



Review Article

Telemedicine in Emergencies, High-Risk Zones, and Remote Access Regions: A Review

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Abstract

Problem: Access to healthcare remains a major challenge during emergencies, disasters, armed conflicts, and in geographically remote or hard-to-reach areas, where inadequate infrastructure, transportation, and healthcare resources frequently delay or prevent timely medical intervention, resulting in increased morbidity, mortality, and adverse physical, psychological, and social outcomes. **Objective:** To review the scientific evidence on the role of telemedicine in improving healthcare delivery in emergencies and high-risk or difficult-access settings, with emphasis on healthcare accessibility, continuity of care, and health system resilience. **Methodology:** A narrative literature review was conducted using peer-reviewed scientific publications on telemedicine in emergency care, disaster response, humanitarian crises, and remote healthcare delivery, focusing on the integration of Information and Communication Technologies (ICT) into health services. **Results:** The evidence shows that telemedicine improves access to healthcare by enabling remote consultation, diagnosis, patient monitoring, and clinical decision-making. It reduces geographical, economic, and logistical barriers, supports timely interventions, ensures continuity of care, optimizes healthcare resource allocation, and strengthens emergency response capacity, particularly where conventional healthcare services are disrupted by disasters, conflicts, poor transportation infrastructure, or shortages of healthcare professionals. **Conclusions:** Telemedicine is an effective and innovative strategy for healthcare delivery in emergencies and difficult-access areas. ICT integration enhances service accessibility, quality of care, patient outcomes, and health system resilience. **Recommendations and Future Work:** Expanding telemedicine requires investment in digital infrastructure, telecommunications, regulatory frameworks, and workforce training. Future research should evaluate the long-term effectiveness, cost-effectiveness, implementation challenges, and equity of telemedicine across diverse healthcare settings, especially in low- and middle-income countries.

Keywords

Telemedicine, Disaster, Emergency Medical Center Advanced, Information System

1. Introduction

With the evolution of knowledge in the area of providing medical care to patients, the difficulties that nature sometimes

presents us with, and the ever-increasing need to provide well-being to patients, scientists, manufacturers, and healthcare

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Received: 14 July 2026; Accepted: 27 July 2026; Published: 9 October 2026



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professionals seem to be more determined. that never before in the promotion of health, prevention and treatment of diseases, thus guaranteeing the quality of life of citizens, taking advantage of technological development both for purely clinical purposes and also to exchange information and experiences among health professionals

The healthcare sector seems to have much to gain with technological development. Currently, more than ever, the use of ICT in the provision of medical care has demonstrated many advantages. Unlike traditional methods, medical interventions in times of natural disasters and rescue emergencies are possible thanks to the use of ICT. With the revolution in communication networks Internet in recent years, It has brought added value to the exchange of clinical information and facilitated TM practices, reducing waiting times for care, significantly contributing to resource savings for users and consequently saving lives. mainly in areas rural communities deprived of developing countries, as well as in areas at risk/difficult to access, natural disasters and wars [1, 2, 5].

Telemedicine is not a recent innovation in healthcare, as various forms of remote communication have historically been used to support healthcare delivery across different societies. In African communities, including the Bijagós ethnic group of Guinea-Bissau, traditional communication tools such as Bombolom drums, animal horns, and palm leaf signals were employed to transmit messages and facilitate remote guidance, including health-related instructions. Although the exact origin of telemedicine remains uncertain, its evolution reflects the continuous adaptation of available communication technologies to overcome geographical barriers and improve access to healthcare.

Today, telemedicine integrates healthcare professionals with Information and Communication Technologies (ICT) to provide remote diagnosis, treatment, prescriptions, patient monitoring, health education, disease prevention, and health system management, thereby expanding access to quality healthcare regardless of distance or accessibility constraints [3, 4].

