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A Century of Telemedicine:
Curatio Sine Distantia et Tempora
A World Wide Overview – Part IV

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Content

Preface

Dear Reader,

The fourth volume of the series "*A Century of Telemedicine. Curatio Sine Distantia et Tempora: A World Wide Overview*" is in your hands.

The goal of the series is to present different national and cultural points of view on the development and implementation of Telemedicine/eHealth and to share the information with international, national and regional institutions and policy makers as well as with all groups and individuals involved with healthcare. It provides directions of a wide variety of decisions, able to affect the form and functioning of the healthcare sector and offers clues towards the expected future of health organization at community level. The results and guidelines presented apply to all – national and local administration, individual practitioners, group practices, healthcare systems, as well as to providers of health-related services where there are Telemedicine/eHealth interactions either directly to the patient or from provider to provider for the purpose of healthcare delivery.

The series "*A Century of Telemedicine. Curatio Sine Distantia et Tempora: A World Wide Overview*" is especially important now, in the time of COVID pandemic as Telemedicine/eHealth comes in many shapes and sizes and offers numerous advantages over the traditional healthcare treatment. Before the pandemic, Telemedicine/eHealth was often neglected. The COVID threat quickly changes the attitude towards it.

This volume presents a historical approach of Telemedicine and eHealth/Digital Health in five countries – Armenia, Côte D'Ivoire, Pakistan, Tunisia and United Kingdom. Thus, the total number of countries introduced in all four parts reaches 21 (Fig. 1)!

Each chapter reveals different solutions for the treatment of patients and wellbeing of citizens, provides a glimpse and summarizes the best practical achievements, governmental policies, existing solutions and experiences in one country.

The editors are convinced that this volume offers useful information to those who are preparing to expand Telemedicine/eHealth/Digital Healthcare in their regions or countries. It will allow them to rely on the experience of the others and make them aware of the benefits and problems that were encountered during and after implementation of systems or services, and as such, will help to possibly avoid mistakes and reduce potential problems.

It is necessary to remind that as in the previous books:

- Each chapter covers various areas of Telemedicine/eHealth in one country;

- The countries presented in the volume are chosen on basis of a random selection method;
- Chapters are listed alphabetically, following the countries names;
- The original style of the authors is respected as much as possible;
- Despite the amount of information included in each chapter, no doubt that many services, projects and facts are still out-of-sight. We hope to be able to fill these gaps in the later editions.

We firmly believe that everyone involved in Telemedicine/eHealth will

Figure 1. Countries presented in all four parts

find this book not only interesting, but most valuable as well.

Enjoy your reading!

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Armenia
History and Current State of Digital Health, eHealth and Telemedicine in Armenia

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Introduction

The Republic of Armenia is a landlocked country located in the South Caucasus. As one of the oldest nations and centers of civilization in the world, Armenia has a rich history and a unique culture. The geographical landscape is mostly mountainous with iconic scenery. Located in the northwestern part of the Armenian Highland, is a combination of lofty mountain ranges, deep river valleys, and lava plateaus dotted with extinct volcanoes. With an area of 29,800 km^2, it is bordered by Georgia to the north, Azerbaijan to the east, Turkey to the west and Iran to the southeast. The capital is Yerevan, with magnificent views dominated by the biblical Mount Ararat across the border with Turkey. The climate is continental with hot summers and cold winters [1, 2].

The History and Economics of the Republic of Armenia

The Republic of Armenia was first established in 1918, following the Russian Revolution and the fall of the Russian Empire. In 1920, Armenia was incorporated into the Transcaucasian Socialist Federative Soviet Republic and became a founding member of the Soviet Union in 1922. By 1936, the Transcaucasian state was dissolved to transform the Armenian Soviet Socialist Republic into a republic of the Soviet Union. On August 23, 1990, Armenia declared sovereignty and thereafter, its independence from the Soviet Union on September 23, 1991.

A former republic within the Soviet Union, Armenia experienced a number of historic changes, including the dissolution of the Soviet Union, independence, the 1988 earthquake in Spitak, continuing economic blockade resulting from the military conflict with the neighboring country, and the difficult economic circumstances that followed. In 2018, in a popular uprising, Armenia's Velvet Revolution represented the climax of a decade of peaceful protest centered on human rights, women's rights, environmentalism, and labor and employment issues – all explicitly non- or minimally geopolitical causes [3, 4].

Fig. 1: Geographical map of Armenia [1]

The Republic of Armenia is a presidential republic and the governance is a parliamentary democracy. The Gross Domestic Product (GDP) per capita is $4,406 (2019 est.). Armenia joined the Commonwealth of Independent States in December 1991. It is a member of the World Bank Group, the International Bank for Reconstruction and Development, the International Monetary Fund, the European Bank for Reconstruction and Development, and the World Trade Organization. Armenia became a member of the United Nations in March 1992 and a full member of the Council of Europe in January 2001 [1, 2]. In 2015, Armenia joined the Eurasian Economic Union alongside Russia, Belarus, Kazakhstan, and Kyrgyzstan. In November 2017, Armenia signed a Comprehensive and Enhanced Partnership Agreement with the European Union [3].

Armenia is an ethnically homogeneous country where approximately 98.1% of the current population of ca. 3 million are Armenian, the remainder being Yezidi – Kurd (1.2%), with others accounting for 0.7% of the population. The official language is Armenian, with a unique alphabet. The predominant religion is Armenian Apostolic (one of the earliest Christian confessions) [3]. An overview of the general demographic data is shown in Table 1. An illustration of the age and sex structure of Armenia's population (2020 est.) is shown in Figure 2.

Armenia has strong ties with the European Union along with a strong partnership with the countries of the Eurasian Economic Union. Following a robust GDP growth of 7.5% in 2017 and 5.2% in 2018, economic performance remained strong in 2019, expanding by 7.6%. Among the sectors, there was an acceleration in tourism output. Industry also expanded strongly, driven by a rebound in mining production. Inflationary pressures remained low, with an average annual inflation rate of 1.4% in 2019 (down from 2.5% in 2018), well below the lower band of the Central Bank of Armenia’s inflation target range. The labor market has improved, but the unemployment rate remains exceptionally high at 18 percent [5].

Table 1. General demographic data - Armenia [3]

Ethnic groups	Armenian 98.1%, Yezidi (Kurd) 1.2%, other 0.7% (2011 est.)
Religion	Armenian Apostolic 92.6%, Evangelical 1%, other 2.4%, none 1.1%, unspecified 2.9% (2011 est.)
Language	Armenian (official) 97.9%, Kurdish (spoken by Yezidi minority) 1%, other 1% (2011 est.) Note: Russian is widely spoken
Population	3,021,324 (July 2020 est.)
Age structure	0-14 years: 18.64% 15-24 years: 11.63% 25-54 years: 43.04% 55-64 years: 14.08% 65 years and over: 12.6% (2020 est.)
Median age	Total: 36.6 years Male: 35.1 years Female: 38.3 years (2020 est.)

Population growth	-0.3% (2020 est.)
Net migration rates	-5.5 migrant(s)/1,000 population (2020 est.)

The Healthcare System of the Republic of Armenia

At independence, Armenia inherited a Semashko 'centralized' model health system. Though it was a system for providing universal coverage for basic healthcare services, the health facilities in Armenia were in poor condition; medical equipment and supplies were outdated, there was an oversupply and distorted allocation of healthcare workers, primary care was underutilized relative to specialist and hospital services, and there were substantial inequalities between urban and rural infrastructure and resources. Poor financial and management skills of those responsible added to inefficient use of limited resources [2].

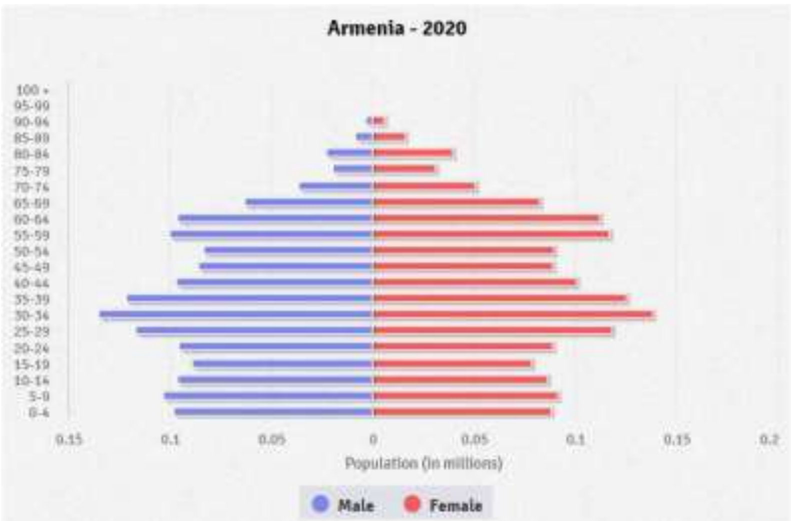

Fig. 2. Population Pyramid of Armenia [3]

Following independence, a general economic downturn had an impact on state budgetary resources available for health. The widespread informal payments for health services coupled with the political and economic pressure to move away from centralized, command-and-control system of the Soviet era, prompted the reform of the health system. The health system today comprises of a network of independent, self-financing (or mixed financing) health services that provide both statutory and private services [2].

Armenia accepts the following basic health values [2]:

- Health and healthcare as a fundamental human right;
- Equity in health and solidarity in action to achieve developed health standards and
- Collaboration and accountability of different individuals and institutions for continuous health development.

The healthcare system is divided into three administrative layers: national (republican), regional (at the level of "marzes" – regions), and municipal or community (decentralized). The ownership and operation of health services is delegated to provincial (regional) and local governments, services and several tertiary care hospitals [2]. Exception is the State Hygiene and Anti-Epidemic Inspectorate (SHAEI) (succeeded by the National Center for Disease Control and Prevention (NCDC), a non-profit organization with the status of a legal entity, the authorized body of which is the Ministry of Health of the Republic of Armenia) [2] (Fig. 3).

The Ministry of Health (MoH) and its subordinated institutions is the key regulator of the health system. It plays a role in defining and applying health standards and norms to ensure quality control and in developing and overseeing state-funded programs. It has weak regulatory capacity at the facility level. Regional governments play a role in the monitoring of volume of care provided [2].

