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Telemedicine: Revolutionizing Healthcare Delivery and Public Health in the 21st Century

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Abstract

Telemedicine is a synchronized way of providing medicine to the patient through telecommunication technology. Through this process we can substantial healthcare to the low-income regions or area. These days, medical services are essential policies that every country's population requires for decent healthcare. Telehealth or telemedicine are the shadow of each other in United states we called it telemedicine but in Europe we called it telehealth. It is a two-way communication process between the physician and patient the other health worker through video call, conferences, or the telephone connected with internet. In the 21st century after the covid-19 pandemic the telemedicine is at its boom in India, from that time by this process we can easily breakdown the chain of transmission of infection from one to another person. By when the telemedicine has been practiced the re-admission to hospital have been decreased and through this, we can easily stop the spread of virus and bacteria from patient to the health worker. Dr. K. Ganapathy a neurosurgeon firstly launched telemedicine in India in 2005.If we can see the market size and value of telemedicine is over USD 71.5 billion in 2022 and will increase by of CAGR of over 12.5% over the year 2023-2032.In this article/paper the knowledge pertinent of application of telemedicine, solution, RPM Healthcare, RPM device, telemedicine market. Through this process or method, the healthcare facility with the help of practitioner and other health worker in wide range or variety of medical facility reaches to their doorstep.

Keyword: Telemedicine, telehealth, Covid-19, healthcare access, medical services, infection control, digital health

INTRODUCTION

Figure 1: The World Health Organization (WHO) defines telemedicine as the provision of healthcare services through information and communication technologies, especially when distance poses a considerable challenge. [1]. Healthcare professionals utilize these technologies to exchange precise information for purposes such as diagnosis, treatment, disease prevention, research, evaluation, and continuous education [2]. This advancement aims to enhance healthcare for individuals and communities. Telemedicine addresses the need for better healthcare delivery through technology, particularly benefiting the elderly who require medical monitoring to prevent injuries and losses [3]. Information and communication technologies serve as vital infrastructure for exchanging data among parties in different locations. Telemedicine overcomes distance and time limitations by using communication technologies and computer systems, such as storing patient-captured photos on database servers for later retrieval by physicians.

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Historical Perspective of Telemedicine: Figures 2 and 3

Jay Sanders, MD, laid the groundwork for telemedicine, influencing G. Byron Brooks in the creation of Teladoc. The earliest documented instance of telemedicine dates back to the early 20th

century, when an ECG was transmitted via telephone lines. In April 1924, Radio News Magazine introduced a futuristic vision for public health, depicting a patient on its cover using a TV and microphones to interact with a doctor remotely [5]. The first online two-way video consultation was happened in The University Of Nebraska in 1959 in the US, the clinicians used interactive video communication to transmit neurological examination across campus to medical students [6].

Telemedicine became pivotal in disaster response when NASA utilized its services during the 1958 Mexico City earthquake [7]. In 1997, NASA furthered its commitment to medical informatics by founding MITAC (Medical Informatics and Technology Applications Consortium), a commercial space centre at Yale University.

Figure 1. Telemedicine application model in context of the coronavirus disease 2019 outbreak [4].

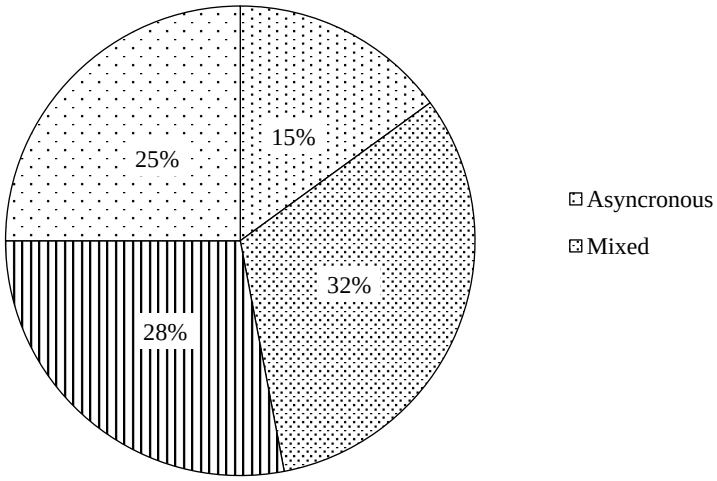

Figure 2. Percent of type of telehealth [8].

