REVIEW ARTICLE **DOI: XXX**

Telemedicine and natural disasters: various services, requirements, challenges, and general framework

Niloofar Mohammadzadeh , Soheila Saeedi , Sorayya Rezayi *

Department of Health Information Management and Medical Informatics, School of Allied Medical Sciences, Tehran University of Medical Sciences, Tehran, Iran.

***Corresponding author:** Sorayya Rezayi; **Email:** s_rezayi@razi.tums.ac.ir

Published online: 2022-05-31

Abstract: Providing early health care services in natural disaster is one of the essential applications of telemedicine. This narrative review aims to investigate the applications, advantages and challenges of telemedicine in natural disaster-stricken areas. Medline (through PubMed), Web of Science (WOS), and Scopus databases were searched for related articles published from beginning to 2022. The keywords used for the search included "telemedicine" and "natural disaster." After removing duplicate papers, irrelevant review articles and letters to editors, 44 relevant papers were selected and reviewed. Information sharing through audio, visual, and data-oriented services is among critical approaches that telemedicine services mainly use. Teleconsultation, tele-education, remote interpretation, tele-psychiatry, and tele-surgery are among measures that can be implemented in emergencies like earthquakes, fires, floods, storms, and drought. The fundamental requirements of a telemedicine-oriented system for providing emergency services in natural disasters include wireless scales, conversation tools, blood pressure monitor, respiratory rate monitor, spo2 sensor, glucometer, portable ultrasound unit, wearable thermometers, virtual stethoscopes, portable three leads electrocardiograph monitor, and digital otoscopes. Simple telemedicine systems can have many advantages in the natural disasters. However, the main challenge in this regard is to adapt the necessary communication systems to a telemedicine paradigm. Another critical challenge is to interpret and apply the summary of acquired information and the inevitable interaction outcomes at the required time and place.

Keywords: Communication; Natural Disasters; Information Technology; Telemedicine

Cite this article as: Mohammadzadeh N, Saeedi S, Rezayi S. Telemedicine and natural disasters: various services, requirements, challenges, and general framework. Front Emerg Med. In Press.

1. Introduction

Telemedicine is the use of electronic and digital technology to provide medical and health care to patients living far from the treatment center (1). The extent of these concepts is such that telemedicine, before being regarded as a service, is also considered as a culture of using the features of communication to provide health care services (2). Telemedicine approaches provide the possibility of improving the quality and accessibility of health services regardless of geographical location. The following are four main factors that influence the provision of telemedicine aids; proper infrastructure, providers' motivation, ongoing and continuous investment, and technical support (3).

It is an undeniable fact that in conjunction with scientific and health advances, pollution, diseases, potential dangers, and natural emergencies threaten people, and to have a healthy and disaster-free world, there is no choice but to use scientific exchanges and joint interaction (4). Providing health care services in natural disasters is one of the essential applications of telemedicine. In the event of disasters, local health facilities can be severely damaged or local hospitals and clinics may be spoiled or inaccessible, so various telemedicine services can be used (5). On the other hand, the impossibility of communicating with the affected area has always been one of the main problems facing health care delivery in natural disasters (6). Consequently, increasing the time of rendering services to the affected people is considered a necessity. Fortunately, with the advancement of technology, this problem has been somewhat alleviated, and telemedicine is now an approach to speeding up treatment, providing clinical care and health care services to people in natural disasters (7). In short, the lack of safety in the affected area, the low number of physicians, and the lack of easy access to the affected area to help the injured are the reasons for the importance of telemedicine in natural disasters (8).

The main purpose of this narrative review is to investigate the various applications, advantages and challenges of telemedicine in natural disaster-stricken areas.

2. Evidence acquisition

This research was conducted in the form of a narrative review. To analyze the papers related to the use of telemedicine in natural-environmental disasters, Medline (through PubMed), Web of Science (WOS), and Scopus databases were searched for related papers published from 1980 to 23 April 2022. In this study, keywords such as

Table 1 Search strategy for databases

PubMed	("Telemedicine"[Mesh] OR "Telehealth") AND ("Natural Disaster"[Mesh] OR "fire" OR "flood" OR "storm" OR "earthquake" OR "drought") Results=123
Scopus	TITLE-ABS-KEY (("Telemedicine" OR "Telehealth") AND ("Natural Disaster" OR "fire" OR "flood" OR "storm" OR "earthquake" OR "drought")) Results=397
Web of Sciences	TS= ("Telemedicine "OR "Telehealth") AND TS = ("Natural Disaster" OR "fire" OR" flood" OR "storm" OR "earthquake" OR "drought") Results=126

telemedicine and natural disaster were used for the search. All articles dealing with the use of telemedicine in natural disasters were accepted into the study. Our search strategy is provided in Table 1.

Articles were included in this narrative review if they were; 1) original research, proceedings and reviews, 2) focusing on the application of various telemedicine approaches in natural disaster-stricken areas, 3) using telemedicine services for managing the victims, 4) published in English language, 5) had no time limitation. The exclusion criteria were; 1) not being related to the use of telemedicine services in natural disaster-stricken areas, 2) being chapters, letter, reports, and technical reports, 3) being non-English article, and 4) being manuscripts in preprint phase. The flowchart of screening phase is illustrating in Figure 1.

3. Results

After conducting the search, 646 papers were retrieved from three scientific databases. We removed the duplicate papers, irrelevant review articles, and letters and finally, 44 articles that were relevant to the topic were selected.

3.1. *Types of telemedicine services*

Telemedicine and telehealth can be used in applications that improve the quality of health services in disasters (9-11). Telemedicine deals with different types of medical information and different forms of communication technologies.

3.1.1. Information and voice services

The most straightforward telemedicine service is when a healthcare professional consults with another specialist over the phone. Extensive telephone service is perhaps the most cost-effective consultation between mobile centers in disaster-stricken areas and central hospitals in one country or another (5, 7).