The financing of healthcare is a network of independent and self-financing health services that provide statutory and private services. The State Healthcare Agency (SHA) acts as the third-party payer, purchasing services covered under the Basic Benefits Package (BBP) on behalf of the state. Hospitals have financial autonomy and are responsible for their own budgets and management. A majority of the pharmacies, dental services and medical equipment support are privately owned. Most hospitals in Yerevan are privately owned [2, 6].

Currently, the following coverage is available to the population of Armenia through the SHA within the country's statutory or public health system: The BBP covers some essential services for the entire population, as well as nearly all healthcare services for some vulnerable population groups [7].

The services covered by the SHA for all legal residents in Armenia are:

1. Primary healthcare;
2. Maternity and perinatal care;

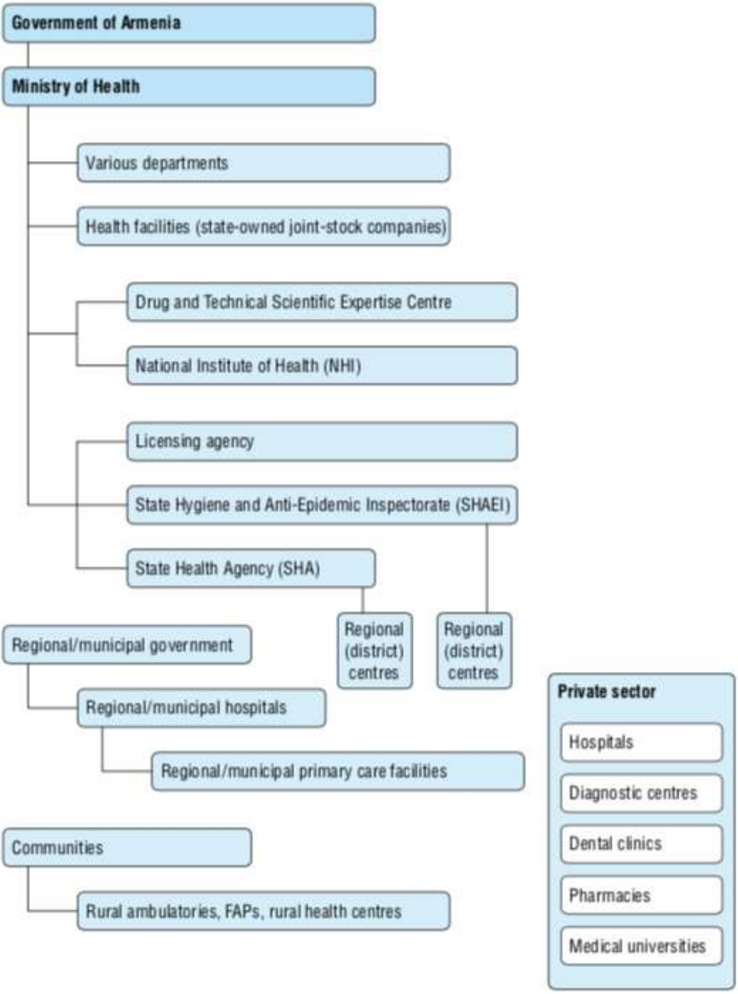

Fig. 3. Overview of the Health System of Armenia [2]

3. Acute and critical care for emergency life-threatening conditions (e.g. acute trauma, acute hemorrhage, acute cardiovascular conditions such as stroke or myocardial infarction, acute infections such as peritonitis or Coronavirus Disease 2019 (COVID-19), and others);
4. Most mental care;

5. Some long-term care.

Those services are typically free at the point of care, less the co-payments.

The major population groups benefiting from the statutory coverage of most health conditions (exceptions are non-essential services such as eye care, most of dental care, aesthetic procedures, etc.) are the following (a total of 29 categories) [7]:

1. Military and veterans;
2. Children up to the age of 7;
3. People with disabilities (medium to severe);
4. People with income levels below the minimal living wage.

People of the vulnerable population groups also receive care for free and are typically exempt from co-payments. Most urgent and elective care services for non-vulnerable population groups are covered either by voluntary or employer-sponsored private insurance (less than 5% of the population), or out of pocket. Civil servants receive care under Social Security Package mediated through contracts with private health insurers [7].

Thus, using the GCM – Generic Coverage Model™ developed and described by G. Chaltikyan [8], Armenia's public (statutory) system can best be described as 'BxF + CxD' model type (Figures 4).

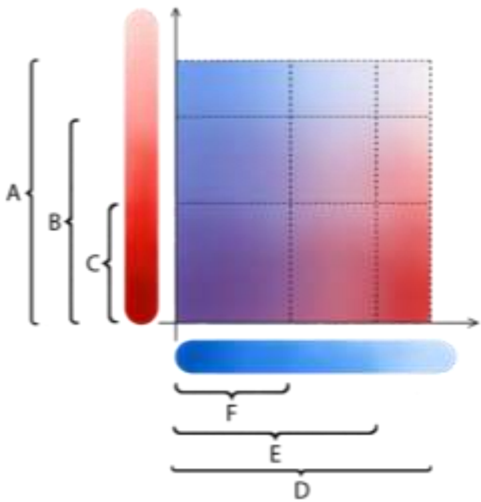

Fig. 4. The GCM – Generic Coverage Model™: the vertical axis shows healthcare services, from most essential (C) to all (A), and the horizontal axis shows population groups, from most vulnerable (F) to all (D) [8]

The current cabinet of the Prime Minister N. Pashinyan has proclaimed commitment to establish universal health insurance in Armenia. The group led by the Minister of Health A. Torosyan has been working on their concept of Statutory Universal Health Insurance based on a 6% payroll tax, and presented it in late 2019 for public review and commenting [9]. The concept was however met with little enthusiasm and received significant criticism, and with the breakout of the COVID-19 epidemic in February 2020, the work has temporarily been stalled.

In 2017, the current health expenditure as a percentage of GDP was estimated by the World Bank at 10.36% (4.5% in 2014), while the health expenditure per capita was US$407.6. In the same year, 84.3% of all health spending (% of current health expenditure) was paid out-of-pocket. The health expenditure per capita of Armenia showed an increase from US$67 in 2003 to US$407.6 in 2017, growing at an average annual rate of 15.08% [5]. Figure 5 shows the current and expected expenditure on health in Armenia.

An overview of the population health indicators in Armenia is shown in Table 2. The leading cause of death is ischemic heart disease accounting for 33.3% of total deaths; followed by stroke, and tracheal, bronchus and lung cancer. Similarly, the leading causes of disability adjusted life years (DALYs) are ischemic heart disease and diabetes. The average life expectancy at birth is 74.8 years in 2017, steadily increasing since 1991, when the average life expectancy was 67.9 years [5, 10] (Figure 6).

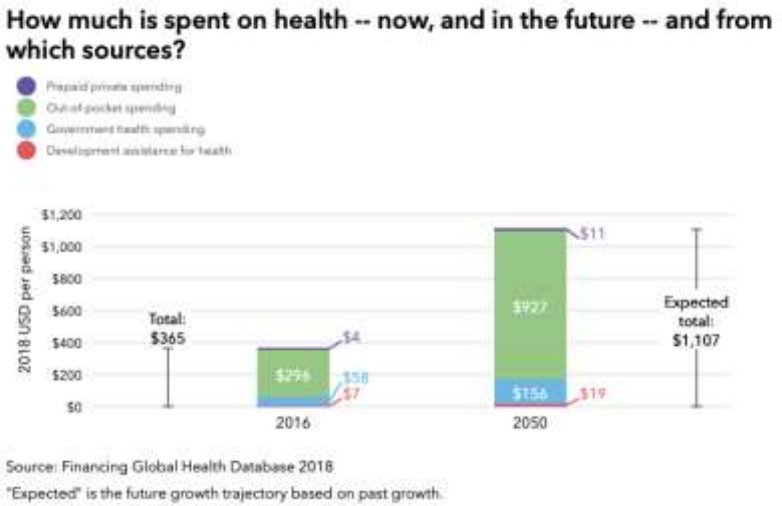

Fig. 5. Overview of current and expected expenditures on health [10]

Table 2 General health data [5]

Birth rate	11.9 births/1,000 population (2020 est.)
Death rate	9.5 deaths/1,000 population (2020 est.
Disease burden	Communicable disease deaths: 2.8 (% of total) (2016) Noncommunicable disease deaths: 93.3 (% of total) (2016) Injury deaths: 3.9 (% of total) (2016)
Infant mortality rate	Total: 11.5 deaths/1,000 live births Male: 12.9 deaths/1,000 live births Female: 10 deaths/1,000 live births (2020 est.)
Maternal mortality	26 deaths/100,000 live births (2017 est.)
Life expectancy at birth	Total population: 75.6 years Male: 72.3 years Female: 79.2 years (2020 est.)
Total fertility rate	1.65 children born/woman (2020 est.)
HIV/AIDS prevalence rate	0.2% (2018 est.)
People living /w HIV/AIDS	3,500 (2018 est.)
HIV/AIDS deaths	<200 (2018 est.)
Incidence of TB	31 (per 100,000 people) (2018)

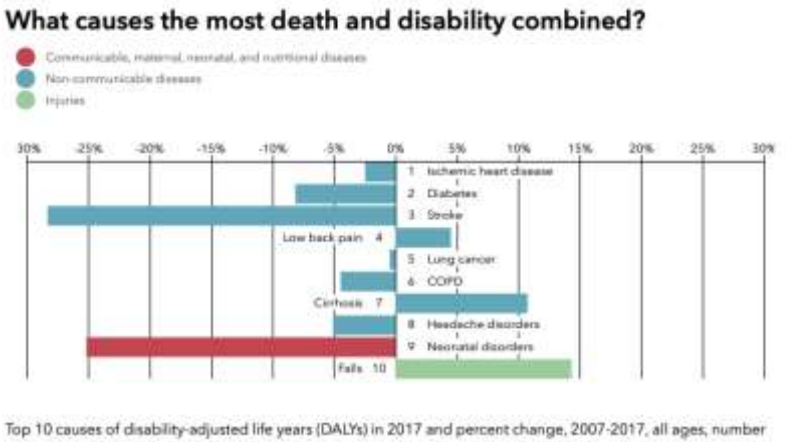

Fig. 6. Leading causes of deaths and disability combined – Armenia (2017 and percent change 2007-2017) [10]

Healthcare Workforce: The professional education of healthcare human resources in Armenia is provided by Yerevan State Medical University and five private higher education medical institutions. Vocational education of secondary medical workforce is performed by 20 secondary medical vocational institutions (12 public and 8 private). The overall trends of the Armenian healthcare workforce denote a contraction in the numbers. An overview of the healthcare workforce is provided in Table 3. The number of male and female doctors has increased between 2014 and 2015: males by 80 and females by 135 [11].