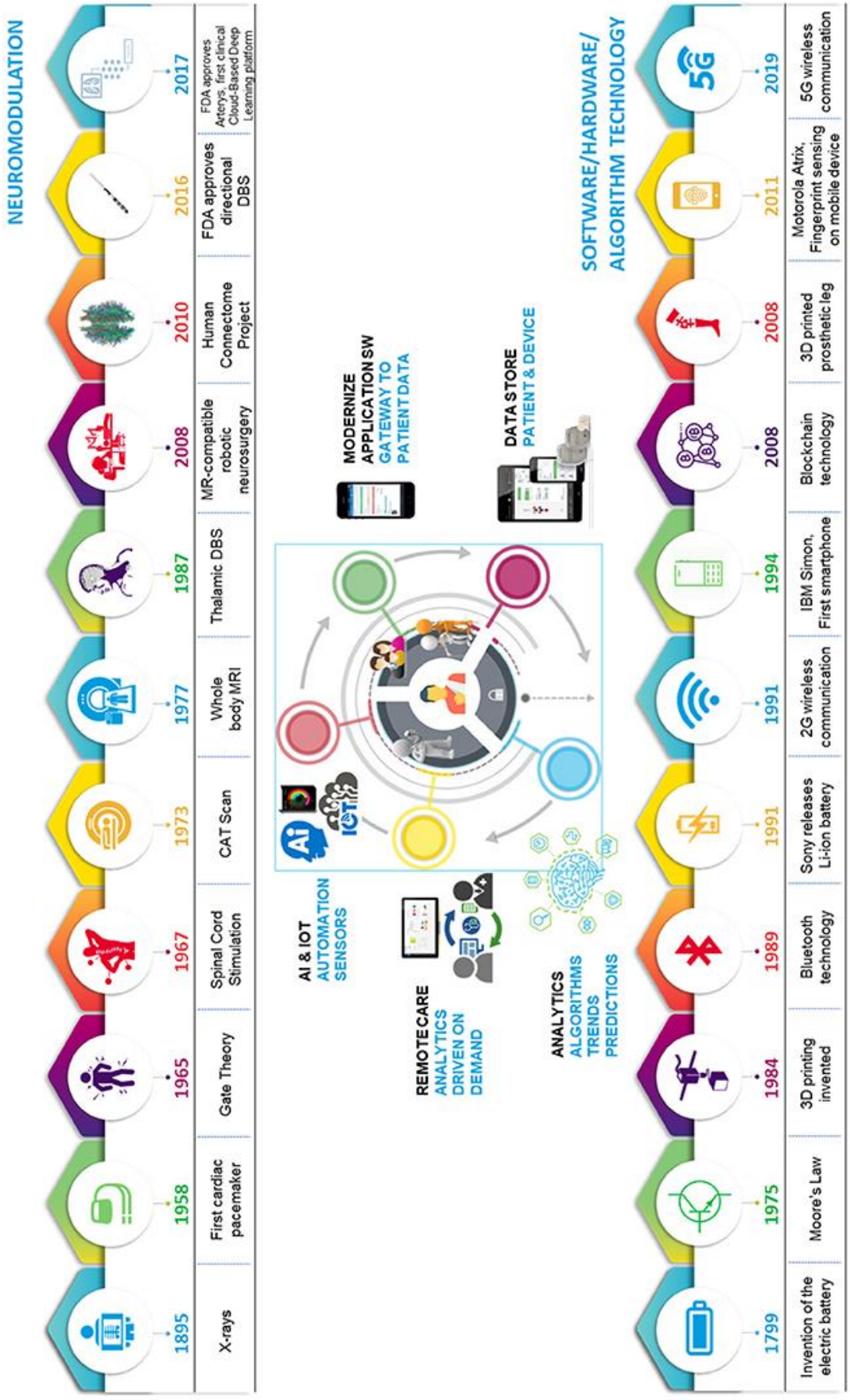

Figure 3. Evolution of technology leading to the age of digital healthcare. Iterative advances in technology have fueled progress in healthcare and software/hardware/algorithm spaces, leading to an optimal time for digital health integration with neuromodulation [9].

Modern Telemedicine: (Figure 4)

In recent decades, advancements in wireless broadband technology have led to widespread use of cell phones and the internet [10]. Improvements in internet infrastructure include faster communication speeds, larger information storage capacities, reliable web services backups, standardized data transmission formats, encryption, password protection, and compliance with HIPAA (Health Insurance Portability and Accountability Act of 1996) [11]. Modern telemedicine now utilizes patients' and physicians' existing computing devices and affordable, self-owned equipment like smartphone cameras and wearable biosensors. As the 21st century began, many national and international organizations, including the American Telemedicine Association based in Washington, DC, were founded.