The definition of TM depends on who defines it and the area of... Its application, as it continues to evolve over time, lacks a conclusive definition. Being a remote healthcare service, it needs to be able to overcome some of the barriers that still exist. Practice doctor traditional requires A team effort among healthcare professionals, including doctors, nurses, assistants, administrators, etc., and the use of telemedicine are essential, especially when it comes to emergencies. It is extremely important to have a team. multidisciplinary of administrators, nurses, Doctors, paramedics, drivers, pilots, security guards, etc... saving lives in emergency situations goes beyond individual capabilities, so it is important to have a dynamic team capable of coordinating its activities with the common goal of saving lives. that at the moment need to be saved, knowing how to locate patients in record time and carry out the work of providing care, the team on the ground may also lack specialists, as is most of the time, so remotely located teams must be

securely connected to emergency teams through uninterrupted communication channels, avoiding information disruption that can compromise the credibility of information and negatively affect the provision of care to users [3, 6, 7].

Providing remote medical care, such as telemonitoring, telesurgery, teledermatology, teleradiology, teleconsultation, and videoconferencing among healthcare professionals, are all practices of healthcare professionals using ICT to perform work remotely. The combination of these tasks, or the way these types of tasks are performed, gave rise to a branch of medical activities that is now known as Telemedicine [8].

The aim of this review is to highlight, or reinforce for the general public and the scientific and medical community, the importance of applying technologies in the health field to solve problems that traditional medical practices have been unable to address.

2. Materials and Methods (Methodology)

The following methods were used to prepare this review article:

Searched in Google Scholar (scientific articles and academic papers) that deal with Querys: Emergencies, risk and difficult access areas, history, evolution, advantages, and challenges of using telemedicine in Low-Income Countries.

2.1. Results of the Search

The search for articles included in this review was done in 4 different databases:

Identification

(PubMed=34 artigos), utilizando os seguintes queries: (((Telemedicine) AND (Challenges)) AND (Advantages)) AND (Low-income countries).

Google scholar (1415 articles) - Telemedicine: advantages and challenges

RCAAP (8 articles) - Telemedicine advantages and challenge

SciELO (3 articles) - Use of telemedicine in an emergency context

In total, 1460 articles were found.

Screening

Of the 1460 articles found, 157 were retained after filtering complete and open access review articles, in the brief reading of the titles, 80 were discarded for not corresponding to the theme, thus leaving 77 articles for the next phase.

After reading the abstracts of the 77 articles, 35 were excluded because they were telemedicine in other contexts outside the theme, leaving 42.

Eligibility

After reading the 42 articles in full, 39 were included in the review and the 3 were excluded because they did not present sufficient elements to be included in the study.

Inclusion

Therefore, the 39 articles, because they were more convincing and more informative, were retained and included in the study.

2.2. State of the Art

Telemedicine can be considered as, a medical practice without borders that can be exercised anywhere in the world once the necessary and favorable conditions are created, is practiced today. in war zones or high-risk and difficult-to-access areas. Healthcare professionals can communicate with each other to resolve a patient's health problems or Interact directly with the patient through computer and communication means [9].

In the event of major disasters neither all what provide first aid they are health experts are able to provide basic medical care or even major interventions thanks to telemedicine, interacting with leading specialists in hospital centers remotely, receiving instructions on how to save an individual's life through electronic means of communication, enabling the transmission of images, sounds, and signals [10].

TM enables fast and secure sharing of information between healthcare delivery centers and the healthcare professionals thanks to the development of ICTs, clearly motivated and developed by human thought, make it possible to connect healthcare professionals and... their users, as well as among themselves, in the management of clinical information, even when they are geographically located in healthcare centers. scattered, without the need of the movement of either party is not necessary; in this case, the movement is limited to clinical information and not to patients and healthcare professionals, thus breaking down geographical barriers. making it a cross-border practice for providing care. Fortunately, to date, no type of clinical information has been identified that cannot be transferred via TM. On the other hand, to guarantee the provision of care to users, communication networks must be robust and flexible, of a point-to-point type, available and secure as much as possible, and information should not remain stored in external entities, but rather transferred and stored as quickly as possible in the data repositories of the entities responsible for its security, storage and availability [11].

Improvement and investment in ICTs promoting to foster relationships and facilitate the exchange of information, increasing partnerships, saving time and other economic and financial resources by avoiding unnecessary travel to seek medical care, as well as ensuring communication on all aspects of prevention, control, and intervention in... Timely intervention is one of the problems that TM seeks to solve. This includes identifying, preventing, and resolving healthcare problems more effectively, efficiently, and quickly. and today up to date possible thanks to the advantages of use of the technology that the world has seen in recent times.