Table 3 Healthcare workforce statistics - Armenia [12]

Number of physicians	12,964 (2017)
Number of nurses and midwives	17,984 (2017)
Number of dentists	1,138 (2014)
Number of pharmacists	143 (2015)
Physician density	44 (per 10,000 population) (2017)
Nursing and midwifery density	61 (per 10,000 population) (2017)
Dentistry personnel density	3.9 (per 10,000 population) (2014)
Pharmaceutical personnel density	0.5 (per 10,000 population) (2015)
Hospital beds	4.2 (per 1,000 people) (2015)

Primary care is typically provided by a network of first-contact outpatient facilities involving urban polyclinics, health centers, rural ambulatory facilities and “FAPs” (Feldscher/midwife health post), depending on the size of the population in a particular community. According to government norms, a physician at the primary care level serves a population of 1,200–2,000 adults and a pediatrician typically covers 700–800 children. Most rural Primary Health Care (PHC) clinics have been upgraded and provided with modern medical equipment and supplies [2, 7]. Hospital capacity, measured in terms of the number of beds and facilities in the country, has fallen considerably since independence, from 9.1 hospital beds available (per 1,000 people) in 1990 to 3.9 in 2012 [7]. The most comprehensive facilities are the International Post-Trauma Rehabilitation Centre for patients with spinal cord injuries and the Children’s Rehabilitation Centre. There are virtually no dedicated facilities for long-term care as the responsibility for care falls mainly to families. In 2010, there were over 504 ambulatory facilities and polyclinics in the country [2]. A breakdown of healthcare facilities is as follows: 238 health posts, 16 health centers, 54 district hospitals, 47 provincial hospitals and 19 regional hospitals [13].

According to the Global atlas of medical devices, in 2014 there were 7 magnetic resonance imaging units, 9 computerized tomography scanners, 4 nuclear medicine units, 7 mammography units, 1 linear accelerator, 3 telecobalt (Cobalt-60) units and 4 other radiotherapy units. The density per 1,000,000 population of magnetic resonance imaging and computerized tomography scanners were 2.4 and 3.0 respectively. The density of mammography units per 1,000,000 population was 22.5. Units for radiodiagnosis and radiotherapy were limited to a density of 1.0 to 1.3 per 1,000,000 population [13].

The Information and Telecommunications Industry in Armenia

Armenia has a great potential for technology development and considered as a hub for software development, industrial computing, electronics, and semiconductor production [14]. It was one of the most industrialized republics of the former Soviet Union. Since 1996, specialists and organizations evaluated the potential of Armenia in the development of IT and programs have been adopted and aimed at choosing certain sectors for developing the mechanisms of implementation. This was supported by the government that declared the information technology industry as a priority area of economic development in Armenia [15]. Nowadays, Armenia is a regional leader in IT and high-tech industry due to its competitive labor, its share in GDP, and its constant growth in the number of companies and total turnover [14]. The Information and communications technology (ICT) domain is one of the most successful and fastest growing industries in Armenia. The competitive advantages of Armenia in ICT business are the following [16]:

- World-class Research and Development (R&D) capabilities in computer science, physics, and mathematics;
- Well-educated and talented workforce with a high degree of technical skills, and English language proficiency;
- Strong university programs with specializations in IT and sciences;
- High quality technical workforce (according to the Brainbench Global Skills IQ Report for 2006, Armenia was ranked second in the world, after USA, in the number of IT certifications received per capita);
- Highly competitive cost of labor and low operating costs;
- Government support of the sector and commitment to improve the investment climate;
- Strong and successful diaspora in Europe and North America;
- Extensive experience with large multi-national companies;

- Sound laws and regulations for IPR protection.

Investments in telecommunications have made major inroads in modernizing and upgrading the outdated telecommunications network inherited from the Soviet era. Telecommunication systems are now 100% privately owned and undergoing continued modernization and expansion. There is strong growth in the mobile broadband sector and mobile services dominate over fixed-lines [3].

Mobile Connections: There are three main mobile operators in Armenia today. These are VivaCell MTS, Beeline, and Ucom. VivaCell MTS is one of the largest mobile communication operators, having around 2.2 million subscribers in 2019. The Russian mobile operator Mobile TeleSystems (MTS) owns it. Beeline Armenia is owned by VEON Armenia CJSC (Closed Joint-Stock Company) (formerly called ArmenTel) and offers fixed telephony. The third mobile operator is Ucom that was established in 2009 as an Internet service provider. On acquisition of Orange Armenia, Ucom entered the mobile market in 2015. The penetration of the market is 114%, with a total number of subscriptions of 3.4 million. In 2016, K-Telecom (MTS) led the market with 61% share and over 2 million customers; Beeline has 25.6% and 0.88 million subscriptions, and Ucom serves 13.4% of the market with 0.46 million customers [17, 18].

Fixed Communication: The fixed-line Internet market is responsible for a small share of Internet penetration in Armenia, delivered predominantly by wireless connections. The fixed-line market is dominated by four major Internet service providers (ISPs), three of which are also mobile providers. These are Beeline, Ucom, K-Telecom (MTS), and GNC Alpha (Rostelecom). Asymmetric digital subscriber line (ADSL) remains the most dominant type of fixed connections, available across Armenia with the exception of 150 villages that have no landline telephone network, but faster fiber-optic connections are growing in popularity [18].

Table 4. General data on telecommunications – Armenia [3, 19]

Telephones – fixed lines total subscriptions	477,932
Telephones – fixed lines subscriptions per 100 inhabitants	16 (2018 est.)
Telephones – mobile cellular total subscriptions	3,579,257
Telephones – mobile cellular subscriptions per 100 inhabitants	118 (2018 est.)
Total Internet users	1,891,775
Total Internet users (% of populations)	62% (2016 est.)

Broadband – total fixed subscriptions	347,448 (2016 est.)
Broadband – fixed subscriptions per 100 inhabitants	11 (2018 est.)
Household with a computer (%)	64.6% (2018 est.)
Households with Internet access at home (%)	64.7% (2018 est.)

Access to Internet and Internet services: Armenia has relatively high Internet penetration indicators in the post-Soviet area. By end of 2016, International Telecommunications Union (ITU) lists the percentage of individuals aged 6+, using Internet in Armenia to be 62%, up from 59% in 2015. According to the country's National Statistical Service, by end of 2016, there were 2.4 million subscribers with access to Internet, including the mobile Internet connections, which amounts to 80% penetration. However, according to reports of main operators, by end of 2016, the number of fixed broadband subscriptions was just over 347,000 [15].

The three major companies offer broadband connectivity, including 4G services. The first 4G network was launched in 2010 by MTS, providing access to 4G+ service to 52% of the country's population. In the following years, Beeline and Ucom also offered 4G services. Armenian ISPs also offer wireless services (WiMax and WiFi), with about 250 thousand subscribers served in 2015. Satellite Internet is available throughout Armenia, through both local and foreign companies, but remains a costly niche service used primarily by corporate customers [15].

International Communication: Armenia is connected externally only with Georgia and Iran. Five gateways link the country with Georgia and two with Iran. The gateways with Georgia enable Armenia to connect with Russian and European segments of Internet, through terrestrial connections and undersea routes in the Black Sea. Yerevan is connected to the Caucasus Cable System fiber-optic cable through Georgia and Iran to Europe. Additional international service is available by microwave radio relay and landline connections to the other countries of the Commonwealth of Independent States, through the Moscow international switch, and by satellite to the rest of the world (satellite earth stations – 3) [3, 18].

The History of Telemedicine in Armenia

The Armenia-U.S.A. NASA Spacebridge Program of 1988-89

The Spitak earthquake on December 7, 1988, in which an initial 7.0 tremor was followed only 4 minutes later by a brutal 5.8 aftershock between the cities of Gyumri and Vanadzor in the north of the country, immediately claimed more than 25,000 lives, and flattened all available medical and public health infrastructure for hundreds of miles. In the first Soviet request for aid from the United States since the beginning of the Cold War, Soviet President Mikhail Gorbachev called on United States President Ronald Reagan for help. The resulting effort, called Spacebridge, brought together Dr. Arnauld Nicogossian of National Aeronautics and Space Administration (NASA) Life Sciences and Dr. Oleg Gazenko of the Soviet Union's Institute for Medical and Biological Problems in what would become the earliest, largest and successful international telemedicine effort to date, built to meet the needs of a rapidly unfolding public health disaster (Fig. 7) [20, 21].

Communication equipment was transported by Aeroflot from the United States to Yerevan with the broadcasts commencing on May 4th, 1989. The major mode of communications in the spacebridge was voice communications. A video channel served for visual access to the patient, presentation of medical images, diagrams, charts, etc., and also to show the audience the work of the physicians participating in the conference. A facsimile communication line was used to transmit data between Armenia and the United States of America (U.S.A.) consulting centers. Attention was also given to deontological issues. On U.S.A. territory, the video signal was propagated in a coded form, in order to guarantee the medical privacy of the patient and avoid accidental reception by private individuals or nonmedical organizations [22].

The Spacebridge to Armenia enabled physicians at the Republic Diagnostic Center in Yerevan to consult with American medical specialists in four centers via an audiovisual network. Over the 60-day period, NASA satellites connected 209 Armenian patients to specialists in burn management, urology, infectious disease, and post-traumatic stress disorder in the United States. Following a train crash in the Bashkir Autonomous S.S.R. in the following month, a teleconferencing studio was established in the city of Ufa, where burn cases were being treated, and connected this studio to the Yerevan-U.S.A. teleconferencing network. While the Armenia-U.S.A. spacebridge was in operation, there were 31 thematic conferences in 13 medical specialties [20, 21, 22].