Important Notes

1. Geographic areas with widespread community transmission include countries with Level 2 or 3 CDC travel warnings and locations within the US with widespread ongoing transmission of COVID-19.
2. Close contact is defined as being within 3-6 feet of a person for 1-2 minutes without personal protective equipment (PPE).
3. Healthcare worker contact includes caring for a laboratory confirmed case without PPE.
4. Only one symptom is required for high-risk exposures such as healthcare workers or those caring for a laboratory confirmed case.
5. High-risk conditions associated with poor outcomes include:
    a. Blood disorders (sickle cell disease, blood thinners)
    b. Chronic kidney disease (CKD)
    c. Chronic liver disease
    d. Immunosuppression (due to cancer treatment, chemotherapy or radiation, organ or bone marrow transplantation, HIV/AIDS)

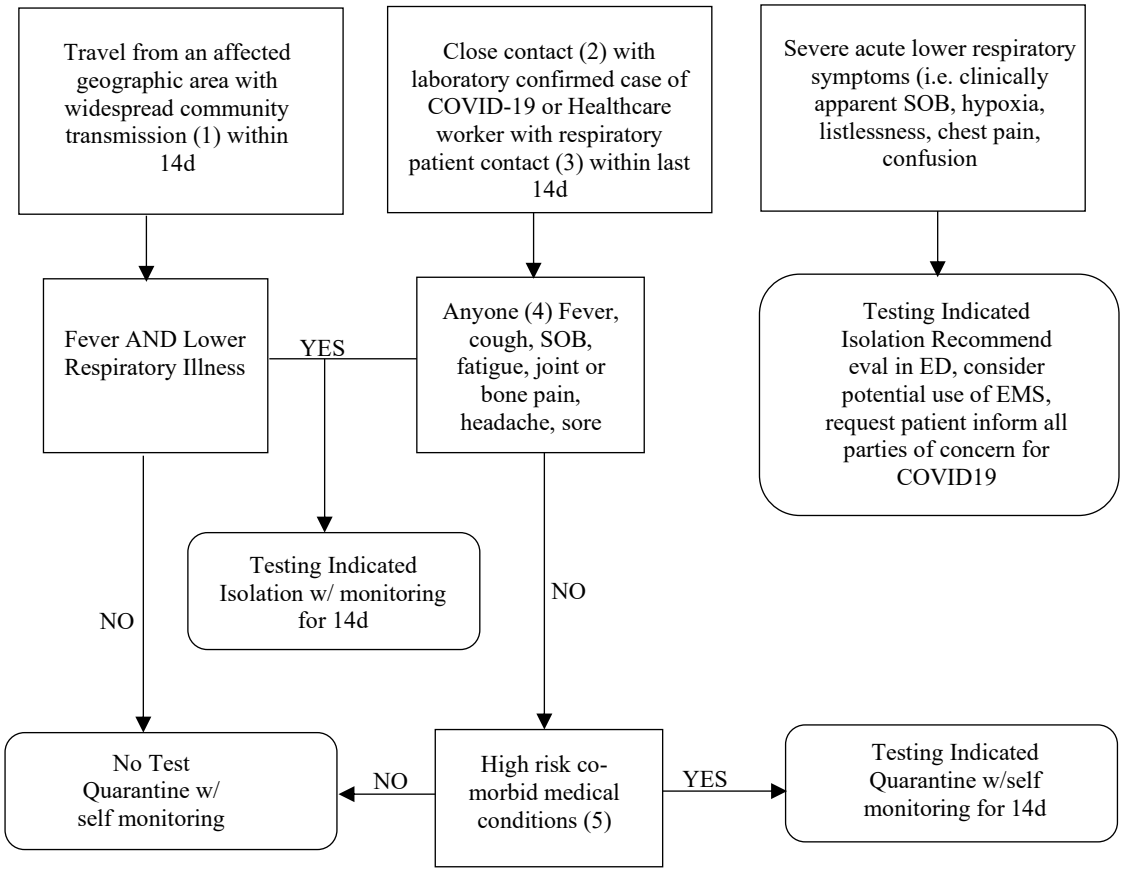

Figure 4. Telemedicine COVID19 Screening Algorithm [12].

e. Pregnant or recently pregnant (within 2 weeks)
f. Inherited metabolic disorders
g. Heart disease (congenital heart disease, congestive heart failure, coronary artery disease)
h. Lung disease (asthma, COPD, chronic bronchitis, on home oxygen)
i. Severe disabling neurologic disorders

Telemedicine in India

The adoption of telemedicine in India has grown significantly, spurred by efforts from ISRO, the Department of Information Technology (DIT), the Ministry of External Affairs, the Ministry of Health and Family Welfare, and various state governments. Significant contributions to telemedicine services in India include the establishment of one of the earliest Telecardiology systems for transmitting ECGs at GR Medical College in Gwalior in 1975. Moreover, Dr. Pratap Chauhan, Director of Jiva Ayurveda, established India's inaugural Ayurveda Telemedicine centre in 2007 [13].

Health Care in Rural Area

Seventy percent of India's population resides in rural areas, where only ten percent have access to secondary and tertiary healthcare facilities located predominantly in urban areas. Rural areas suffer from limited healthcare service availability, insufficient investment in healthcare infrastructure, and inadequate medical facilities, leading to challenges in retaining specialist doctors [14].