3.1.2. Information and visual services

Sending and receiving images: Video conferencing and image transfer are perhaps one of the most common uses of telemedicine. The more bandwidth would be provided to the specialists, the shorter the loading time of the image will be, and immediately after taking the medical images, the specialists can receive them and, if necessary, analyze and make decisions in case of emergency (12). After transferring the medical image, the image is received for more interpretation. It is possible to produce digital images of analog radiographic films with digital cameras or by using film scanners (13, 14).

3.1.3. Information and data services

Online access to databases: Telemedicine allows patients' information to be kept up to date, and physicians can easily and remotely access patients' information and make the necessary changes to them. Telemetry is one of the approaches of data services (13, 14). Telemetry is a concept of studying and displaying the physiological functions of humans or animals from distant and mobile centers. Today, telemetry systems focus on transmitting vital signals from remote or mobile areas to medical centers and hospitals. In most air services and other transportation systems, and also in most emergencies (such as earthquakes, storms, floods and fires), telemetry is one of the main ways of information transmission. This information also provides the possibility of medical advice online or offline, especially in an emergency. NASA's first remote sensing experiments were performed by physicians on Earth, which measured and demonstrated the physiological performance of astronauts in space (15, 16).

3.2. *Application of telemedicine services*

3.2.1. Medical emergencies and assistance to the victims of natural disasters

One of the most basic needs of countries is to provide health services in emergencies. In a disaster, large groups of victims usually move to other areas or larger cities to receive medical care. Telemedicine services in these cases also provide health care services to victims, and allows communication with limited specialized centers (17). Communication in emergency services is crucial. It is essential to create a communication platform between on-site specialists and other experts that will meet the communication needs of the two parties. Among the telemedicine services used in emergencies, tele-consultation, tele-visit and telemonitoring and tele-psychiatry (18) are more common among other types (7, 13, 19-22). All telemedicine services can be categorized into a store, forward and real-time based on their provided services (5, 19, 21, 23).

3.2.1.1. Tele-consultation

One of the vital services of telemedicine is creating a consultation opportunity between physicians and other health centers. Consultation can be done in different ways and

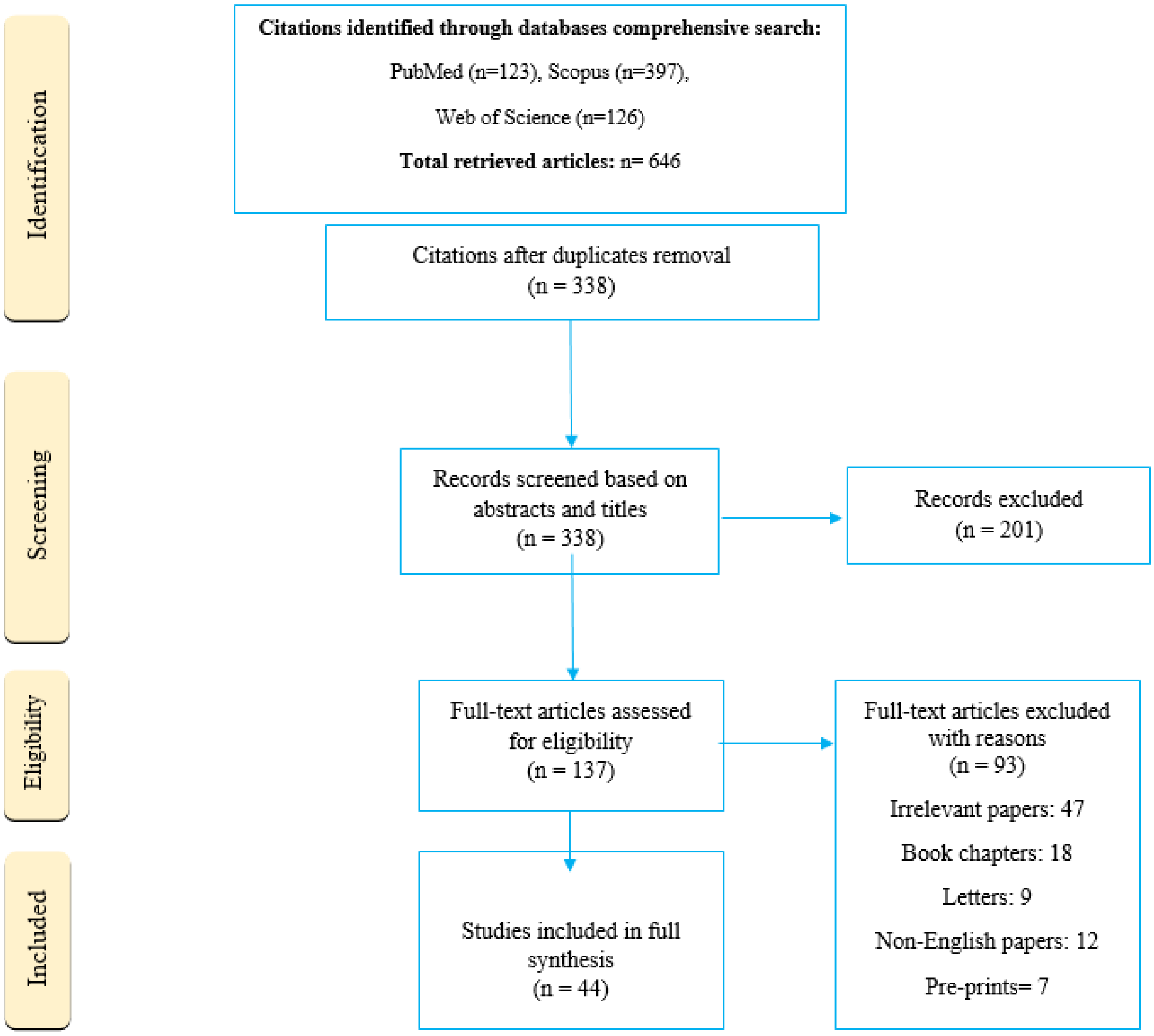

Figure 1 The flowchart for the records search and study selection

through different routes such as telephone lines, mailing lists, and video conferencing. Teleconsultation may go beyond simple counseling and may even involve treatment (24). The transmission of images and information through communication channels and providing a teleconferencing environment is known as the core of mobile consulting. The advantages of using telemedicine approaches in emergency medical services, especially in natural disasters, have been reported to be very effective (25).