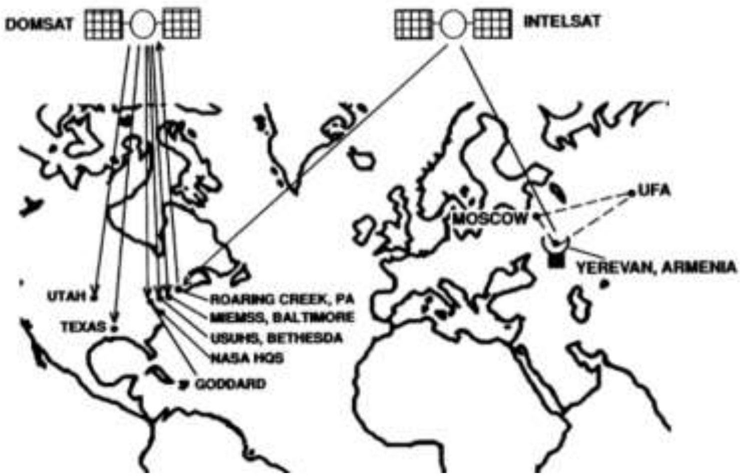

Fig. 7. Armenia-U.S.A. Spacebridge telecommunication network

The Diagnostica Medical Centre in Yerevan had several international collaborative programs and telemedicine activities with the University of Maryland and Yale Medical School. A program with the East–West Space Science Center of the University of Maryland, involved the study of a low-cost, PC-based Internet telemedicine system for interactive diagnosis, using teleradiology and ultrasound images transmitted between Maryland and Yerevan. This telemedicine system provided store-and-forward facilities for images, electronic patient records and teaching materials. It was designed to operate an Internet-based interactive telemedicine system, study of data transmission times using various telecommunication links, provide real-time voice transmission and study the quality of images transmitted between Maryland and Yerevan [20].

Telemedicine Activities in the 90s

The partnership between Boston University School of Medicine and Emergency Hospital of Yerevan was an audiographic teleconference capability linking the Emergency hospital in Yerevan to the Boston University School of Medicine. The remote connection allowed educational conferences, peer consultations, and distance learning. This teleconference program provided formal continuing medical education for Emergency Hospital. The telemedicine system comprised of Optel Communications' Remote Viewing System computer hardware and software plus two dedicated AT&T telephone lines. It was a key tool of low-cost technology transfer [23].

HyeBridge Telehealth Armenian Telemedicine Program since 2004

A remote medical education program called HyeBridge Telehealth Armenian Telemedicine Program was designed in 2004 to provide an educational forum by connecting doctors and healthcare providers. Along with providing updated medical information and organizing training and seminars, this Armenian telemedicine program aimed for a collaboration among the medical fraternity.

The system used Internet-based videoconferencing technologies via a website to deliver continuous medical education and diagnostic sessions in medical centers, hospitals and universities. The program enabled local Armenian healthcare providers to conduct diagnostic and educational telemedicine sessions with a network of U.S.A. based physician and healthcare providers. HyeBridge has partnered with the Armenian American Health Professionals Organization (AAHPO) and Yerevan State Medical University, along with the web-based consultation firm iConsult, and the Internet and telecommunication providers Karabakh Telecom and VivaCell [24, 25].

Establishment of the Armenian Association of Telemedicine (AATM) and Its Early Activities

The Armenian Association of Telemedicine (AATM) is a non-governmental, non-profit professional organization founded in December 2008 by a group of physicians and information and communication technology (ICT) specialists in Yerevan.

The mission of AATM is to promote development of Telemedicine and eHealth field in Armenia, concurrently participating in and contributing to the further advancements in the field worldwide [26]. The AATM in accordance with the recommendation of the World Health Organization (WHO) was instrumental in campaigning for a centralized holistic approach to install Health ICT into the healthcare system. It participated in an interdisciplinary working group called the eHealth Task Force with participation of ministerial officials, Non-Governmental Organizations (NGO), academic and research centers in relation to health ICT, industry representatives, and leading experts in the field, to develop and presented to the government a strategic plan for eHealth (eHealth Master Plan) [27].

The vision and strategy of the AATM published in 2009-10 included [28]:

- In-depth investigation of the field and market of Telemedicine and eHealth (TM/eH) and disclosure of the major medical, social and economic benefits of TM/eH for Armenia;
- Support for and boosting of investments in TM/eH, support for research and development in the combination of technological and

organizational innovations, facilitating synergies between international programs and national policies;

- Participation in the international telemedicine networks;
- Establishment and development of a National Telemedicine Network by establishing 'Remote Expert Second Opinion', special mobile telemedicine units to provide the local population, rural, remote and underserved areas of Armenia with access to advanced healthcare services, facilities and specialists outside the country;
- Creation, expansion and maintenance of eHealth services system for end-users;
- Deployment of a National Public Health portal providing dedicated information to citizens for health education, safety at work and disease prevention;
- Creation, expansion and maintenance of home care (“home telehealth”) facilities and network;
- Organization of educational and training courses on TM/eH for the medical community, GPs / family physicians, and other interested parties and professional organization, involvement of necessary medical, ICT and other specialists in the group;
- Establishment of a national distant medical education network organizing regular Continuing Medical Education (CME) activities;
- Development of roadmaps, recommendations and guidelines for wide implementation of TM/eH systems and services.

Among its activities, the AATM has been involved in:

- Monitoring of local and international news, literature and publications in the field of Telemedicine and eHealth (TM/eH);
- Assessment of local needs and requirements in the field of TM/eH;
- Evaluation and adaptation of existing international standards and protocols in the field of TM/eH to the local environment and conditions;
- Establishment of long-term cooperation and partnerships with local and international associations, working groups, organizations, institutions, funds and companies relevant to the field, including those working in the area of Information and Communication Technologies;
- Coordination of / participation in various practical, educational, and scientific research projects related to TM/eH applications in Armenia;

- Organization of / participation in various local and international congresses, conferences, seminars, workshops, working meetings, and training courses in the field of TM/eH.

Development of Specialist Teleconsulting System for Primary Health Care in Armenia

Armenia has a relatively developed primary healthcare network; however, shortage of specialist physicians in rural areas, as well as financial constraints frequently hamper the maintenance of appropriate quality of care at community levels. As a result, patients from rural areas seek specialty healthcare in large urban centers, mostly in Yerevan, which is associated with significant direct and indirect costs (such as travel and temporary stay, absence from workplace), and frequently results in delays in diagnosis and initiation of treatment. In 2010, a pilot telemedicine system for primary community healthcare in rural areas in Armenia was implemented. The project aimed at delivering distant specialty consultations to patients and primary care workers in remote locations by establishing and operating a telemedicine connection between a primary healthcare facility in remote rural location ("Referral Site") and a health center in Yerevan ("Consult Site"). Teleconsulting services by selected medical and surgical specialists in Yerevan was provided to patients presenting in the referral site and their managing physicians (general practitioners) [29].

Elaboration of Strategic Plan of Long-Term Development of eHealth Applications and Services in Armenia (eHealth Master Plan)

The AATM participated in a working group (eHealth Task Force) together with the government authorities, academic and research centers, ICT representatives, and leading experts in the field, to develop and present to the government a strategic plan for eHealth [30].

Establishment, Development & Maintenance of Nationwide Telemedicine Network in Armenia

AATM proclaimed a long-term goal to establish, develop, operate and maintain a comprehensive nation-wide telemedicine network connecting together all country's healthcare facilities, as well as providing them with access to leading international healthcare institutions. An example is the launch of a pilot telemedicine connection between a community primary care facility and consult site in Yerevan, to serve as a model for future telemedicine network [30].

Some of the other important activities involving the AATM were participation in the meetings organized and conducted by the Union of Information Technology Enterprises of Armenia (UITE, currently – Union of Advanced

Technology Enterprises, UATE) resulting in cooperation agreement and establishment of partnership with a number of local and international ICT companies and related organizations. In 2009-16, AATM participated in Med-e-Tel forums (The International Forums on Telemedicine, eHealth and Health ICT, organized under the auspices of the International Society for Telemedicine and eHealth – ISfTeH) in Luxembourg and was admitted into ISfTeH as the National Member representing Armenia in the global Telemedicine and eHealth community. AATM established partnership and cooperation with major international organizations, professional associations and industry representatives in the field of Telemedicine and eHealth and discussed important global tendencies with regard to national, international and global telemedicine and eHealth initiatives. AATM also participated in several Annual Meetings and Expositions of the American Telemedicine Association (ATA) – the world's largest international congress and exposition in the field of Telemedicine, eHealth and Health ICT and presented its vision and efforts in advancing Telemedicine and eHealth in Armenia, as well as explored opportunities for networking and collaboration with leading US-based and international organizations in the field. At the end of 2010, an official Memorandum of Understanding was signed between AATM and the American Telemedicine Association (ATA), thus formalizing partnership relations between the two organizations aimed at promoting development of Telemedicine and eHealth in Armenia and globally, and participation in international initiatives and programs [28].

Pilot Telemedicine Projects by AATM in 2010

The Armenian Association of Telemedicine (AATM) conducted two pilot telemedicine projects in 2010. The pilot projects were intended to become the first step in a larger initiative of telehealth network establishment. The pilot project funded by United States Agency of International Development's (USAID) Primary Health Care Reform project (PHCR) served as a model for the future expanded telemedicine network.

First Pilot Project: Funded by the United States Agency for International Development (USAID) within the framework of Primary Health Care Reform (PHCR) program, the project was titled "Capacity building of the Armenian Association of Telemedicine to result in improved primary healthcare services in Armenia". The project consisted of four major segments: capacity building and expansion of the Association; research on the role of Telemedicine and eHealth in improving quality, accessibility and cost-effectiveness of healthcare system in Armenia; demonstrational telemedicine model system; evaluation and dissemination of the outcomes, including public awareness campaign. The most important part of the project was the establishment of a fully functional model of telemedicine network consisting of two PC-based stations (the "referral station" at a rural primary care center in northern region, and the "consult station" at AATM's central office in downtown Yerevan), equipped with video-conferencing devices and commercially available medical peripherals, and connected via virtual private network, providing a minimum of 2 Mbps of symmetric bandwidth.

Throughout the 8 weeks that the system was operational, 16 connection sessions were organized, delivering a total of 93 teleconsultations (mean 5.81 per connection session) to 76 patients (mean 4.75 patient per connection session). During the period of operation of the pilot telemedicine system and upon completion, systematic assessment was conducted evaluating the project's feasibility and impact on primary healthcare. The system was shown to reduce more than 70% patients' visits to remote specialists, allowing timely 377 diagnoses, improving treatment outcomes, increasing patients' satisfaction, ensuring primary care personnel's professional growth, reducing healthcare costs, and contributing to overall development of the target rural community [31].