India's telemedicine efforts were initiated by ISRO in 2001 with a pilot project that connected Chennai's Apollo Hospital to the Apollo Rural Hospital in Aragonda village, Chittoor district, Andhra Pradesh [15].

Recently, the Ministry of Health in India has introduced several initiatives including the Integrated Disease Surveillance Project, ONCONET (National Cancer Network), the National Rural Telemedicine Network, the National Medical College Network, and the Digital Library Network [16].

The private sector's involvement in telemedicine is growing, with major Indian organizations such as Narayana Hrudayalaya, Apollo Telemedicine Enterprises, Asia Heart Foundation, Escort Heart Institute, and Amrita Institute of Medical Science demonstrating significant interest in the field. [17].

In India, telemedicine services are branded under the name E-Sanjeevani-National Telemedicine Service. Additionally, popular telemedicine applications like Practo, Lybrate, and 1mg are also actively providing their services in the country.

Current State of Telemedicine:

The World Health Organization suggests a ratio of one doctor per 1000 people, but in India, this ratio is currently at 0.62 doctors per 1000 people [18]. Training new physicians is both time-consuming and costly, suggesting that the doctor-to-patient ratio may remain low for the foreseeable future. The Ministry of Health and Family Welfare, Government of India, through its Telemedicine division, has introduced a National Telemedicine Portal as part of a new e-health initiative [18]. This project aims to establish a National Medical College Network (NMCN) to connect medical colleges nationwide for e-education, and a National Rural Telemedicine Network to enhance healthcare delivery through electronic means in rural areas.

Telemedicine currently offers diverse medical services including tele laboratory services, telehealth education, and ambulance services. A comprehensive study, based on thorough reviews and interviews, examines the present status and upcoming trends in telemedicine applications for Europe's aging population. Recent data indicates that around 17% of the population in Europe is aged 60 or above [19].

Village Resource Centre (VRC)

ISRO has introduced the concept of Village Resource Centres (VRCs), which provide services such as tele-education, telemedicine, online decision support, interactive advisory services for farmers, tele-

fishery, e-governance services, weather services, and water management. Approximately 500 VRCs have been set up across the country [13].

AROGYASREE, Led by the Indian Council of Medical Research (ICMR), this initiative is an internet-based mobile telemedicine program that connects multiple hospitals, mobile medical specialists, and rural mobile units/clinics.

Implementing telemedicine faces significant barriers including insufficient legal policies and regulations, unsupportive organizational culture, competing priorities, limited understanding of applications, and a lack of technical expertise. Since 2005, Thailand has been engaged with the Telemedicine Development Center of Asia (TEMDEC). Siriraj Hospital was the pioneering hospital to join Thailand's telemedicine program. By 2017, a total of 144 such programs had been successfully conducted across the country [20].

Types and Application of telemedicine

Telemedicine can be classified into 5 basic types:

1. Interactive telemedicine service.
2. Specialist and primary care consultations
3. Store-and-forward telemedicine
4. Remote monitoring
5. Imaging Services

APPLICATION OF TELEMEDICINE

Educational

- *Tele-education:* This program offers flexible and interactive distance learning, facilitating easier training and updates on the latest advancements for more precise and efficient treatment methods.
- *Tele-conferencing:* The use of a telecommunication device to communicate between two or more people. This may include conference,workshop,webinars,seminars.
- *Tele-Proctoring:* Supervising examinations from afar using telecommunications technology is known as teleproctoring, while telementoring involves providing remote guidance or instruction.

Healthcare Delivery

- *School-Based Health Center:* It helps to the school childrens from managing from chronic conditions diabetes, obesity.
- Correctional facilities provide healthcare services to inmates without compromising on safety and security concerns.
- *Mobile Health Clinic:* Provides quick access to a remote area.
- *Shipping & Transport:* Help avoid unscheduled diversion of the medical health facilities.

Healthcare Management

- Tele healthcare prevent and promote healthcare as teleconsultation and tele follow up.
- Diagnostic services like tele radiology and tele endoscopy.

Screening of Disease

- Diabetic screening project by MDRF
- Ophthalmology screening by Aravind Hospital at Andipatti village.

Disaster Management

- NASA tele-medicine service provided during 1985 Mexico city earthquake.
- Amrita Hospital tele-medicine services provided during 2004 Tsunami disaster.

RPM HEALTHCARE

Remote patient monitoring, a branch of home healthcare and telehealth, allows patients to use mobile medical devices and technology to gather patient-generated health data (PGHD) and send it to healthcare providers.

RPM DEVICE

Remote patient monitoring devices facilitate consistent communication and a more comprehensive understanding of a patient's health.