3.2.1.2. Tele-education

Today, it has become clear that an efficient and effective infrastructure in healthcare requires access to experience staff and advanced equipment to train specialist groups and general public. Education can increase the detection of diseases in the early stages and reduce the need for medical intervention (14, 19). Telemedicine inherently provides a good platform for teaching and learning services. Tele-education includes distance education, access to distance information, and health education at the community level. Some of the outcomes of tele-education in natural disaster-stricken areas include; increasing the awareness of affected communities in health care and improving the exchange of information between health centers and specialists in the fields (11, 25, 26).

3.2.1.3. Remote interpretation

Remote interpretation is a subset of telemedicine (the storage and sending type), which involves storing images and other data in one place and transferring them to other centers for interpretation. Areas may include radiography (teleradiology), teleophthalmology, telepathology and telecardiology.

A. Teleradiology is by far the largest field of remote interpretation and the largest field of telemedicine. With the development of imaging and communication archive system that receives, stores, transmits and displays digital radiology images, the line between remote radiology and traditional

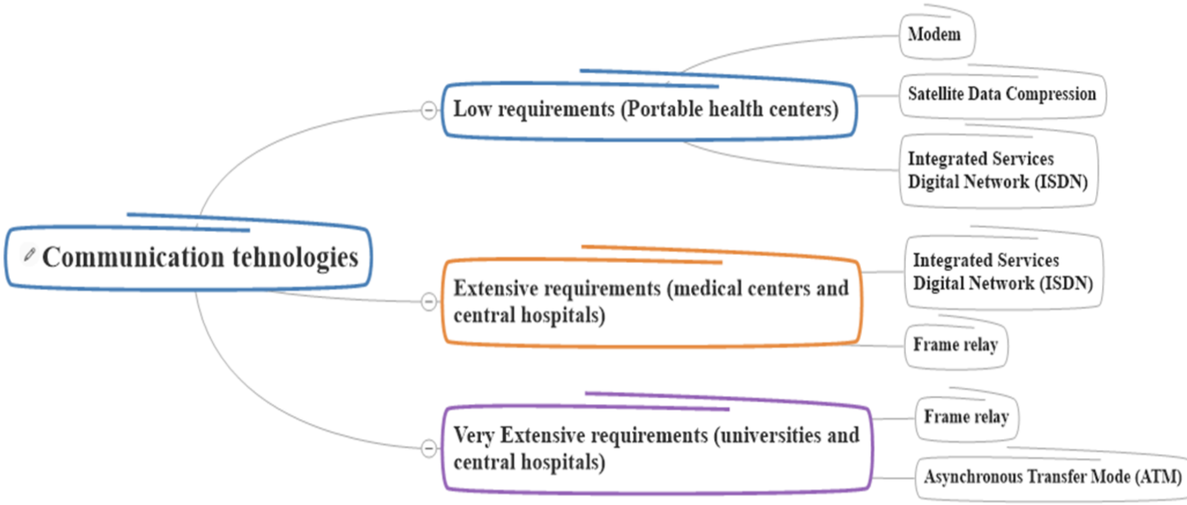

Figure 2 Minimum communication technologies

radiology has become blurred (13, 27, 28).

B. Telepathology can be divided into three groups according to the organization and interaction of images: 1) Static telepathology, which is performed by fixed images sent in different ways. 2) Kinetic telepathology, which includes the ability to monitor the microscope at a distance instead of sampling (full resolution images are sent either statically or live, or both simultaneously). 3) Dynamic telepathology, which includes the second part plus the possibility of having color images without simultaneous compression (17, 21, 22, 29-31). The requirements of this system include; 1) multimedia database for storage, 2) color images with sufficient resolution, 3) active color control (at least knowledge of color theory is needed to understand different instantaneous answers with gamma correction), and 4) controlled sampling (sampling performed by another person or spontaneous sampling), (21, 32, 33).

C. Telecardiology: Today, patients use small devices to send their heart signals to medical centers. The telemetry system that operates in this field transfers information in three stages of generating signals (electrical, etc.), transmitting information, and converting information into interpretable form and improving the information (10, 18, 37).

3.2.1.4. Telepsychiatry

Telepsychiatry is defined as the provision of psychological care and the exchange of mental care information in remote and disaster-stricken areas, which, like other branches of telemedicine, is done in three ways: 1) storage and sending, 2) real-time and 3) hybrid (combination of the previous two methods), (24, 26, 34). One of the benefits of telepsychiatry is the provision of counseling in psychiatric emergencies. Since the morale of victims is very low during disasters, the use of these remote services is considered to be very important (14).

3.2.1.5. Telesurgery

Surgeon robots: For remote surgery, medical images taken from the patient must be scanned, digitized, and then sent to the physician (35). After sending medical images and vital signs to the physician and the physician's complete diagnosis, a satellite connection is established between the specialist and the injured person (3, 20, 36). The physician receives images of the patient in real-time. Under the control of a specialist, the robot arms begin the surgery immediately. The environment should be away from any shaking and vibrations during the surgery. The arms should be perfectly precise and intelligent, and the telecommunication platform should have a high speed (27).

3.3. Communication technologies for telemedicine services

Telemedicine applications are based on audio and video conferencing, multimedia communications, and data transmission with low, medium, and wide bandwidth equipment. Communication technologies are divided into three categories. Figure 2 presents the minimum communication technologies. The minimum requirements of telemedicine-based system for providing emergency services are given in Table 2 (2, 22, 37-40).