In fact, the use of ICTs not only benefits the communications sector, but also the economy by generating not only quality jobs, saving resources, generating advantages in terms of

competitiveness, flexibility in the provision of services and medical care above all in case of emergency, it also facilitates collaboration and strengthens relationships between peoples and services through the admirable speed of information transmission. It allows society to overcome various kinds of deficiencies caused by isolation; the services provided within the scope of mobile technology to needy, isolated, and at-risk populations are a participatory service where opinions, interventions, organizations, and other activities are mostly located remotely thanks to ICTs [12, 13].

All that reality above referenced, only These would be truly possible if there were a willingness to collaborate between the entities that hold "value." The inequality of financial and economic power, the geographical complexities of cities, the unequal distribution of wealth, and many other factors such as armed conflicts, famine, natural disasters, and other emergencies, reveal the need for the development of services at a technological level [14].

Therefore, it can be stated that it is currently impossible to treat a patient without resorting to ICT; this is current practice among healthcare professionals and goes even further, transcending geographical barriers without recognizing borders. in provision of care doctors, since you from the simplest to the most complex, such as remotely guided surgeries.

3. Telemedicine in Disaster or Emergency Zones

Nature seems to be more saturated in recent decades, The world is constantly confronting us with frequent catastrophes, mostly natural ones, and events that are often caused by humankind itself in defence of its often-dubious interests, or due to its weak capacity to control reality. We are referring to... to the wars, accidents collectives etc... In that context, Medicine, as a branch of science, seems increasingly committed to solving the population's health problems. Coupled with the technological boom the world has experienced in recent times, the speed of which is difficult to imagine, medicine continues to reform and develop new ways of... services to patients/users enjoying to the advantages of ICT for providing medical care with Greater efficiency and effectiveness, saving time and resources, increasing knowledge, and spreading forms of care, overcoming geographical barriers and consequently saving many lives [15].

In addition to hospital facilities located in large centers, with TM we can guarantee the provision of care. remotely using information and communication tools to guide doctors, paramedics, or other professionals. remotely located healthcare providers offer medical care.

In reality, it's difficult to find residents for highly qualified doctors or healthcare professionals in rural areas or isolated zones; most, if not all, of them reside in large cities and referral hospitals, leaving those with less qualifications to settle in

the outskirts. But the great truth is that in the event of catastrophes, it is very unpredictable where earthquakes, floods, wars, and accidents might occur. It can happen in large cities. like in the outskirts of cities, things happen randomly. in all part of world, for the what you great healthcare professionals may need assistance. any time depending on the type of emergency you are experiencing [16].

In this case, we can argue that the use of TM (Mobile Tactical Intervention) is important because it safeguards the lives of those who need immediate help, regardless of their qualifications or location, provided, of course, that technological and human resources are available to intervene as quickly as possible [17].

It is very difficult to pinpoint the year when telemedicine practice began, but developed countries have recently experienced a surge in telemedicine, which, in addition to saving resources, also ensures the quality of life of their populations and others.

There are still constant wars, natural disasters, and other types of emergencies that involve many people, most of them innocent civilians, causing deaths, injuries, famine, epidemics, etc. All of these ... In certain situations, what could be the rapid interventions? Effective and efficient ways to save lives? What would a person who is remotely located and without assistance? Without TM, what would the world be like with constant wars and catastrophes? Are natural resources the answer to these questions? These are issues that TM seeks to resolve, for example, in the case of military conflicts where it is very difficult, if not impossible, to gather leading medical specialists on-site to assist the wounded on the battlefield or front lines. Even among the military personnel involved in military operations, there are doctors and nurses, but even so, they all end up being paramedics or healthcare professionals who could only successfully treat their peers in cases of serious injuries through guidance from remotely located specialists, thus ensuring information security. clinic of the injured and ensuring the your evacuation in case of need, TM also guarantees assistance to victims, for example in the event of natural disasters, as can be seen in examples such as floods in Mozambique in recent years, earthquakes and tsunamis, Haiti, etc... [18, 19].