Telemedicine in India during Covid Pandemic and its benefits [21] (Figure 5,6)

At the time of Covid pandemic the cases of covid was expotentially increasing in number worldwide and everyone has to faces many more challenges even the health care system was too also affected due to it.

The World Health Organization advises a doctor-to-population ratio of 1:1000 for India.

In India till now there is no legislation is or any guideline to practice telemedicine.

Impact on Education

Telemedicine has had a significant impact on education, particularly in the fields of medical and healthcare training. By leveraging telemedicine technologies, educational institutions can enhance the learning experience, provide broader access to expertise, and improve the quality of healthcare education. Here are several key impacts of telemedicine on education:

Enhanced Access to Expert Knowledge

- *Remote Lectures and Workshops:* Telemedicine allows students to attend lectures and workshops conducted by experts from around the world without the need for travel. This access to global expertise enriches the educational experience and broadens students' perspectives.
- *Guest Speakers:* Medical schools and training programs can invite guest speakers to deliver lectures remotely, providing students with exposure to diverse viewpoints and specialized knowledge.

Improved Clinical Training

- *Virtual Clinical Rotations:* Telemedicine enables medical students and residents to participate in virtual clinical rotations, where they can observe and interact with patients under the guidance of experienced physicians. This is particularly valuable for students in rural or underserved areas who may have limited access to certain specialties.
- *Tele-mentoring:* Senior healthcare professionals can mentor students and junior doctors remotely, providing guidance on complex cases, discussing treatment plans, and offering real-time feedback.

Increased Opportunities for Interprofessional Education

- *Collaborative Learning:* Telemedicine facilitates interprofessional education by allowing students from different healthcare disciplines (e.g., medicine, nursing, pharmacy) to collaborate on patient care remotely. This fosters teamwork and communication skills, which are crucial for effective healthcare delivery.
- *Simulation-Based Training:* Virtual simulations and telemedicine platforms can be used to conduct interdisciplinary training scenarios, helping students to practice and refine their clinical and decision-making skills in a controlled environment.

Enhanced Continuing Medical Education (CME)

- *Webinars and Online Courses:* Telemedicine platforms offer a wide range of webinars, online courses, and virtual conferences for continuing medical education. Healthcare professionals can easily access these resources to stay updated with the latest advancements in their fields.

