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Catching Up with the Digital Age: The Concept, Scope, and Boundaries of Telemedicine

Dijital Çağı Yakalamak: Teletıp Kavramı, Kapsamı ve Sınırları

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Abstract

Rapid advancements in digital health technologies have led to fundamental changes in the delivery of healthcare services, and telemedicine has emerged as one of the core components of this transformation. By enabling the provision of healthcare services through information and communication technologies in cases where distance is a critical factor, telemedicine supports the continuity of care, particularly in regions where access is limited. In this review, the conceptual framework of telemedicine, its historical development, its prevalence at global and national levels, and its current areas of application are addressed.

While telemedicine offers significant advantages such as increasing access to healthcare services, reducing costs, and improving patient comfort; it also encompasses various challenges such as physical examination limitations, data security risks, technological infrastructure requirements, and disparities in legal regulations. Nevertheless, the increasing integration with artificial intelligence, big data, and mobile health technologies will allow telemedicine to provide more predictive and personalized healthcare services in the future.

It is not possible for healthcare services to remain behind this transformation in the face of the requirements of the digital age. The fact that telemedicine does not remain merely a technological innovation but becomes an integral part of the healthcare system depends on seamless digital infrastructure, inclusive legal regulations, and the adoption of this practice by healthcare personnel. In this regard, providing training is essential to foster adoption and increase awareness among healthcare professionals. Otherwise, the adaptation of healthcare systems to digital transformation will not be sustainable.

Keywords: Telemedicine, digital health, telehealth, medical education, artificial intelligence

Öz

Dijital sağlık teknolojilerindeki hızlı gelişmeler, sağlık hizmetlerinin sunumunda köklü değişimlere yol açmış ve teletıp bu dönüşümün temel bileşenlerinden biri haline gelmiştir. Teletıp; mesafenin kritik olduğu durumlarda bilgi ve iletişim teknolojileri aracılığıyla sağlık hizmetlerinin sunulmasını sağlayarak, özellikle erişimin kısıtlı olduğu bölgelerde bakım sürekliliğini desteklemektedir. Bu derlemede, teletıbbın kavramsal çerçevesi, tarihsel gelişimi, küresel ve ulusal düzeydeki yaygınlığı ile güncel kullanım alanları ele alınmıştır.

Teletıp, sağlık hizmetlerine erişimi artırması, maliyetleri azaltması ve hasta konforunu iyileştirmesi gibi önemli avantajlar sunarken; fiziksel muayene sınırlılıkları, veri güvenliği riskleri, teknolojik altyapı gereksinimleri ve yasal düzenlemelerdeki farklılıklar gibi çeşitli zorluklar da barındırmaktadır. Bununla birlikte, yapay zekâ, büyük veri ve mobil sağlık teknolojileri ile entegrasyonunun artması, teletıbbın gelecekte daha öngörücü ve kişiselleştirilmiş sağlık hizmetleri sunmasına olanak sağlayacaktır.

Dijital çağın gereklilikleri karşısında sağlık hizmetlerinin bu dönüşümün gerisinde kalması mümkün değildir. Teletıbbın sadece teknolojik bir yenilik olarak kalmayıp, sağlık sisteminin ayrılmaz bir parçası haline gelmesi; kesintisiz bir dijital altyapının, kapsayıcı yasal düzenlemelerin ve sağlık personelinin bu uygulamayı benimsemesine bağlıdır. Bu doğrultuda sağlık çalışanlarının bilinçlendirilmesi ve eğitim süreçlerinin güçlendirilmesi kritik önem taşımaktadır. Aksi takdirde, sağlık sistemlerinin dijital dönüşüme uyum sağlaması sürdürülebilir olmayacaktır.