- Communication for video conferencing - (Integrated Services Digital Network: ISDN) and Satellite networks)
- Data transfer between medical centers and hospitals (radiographic images)
- Data transfer between physicians and other people at the same time in the form of conversation (The Global System for Mobile Communications: GSM) and (General Packet Radio Service: GPRS)
- Application for portable hospitals (satellite systems, mobile networks and GSM) (3, 10, 12, 41).

3.4. Advantages of using telemedicine in disaster-stricken areas

The primary purpose of telemedicine is to provide high-quality health care to people who do not have access to ser-

Table 2 Minimum requirements of telemedicine-based system development in natural disasters

Minimum requirements	Descriptions
Data server: data analysis, storage, data manipulation, archiving, and other tasks using client/server architecture (32, 37).	A database server performs tasks such as data analysis, storage, data manipulation, archiving, and other tasks.
Personal identification tools (31, 34, 53).	Patients, doctors and nurse's authentication tool like voice Recognition, fingerprint scanning, facial recognition.
The receiver module (14, 21)	Tiny electronic device used to transmit and/or receive signals between various devices.
Wireless scales (18, 39, 42).	Asymmetric Digital Subscriber Line (ADSL), Fiber-optic network, Cellular Mobile Communication, 3G-Wideband Code Division Multiple Access, CDMA2000, CDMA-evdo, 4G Long Term Evolution (LTE).
Display tools (30, 34, 54, 55).	Laptop, Smart tablet, Smart phone, Personal digital assistant
Conversation tools (15, 30, 31, 42, 55).	Web camera, telephone, High-quality cameras
Blood Pressure meter (11, 26, 30, 34, 49).	A sphygmomanometer, also known as a blood pressure monitor, or blood pressure gauge, is a device used to measure blood pressure.
Respiratory Rate meter (11, 26, 30, 34, 49).	The respiration rate is the number of breaths a person takes per minute.
Spo2 sensor meter (10, 18, 34).	Pulse oximetry is a noninvasive test that measures the oxygen saturation level of blood.
Glucometer (36, 37, 44).	A "glucometer", is a medical device for determining the approximate concentration of glucose in the blood.
Portable Ultrasonographic unit (30, 38, 48).	A modality of medical ultrasonography that utilizes small and light devices which can move in emergency situation.
Wearable thermometers (13, 32, 37).	Smart devices for measuring body temperature.
Virtual stethoscopes (22, 27, 46, 50).	It functions like a regular stethoscope and Otoscope except they plug into smartphone or tablet to be used during emergency situations.
Portable three-leads electrocardiograph monitor Benner.	An ECG with only 3 electrodes has three leads.
Digital otoscopes (15, 46, 52).	A portable digital camera is applied to view a patient's ear canal through the micro-camera in the device's tip.

vices due to environmental conditions. The advantages of using and developing telemedicine are categorized into four main categories, which are given in Table 3 (5, 27, 28, 30, 37, 42).

3.5. Using telemedicine services at different times after the natural disaster

Diverse types of telemedicine techniques have various applications in different time periods in the face of disasters.

1) Short-term:

Providing diagnostic-therapeutic services for 72 hours after the disaster: It is preferable to use emergency programs during this period, including emergency surgeries, to rescue the injured and restore vital signs (25, 34, 38). Two-way interactive television (TWIV) is a tool that is used in cases where face-to-face counseling is needed. This method is considered for short-term emergency surgeries in cases where we do not have access to a specialist (3, 33).

2) Medium term:

From 72 hours to one week is considered a medium-term service period. During this period, the injured are undergoing surgery and non-emergency treatment. Store and forward methods are used to transmit and interpret digital images. This method is usually used in non-emergency situations, so that a diagnosis is made with consultation within 48 hours of the disaster (5, 7, 33, 43). In times of crisis in the face of natural disasters, satellite communications can be a reliable and accessible communication tool that is fully efficient, regardless of the severity of accidents and damage (10).

3) Long-term:

It lasts from a week to months and even years until the community's various activities are re-established (5). During this period, the process of rehabilitation and recovery of the injured is performed. In this time, telemedicine can provide a variety of routine medical advice to affected areas. Two-way interactive television (TWIV), in the long run, is employed to rehabilitate the injured, both physically and mentally (44, 45).

3.6. Ethical considerations of using telemedicine in disasters

3.6.1. The relationships between patients and care providers

Given that traditional medicine is based on the physician-patient relationship, personal and confidential relationships have many socio-cultural effects on the patient (20, 33, 46). Therefore, in all types of telemedicine services, the nature of patient-physician confidential relationship may be compromised. In the event of a natural disaster, direct contact with the service provider may not be established (47). Thus, in a natural disaster, in the case of using telemedicine services and the physical distance between the patient and

Table 3 The benefits of using and developing natural disaster telemedicine

Key factors	Sub-factors
Reduce in costs	- Cost-effective service delivery
Reduce treatment time	- Reduce waiting times for victims to receive treatment - High speed in providing services to the injured patients - Ability to provide services regularly without wasting time
Expand access	- Availability of facilities for specialists to guide examinations and care in natural disaster-stricken areas - Better access to physicians and specialists for treatment advice - Reduce the transfer of the injured to distant medical centers
Improve the quality of treatment	- Improving the quality of medical care for the injured - Primary health education for people in natural disaster-stricken areas - Reduce the psychological stress of the victims and survivors of the disaster - Reduction of patients' anxiety and depression - Patient satisfaction improvement - Morbidity reduction

Table 4 Limitations of studies and obstacles of telemedicine in natural disaster

Reported limitation or obstacles	References
Lack of access to technology	(9), (46), (3), (34), (48)
Poor technology related literacy	(32), (38), (47), (46), (49)
Infrastructural deficient	(40), (27), (38), (34)
Poor reimbursement system	(56), (52), (55), (20)
Lack of legislation and policy in telemedicine	(24), (53), (45)
Lack of sufficient systems	(27), (27), (11)
Lack of clear guideline on reimbursement for primary and secondary care services	(40), (49), (2)
Insufficiently robust internet connections	(53), (37), (19)
Bandwidth limitations	(27), (34)
Security and privacy concerns: protecting medical data	(37), (55)

the doctor, the psychological distance between the two is also considerable (34).