Fig. 8. Referral site with computer system and peripherals

Second Pilot Project: This project established a similar telemedicine connection between a primary healthcare facility in Stepanakert, Nagorno-Karabakh Republic, and the AATM central office in Yerevan.

The system operated throughout one working week, from November 29 to December 3, 2010. During this five-day program, direct teleconsultations were delivered in cardiology (including real-time echocardiography), dermatology, ophthalmology (including real-time ophthalmoscopy), and diagnostic radiology (ultrasound examination). Patients presenting to the referral site were examined and consulted by leading specialists in Armenia [31].

Fig. 9. Consult site at AATM's central office

Fig. 10. Teleconsultation (ophthalmoscopy) at the Second Pilot Project

Fig. 11. Team at the consult site in the Second Pilot Project

First International Congress on Telemedicine and eHealth "ARMTELE-MED: Road to the Future" of 2011

The First Armenian International Congress on Telemedicine and eHealth was held in 2011 in Yerevan, Armenia. Titled “ARMTELEMED: Road to the Future”, the Congress took place under the auspices of the Ministry of Health of the Republic of Armenia, the International Society for Telemedicine and eHealth (ISfTeH) and the American Telemedicine Association (ATA). The Armenian Association of Telemedicine (AATM), jointly with Russian-Armenian (Slavonic) University (RAU) and Union of Information Technology Enterprises (UITE), organized it.

The Congress featured plenary and scientific sessions, panel discussions and round tables, with keynote presentations by world-famous experts in telehealth and related technologies, as well as an educational track (Seminar of the International School of Telemedicine and eHealth), and an exposition of local and international companies.

The event was attended by more 287 participants from more than 20 countries worldwide, including 19 keynote speakers among well-known experts in the field. It brought together policy makers, government officials and senior executives, who are involved in defining and regulating the development of the field of Information and Communication Technologies in medicine and healthcare, in Armenia and beyond.

This Congress was the first-of-the-kind in Armenia and in the entire region. The meeting provided an exceptional platform for bi-directional exchange of experience, networking and collaboration, which posed to become a regular scientific and educational event, to boost developments in the field of Information and Communication Technologies in Medicine and Healthcare. [26, 32].

Fig. 12. Opening Session of '*ARMTELEMED: Road to the Future*' Congress

Fig. 13. AATM President G. Chaltikyan, President of ISfTeH M. Nerlich, and Chairman of the Health Committee A. Babloyan (left to right) chairing a session at the '*ARMTELEMED: Road to the Future*' Congress

Fig. 14. Panel discussion with experts in the field of telemedicine at the '*ARMTELEMED: Road to the Future'* Congress

Pilot ECG-Telemonitoring Project of 2012-13

In 2012, the Armenian Association of Telemedicine (AATM) established a cooperation with a telehealth and mHealth equipment producer company Mega Koto Ltd. from Finland (a subsidiary of Mega Electronics Ltd.) and NA ICT Solutions BV from The Netherlands, aiming to develop Mobile Electrocardiogram (ECG) Telemonitoring system for local cardiology clinics in order to allow a person with cardiac problems to remain under 24/7 ECG surveillance. The system consisted of the central data server connected via dedicated lines with monitoring workstations installed at cardiology institutions and clinics, and lightweight highly portable single lead ECG sensors coupled via Bluetooth with Android smart phones with a preinstalled special application. The sensor was used to read ECG signal and send it to the phone's app, which uploaded the data onto the server through the mobile's broadband connection. The monitoring workstation received the signal in real-time from the server, and displayed it on large LED screens, for live ECG monitoring by dedicated personnel. Physicians were also able to access their patients' ECG data, both live-streamed and stored, via backend web-access platform from any device connected to Internet [33].

The ECG-Telemonitoring system was piloted at three cardiology clinics in Yerevan, in 2012-2013. However, some technological shortcomings of the equipment, coupled with immature business model not matching the country's healthcare system at the time, resulted in low enthusiasm and uptake by the specialist cardiology units, and the pilot project eventually did not transform into a sustainable program.

Fig. 15. Pilot ECG-Telemonitoring Project of 2012-2013: monitoring station at one of the cardiology clinics in Yerevan

German-Armenian Telepathology Project

In 2010, members of One World Medical Network collaborated with the pathologist Prof. Dr. med. Martin Oberholzer building up a telemedicine network in Armenia which helped physicians make diagnoses and clinical decisions.

The "ArmTelNet Telemedicine Project" was implemented at Medical Center "Arabkir" in Yerevan, as well as at Vanadzor and Gyumri Hospitals. These hospitals were equipped with computers, microscopes, light tables and cameras for digitizing radiographs. It was supported by the telemedicine platform CampusMedicus™ by a German telemedicine provider Klughammer GmbH (led by the long-time ISfTeH member and telemedicine enthusiast and expert Anna Schmaus-Klughammer), a medical network communication platform allowing a simple structured dialogue among health professionals. The requisites during a telemedicine discussion included an image source, a computer, and access to Internet (for non-experts); and a computer and access to the Internet (for experts).

The goal of this project was to establish a telemedical consultation for every case requiring an urgent referral prior to the transport of the patient to the university hospital. Additionally, use of this service helped to reduce the sum of the transport fees, increase quality of diagnoses and treatment, train medical personnel in the periphery and continuing medical education. This telemedicine network enabled doctors to be connected to each other in Armenia, as well as to international radiologists and pathologists [34].

Activities by the MoH to Provide Telemedicine Access in Rural Hospitals and Other Telemedicine Activities in Armenia

In 2005, the Medical Missions for Children (MMC) and Armenia Fund USA partnered with the Armenia's Ministry of Health and other in-country medical groups to open a healthcare facility in the capital of Armenian-populated Nagorno-Karabach Republic. The healthcare facility called "The Stepanakert Polyclinic", provided care to seriously ill children and adults. The group furnished the clinic with telemedical instruments and technologies enabling physicians and specialists based in New Jersey to examine, diagnose, and advise Armenian physicians on the treatment for pediatric illnesses of the upper and lower respiratory tracts and infections of the eye, ear, nose, and throat [35].

In 2011, VivaCell-MTS and the Yerevan State Medical University presented a Mobile-Health Solution pilot program, based on Ericsson's wireless mHealth technology. The technology aimed at establishing new improved means for providing healthcare services' availability. The solution provided the doctor with the chance to establish remote access to the health of the patient, and the patient has the chance to send information on their health through the VivaCell-MTS network, enabling a medical employee to carry out analysis of the data by means of special mobile devices. The mHealth system of VivaCell-MTS included a spirometer, a blood pressure monitor, a pulse oximeter and a communication device gathering data from different sensors via Bluetooth connection and transmitting through the VivaCell-MTS network to a back-end system and server. The system includes a web application for medical providers [36].

In 2014, the MoH of the Republic of Armenia signed a Memorandum of Understanding on creating a telemedicine network between the Government of the Republic of India and the Government of the Republic of Armenia.

With India's assistance, the decision intended to provide one medical center in Yerevan and nine regional hospitals with technical expertise, supply and installation of telemedicine software. A connection was also established between the hospitals in Armenia and leading medical centers of India for mutual professional advice, experience and knowledge exchange, facilitated disease diagnosis and treatment. With India's support, educational programs will also be implemented for the Armenian doctors, nurses, technical workers in the field of telemedicine. The program operated in eleven medical centers of Armenia located in eleven cities: Yerevan, Alaverdi, Goris, Kapan, Meghri, Yeghegnadzor, Gyumri, Gavar, Jambarak, Vanadzor and Stepanavan and all these eleven hospitals are now connected with each other [37].

In 2019, a proposal for enhancing healthcare and human rights protection in prisons in Armenia was put forward. The 30-months project is part of the Council of Europe Action Plan for Armenia 2019-2022. The Council of Europe in cooperation with the Ministry of Justice, the Ministry of Health and the Penitentiary Medicine Center implements it. The project aims to focus on the improvement of prison healthcare services through the introduction of new technologies in healthcare services, such as telemedicine and electronic database system of medical records, and modernizing hospital/specialized medical care and services in the penitentiary institutions [38].

Educational and Public Awareness Activities

"Telemedicine for Family Physicians": A one-day seminar organized by the AATM jointly with the PHCR aimed at the dissemination of general knowledge about Telemedicine and eHealth, as well as about AATM and its activities, among primary care physicians in Armenia. During this educational event AATM president, Dr. G. Chaltikyan delivered an introductory lecture via live videoconferencing from Los Angeles, USA, followed by presentations by other AATM board members. The seminar culminated in a lively discussion on possible pathways of implementation of telemedicine and eHealth in Armenia [28].

Participation in DigiTec Business Forums: These are forums organized by the Union of Information Technology Enterprises (UITE, now UATE). Since 2009, the AATM presented its recent achievements and ongoing activities within the frameworks of the pilot telemedicine project and perspectives on future developments in the field of Telemedicine and eHealth in Armenia [28].

In 2012-2015 AATM participated in DigiTec Business Forums and co-hosted single-day sessions on eHealth and Telemedicine featuring prominent local and international speakers, and attended by between 60 and 100 practitioners, academics, scholars and students of Digital Health.

BME-ENA Project in Armenia: A 3-year international capacity-building and curriculum development project titled "Biomedical Engineering Education Tempus Initiative in Eastern Neighboring Area (BME-ENA)" was funded by the EU's Tempus IV program, and implemented by 17 institutions from 11 EU and ENA countries in 2014-17.

Fig. 16. Session on eHealth at DigiTec Business Forum presided by specialists of the AATM and ISfTeH, Yerevan, 2012

Fig. 17. Session on eHealth at DigiTec Business Forum, Yerevan, 2012

The BME-ENA project enabled Armenia, Georgia, Moldova and Ukraine to further develop biomedical technology education.

Armenia was represented by the National Polytechnical University of Armenia (NPUA), Russian-Armenian University (RAU) and the Armenian Association of Telemedicine.