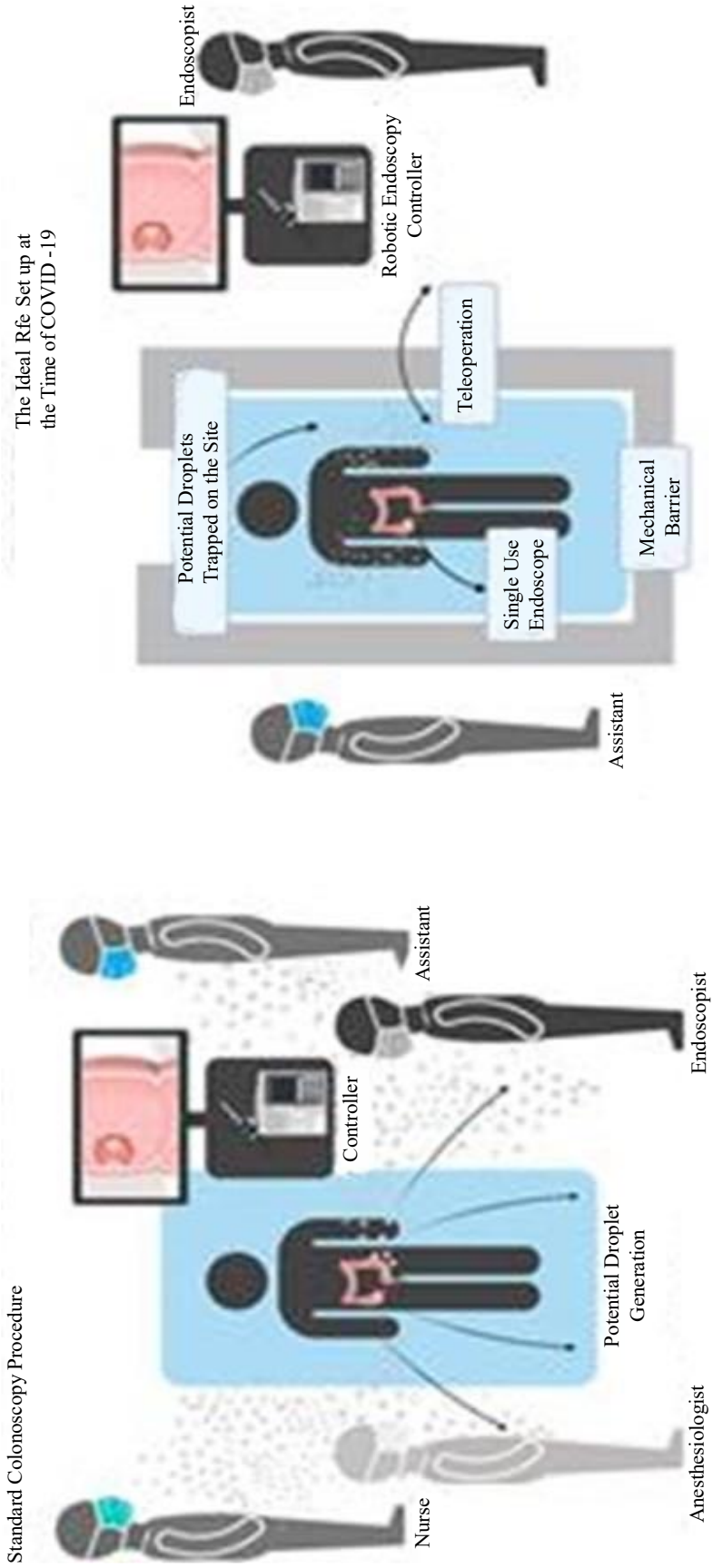

Figure 5. Comparison of conventional endoscopy with robotic flexible endoscopy which can increase distance and decrease number of people in the room [22].

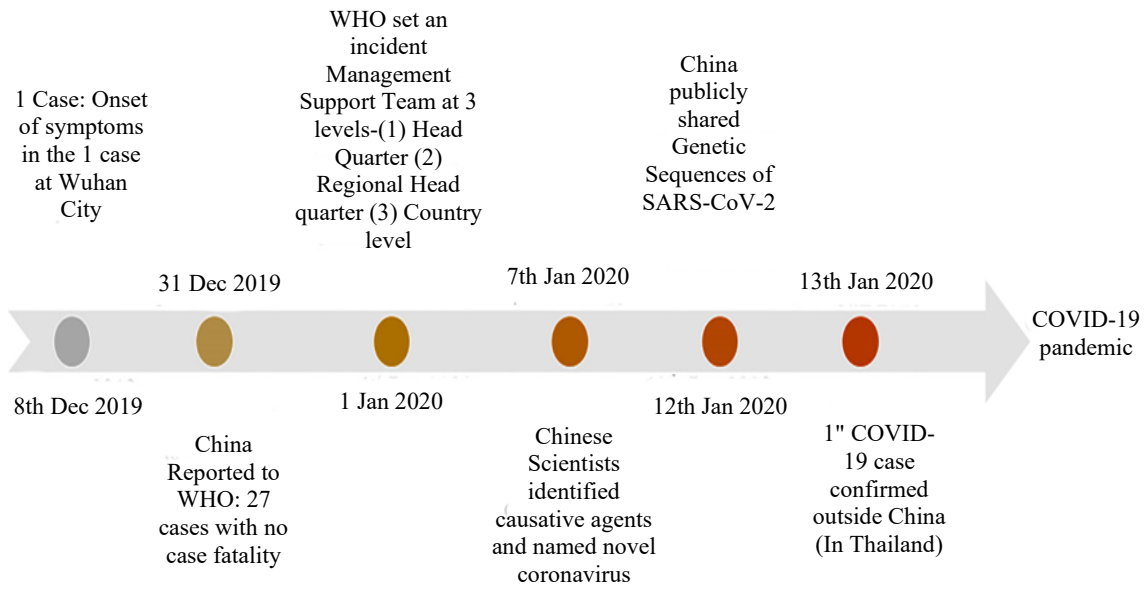

Figure 6. The major chronological events in the emergences of SARS-CoV-2 [23].

- *Flexible Learning:* Telemedicine allows for asynchronous learning, where professionals can access educational materials at their convenience, making it easier to balance work and continuing education.

Expanded Access to Training in Underserved Areas

- *Bridging Gaps:* Telemedicine helps bridge the gap in healthcare education in rural and underserved areas by providing access to quality training and educational resources. This can lead to improved healthcare delivery in these regions.
- *Capacity Building:* By offering training and educational opportunities to healthcare workers in remote areas, telemedicine contributes to building local capacity and improving the overall standard of care.

Enhanced Patient Education

- *Health Literacy:* Telemedicine can educate patients about their conditions, treatment options, and preventive measures. Informed patients are more likely to engage in their care and make well-informed decisions.
- *Chronic Disease Management:* Telemedicine platforms can provide educational resources for patients managing chronic diseases, helping them understand their condition and adhere to treatment plans.

Research and Innovation

- *Telehealth Research:* Educational institutions can conduct research on telehealth technologies and their impact on healthcare delivery and education. This research can lead to innovations and improvements in telemedicine practices.
- *Data Collection and Analysis:* Telemedicine platforms can collect valuable data on patient outcomes and educational effectiveness, providing insights that can be used to enhance both clinical practice and training programs.