Anahtar Kelimeler: Teletıp, dijital sağlık, telesağlık, tıp eğitimi, yapay zeka

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INTRODUCTION

The use of information and communication technologies (ICT) in the delivery of healthcare services has created a significant transformation in recent years and has led to the emergence of concepts such as "electronic health (e-health)", "digital health", "telemedicine", "telehealth", and "mobile health (m-health)".[1]

Digital Health: It is the broadest umbrella term that encompasses e-health and m-health, and includes emerging fields such as artificial intelligence, big data, and genomics.[1]

E-Health: It is the use of ICT for the purposes of healthcare services, education, and research.[1]

M-Health: It is the use of mobile and wireless technologies (smartphones, etc.) in healthcare services.[1]

Telemedicine: It is the delivery of healthcare services using information and communication technologies by all healthcare professionals for the diagnosis, treatment, and prevention of diseases and injuries in situations where distance is a critical factor.[1]

Telehealth: It refers to a broader approach that encompasses telemedicine applications but is not limited to them, including non-clinical services such as health education, public health applications, and health management.[1] In some literature, telemedicine is defined as clinical services provided exclusively by physicians, whereas the concept of telehealth encompasses a broader framework that includes services delivered by all healthcare professionals, such as nursing and pharmacy. Nevertheless, the two terms are often used interchangeably.[2]

Today, these digital interventions are positioned as an integral part of modern medical practice with the aim of increasing access to healthcare services, ensuring continuity of care particularly in underserved communities, and strengthening health systems.[1]

MATERIAL AND METHOD

Telemedicine Use and Prevalence Worldwide and in Türkiye

Telemedicine has rapidly evolved into a prominent healthcare delivery model in the 21st century, demonstrating significant growth in both market size and utilization rates.[3] The American Medical Association (AMA) has called on the U.S. House of Representatives to promote the widespread adoption of telehealth in order to address workforce shortages, improve access to care, and reduce the cost of delivering healthcare in remote settings, while also emphasizing telehealth as a core competency for medical students.[4]

Prior to the COVID-19 pandemic, telemedicine use remained relatively limited; data from the United States in 2016 indicated that only 11.8% of family physicians and pediatricians utilized telemedicine services,[5] while overall physician adoption was approximately 15.4%.[6] However, the pandemic acted as a major catalyst, accelerating the adoption of these technologies. By 2021, 37% of adults in the United States reported using telemedicine services, with the highest usage observed among individuals aged 65 years and older (43.3%).[7]

At the international level, evaluations across the 53 member states of the World Health Organization (WHO) European Region indicate that telemedicine is well established in countries such as the United Kingdom, Italy, Denmark, and the Netherlands.[8] Even before the pandemic, countries like Sweden reported relatively high usage rates (47% of adults), which further increased during the pandemic. For example, teleconsultations in France rose from 136,000 in 2019 to 4.5 million in April 2020 alone, while in Germany they increased from 3,000 to 2.7 million during the same period.[9]

Similarly, in the Asia-Pacific region, telemedicine use nearly doubled between 2019 and 2021, with countries such as Australia experiencing up to a ninefold increase.[9] In the post-pandemic period, however, trends have varied across regions: while telemedicine use increased between 2021 and 2023 in Singapore and Australia (by 9%) and in Indonesia (by 7%),[10,11] a decline of 4% was observed in India (from 59% to 55%), reflecting regional differences in digital infrastructure, regulatory frameworks, and user engagement.[9]

In Türkiye, telemedicine applications were formally included among national objectives with the publication of the "Information Society Strategy Action Plan" in 2006.[12] Within this framework, initial steps were taken between 2007 and 2008 with the establishment of teleradiology, telepathology, and tele-ECG systems, enabling the initiation of image and data sharing among pilot hospitals.[12-14]

The widespread adoption of telemedicine applications in Türkiye, effectively becoming a necessity, occurred during the COVID-19 pandemic.[12,14] During this period, when physical contact posed significant risks, various interventions were implemented to prevent overcrowding in hospitals:

- Patients in quarantine, those with suspected contact, or individuals in high-risk groups were enabled to undergo online video consultations with their physicians via mobile phones or computers by scheduling appointments through the system.[12,14]
- Family physicians monitored their patients at home through Family Medicine Information Systems (AHBS) and e-Nabız, performing remote consultation and triage services in coordination with filiation teams.[15]
- Various university hospitals established "internet outpatient clinics" or "telemedicine polyclinic systems" to ensure the continuity of treatment, particularly for patients with chronic conditions.[12,15]