Fig. 18. Dr. Georgi Chaltikyan explaining AATM's pilot ECG monitoring project at DigiTec Expo, Yerevan, 2012

Fig. 19. AATM hosting a session at DigiTec Business Forum, 2012

Fig. 20. AATM President Dr. Georgi Chaltikyan presenting the new educational program "New European Joint Master's Program in Biomedical Engineering", launched at the National Polytechnic University of Armenia (NPUA) and Russian-Armenian (Slavonic) University (RAU) in 2015, developed under TEMPUS IV project BME-ENA.

Armenia Eye Care Project

In 2017, a team of doctors from a group within the Children's Hospital Los Angeles, a pediatric multispecialty medical group in the United States travelled to Armenia to assess the need to train remote care teams. Thomas Lee, MD, joined the Armenia EyeCare Project at Children's Hospital Los Angeles. He and a team of doctors assessed the need to train remote care teams. This was evident since there were not enough surgeons with specialized knowledge, required to provide life-changing eye surgeries. Additionally, a critical issue was that some of these sight-saving surgeries for premature infants with certain retinal conditions needed to take place within 48 hours of birth. The lack of trained surgeons meant many infants might miss their opportunity.

Fig. 21. The Armenia EyeCare project

With the help of SADA Systems, a Microsoft partner, a telemedicine system was built using Microsoft technology, Skype for Business along with a Polycom codec, which allowed doctors from Los Angeles to be present virtually during operations. Therefore, by having a remote platform available, the doctors were able to provide the supervision needed in a timely fashion for the patient without requiring the expert to travel to the remote country and assist the doctor directly [40].

German-Armenian Telemedicine Project

In 2014-2015, a project titled "Evaluation of scientific, educational and practical cooperation between German and Armenian institutions in the field of healthcare information and communication technologies" was conducted jointly funded by the German Ministry of Education and Research (BMBF) and the Armenian Ministry of Education and Science.

The goal of this project was to develop a bilateral exchange of knowledge in Digital Health between Germany and Armenia. The increasing use of Information and Communication Technologies (ICT) in healthcare was used to address the needs of Armenian healthcare system. The project partners were: Russian-Armenian (Slavonic) University (RAU), the Armenian Association of Telemedicine (AATM), Deggendorf Institute of Technology (DIT, Germany) and web-based telemedicine platform provider Klughammer GmbH (Deggendorf, Germany).

Fig. 22. Prof. Dr. Georgi Chaltikyan and Prof. Dr. Horst Kunhardt presenting the 1st German-Armenian Telemedicine and eHealth Workshop

The main activities of the project were organized around three German-Armenian Scientific-Practical Workshops on Telemedicine and eHealth conducted in Yerevan (in November 2014 and October 2015) and in Deggendorf (in April 2015) [41]. One important result of the project was the establishment of long-term education and R&D cooperation between the two higher education institutions – RAU in Armenia and DIT in Germany.

Fig. 23. President of Russian-Armenian University (RAU) Prof. A. Darbinyan at the 1st German-Armenian Telemedicine and eHealth Workshop

Fig. 24. Team members of the German-Armenian telemedicine project (left to right: Dr. A. Ernstberger, Mrs. A. Schmaus-Klughammer, Prof. M. Nerlich, Dr. G. Chaltikyan, Dr. T. Saghatelyan, and Dr. A. Haroyan), 2015

The collaboration relations between RAU and DIT were formalized by a Memorandum of Understanding signed by the presidents of both universities, Prof. A. Darbinyan and Prof. P. Sperber in 2018. Perhaps the most significant result of such cooperation is the establishment of a new international and innovative double-degree study program “Master of Digital Health (MDH)”. The program is expected to launch in the academic year 2020-21.

Web-based International Telehealth Platform "Global Virtual Clinics"

The web-based telehealth platform “GVC – Global Virtual Clinics” is a new direct-to-consumer telehealth product launching in Armenia with international participation. It is a web-based platform allowing individual physicians, as well as clinics and other providers to communicate with patients and consumers virtually in an easy and efficient manner.

Health professionals, providers and consumers are able to create profiles, schedule and conduct teleconsultations, exchange messages and files (medical documents, images, lab and other diagnostic test reports), and create, maintain and share health records. The platform will have multiple functionalities, including videoconferencing, messaging, file sharing, and analytics. In the future it is planned to add AI-based self-check and triage tools, genomic data, and personalized care algorithms based on a significant number of biomedical, social and omics parameters.

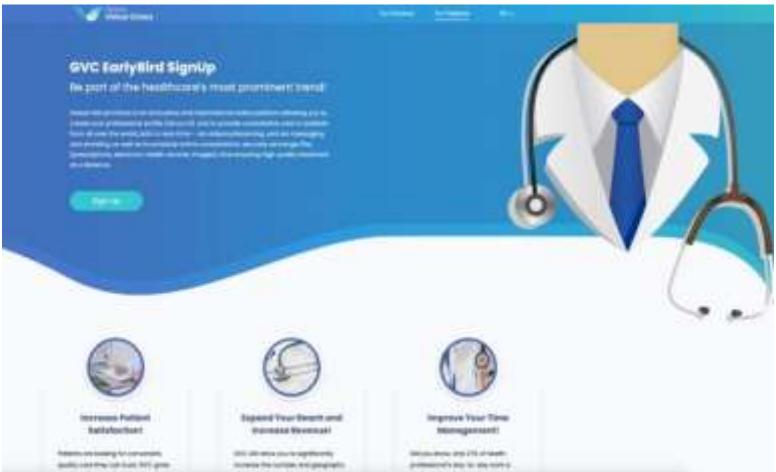

Fig. 25. The web-based platform – Global Virtual Clinics

GVC will allow thousands of patients to seamlessly connect with prominent clinicians not only in Armenia, but also around the world, and to benefit from the revolutionizing opportunities of global digital healthcare.

The platform currently in its beta-phase, is open for early bird preliminary registration to build a solid customer base. The launch is planned in the last quarter of 2020.

The History and Current State of eHealth in Armenia: The Integrated Health Information System of Armenia (IHISA)

History of the Development of the National eHealth System

The establishment and implementation of a health information system in Armenia underwent several phases. Early in 1998, the Government of Armenia initiated health sector reforms through which the State Health Agency (SHA) was established. The SHA served as a single healthcare service purchasing body for state-guaranteed healthcare services. Through these reforms, the Government separated the financing functions from the Ministry of Health (MoH) to a separate unit specialized only in financing operations. As a result, the structure of healthcare budgeting and financing mechanisms changed cardinally, and the Soviet time line-by-line financing mechanism was transformed into the financing per cases for hospital and per capita financing of primary healthcare services. In 1999, collection of hospital case information was performed using paper forms.

In order to manage newly introduced financing and quality control verification systems, there was a need for comprehensive, accurate, and timely collected data, and the paper forms were not effective enough. At the early stages of the healthcare reform initiative, all filled paper forms had to be collected at the SHA and its regional branches and scanned into the electronic system by SHA data operators. In terms of the collection and creation of electronic health data, this phase was fragile. However, the SHA, with its regional branches, became advanced for more sophisticated data collection, analysis, and payment mechanisms. The critical advantage of this phase was the preparation and involvement of all healthcare service providers for the next, more advanced step of electronic data generation. In this early phase, all healthcare provider facilities understood the need for the development of their internal staffing and IT resources, relevant internal procedures, and capacities for assurance of data collection accuracy. In addition to the development of electronic health systems, other elements such as necessary hardware, regulations, awareness, and other components, were also considered as important factors.

With the increase of financing control mechanisms, the introduction of a more comprehensive data collection system became crucial, allowing health facilities to organize data entry in the facilities instead of sending the paper forms to SHA. Parallel with this, many large facilities (initially hospitals, then large polyclinics) realized the need for investing in computer and network technologies.

In 2000-2001 all hospitals were transformed into a so-called global budget modality of governance, meaning that the hospital management became independent in their day-to-day management, including internal allocations of received state funds and earned income from out-of-pocket payments. Most of the managers accepting this initiative were not prepared and capable of effective management. In this situation, the importance of internal use of accumulated data was acknowledged, and many facility managers started paying more value to the development of IT resources – through external support or by investing their resources. In this stage, the establishment of IT resources was more affordable for hospital care providers. The primary healthcare facilities stayed behind in the electronic data generation process as initially, it was required to report only annually and only for the upgraded numbers of their serving population.

Only later, in 2003-2005, the primary service providers became involved in the creation, processing, generation, and vertical transfer of electronic health data to higher levels for funding and verification of performance in terms of compliance of reported services with the scope and volume of annually approved state order services. The compliance verification, incorrectly called quality assurance, was essential to prevent, reduce or eliminate encountered fraud or double reporting on cases aimed to receive state funds for groups of the population not eligible and not included in the package of state-guaranteed services. During this stage, the SHA migrated the existing system into two distributed health information systems for hospital and PHC facilities, as described further in this section.

MIDAS (E-Hospital)

In 2000, the MoH with funding and technical support of international organizations, designed and implemented a simple but robust system called "Medical information data analysis system" (MIDAS) for collection, control, and management of state order-related data for in-patient service provider organizations. The MIDAS system capitalized on all the advantages of the preceding prototype system. MIDAS established the three-level infrastructure hierarchy of data transfer and use, and step-by-step modernization with new IT solutions. With the permanent increase of data volume, and with a necessity for possessing timely submitted information for the different decision making actions, the use of MIDAS became imperative to all involved parties, including SHA, hospital care organizations, MoH and Ministry of Finances.

The 2010 MIDAS system, further renamed as E-Hospital, included additional modules for the calculation of the salary of medical staff, use of drugs, and registration of dental cases. The latter feature of the system eventually separated from the E-Hospital. It was used as a standalone software solution serving more than 80 dental clinics over the country for more than five years.

E-PHC System

The next important step for Armenia towards the development of the health information system was the introduction and support of a patient choice of healthcare service provider and the registration of ambulatory cases for quality control at the primary healthcare (PHC) level. The scope of this process was the new paper forms for data collection, necessary hardware components; training, full packages of process guideline documentation, and finally, SHA introduced E-PHC electronic system.