Challenges and Considerations (Figures 7 and 8) and Table 1

While telemedicine offers numerous benefits for education, there are also challenges that need to be addressed:

- *Technology Access and Literacy:* Ensuring that all students and educators have access to the necessary technology and are comfortable using telemedicine platforms.

- *Quality Assurance:* Maintaining high standards of education and training in a virtual environment.
- *Privacy and Security:* Protecting patient and student data in compliance with regulatory requirements.
- *Accreditation and Regulation:* Ensuring that telemedicine-based educational programs meet accreditation standards and regulatory guidelines.

Table 1. Five areas of telemedicine as defined in the French public health code [26].

Area	Comment
Teleconsultation	Consultation at distance between a doctor and a patient
Tele-assistance	Doctor assists another health professional in performing specific procedure
Telemonitoring	Doctor interprets at distance patient data
Medical call center emergency	Triage of calls from the general public, usually by telephone
Tele-expertise	Dialog between treating doctor and a specialist

BENEFITS

- Telemedicine is valuable for offering psychological support to patients and their families.
- It supports the ongoing management of chronic diseases like bronchial asthma, diabetes mellitus, and hypertension.
- Telemedicine provides a safe and effective substitute for in-person healthcare.
- By providing diagnosis and treatment locally, telemedicine reduces the load on tertiary hospitals.
- Telemedicine also aids in training caregivers for sick and disabled children and elderly individuals.

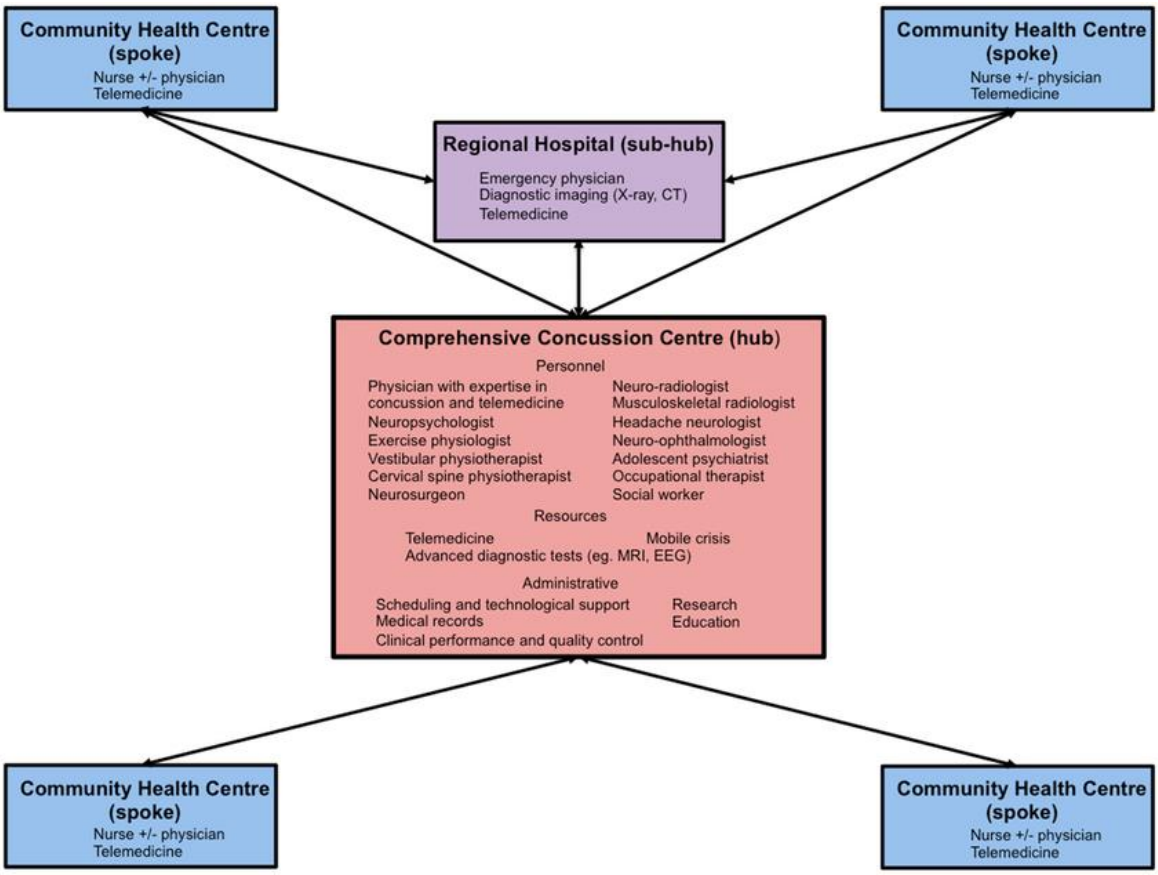

Figure 7. Diagram of a proposed "hub-and-spoke" regional pediatric concussion network. CT, computerized tomography; MRI, magnetic resonance imaging; EEG, electroencephalography [24].