3.6.2. Equal access to all telemedicine services

One of the first demands for setting up telemedicine in natural disaster-stricken areas is to provide high-bandwidth technology infrastructure such as Internet. Considering that disasters, network infrastructures, and technological-based requirements may be destroyed in natural disaster, applying telemedicine services is definitely challenging (11, 18, 31, 38). Therefore, health care providers should consider the inconsistency the lack of telemedicine-based technologies for a while.

3.6.3. Involvement of all people (dignity)

All people in the natural disaster-stricken areas (end users) such as patients and physicians should be involved in using telemedicine services and trust these services (10, 17).

3.6.4. Resources/standards for care and treatment

Providers of telemedicine services in natural disaster-stricken areas need to effectively understand the limited resources of concerned communities and use common remote care standards (11, 16, 38).

3.6.5. Confidentiality and privacy

HIPPA rules and regulations protect the principles of safe implementation of telemedicine services in any disaster-stricken area (48). However, in a disaster, privacy and confidentiality standards may be violated by the service providers (13, 19). Nevertheless, in any case, the nature of telemedicine is to reduce the potential risks of privacy and confidentiality and develop robust strategies.

3.6.6. Full authority to patients in the event of disasters (autonomy)

All patients have the right to make informed decisions about their care process, including a proper understanding of the function of telemedicine (6). By choosing a treatment-diagnostic method (based on telemedicine or traditional), each patient can maximize his / her benefit from care and treatment and minimize the burden imposed on the medical system in critical situations (33, 37, 48).

3.6.7. Establishing justice and equality among victims

The occurrence of disasters leads to severely limited resources. Telemedicine in catastrophic conditions determines the fair distribution of health care resources between the affected people (7, 18, 34). Telemedicine service providers decide how to distribute specific resources in natural disaster-stricken areas, such as providing specialty-oriented tele-consultation services, due to infrastructure constraints and lack of access to technology (24, 26, 49).

3.6.8. Non-maleficence

Risks in disaster telemedicine include; involving unauthorized health care providers, leaving the patient after consecutive visits, using technology for commercial purposes, doctors' irresponsibility in decision making, misdiagnosis, and taking decisions incorrectly by specialist (17, 24, 26, 31, 49).

3.6.9. Truthfulness and loyalty of health care providers in telemedicine

Telemedicine-based medical care services in the event of natural disasters should be provided in good faith to all patients involved and the affected community. In a resource-constrained environment, the loyalty of treatment team to the use of telemedicine services leads to the use of all available resources in the best way to treat traumatized patients (12, 46, 50, 51).

3.7. Limitations and challenges of using telemedicine in natural disasters

Although the effectiveness of telemedicine in disaster management is crystal clear, there are many obstacles in this regard. While almost every article included in this study made at least one point about how helpful telemedicine is, some of them also declared what it costs to get to the place where they actually are, or why they already are not a part of health care systems in disasters. Table 4 indicates the limitation of using any form of telemedicine in disaster management.

4. Discussion

Immediate action in natural disasters is made possible by using telecommunications and information technologies. The main goal of telemedicine is to provide high-quality services to help damaged and injured patients and provide optimal treatment in the shortest possible time. The main purpose of this article is to introduce the types of telemedicine services, uses, benefits, challenges, and ethical considerations of using telemedicine services. Telemedicine deals with different types of medical information and different forms of communication technologies. Information sharing through audio, visual, and data-oriented services is among critical approaches that telemedicine services mainly use (51).

The results of related articles show that tele-consultation, tele-education, remote interpretation, tele-psychiatry, and tele-surgery are among telemedicine services that can be used in emergencies like natural disasters (6, 19). The essential requirements of a telemedicine-based system for providing emergency services include wireless scales, conversation tools, blood pressure monitor, respiratory rate monitor, spo2 sensor, glucometer, portable ultrasound unit, wearable thermometers, virtual stethoscopes, portable three leads electrocardiograph monitor, and digital otoscopes (6, 19). Accordingly, the general framework for telemedicine in natural disasters is outlined in Figure 3.

As expected, the use of telemedicine services in the event of natural disasters has many challenges and obstacles, including the lack of familiarity with telemedicine technology, the need for complex technical and electronic infrastructure, high cost of equipment, methods of information security, the need for legal methods for pursuing errors (5, 33, 41, 50) and negligence of telemedicine, issues related to insurance companies, patients' fear in using this method, fear of some physicians, and the occurrence of medical errors (23).

Preserving privacy and confidentiality in patient care in telemedicine at disaster settings may be challenged (4, 5, 33, 41, 50). The telemedicine interface can pose risks to both privacy and confidentiality in patient care. In a complex telemedicine scenario, the requirements and responsibilities are alternately divided between the telemedicine consultant and the local physician (11). These services must be provided in a private environment via a digital line. The consumer should be adequately educated about the nature and purpose of the tools used, and also the possibility of leaking confidential information to patients using these tools. The lack of legal and ethical standards decreases the success of telemedicine and electronic medicine in natural disasters (43, 52, 57). Therefore, health organizations and governments must be able to act under ethical principles within the set standards, and also privacy and confidentiality considerations must also be respected (48).