In its initial stages, these reforms were implemented by the international partner's funds, with the further transfer of knowledge to MoH. In 2009-2010, the system was available in 450 primary healthcare facilities, including medical centers, free-standing polyclinics, rural ambulatories, and even some of the larger health posts. Similar to the MIDAS, the E-PHC system was a three-level distributed database allowing the collections and transfer of the PHC from medical institutions to regional levels with the further accumulation and aggregation of the data in the central office of SHA. During its lifetime, the E-PHC system continuously evolved, adding support for the collection of specific data to generate various healthcare indicators, immunization control, and child nutrition indicators. In 2010, the system started to support the collection and analysis of data for 30 PHC performance indicators targeting preventive and curative indicators linked to high incidence diseases towards MoH policy priorities. These changes have been successfully implemented countrywide and were recognized as a regional success case, becoming a subject for many study tours to Armenia from other countries.

Architecturally, the MIDAS and E-PHC systems are distributed database systems with a three-hierarchy level architecture. Initially, data transferred between these levels on e-carriers such as optical discs or USB devices, and further with the development of e-communication services, organized the data through the available communication channels. Parallel with this, the maintenance services of the systems were upgraded to a centralized online format that does not require visiting each facility for any troubleshooting and updating installation versions that was taking place earlier. SHA used both these systems until 2017. By that time, the Government of Armenia introduced a unified eHealth solution, described later in this section. However, both MIDAS and E-PHC systems are still operational and used by the State Health Agency as a source of archived and historical data.

Concept of A Unified eHealth System

The earliest concept of a unified eHealth system was developed in 2008 by the Central Bank of Armenia. This concept was based on the usage of a smart card. The planning of a unified eHealth system started early in 2010 when the Government of Armenia adopted the concept paper on the development of a unified electronic healthcare system. The Government had a leading role in the initial steps of defining a roadmap for the design and development of a national eHealth system since 2010. The Government of Armenia initially implemented these activities via the e-Governance infrastructure implementation agency (EKENG), which is the coordinator of e-government projects in the Republic of Armenia. The Government of Armenia is the founder of EKENG, and all the shares belong to the Republic of Armenia. The Staff of the Government is the relevant authority managing the organization. EKENG has the responsibility of implementing e-society projects in Armenia and in implementing many significant projects aimed at the development and progress of e-government. EKENG is the only authorized company in the Republic of Armenia that provides electronic digital signatures to individuals with identification cards, which is one of the critical technological features of the current eHealth system.

In 2012, the Government approved the program and the timeline of activities for the implementation of the eHealth system. A year later, in 2013, the Government accepted the list of measures for the development of legal acts necessary for the introduction and operation of the health information system. The main result of these activities was the design, development, and implementation of a unified electronic health information system.

In 2013-2014, the Government organized a tender, and selected a consortium of the international (Ericsson Nicola Tesla, Croatia) and local companies (Masys Apahov) that was in charge of adopting and localizing the existing off-the-shelf eHealth solution by the Ericsson Nicola Tesla for Armenia. After the adoption of the system, in 2016 the Government signed a concession agreement with the newly established local private company - "National Electronic Healthcare Operator" CJSC (NEO), for 15 years. The National Electronic Healthcare Operator is in charge of operating the eHealth system in the country. Thus by 2017, a unified eHealth system was introduced, called “ARMED”. The Operator started the nationwide implementation of the system according to the Government decree issued in 2017.

As of the end of 2018, the timeline and activities defined in the first Government approved program for eHealth expired, and the MoH started working on the vision and strategy for the further use and enhancement of existing eHealth system in the country. These are the main policy documents that are intended to regulate the eHealth sector processes and activities for the years 2018-2023.

Currently, the system is available online at 487 medical institutions and six insurance companies. It enables a user to enter data on hospitalizations, primary healthcare services, dental and pregnancy control cases. The system also allows collecting data on state-funded services provided to the beneficiaries of the social package (BBP) that are used by the SHA to make financial reimbursements based on the performance reports of medical facilities within the scope of state-funded medical care and services. The system also has a population register and management section. It enables the population to exercise the process of freely choosing a physician similar to the functions supported by the previous E-PHC system. According to the concession agreement, the technical components of the system belong to the Government of Armenia. They are provided to the NEO on a free-of-charge basis during the period of the concession agreement.

Milestones in the Development of the Current National eHealth System

- 2008-2009 – Decree to develop an Integrated Health Information System in Armenia (IHISA) and adoption of the IHISA concept;
- 2010 – Armenian eHealth Feasibility Study with South Korean IT development agency National IT Industry Promotion Agency (NIPA);
- 2012 – AATM cooperation with the governmental authorities on creation of eHealth vision for the country;
- 2013 – the Government of Armenia secures funding to develop the National eHealth program and an official invitation for bids for supply and installation of Integrated Health Information System in Armenia (IHISA) begins;
- Implementation of electronic healthcare system, carried out in 3 stages:
  - 2014 – The phase of technical design of the system completed;
  - 2015 – EKENG CJSC and Ericson Nicola Tesla completed the development, deployment and localization of the project;
  - Last three months of 2015 - Launch of the pilot system at "Heratsi" and "Muratsan" medical centers, "Goris" and "Abovyan" clinics, "Vanadzor N1" polyclinic, "Balahovit" medical ambulatory and "INGO Armenia" insurance company.
- July 2017 – A joint venture of "Sylex SARL" (Switzerland) and "Masys Apahov" LLC (Armenia) established [42];
- eHealth in Armenia is in the implementation phase. Implementation of the system is proceeding in accordance with programs approved by Government of Armenia in 2017-2023, and in 2019 [42];

- December 29, 2019 – Confirmation of the roadmap for the introduction of unified electronic information system by the Prime Minister of the Republic of Armenia [42].

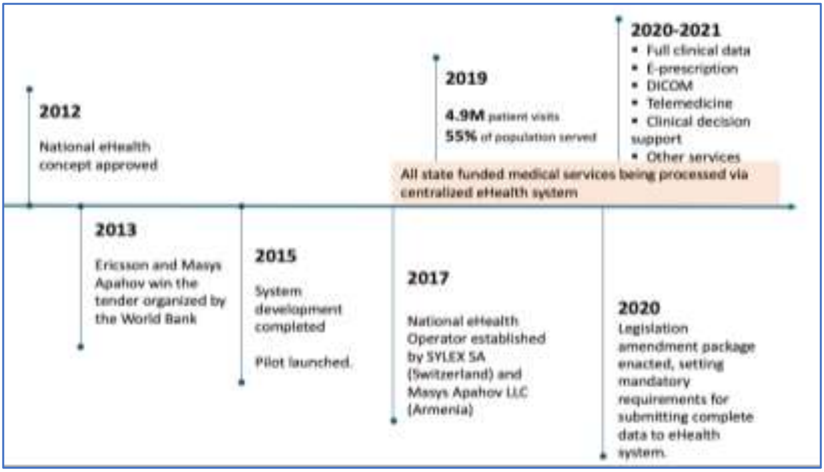

Fig. 26. Chronology of development of eHealth System in Armenia [43]

Authorities in Charge of the National eHealth System

The main authorities in charge of the national eHealth system are MoH and e-Governance Infrastructure Implementation Agency (EKENG) on behalf of the Government of Armenia. Currently, MoH has the central role of managing the existing National eHealth System in the county. The MoH is responsible for the implementation of the healthcare legislation, which includes the eHealth terms as well. In 2018-2020, MoH initiated the amendments in the law on "Medical Assistance and Service to the Population," which was then passed by the National Assembly of Armenia in 2020. The law defines all components of the National eHealth System and regulates the eHealth-related functions.

Meantime, in a broader scope, the Government of Armenia regulates relevant aspects of the eHealth system in terms of interoperability with other systems and defining standardization aspects. Since 2010, the Government has had the leading role in the initial steps of defining a roadmap for the design and development of the National eHealth System. The Government of Armenia implements these activities via the e-Governance Infrastructure Implementation Agency (EKENG). EKENG is the operator of Armenia's state component of the common infrastructure for documenting information in electronic form, created in the framework of Armenia’s accession to the Single Economic Space and the Eurasian Economic Union [44].

Besides the law, MoH is in charge of the development and implementation of the national eHealth vision and strategy. The goal of the National eHealth System, as defined by the MoH, is the usage of modern Information and Communication Technologies providing high quality, safe, accessible and cost-effective medical services to the public [42].

The National eHealth Operator CJSC (NEO) on a concession basis manages and operates the Republic of Armenia's eHealth system, i.e., the unified integrated health information system, where full data about the health of population is entered and retained [43]. NEO began its operations in 2017 and contributed to the drafting of a package of legislative amendments. Its main functions include:

- Technical management and improvement of the system;
- Software maintenance;
- 24/7 subscriber and user service;
- User trainings (ToT);
- Continuous development based on roadmap agreed with the Government.

NEO CJSC has been operating since September 2017 and is a joint venture by two IT companies - "Sylex SARL” LLC (Switzerland) and “Masys Apahov” LLC (Armenia). "Sylex SARL" is the global partner of Ericsson Nikola Tesla and is involved in projects related to the launch of electronic healthcare systems. The company has a significant international experience in electronic healthcare, insurance and in the development of the diagnostic decision system based on artificial intelligence. "Masys Apahov" LLC supplies eHealth and insurance information technologies and is specialized in development and implementation of insurance management and eHealth systems in Armenia and abroad [42].

Legislative Framework Supporting The eHealth Infrastructure

Several sector-specific and universal laws, government decrees and ministerial orders represent the eHealth regulatory framework of the country. In the core of these regulations are two most significant laws:

- Law on Medical Assistance and Service to the Population and
- Law on Personal Data Protection.

Table 5 shows the pertinent legislations supporting the implementation of a national eHealth system.

Law on Medical Assistance and Service to the Population

Passed in 1996, this was the first legal document stating the main definitions, the scope of services, the functions, rights and responsibilities in the healthcare sector. In its initial version, it provides the first legislative reference on health information under point 13 of article 1 – General definitions:

"A medical certificate is a recording or a reporting paper or electronic document with a format approved by the legislation of the Republic of Armenia, handled or filled out by a healthcare provider which includes medical and non-medical data on patient health, on receiving of medical care and services, on consent or refusal to do so, as well as on the promotion of patient's health and diseases prevention."

In the late 90s and 2000s parallel to the health reforms, the law underwent several amendments. However, there was little attention to health information systems, and there was no single or synchronized holistic package of consolidated regulatory documents for assurance of data quality, completeness, timeliness, and protection. There were several attempts, out of which of particular interest was the development of a draft governmental decree in 2007-2008 to regulate all relations, rights, and responsibilities for PHC level data collection, storage, editing, and transfer. It also included management of different level databases, establishment and management of duplicate databases, as well as other technical aspects requiring regulation. Although relevant institutions initially approved the draft decree, responsible governing institutions did not promote its approval and implementation.

