essential method to deal with the pandemic, especially for affected people (29-31).

5- CONCLUSION

With the advent of the COVID-19 pandemic, the use of technology has become essential to help people with mild/moderate symptoms who need home care. The coronavirus disease mainly causes respiratory symptoms that can be very similar to the common cold, flu, or pneumonia; however, the coronavirus can also cause damage to other parts of the body, and people with underlying conditions are more likely to be more seriously infected. The rapid progression

of the COVID-19 pandemic is a serious global challenge. One of the most important strategies to counter the coronavirus epidemic is remote social measures. This is where telemedicine can play an important role and support healthcare systems, especially in the areas of public health, prevention, and clinical practices. Telemedicine allows physicians to care for the patients, diagnose and treat diseases, and consult other physicians from one place to another in order to save lives. During the coronavirus pandemic, telemedicine is the physicians' first line of defense to slow the spread of the coronavirus, maintain social distance, and provide telephone or video conferencing services for some degree of focus on personal care and resource constraints in the most urgent cases. The application of technology in medical sciences can lead to the establishment of smart hospitals and the use of robots in surgeries in the near future, which will make dramatic changes for longer, safer, and healthier lives. However, there are also challenges regarding to geographical factors, organizational structures, and infrastructure-related issues in telemedicine in developing as well as underdeveloped countries.

6- AUTHORS' CONTRIBUTIONS

Study conception or design: MS, MS, and ZD; Data analyzing and draft manuscript preparation: MS, MM, ZT, BM, SN, and ZD; Critical revision of the paper: MS, MS; Supervision of the research: MS and BM; Final approval of the version to be published: MS, MM, ZT, BM, SN, ZD, and MS.

7- CONFLICT OF INTEREST: None.

8- REFERENCES

1. Page J, Hinshaw D, McKay B. "In Hunt for Covid-19 Origin, Patient Zero Points to Second Wuhan Market – The man with the first confirmed infection of the new coronavirus told the WHO team that his parents had shopped there". The Wall Street Journal. Retrieved 27 February 2021.

2. Zimmer C "The Secret Life of a Coronavirus – An oily, 100-nanometer-wide bubble of genes has killed more than two million people and reshaped the world. Scientists don't quite know what to make of it". Retrieved 28 February 2021.

3. Farhat A, Sayedi S, Akhlaghi F, Hamedi A, Ghodsi A. Coronavirus (COVID-19) Infection in Newborns. International Journal of Pediatrics, 2020; 8(6): 11513-11517. 10.22038/ijp.2020.48004.3871.

4. Ghodsi A, Azarfar A, Ghahremani S. A Review of Coronavirus Disease (COVID-19) in Children. Journal of Pediatric Nephrology. 2020; 8(3):1-6.

5. Tyrrell Da, Bynoe Ml. Cultivation of A Novel Type of Common-Cold Virus In Organ Cultures. Br Med J. 1965 Jun 5;1(5448):1467-70.

6. "WHO. Novel Coronavirus-China". WHO. Retrieved 2020-02-01.

7. Calton B, Abedini N, Fratkin M. Telemedicine in the time of coronavirus. Journal of Pain and Symptom Management. 2020 Jul 1;60(1):e12-4.

8. "TeleHealth". The Health Resources and Services Administration. 2017-04-28.

9. What is Telemedicine/E what is Telemedicine/E - health? Available at: https://www.itu.int/itudoc/itu-t/workshop/e-health/s0-01.pdf.

10. Strategies for setting up remote health service clinics in Covid epidemic management 19. Available at: https://web.ssu.ac.ir/Dorsapax/userfiles/Sub56/salamatazrahedoor.pdf.

11. Taylor P. Evaluating telemedicine systems and services. Journal of telemedicine and telecare. 2005 Jun 1;11(4):167-77.

12. Perednia DA, Allen A. Telemedicine technology and clinical applications. Jama. 1995 Feb 8;273(6):483-8.

13. Ohannessian R. Telemedicine: potential applications in epidemic situations. European Research in Telemedicine/La

Recherche Européenne en Télémédecine. 2015 Sep 1;4(3):95-8.