5. Conclusion

Due to the increasing development of information and communication technology and its application in the medical industry, telemedicine technology is one of the topics of information and communication technology in medicine that has many benefits for service providers and consumers in society. Simple telemedicine systems can often bring benefits in the event of disasters. The main challenge is to adapt the necessary communication systems to a telemedicine paradigm. Another critical challenge is to interpret and apply the summary of acquired information and the inevitable interaction outcomes at the required time and place. Planning for telemedicine should commence before the occurrence of a disaster. Mobile technology can be adjusted to regional demands, and training exercises should involve the participation of local healthcare providers. At post-disaster time, resource constraints, loss of medical communications and infrastructure, limited access to assets, and lack of trained local personnel are significant barriers to telemedicine use.

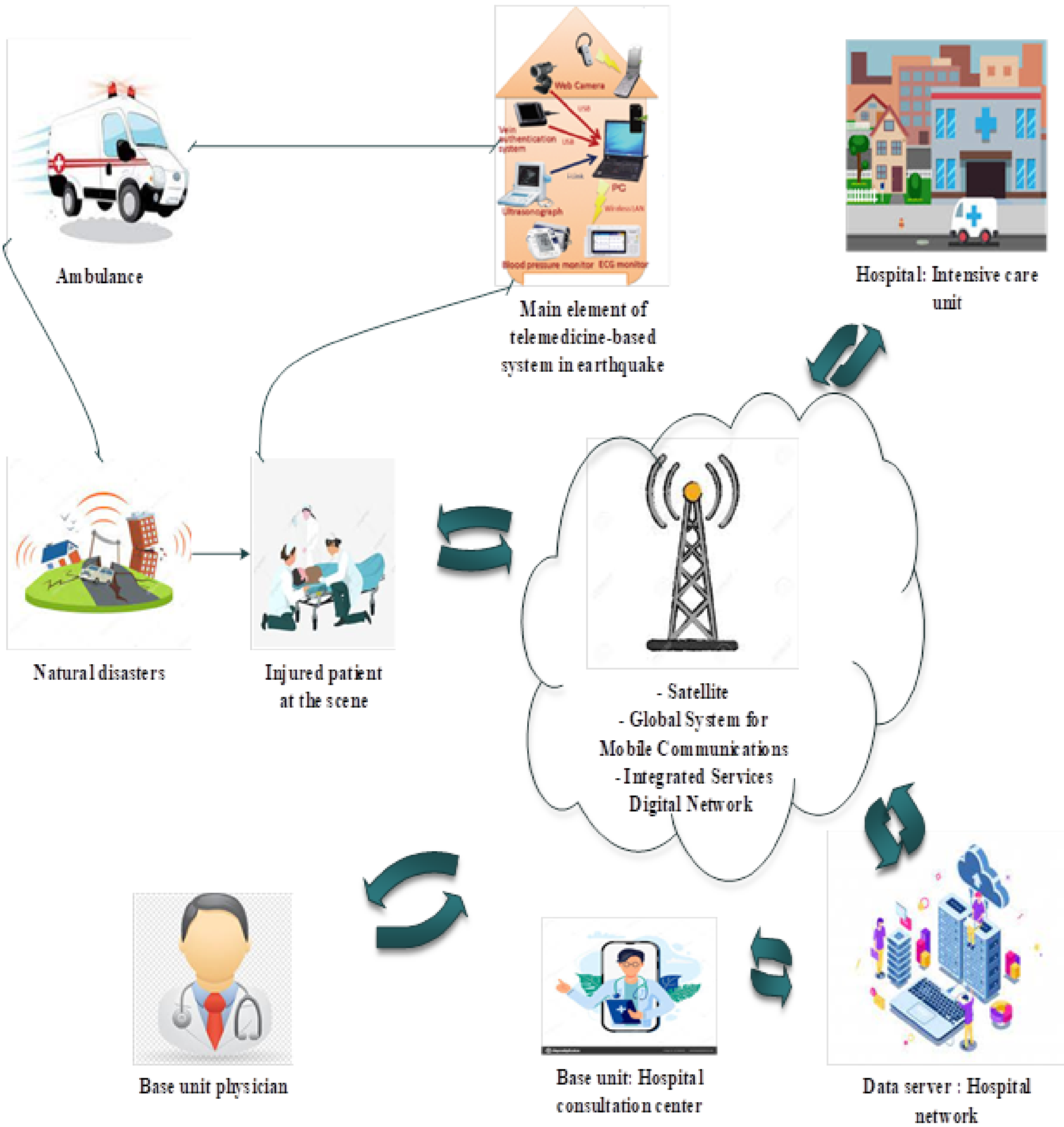

Figure 3 The general framework for the application of telemedicine in natural disasters

6. Declarations

6.1. Acknowledgment

This research was supported by Tehran University of Medical Sciences.

6.2. Authors' contributions

NM and SR designed the narrative review, search strategy and conducted database searches. SR and SS conducted article screenings under NM supervision. SR carried the analysis and interpretation under NM supervision. Finally, NM, SR, and SS drafted the manuscript. All authors reviewed the content and approved it.

6.3. Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

6.4. Funding

In this paper, we didn't have any financial sponsors.