The lack of a comprehensive legal framework before and during the pandemic represented a significant barrier to the implementation of telemedicine. This gap was addressed with the enactment of the "Uzaktan Sağlık Hizmetlerinin Sunumu Hakkında Yönetmelik" (Regulation on the Provision of Remote Healthcare Services), published in the Official Gazette on February 10, 2022.[16] This regulation

established a formal legal basis for remote consultations, clinical monitoring, e-prescriptions, and electronic medical reporting, thereby institutionalizing and legitimizing telemedicine practices in Türkiye.[12]

In Türkiye, a major milestone for the sustainability and financing of telemedicine services was the amendment to the Health Implementation Communiqué (Sağlık Uygulama Tebliği, SUT) issued by the Social Security Institution (SGK) on April 21, 2024. With this regulation, "Remote Patient Evaluation Healthcare Services" were, for the first time, formally included in the SGK reimbursement list. This development represents a critical turning point, providing an economic foundation for the legal status of telemedicine in Türkiye and facilitating the integration of digital health applications into the national health insurance system.[17]

History of Telemedicine

An examination of the development of telemedicine reveals that its historical roots date back much further than commonly assumed. Early forms of remote information exchange, such as the use of smoke signals, evolved into more systematic methods with the invention of the telegraph and telephone.[18,19] In the early 20th century, medical consultations conducted via telephone and radio played a significant role in delivering healthcare services, particularly in regions where transportation was limited.[20]

With the advancement of television and space technologies in the 1950s and 1960s, telemedicine applications gained considerable momentum, and NASA's biotelemetry initiatives marked a major turning point in the field.[21] The introduction of the term "telemedicine" in the 1970s further accelerated the development of systematic applications, while the emergence of internet technologies enabled telemedicine to evolve into its modern form.[22-24] Since the 2000s, the widespread adoption of broadband internet, mobile devices, and smart technologies has led to a rapid global expansion of telemedicine applications.[22]

Multidimensional Application Areas of Telemedicine

WHO data demonstrate that telemedicine is not limited solely to clinical services but is utilized across a broad spectrum, including education, research, and the strengthening of health systems.[2]

1. Clinical Diagnosis, Treatment, and Remote Monitoring

The primary focus of telemedicine is to overcome geographical barriers and facilitate patient access to specialist care.[2]

Direct Services: Clinical consultations via video conferencing, e-prescription services, and postoperative follow-up processes can be conducted independently of physical location.[25,26] Telemedicine also provides significant advantages in the management of chronic diseases requiring long-term follow-up, such as hypertension, diabetes, chronic obstructive pulmonary disease (COPD), cardiovascular diseases, and rheumatoid arthritis. Through remote consultations and digital monitoring systems, patients can securely share vital data such as blood pressure and glucose levels with healthcare professionals without the need for hospital visits. This approach may improve medication adherence, reduce anxiety related to disease management, and contribute to positive clinical outcomes, including reductions in systolic blood pressure and improvements in HbA1c levels. By supporting continuity of care and reducing unnecessary hospital visits, telemedicine contributes to the more efficient use of healthcare resources while enhancing patient self-management and quality of life.[27,28]

Telemonitoring: Real-time monitoring of vital signs is enabled through sensor technologies and remote monitoring systems.[25] The integration of portable diagnostic devices further supports home healthcare services and the remote monitoring of chronic conditions, particularly for elderly, disabled, bedridden, or mobility-restricted patients. Through remote consultations, these patients can access healthcare services without the need for long-distance travel, thereby reducing hospitalization, transportation-related burdens, caregiver burden, and healthcare costs.[27,28] This approach has been shown to reduce hospitalization rates, particularly in the management of chronic conditions such as diabetes, COPD, and cardiovascular diseases.[21,29]

2. Interprofessional Consultation (Teleconsultation)

Telemedicine facilitates information sharing among healthcare professionals and accelerates consultation processes between specialists. Particularly in complex cases, specialists from different disciplines can provide synchronous or asynchronous opinions remotely.[2] Patients' electronic medical records, radiological images, laboratory results, and treatment data can be securely shared with relevant specialists for consultation and referral guidance.[30]

In Türkiye, interprofessional teleconsultation has been supported through digital health infrastructures such as teleradiology systems, tele-ECG applications, and integrated platforms including e-Nabız. These systems enable physicians working in rural or peripheral healthcare facilities to electronically share patient data with specialists in tertiary referral centers. Teleradiology systems also support second-opinion services, remote reporting by radiologists, and interinstitutional data sharing. Such applications may help reduce unnecessary patient transfers and improve timely clinical decision-making.[31]