In the event of flooding in Mozambique, the rising water levels of the Limpopo River in different years have caused crop losses, displacement of people living in affected areas, lack of drinking water, food shortages, and the outbreak of epidemics, among other problems. Interventions from the international community were made. in this case in the sector humanitarian aid, specifically in the health sector, thanks to the use of TM [20].

Earthquakes in different parts of the world have caused many deaths and injuries, requiring interventions. Given that rescue teams are comprised of professionals from different areas, including healthcare professionals, the use of telemedicine services to save the lives of those in need is obvious. However, this requires not only technological equipment but

also consideration of crucial aspects such as the installation of advanced first aid posts. These are mostly infrastructures located closer to the scene of incidents, allowing for easier access and movement of healthcare professionals or rescue teams, ensuring maximum safety.

In cases lacking nearby buildings, improvised tents can be used as field hospitals. To achieve this, it's essential to guarantee the safety of both patients and the professionals involved. Advanced medical posts, besides the importance of their safety, should be easy to transport and install, preferably in locations as close as possible to the scene of incidents. In the event of disasters, this allows for the triage of patients and evacuation if necessary. If the case is less complicated, the patient can be stabilized before being evacuated to a final hospital that would continue to monitor their health status [21].

By the law of nature or of life, humanity is not grouped into a single continent, country, city, place of work, or home. Therefore, it is easy to understand that not all... countries They have the same power. Economic or even level development, some located in large cities and others in wealthier countries, some jobs with lower risk and others with higher risk, without taking into account natural disasters such as floods, earthquakes and Wars, as I mentioned above. In this context, it's normal to think about the benefits that TM can bring us as human beings, all exposed to the "tricks" that nature sometimes plays on us.

For example, we can focus on the case of Haiti in 2010, Mozambique in recent decades, Guinea-Bissau in 1998, the attacks on the Twin Towers in the US in 2001, the earthquake and tsunami. in 2004 and many others countries with the majority These are located on the African continent, where political and military instability leads to wars, creating risks for residents and even those involved in military conflicts. In daily activities, professionals need to be accompanied and assisted, when necessary, as the nature of their work exposes them to associated risks. you fishermen of high seas, you miners They can be assisted remotely by doctors and nurses in in case of need [21-23].

Is very important to clarify emergencies and urgencys, because these concepts are often considered one and the same or different, in this work emergency and urgency have different meanings in the interpretation of the same reality or even in the attempt to solve a problem. Urgency refers to the need for intervention as quickly as possible to save the life of someone who needs help at that moment; on the other hand, emergency refers to the intervention and readiness of healthcare professional teams to be at the scene of accidents or catastrophes to save lives with maximum urgency and under the best possible conditions. safe to the lives of the what need of provision Regarding care. In case of emergencies, it is important to have both human and material resources and logistics available to provide emergency care, although telemedicine has received much criticism to this day, but the important thing is that it has contributed to saving lives by reducing mortality among users

or patients located remotely and who have benefited from telemedicine services [24].

4. Advantages and Disadvantages

Can we ask if TM exists all over the world? All of them. Have societies accepted the practice of TM? It is a well-known practice of TM for communities, for example, remote villages of Africa and other so-called third-world countries? Answers to these questions depend on the perception of whoever wants to answer them. Developed countries adopt technology transfer practices not only because they have the conditions to do so, but also because there is a need and the benefits outweigh the costs. It is worth noting that technology transfer is not limited to the borders of the countries that adopt it, but its effects spread to countries and communities that are remotely located, isolated, and unable to adopt it. put several reasons, which is why we can recognize its positive externalities [25-27].

Telemedicine is one of the most evolved sectors in recent times, despite being a practice dating back many centuries, as I mentioned above. For example, in Portugal, it became more noticeable in the 1990s with large investments in sectors not only of health but also of communication, and all of this could not have succeeded without the development and robustness of communication networks, especially the internet. The health sector took advantage of this added value of development, of ICTs to organization and creation of New projects, as always, place the citizen at the center of everything, in contrast to the healthcare professional or the same consultation activity [28].