References

1. Anwar S, Prasad R, Chowdhary BS, Anjum MR. A telemedicine platform for disaster management and emergency care. Wirel Pers Commun. 2019;106(1):191-

204.
2. Baek J, Simon-Friedt B, Lopez A, Kolman JM, Nicolas J, Jones SL, et al. Assessing Patient Needs During Natural Disasters: Mixed Methods Analysis of Portal Messages Sent During Hurricane Harvey. J Med Internet Res. 2021;23(9):e31264.
3. Callaway DW, Peabody CR, Hoffman A, Cote E, Moulton S, Baez AA, et al. Disaster mobile health technology: lessons from Haiti. Prehosp Disaster Med. 2012;27(2):148-52.
4. Augusterfer EF, Mollica RF, Lavelle J. A review of telemental health in international and post-disaster settings. Int Rev Psychiatry. 2015;27(6):540-6.
5. Bhardwaj A, Subba P, Rai S, Bhat C, Ghimire R, Jordans MJD, et al. Lessons learned through piloting a community-based SMS referral system for common mental health disorders used by female community health volunteers in rural Nepal. BMC Res Notes. 2020;13(1):309.
6. Benner T, Schachinger U, Nerlich M. Telemedicine in trauma and disasters–from war to earthquake: are we ready? Stud Health Technol Inform. 2004;104:106-15.
7. Benner T, Schaechinger U, Nerlich M. Medical telematics in disaster response. Stud Health Technol Inform. 2003;97:15-23.
8. Augusterfer EF, O'Neal CR, Martin SW, Sheikh TL, Mollica RF. The Role of Telemental Health, Tele-consultation, and Tele-supervision in Post-disaster and Low-resource Settings. Curr Psychiatry Rep. 2020;22(12):85.
9. Mitsusada M, Osaka I, Koga N, Yamazaki T. Aerotransportaion and Telemedicine of the Injured Patients from Remote Volcanic Islands. Prehosp Disaster Medicine. 2002;17(S1):S20-1.
10. Raghavendra S, Santosh KJ. Performance evaluation of random forest with feature selection methods in prediction of diabetes. Int J Electr Comput Eng. 2020;10(1):353-9.
11. Wang H, Xiong W, Hupert N, Sandrock C, Siddiqui J, Bair A. Concept of operations for a regional telemedicine hub to improve medical emergency response. InProceedings of the 2009 Winter Simulation Conference (WSC) 2009 Dec 13 (pp. 2809-2819). IEEE.
12. Doarn CR, Barrigan CR, Poropatich RK. Application of health technology in humanitarian response: U.S. military deployed health technology summit-A summary. Telemed J E Health. 2011;17(6):501-6.
13. Carrasco AE, Moessner M, Carbonell CG, Rodriguez C, Martini N, Perez JC, et al. SIN-E-STRES: An adjunct Internet-based intervention for the treatment of patients with posttraumatic stress disorder in Chile. Revista Ces Psicologia. 2020;13(3):239-58.
14. Cenname G, D'Ambrosio I, Ajello C. Teleradiology: case series and experience acquired in the military field. La Radiologia medica. 2013;118(4):688-99. [Article in Italian]
15. Houtchens BA, Clemmer TP, Holloway HC, Kiselev AA, Logan JS, Merrell RC, et al. Telemedicine and international disaster response: medical consultation to Armenia and Russia via a Telemedicine Spacebridge. Prehosp Disaster Med. 1993;8(1):57-66.
16. Latifi R, Tilley EH. Telemedicine for disaster management: can it transform chaos into an organized, structured care from the distance? Am J Disaster Med. 2014;9(1):25-37.
17. Yu JN, Brock TK, Mecozzi DM, Tran NK, Kost GJ. Future connectivity for disaster and emergency point of care. Point Care. 2010;9(4):185-92.
18. Yambe T, Shibata M, Sumiyoshi T, Mibiki Y, Osawa N, Katahira Y, et al. Medical responses following the sendai quake (East Japan earthquake, March 11, 2011). Artif Organs. 2012;36(8):760-3.
19. Benner T, Röckelein W, Perk A, Nerlich M, Schaechinger U. Opportunities of medical telematics in disaster medicine. Intensiv- und Notfallbehandlung. 2004;29(2):94-102.
20. Burke RV, Berg BM, Vee P, Morton I, Nager A, Neches R, et al. Using robotic telecommunications to triage pediatric disaster victims. J Pediat Surg. 2012;47(1):221-4.
21. Chang T, Lee J, Wu S. The telemedicine and teleconsultation system application in clinical medicine. Conf Proc IEEE Eng Med Biol Soc. 2004;2004:3392-5.
22. Doarn CR, Merrell RC. Spacebridge to armenia: a look back at its impact on telemedicine in disaster response. Telemed J E Health. 2011;17(7):546-52.
23. Balch D, Taylor C, Rosenthal D, Bausch C, Warner D, Morris R. Shadow bowl 2003: A collaborative exercise in community readiness, agency cooperation, and medical response. Telemed J E Health. 2004;10(3):330-42.
24. Tanaka K, Ono T, Takemoto T, Kimura H, Harada M, Iida M, Nakajima I. Proposal of high-definition digital video IP transmission application on emergency satellite network at disaster areas. InHEALTHCOM 2006 8th International Conference on e-Health Networking, Applications and Services 2006 Aug 17 (pp. 9-12). IEEE.
25. Yoshizawa M, Yambe T, Sugita N, Konno S, Abe M, Homma N, et al. Application of a Telemedical Tool in an Isolated Island and a Disaster Area of the Great East Japan Earthquake. IEICE Trans Commun. 2012;E95B(10):3067-73.
26. Yuliastuti GE, Alfiyatin AN, Rizki AM, Hamdianah A, Taufiq H, Mahmudy W. Performance Analysis of Data Mining Methods for Sexually Transmitted Disease Classification. Int J Electr Comput Eng. 2018;8(5):3933-9.
27. Cadger F, Curran K, Santos J, Moffett S. Location and mobility-aware routing for multimedia streaming in disaster telemedicine. Ad Hoc Networks. 2016;36:332-48.
28. Chai JK, Li TS. Professional technology being reached to the field, so that traumatic treatment level is elevated in earthquake. Zhonghua wei zhong bing ji jiu yi xue. 2013;25(5):268-9. [Article in Chinese]