Furthermore, teleconsultation reduces the professional isolation of physicians working in underserved areas, promotes collaborative learning, and contributes to the continuous professional development of healthcare personnel.[1,2]

3. Specialty-Specific Applications

Telemedicine provides tailored solutions across various medical specialties:

Telepsychiatry: Enhances access to mental health services by overcoming stigma-related barriers and has been shown to be comparable in effectiveness to face-to-face consultations.[32,33]

Teledermatology & Telepathology: Enable high diagnostic accuracy and rapid results through the transmission of visual data and digital specimens.[34,35]

Teleradiology: Represents one of the most mature and widely adopted telemedicine fields globally, commonly used to address specialist shortages and manage emergency cases.[36]

Teleophthalmology: Plays a critical role in the early detection of vision-threatening conditions, particularly diabetic retinopathy.[37]

Telesurgery: Represents the cutting edge of telemedicine, allowing surgeons to perform procedures remotely through the integration of 5G and robotic technologies.[38]

4. Emergency Situations and Disaster Management

In cases of disaster or conflict, remote triage and treatment consultation are provided in areas where specialists cannot physically reach.[39]

In emergency medicine, telemedicine provides a critical intervention, particularly for hospitals in rural areas with limited access to specialist physicians. By enabling real-time transmission of vital signs, medical images, and patient data, it supports rapid, expert-informed decision-making within the "golden hour" following trauma. Systems that connect ambulances directly to specialized centers further accelerate triage processes and play a vital role in acute stroke management by significantly reducing the time to initiation of thrombolytic therapy.[40]

5. Medical Education and Public Health

Medical Education: Virtual patient encounters and telesimulation methods support the development of professional competencies and ensure continuity of training, particularly during disruptions such as pandemics.[25]

Public Health: Telemedicine strengthens preventive healthcare services through vaccination information, epidemiological data tracking, and health awareness programs.[1]

Advantages of Telemedicine

One of the most prominent benefits of telemedicine is that it provides significant savings in time and transportation costs by relieving patients of the burden of unnecessary travel.[5,41] While it shortens the duration that individuals are away from work or children are away from school, it also substantially reduces appointment waiting times in clinics.[42] Furthermore, patients can receive healthcare services in the comfort of their own homes, which contributes to an improvement in their overall quality of life.[43]

Telemedicine not only enhances patients' perception of privacy,[44] but also serves as an effective tool in providing necessary psychological support and improving adherence to treatment protocols and medication use.[45] By overcoming geographical barriers, it enables patients living in rural, remote, or underserved areas to access high-quality healthcare.[46] Furthermore, it significantly improves access to care for disadvantaged populations, including the elderly, individuals with physical or developmental disabilities, prisoners, and socially isolated communities.[5,47]

Telemedicine applications reduce unnecessary hospitalizations, physical referrals, and outpatient waiting times; thereby creating opportunities for severely ill patients who truly require face-to-face examinations to be seen.[21,41] Furthermore, it serves as an ideal method for medication renewals that do not require a physical examination, the evaluation of test results, and the routine monitoring of chronic diseases such as cancer or diabetes.[5,41,48]

During pandemic periods such as COVID-19, it prevents the spread of infection by enabling the maintenance of social distancing.[41,49] In addition to reducing the risk of transmission associated with physical contact, it enables healthcare providers to continue delivering care and serving the community without interruption.[50]

Telemedicine facilitates rapid coordination between primary care physicians and specialists, enabling seamless and integrated patient care.[51,52] It allows healthcare professionals to securely share laboratory results, high-resolution radiological images, and electronic health records.[46,53] Additionally, it serves as an extremely effective educational tool, enabling doctors working in remote areas to participate in Continuing Medical Education (CME), facilitating the training of residents, allowing virtual attendance at overseas medical conferences, conducting online competency examinations, and fostering the global exchange of medical knowledge.[42,53]