14. Hailey D, Roine R, Ohinmaa A. Systematic review of evidence for the benefits of telemedicine. Journal of telemedicine and telecare. 2002 Mar;8(1_suppl):1-7.

15. Bashshur R, Doarn CR, Frenk JM, Kvedar JC, Woolliscroft JO. Telemedicine and the COVID-19 Pandemic, Lessons for the Future. Telemed J E Health. 2020 May; 26(5):571-573.

16. Gadzinski AJ, Gore JL, Ellimoottil C, Odisho AY, Watts KL. Implementing Telemedicine in Response to the COVID-19 Pandemic. J Urol. 2020 Jul;204(1):14-16.

17. Portnoy J, Waller M, Elliott T. Telemedicine in the era of COVID-19. The Journal of Allergy and Clinical Immunology: In Practice. 2020 May 1;8(5):1489-91.

18. Salehahmadi Z, Hajialiasghari F. Telemedicine in Iran: chances and challenges. World J Plast Surg 2013; 2(1): 18-25.

19. Bafghizadeh M, Najjarzadeh Z, Imanzadeh M. The role of GIS in the optimal establishment of Remote medical systems. Journal of hospital 2013; 12(4): 4.

20. Rahimzadeh E, Rahimzadeh S, Amani F. Feasibility study of application and the deployment of telemedicine in Imam Khomein hospital. Student Research Committee. 2 (2). S.s.1-11. ISSN 1735- 2584.

21. Hajavi A, Midani Z, Ghazisaeidi M. Legal aspects of telemedicine.scientific journal of Forensic medicine, 2006;15;12(2):113-4

22. Galiero R, Pafundi PC, Nevola R, Rinaldi L, Acierno C, Caturano A, Salvatore T, Adinolfi LE, Costagliola C, Sasso FC. The Importance of Telemedicine during COVID-19 Pandemic: A Focus on Diabetic Retinopathy. Journal of diabetes research. 2020 Oct 15; 2020.

23. Monaghesh, E., Hajizadeh, A. The role of telehealth during COVID-19 outbreak: a systematic review based on current evidence. BMC Public Health 20, 1193 (2020). https://doi.org/10.1186/s12889-020-09301-4.

24. Hong Z, Li N, Li D, Li J, Li B, Xiong W, et al. Telemedicine during the COVID-19 pandemic: experiences from Western China. Journal of medical Internet research. 2020;22(5):e19577.

25. Xu H, Huang S, Qiu C, Liu S, Deng J, Jiao B, Tan X, Ai L, Xiao Y, Belliato M, Yan L. Monitoring and Management of Home-Quarantined Patients with COVID-19 using a WeChat-based telemedicine system: retrospective cohort study. Journal of medical Internet research. 2020;22(7):e19514.

26. Bhaskar S, Bradley S, Sakhamuri S, Moguilner S, Chattu VK, Pandya S, Schroeder S, Ray D, Banach M. Designing futuristic telemedicine using artificial intelligence and robotics in the COVID-19 era. Frontiers in public health. 2020 Nov 2;8:708.

27. Faezipour M, Abuzneid A. Smartphone-based self-testing of covid-19 using breathing sounds. Telemedicine and e-Health. 2020 Oct 1;26(10):1202-5.

28. Yellowlees PM. Successfully developing a telemedicine system. InIntroduction to telemedicine 2017 Dec 21 (pp. 93-100). CRC Press.

29. Kaplan B, Litewka S. Ethical challenges of telemedicine and telehealth. Cambridge Q. Healthcare Ethics. 2008;17:401.

30. Mirimoghaddam, M., Bahrami, F., Rahimi, R., Ahmadi, R., Jafari, M., Vafi sani, F., Dadshahi, S., Saeidi, M. Reflections on Telemedicine with an Emphasis on Ethical Aspects: A Review. International Journal of Pediatrics, 2020; 8(10): 12223-233.

31. Ghodsi A, Malek A, Ghahremani S. A Review of Multisystem Inflammatory Syndrome in Children (MIS-C) Associated with COVID-19. Hormozgan Med J. 2020 December; 24(4):e107048.