Based on the above, telemedicine in Portugal has come to be seen as a health subsystem. In this context, when we refer to telemedicine, we are talking about telecare, medical training and consultancy, integration of clinical and administrative information, and public health. in sum one system of information doctor This is aimed not only at healthcare professionals in providing their services to patients, but also at patients themselves, towards a healthy life path through prevention, taking into account the knowledge acquired and developed. The elements involved in the process of providing remote medical care extend from patients/users to doctors, including nurses and other healthcare professionals and administrators, as well as the justice system [28, 29].

Despite presenting all the advantages in the treatment of patients and their clinical information, it also has disadvantages. The use of ICTs in the provision of medical care, as we have been discussing so far, calls into question personal connection, because the trust that the patient has in their doctor is affected. allows expose all relatively to the your state of health, also feels comfort from their doctor, for other reasons. While the patient and doctor create an environment of trust and confidentiality through automated communication (TM), what the patient might discuss with their personal physician ends up being shared with another healthcare professional who is not their doctor. Another disadvantage is that the issue of consent

is called into question. Regarding the costs of acquiring equipment and training personnel, this is one of the... Disadvantages of telemedicine [25].

5. Successes and Guarantees of Telemedicine

A comparison of telemedicine practice output between physicians and paramedics assisted by remotely located physicians reveals no serious flaws, so we can affirm the usefulness of telemedicine. Beyond the results being almost identical to those obtained when telemedicine practice is applied by paramedics or healthcare professionals with less training, levels, and skills, usually assisted by more experienced and remotely located physicians, the most remarkable aspect is telesurgery, where a remote physician assists a device—in this case, a robot— saving patients' lives by performing surgeries, from the simplest to the most basic. to the most complex with great precision [30]. Furthermore, regarding the application of different TM techniques, using portable devices such as cell phones for bidirectional remote assistance between professionals located remotely, as well as verification of biomedical images in different geographical locations, reveals that the difference between the results is minimal, if not nonexistent; in this case, TM does not recognize spatial isolation [31].

Healthcare professionals use technological resources in emergency services to save the lives of those in need. ready first aid, no only to give instructions, second the purpose of providing formative opinions remotely is also to record, store, protect, and make available clinical information of those involved in interventions, with the aim of ensuring the continuity of care services and justifying their interventions. To this end, rescue or emergency teams, as well as referral hospital centers, need to be equipped with modern equipment capable of providing well-being to patients and saving their lives if used properly [2, 12].

For example, emergency teams are equipped with vehicles, ships, and aerial rescue resources, having all the necessary equipment on board to provide medical care, from navigation equipment, geolocation, and geographic information systems for the fastest possible location of victims, as well as other equipment to intervene promptly if necessary.

Monitoring healthcare professionals by a remotely located expert would have a better impact. in the provision of care as well as training of other professionals and even participation in work meetings where distance or other factors do not allow them to be present, when human, material and communication network resources are ready and sophisticated to allow this practice [32].

6. Difficulties in Practicing TM

The difficulties with TM lie precisely in the quality. of the

materials and guarantee of the communication line, for example when communication between the elements that they are node land and the specialist remotely located Poor quality equipment can significantly and negatively impact caregiving or training efforts. Another crucial aspect is selecting equipment and software capable of providing the necessary resources for communication and visualization of clinical information.

The evidence reported above shows the benefits that TM brings to patients and healthcare professionals, but in some cases, such as the complication of a pathology or a very serious accident where the injured person needs more specialized care exceeding the capacity of professionals, or where there is no sophisticated equipment locally to provide care, transfer to more sophisticated centers is always resorted to. This reaffirms that TM does not replace the tasks of doctors; in fact, in the end, TM is practiced by healthcare professionals [33].

In the specific case of African countries, most of which are considered high-risk zones due to cyclical wars, insufficient and inadequate health infrastructure, natural disasters, and a lack of investment in both materials and specialized training for their health professionals, among other factors, this can contribute to the ineffective and inefficient use of TM (transplantation therapy).