Disadvantages of Telemedicine

Despite improving access to healthcare services, telemedicine presents several important limitations related to technological infrastructure, data security, ethical concerns, and clinical evaluation. One of the most commonly reported limitations is the inability to perform a comprehensive physical examination in a remote setting.[45,49] The lack of direct face-to-face interaction and hands-on clinical assessment may hinder accurate diagnosis and increase the risk of missing important clinical findings.[45,54,55] In addition, incomplete or inaccurate patient information may further compromise patient safety. The absence of physical examination may also contribute to medico-legal uncertainties regarding professional liability and malpractice in telemedicine practices.[47,56] Furthermore, the lack of universally accepted standards and guidelines concerning clinical practice and medical liability may increase legal risks for healthcare professionals.[47] Telemedicine may therefore not be appropriate for all patients or clinical scenarios.[54] Moreover, delivering sensitive medical information through virtual

platforms may negatively affect patient dignity, autonomy, and the physician–patient relationship.[47,56]

Ethical and legal considerations also constitute important challenges in telemedicine practices. The storage, processing, and transmission of personal health information—including video, audio, text, and medical records—through telecommunication systems may increase the risk of cyberattacks, unauthorized access, data interception, theft, and misuse of sensitive health data.[47,56-58] In addition, uncertainties regarding how collected health data may be stored, shared, and used in the long term raise concerns about the adequacy of traditional informed consent models.[56]

Türkiye is among the countries that have introduced specific legal regulations governing telemedicine practices. In this context, the "Regulation on the Provision of Remote Healthcare Services," published in 2022, outlines important principles regarding physicians' responsibilities, patient privacy, data security, informed consent, and the management of emergency medical conditions during telemedicine practices. The regulation also emphasizes that telemedicine should not replace face-to-face healthcare services in situations requiring physical examination or urgent medical intervention.[16]

The success of telemedicine systems also depends on adequate technological infrastructure. Internet interruptions, technical failures, and equipment-related problems may reduce service quality, while hardware installation and the employment of technical personnel impose substantial operational and financial burdens, particularly for smaller healthcare organizations.[47,55,59]

In many countries, physicians are not legally permitted to establish an initial diagnosis remotely, and telemedicine services are often limited to follow-up care or prescription renewals based on a prior face-to-face diagnosis.[60] Reimbursement policies also remain complex, as discrepancies between insurance plans and physician fee schedules may increase operational burdens and patient costs.[58]

To minimize these ethical and legal concerns, comprehensive regulations and guidelines should clearly define data ownership, strengthen informed consent models for long-term data storage and sharing, and ensure equitable access to telemedicine services for vulnerable or technologically underserved populations.[56]

Future of Telemedicine

Telemedicine is evolving beyond simple video consultations into an advanced healthcare model integrated with technologies such as artificial intelligence (AI), machine learning, and the Internet of Things, enabling more predictive and personalized care.[55] One of the key focal points of this transformation is the integration of digital health monitoring systems with AI.[55] Data collected through wearable devices and sensors in patients' homes are transmitted to cloud-based platforms, where AI algorithms analyze emerging patterns and alert healthcare professionals to potential risks before clinical deterioration occurs.[61-63]

Natural Language Processing (NLP) technologies will play a major role in future telemedicine applications; by enabling clinicians to automatically generate medical notes during patient consultations, these technologies will alleviate administrative burdens and allow physicians to dedicate their time directly to patient care.[61-64] Furthermore, instead of completing lengthy forms during the appointment process, patients will be able to easily upload their medical history, verification documents, laboratory results, and past prescriptions into the system. Consequently, physicians will be able to utilize this data via the patient interface to rapidly develop urgent care plans.[55]

AI-powered virtual assistants (chatbots) will enable patients to receive 24/7 personalized medical support, education, and automated appointment reminders, thereby significantly enhancing patient adherence and clinical efficiency.[64] This technological evolution will establish the foundation for precision medicine and predictive analytics in healthcare. By analyzing patients' genetic, demographic, and lifestyle data, machine learning algorithms will be capable of predicting disease progression and potential risks, identifying at-risk patients, and recommending the most appropriate, customized treatment modalities.[64]

Operationally, telemedicine will evolve into an advanced structure where specialists can participate in surgeries and provide consultations from remote distances in emergencies, and robotic systems can deliver specialized medical treatments to previously inaccessible regions.[61-63] Ultimately, the fundamental vision for the future of telemedicine is to provide more accurate, efficient, and digitally expanding medical care for every patient through the case-specific integration of video conferencing and machine learning.[55]