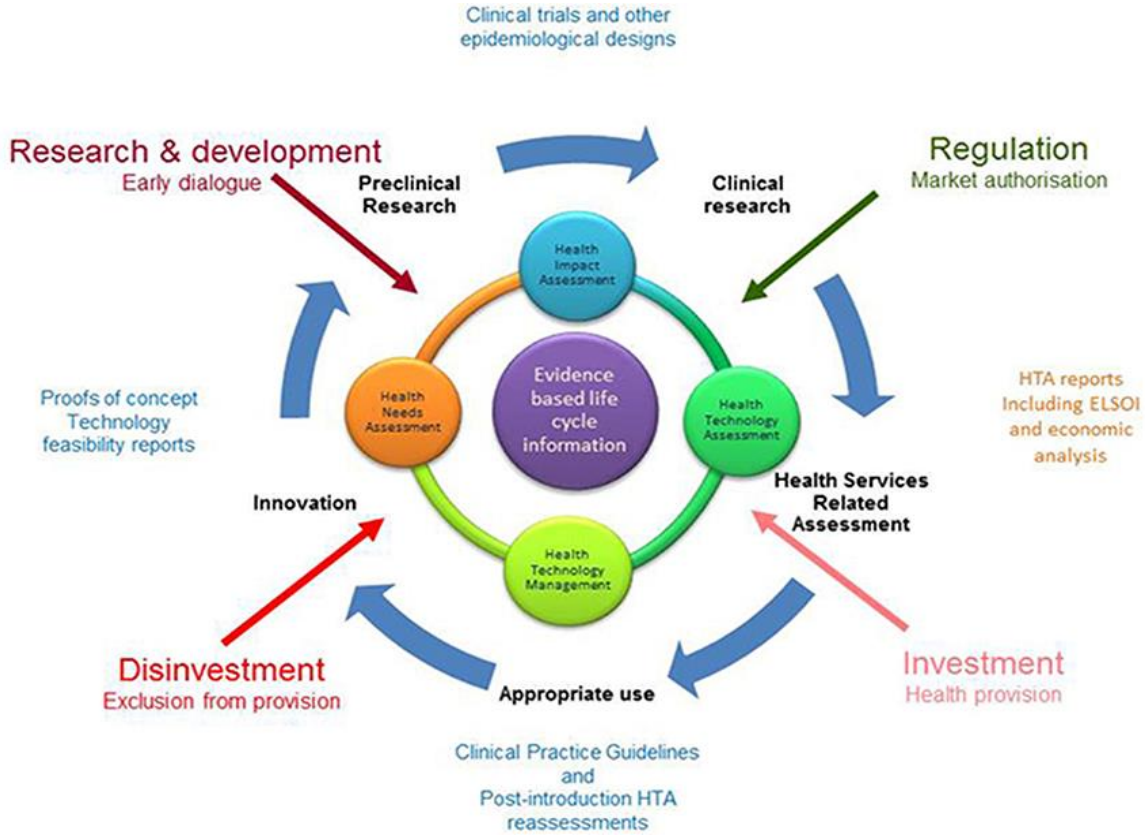

Figure 8. The life cycle of health technologies concept. ELSOI (Ethical, Legal, Social and Organizational Issues) [25].

ROLE IN FAMILY MEDICINE

Telehealth differ from telemedicine through this we can telecommunicate and provide traditional healthcare facilities. Telehealth services include four primary categories: video conferencing, store-and-forward, mobile health (m-health), and patient monitoring. Additionally, telemedicine enables family physicians to remotely access specialist medical opinions for cross-consultations.

ROLE IN PUBLIC HEALTH

The technology used in telemedicine enables healthcare providers and patients to connect from virtually any location, which is crucial for delivering quality healthcare to underserved populations. Initially, the challenge of starting telemedicine programs in remote areas without primary centres was addressed by introducing mobile telemedicine units equipped with satellite communication.

CONCLUSION

Telemedicine has been recognized globally as a critical tool for providing enhanced and quality medical services. While it may not solve every healthcare challenge, telemedicine significantly contributes to addressing a broad range of issues. Telemedicine is expected to expand further as more healthcare providers and patients adopt it in various capacities, guided by practice guidelines that support its growth. Despite its substantial potential, telemedicine has not yet reached the explosive growth anticipated. Beyond technological hurdles, economic and societal factors also need careful consideration. With time, it is hoped that telemedicine practices will achieve their full potential.

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