TM as already he was focused guarantees the Safe and effective treatment in areas where the presence of specialists is difficult, if not impossible, allows specialists to guide personnel in remote locations to save the lives of those in need. Safety in both the provision of medical care and the security of patients' clinical information, monitoring of surgical procedures, and the provision of formative and clinical second opinions among healthcare professionals are factors contributing to the expansion and acceptance of TM worldwide [34].

Factors that constitute barriers to the practice of technology as such, despite its great potential, are related to the cultural realities of peoples and countries, the legislation in force in certain countries, and the fact that the use of technology requires large investments that not all countries or peoples have, whether in materials such as machines and other types of infrastructure (buildings, work materials, etc.) as well as communication infrastructure and the availability of communication networks, such as internet lines, among other necessary means. Obviously, this is a very high cost. Above all, for peripheral or low-income countries, on the other hand, the use of TM requires investment in the training of health professionals, which in most cases makes it very expensive for poor countries; finally, it depends on the context in which society views the application of TM [35].

Taking in account all those factors, we see what Applying technology in a given country requires not only having the knowledge and resources, but also overcoming the necessary barriers to achieve success. raisin necessarily put inform, form, to raise awareness in society as a whole in order to convince it to believe. in the potential and benefits While TM has the potential to contribute to minimizing citizen suffering, saving

lives, especially during the most difficult times (emergencies or natural or man-made disasters), as well as training healthcare professionals and even users, it is also necessary to establish accountability standards for those involved [1, 36, 37].

7. Who Is Responsible and Who Should Be Compensated?

Whatever the job, professional or not, there is a certain level of responsibility; telemedicine is no exception. Of course, the doctor provides healthcare to their patient through telemedicine guidance, even if the two know each other or not. If an error occurs due to negligence, Negligence or even incompetence on the part of the healthcare professional does not exempt them from liability or compensation.

The big dilemma in TM is when the healthcare professional should advise. Your user through of opinion requested the other Even as the most experienced professional, it is currently difficult to say or decide who should be remunerated in case of success or held responsible in case of errors, all because policies or shortcomings in legislation still constitute major barriers to TM [38].

To conclude this discussion of who is held responsible Whether or not remunerated for the practice of TM, it is worth noting that the success of TM depends not only on the skills and abilities of the physician or healthcare professional as a consultant, but also on the quality of equipment used and compliance on the part of the patient/user if the latter is responsible for their own self-monitoring and transmission of recorded data or signals. In fact, the equipment should be easy to use, anticipating... differences of experiences, must to be also High-resolution images and sound, easy maintenance, and finally... of the lowest possible costs [39].

8. Questions for Discussion

When will TM overcome the barriers to its use?

Why in some societies no recognize TM how can TM (Transportation Technology) be an effective way to provide medical care to patients? How can it work in countries where communication lines are almost non-existent?

9. Conclusion

Telemedicine improves access to quality healthcare, reduces infection risks through virtual doctor-patient interaction, and expands equity, especially in low- and middle-income countries and in emergency contexts, remote areas, and humanitarian crises.

It stands out for its effectiveness not only in pediatric care, sexual and reproductive health, but also in teledermatology, follow-up of cancer patients, chronic diseases, infectious diseases and even robotic telesurgery.

Telemedicine also shows the advantages of distance therapeutic education as well as remote training of health professionals by specialists from specialized centers located in large cities.

However, challenges remain related to infrastructure, regulation, data security, professional training and sustainable reimbursement models.

Its potential to save lives, reduce response times and support vulnerable populations confirms telemedicine as an essential strategy to strengthen health systems and save more lives, especially in peripheral countries.

10. Recommendations

It is recommended that healthcare professionals receive increasing training in telemedicine, and that access to both material and financial resources and secure infrastructure be guaranteed for the effective application of telemedicine, in order to improve the quality of life and ensure the safety and well-being of populations, especially in peripheral African countries.

Abbreviations

TM	Telemedicine
INEM	National Institute of Medical Emergencies
ICT	Information Communication Technology

Author Contributions

Adulai Gomes Rodrigues: Conceptualization, Data curation, Methodology, Writing – original draft, Writing – review & editing

Conflicts of Interest

The authors do not declare conflicts of interest.

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