Approaches Toward the Use of Telemedicine

Current data indicate that despite high interest in telemedicine and telehealth applications, actual utilization rates remain limited.[65-67] A survey conducted in 2019 reported that approximately 85% of consumers expressed a desire to receive virtual healthcare services, yet only 17% were able to access them.[65] Similarly, a 2017 study involving 4,980 family physicians found that only 15% of participants utilized telehealth; notably, 55% cited a lack of training regarding telehealth applications as the primary reason for non-use.[66] Research focusing on 'Video Consultation Hours' further supports these findings, revealing that although 45% of patients were willing to use such services, approximately two-thirds of physicians did not offer telemedical consultations or only implemented them when legally required.[67] These findings suggest that a lack of training in telemedicine, limited familiarity with technology, legal uncertainties, and inadequacies regarding reimbursement and fee structures constitute significant barriers to adoption. Furthermore, healthcare providers may resist innovations in telemedicine if they perceive the technology as being in competition with their own services.[68]

The expansion of telehealth applications offers a strategic solution to overcoming barriers in accessing healthcare services, particularly for rural communities facing a shortage of specialist physicians. However, the increasing role of telemedicine in healthcare has made it imperative to train competent health professionals who can utilize these systems effectively. It is reported that current medical curricula do not sufficiently cover digital health and telemedicine applications, and a standardized educational model in this field has yet to be established.[69-75]

Guided telemedicine experiences designed for students, residents, and physicians can increase their willingness to provide telemedicine care by allowing them to better understand its benefits and limitations.[76] In this regard, the effort to integrate telemedicine competencies into medical education is an internationally supported approach. For instance, in 2016, the AMA publicly adopted a policy aimed at ensuring that medical students and residents are appropriately trained in the use of telemedicine in clinical practice. Additionally, the AMA has provided over 12.5 million USD in grants to medical schools for the development of innovative curricular enhancements that could eventually be implemented nationwide.[77]

CONCLUSION

As a core component of the digital health ecosystem, telemedicine is fundamentally transforming the delivery of healthcare services. Driven by rapid advancements in information and communication technologies, it has reached a broad scope of application—ranging from clinical services and patient monitoring to interprofessional consultations and medical education—significantly facilitating access to healthcare, particularly in underserved regions. The COVID-19 pandemic clearly demonstrated that telemedicine is an indispensable tool for health systems and paved the way for its rapid global expansion.

However, despite these advantages, significant limitations such as physical examination constraints, data security risks, technological infrastructure requirements, and heterogeneous legal regulations persist. This indicates that the effective and safe utilization of telemedicine depends not only on technological progress but also on the establishment of appropriate legal and ethical frameworks and the enhancement of healthcare professionals' competencies in this field.

In the future, telemedicine is expected to integrate more deeply with artificial intelligence, big data, and mobile health technologies. This integration may contribute to the development of more predictive, personalized, and sustainable healthcare models. Nevertheless, for this transformation to be effectively reflected in clinical practice, healthcare professionals must be equipped with the knowledge and skills required for digital health applications.

In this context, the systematic integration of telemedicine training into undergraduate medical curricula, postgraduate education, and Continuing Medical Education (CME) programs for practicing physicians has become a necessity. In addition to education and technological infrastructure, encouraging physicians to adopt telemedicine practices is another key factor for the successful integration of telemedicine into healthcare systems. Physicians may require both intrinsic motivation, such as improving patient access and continuity of care, and extrinsic incentives, including appropriate reimbursement policies, institutional support, workload regulation, and legal protection. Therefore, policymakers and healthcare institutions should develop supportive strategies to increase physician engagement and promote the sustainable adoption of telemedicine practices.

Ultimately, the successful integration of telemedicine into healthcare systems will depend on balanced technological advancement, comprehensive regulations, ethical governance, and the active participation of healthcare professionals. In an era of accelerating digital transformation, adaptation to evolving healthcare delivery models is no longer optional but an essential requirement for the sustainability of modern medical practice.

ETHICAL DECLARATIONS

Ethics Committee Approval: Ethics committee approval was not required for this study.
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