29. Garshnek V, Burkle Jr FM. Applications of telemedicine and telecommunications to disaster medicine: historical and future perspectives. J Am Med Inform Assoc. 1999;6(1):26-37.
30. Meinander H, Honkala M. Potential applications of smart clothing solutions in health care and personal protection. Stud Health Technol Inform. 2004;108:278-85.
31. Nejadshafiee M, Nekoei-Moghadam M, Bahaadinbeigy K, Khankeh H, Sheikhbardsiri H. Providing telenursing care for victims: a simulated study for introducing of possibility nursing interventions in disasters. BMC Med Inform Decis Mak. 2022;22(1):54.
32. Chen XL, Lu L, Shi J, Zhang X, Fan HJ, Fan B, et al. Application and Prospect of a Mobile Hospital in Disaster Response. Disaster Med Public Health Prep. 2020;14(3):377-83.
33. Chronaki CE, Berthier A, Lleo MM, Esterle L, Lenglet A, Simon F, et al. A satellite infrastructure for health early warning in post-disaster health management. Stud Health Technol Inform. 2007;129(Pt 1):87-91.
34. Pasipanodya EC, Shem K. Provision of care through telemedicine during a natural disaster: a case study. Spinal Cord Ser Cases. 2020;6(1):60.
35. Jimmy NY, Brock TK, Mecozzi DM, Tran NK, Kost GJ. Future connectivity for disaster and emergency point of care. Point Care. 2010;9(4):185-92.
36. Gul S, Ghaffar H, Mirza S, Fizza Tauqir S, Murad F, Ali Q, et al. Multitasking a telemedicine training unit in earthquake disaster response: paraplegic rehabilitation assessment. Telemed J E Health. 2008;14(3):280-3.
37. Doarn CR, Latifi R, Poropatich RK, Sokolovich N, Kosiak D, Hostiuc F, et al. Development and Validation of Telemedicine for Disaster Response: The North Atlantic Treaty Organization Multinational System. Telemed J E-Health. 2018;24(9):657-68.
38. Hamilton K, Keech JJ, Peden AE, Hagger MS. Protocol for developing a mental imagery intervention: A randomised controlled trial testing a novel implementation imagery e-health intervention to change driver behaviour during floods. BMJ Open. 2019;9(2):e025565.
39. Perez-Ramos JG, McIntosh S, Barrett ES, Velez Vega CM, Dye TD. Attitudes Toward the Environment and Use of Information and Communication Technologies to Address Environmental Health Risks in Marginalized Communities: Prospective Cohort Study. J Med Internet Res. 2021;23(9):e24671.
40. Radcliff TA, Chu K, Der-Martirosian C, Dobalian A. A model for measuring ambulatory access to care recovery after disasters. J Am Board Fam Med. 2018;31(2):252-9.
41. Doarn CR, Merrell RC. Telemedicine and e-health in disaster response. Telemed J E Health. 2014;20(7):605-6.
42. Yuen EK, Gros K, Welsh KE, McCauley J, Resnick HS, Danielson CK, et al. Development and preliminary testing of a web-based, self-help application for disaster-affected families. Health Inform J. 2016;22(3):659-75.
43. Andrews RJ, Quintana LM. Unpredictable, unpreventable and impersonal medicine: Global disaster response in the 21st century. EPMA J. 2015;6(1):2.
44. Fan KL, Avashia YJ, Dayicioglu D, Degennaro VA, Thaller SR. The efficacy of online communication platforms for plastic surgeons providing extended disaster relief. Ann Plast Surg. 2014;72(4):457-62.
45. Fatehi F, Taylor M, Caffery LJ, Smith AC. Telemedicine for clinical management of adults in remote and rural areas. 2019. [https://doi.org/10.1002/9781119282686.ch26].
46. Etienne M, Alessi AG. Disaster neurology: A new practice opportunity and challenge for the neurologist. Neurol Clin Pract. 2013;3(6):493–500.
47. Litvak M, Miller K, Boyle T, Bedenbaugh R, Smith C, Meguerdichian D, et al. Telemedicine use in disasters: a scoping review. Disaster Med Public Health Prep. 2021; Online ahead of print.
48. Tedeschi C. Ethical, legal, and social challenges in the development and implementation of disaster telemedicine. Disaster Med Public Health Prep. 2021;15(5):649-56.
49. Nicogossian AE, Doarn CR. Armenia 1988 earthquake and telemedicine: lessons learned and forgotten. Telemed J E-Health. 2011;17(9):741-5.
50. Gulzari A, Tarakci H. A healthcare location-allocation model with an application of telemedicine for an earthquake response phase. Int J Disaster Risk Reduct. 2021;55:102100.
51. Doarn CR, Latifi R. Telemedicine and Disaster Response–An Historical Review. InA Multinational Telemedicine Systems for Disaster Response: Opportunities and Challenges 2017 (pp. 1-13). IOS Press.
52. Ferranti L, D'oro S, Bonati L, Cuomo F, Melodia T. HIRO-NET: Heterogeneous Intelligent RObotic Network for Internet sharing in Disaster Scenarios. IEEE Transactions on Mobile Computing. 2021 May 6.
53. Grover JM, Smith B, Williams JG, Patel MD, Cabanas JG, Brice JH. Novel Use of Telemedicine by Hurricane Evacuation Shelters. Prehosp Emerg Care. 2020;24(6):804-12.
54. Gogia SB, Maeder A, Mars M, Hartvigsen G, Basu A, Abbott P. Unintended consequences of tele health and their possible solutions. Yearb Med Inform. 2016;(1):41-6.
55. Murren-Boezem J, Solo-Josephson P, Zettler-Greeley CM. A Pediatric Telemedicine Response to a Natural Disaster. Telemed J E-Health. 2020;26(6):720-4.
56. Rajkumar KV, Yesubabu A, Subrahmanyam K. Fuzzy clustering and Fuzzy C-Means partition cluster analysis and validation studies on a subset of CiteScore dataset. Int J Electr Comput Eng. 2019;9(4):2760-70.
57. Chaet D, Clearfield R, Sabin JE, Skimming K. Ethical practice in Telehealth and Telemedicine. J Gen Intern Med. 2017;32(10):1136-40.