The other attempt to specify the requirements for the electronic health development and implementation was within the initiative of amending the law "On Medical Assistance and Service to the Population," which was in process since the early 2000s. By amendments, it provided statements for the establishment of requirements for the introduction and implementation of an integrated electronic health information system for healthcare practitioners in the territory of the Republic of Armenia. The law specified basic principles of the electronic information system, the rights, and responsibilities of all users. It defined that the changes introduced in the system are obligatory to be implemented by all users and are not subject to non-implementation or partial implementation. It described that the Government of the Republic of Armenia approves procedures of integrated electronic health information system functioning and the application of liability for their violation or improper implementation or non-fulfilment.

To advance with this situation, in 2018 the MoH initiated fundamental changes in the law, which included specific chapters on eHealth and telemedicine.

The new amendment of the law contains the following:

- Definition of eHealth system;

- Definition of and description of telemedicine, healthcare databases and purposes of their maintenance, electronic healthcare system, and principles and non-alignment with the electronic healthcare system.

The National Assembly (the parliament of the country) accepted this amendment in April 2020, which makes the law the principal regulatory document for eHealth and telemedicine.

The Ministry of Health along with the National E-Health Operator drafted the following legislative amendments, which were approved by the Parliament in May 2020:

a. Provide definitions of eHealth, Telemedicine, National Operator, etc.;
b. Specify mandatory requirements to all licensed healthcare organizations to submit administrative, financial and clinical data;
c. Define the range of users that can access the system;
d. Define the possible uses of information and the ownership of data;
e. Regulate other aspects important for the development of eHealth system.

Law on Personal Data Protection

The law on "Personal Data Protection" regulates the procedure and conditions for processing personal data, exercising state control over them by state administration or local self-government bodies, state or community institutions or organizations, legal or natural persons. It defines the main terms such as personal data, processing of personal data, transfer of personal data to third parties, use of personal data, the processor of personal data, the data subject, database, information system, and others. The law defines that personal data is being processed for legitimate and specified purposes and may not be used for other purposes without the data subject's consent. It also follows the concept of minimum data use when the processor of personal data is obliged to process the minimum volume of personal data that is necessary for achieving legitimate purposes [45].

Table 5. Legislative framework of the Republic of Armenia for the implementation of a national eHealth system

No (year)	**Title of the law and important points**
Law on Medical Care and Service to the Population (1996)	First legal document stating main definitions, the scope of services, functions, rights, and responsibilities in the healthcare sector.
Protocol No. 50 (2010)	Approval of Electronic Information System implementation concept in the Republic of Armenia.

Memorandum (2010)	Memorandum of eHealth introduction in Armenia by the Ministry of Heath of Armenia. The coordination and implementation of the project was assigned to Electronic Governance Infrastructure Implementation Agency (EKENG) Closed Joint-Stock Company.
Protocol Decision No. 43 (2012)	Approval of the concept of implementation of Electronic Healthcare Information System in the Republic of Armenia in 2012. The necessity of eHealth was approved and the roadmap of project implementation confirmed.
Law on Protection of Personal Data (2015)	Regulates the procedure and conditions for processing personal data, exercising state control over them by state administration or local self-government bodies, state or community institutions or organizations, legal or natural persons.
Decision No. 95-N (2017)	Approval of the procedure for transferring the electronic healthcare system under the concession agreement by the Government of the Republic of Armenia.
Decree No. 866-N (2017)	The decision to convey an eHealth system to a concession agreement states: *"To approve the tender for transmission of the electronic healthcare system under the management of Electronic Governance Infrastructure Implementation Agency (EKENG) Closed Joint-Stock Company, implemented under the Credit Agreement (Second Public Sector Modernization Project) signed between the Republic of Armenia and the International Bank for Reconstruction and Development recognizing "Sylex SARL" company acting as a joint venture contract (Swiss Confederation) and "Masys Apahov" Limited Liability Company (the Republic of Armenia) the winner of the competition."*
Amendment to Law on Medical Assistance and Service to the Population (May 2020)	The National Assembly accepted this amendment of the law in April 2020, which makes the law as the main regulatory document for the e-Health and telemedicine. The law defines all components of the National eHealth system and regulates the eHealth related functions.

Except for the other intersectoral laws, several governmental decrees and ministerial orders are regulating the technical aspects of using eHealth such as the Government decrees on approving the concept of the implementation of the integrated electronic information system, the implementation of integrated electronic health information system, and others.

Despite the presence of the above-mentioned laws and regulatory documents, there is still a lack in the regulatory framework for this sector, including the lack of standards, vision, and strategy for the future development of eHealth in the country. Data sharing cannot be organized and managed correctly without the use of respective standards for healthcare processes and digital and electronic communication elements. Without clearly defined and adopted measures, it is not feasible to create effectively functioning e-services only because the proper communication channel is missing. As recommended, standards need to be unique. One option for an effective model is the top-down direction, when the Government promotes standards and all participating medical institutions develop their software systems to reach the nationally established standards and data sharing. Currently, the Ministry of High Technology Industry of Armenia is working on the establishment of common standards, including the design, development, and implementation and interconnection of country-level information systems and solutions.

The ARMED Electronic Healthcare System

The Republic of Armenia's eHealth system is called the 'ARMED Electronic Healthcare System'. It is a unified health information management system, where patients' medical data is entered and stored. It is a comprehensive and synchronous data-transmission platform for three types of data: clinical, administrative, and financial. This allows a physician to access the patient's medical history and use it for diagnostic and treatment decisions. The eHealth system is implemented to enhance the quality of healthcare by allowing comparisons between different providers, patient empowerment, and regulation of patient flows. Currently, the services include registration and transfer of administrative, financial, some clinical data related to the healthcare visits within the framework of the Basic Benefit Package (BBP), and their reimbursement by state and insurance organizations.

Around 2.9 million citizens of Armenia have their basic personal Electronic Health Records (EHRs) established within the system. Citizens can access their personal page at the website http://www.armed.am, using their ID card and PIN. The personal page of the patient currently contains information on the primary healthcare facility (PHF) and the physician in that PHF where the patient is registered. It also provides information on the received treatment during visits, in the case of the Basic Benefit Package (BBP) and social insurance package.

Once the eHealth system is fully operational, a citizen will have the opportunity to access and manage their health-related information from one point.

The e-Health system stores three main registries as follows:

- Business registry, which contains a database of healthcare provider;
- Registry of the population attached to the healthcare service providers;
- Registry of medical equipment, technical facilities and other essential material resources for provision of healthcare services.

Fig. 27. The four beneficiaries of the ARMED eHealth System [46]

Fig. 28. Introductory screen to the *armed.am* website

Fig. 29. Patients and users of the ARMED system can access the electronic healthcare system on domain armed.am, using the national ID card

Fig. 30. Login to armed.am using the National ID card

Software Subcomponents of the ARMED System

The ARMED System consists of 5 software subcomponents.

1. The Patient Flow Management Module, which includes:
    - Sub-module of registration, queuing and referral of patients in order to provide healthcare services;
    - Sub-module of registration of visits of patients and cases;
    - Schedule of work, workload of senior, middle, junior medical staff;
    - Schedule of accessibility and workload of medical equipment, technical facilities and other essential material resources for provision of healthcare services.
2. Electronic Health Records of patients containing:
    - Information on health issues and diagnoses;
    - Laboratory tests results;
    - List of medications received;
    - Information on visits and other details, which have been filled in and uploaded by healthcare providers.
3. The Reporting subsystem, which includes:
    - Quantitative reports by population, age and gender-based group;
    - Quantitative and financial reports by state funded services;
    - Quantitative and financial reports by services provided within the scope of social package-based insurance;
    - Quantitative reports by measurements and activities.
4. Module of management of insurance claims and initial inquiries:
    - Ability to reject and approve the insurance claims and initial inquiries;
    - Ability to filter and export the rejected, approved, cancelled and automatically approved claims.
5. Analytical Module, which includes:
    - Receiving quantitative data per specialization of medical staff and hospitals;
    - Receiving quantitative data concerning attached population per healthcare facilities;
    - Receiving quantitative data on diagnoses per healthcare facilities;
    - Receiving quantitative data on visits per dates and healthcare facilities.

Features of the ARMED eHealth System

Currently, ARMED eHealth system has the following features [43, 45]:

1. Medical Institutions:
    - Visit Registration: Mandatory for BBP and social insurance packages and optional for out-of-pocket and voluntary insurance paid visits;
    - Business Registries for sub-departments, human and material resources as well as standardized dictionary of medical specializations and schedule tables for employees;
    - Financial reporting for inputted visits according to provided services. Storage and management of pricelist for paid services;
    - Storage and management of data regarding diagnoses, medical actions and procedures, diagnostic tests, prescription and dispense of medication;
    - Effective communication mechanism with SHA or Insurance company that includes sending of preauthorization request and getting real-time approval.
2. Insurance companies:
    - Denial and approval for preliminary requests and insurance claims;
    - Flexible sorting and report exporting options for approved, automatically approved and denied claims.

Fig. 31. Patient Chart section allows attending medical personnel to view summary information about their patient's health status, including current medications, allergies, risk factors, chronic diseases, history of clinical procedures, surgeries, etc.

Structure and Services of the National eHealth Operator (NEO)

The services provided by NEO are of two categories [43]:

A. Services provided by NEO as per the initial scope defined by the World Bank:

a. Mandatory services – medical organizations are obliged to use the following five services:

- Registration of patient visits and services: those that are funded by the State Healthcare Agency (SHA). According to SHA rules, medical organizations may only be funded / reimbursed for their services, if those services have been registered into ARMED eHealth portal. Medical organizations must register patient visits with encounters, diagnoses and procedures to claim for reimbursements. For procedures costing over $625 (AMD 300,000), medical organizations should also submit preliminary approval requests. Once services are completed, ARMED generates invoices on behalf of medical organizations and delivers to SHA.
- Registration of patient visits and services: those that are funded by private insurance companies within the social packages funded by the state. The state has granted around 120,000 Armenian citizens employed by state agencies (the Government) and municipalities with health insurance policies issued by Armenian private insurance companies. Medical organizations must send claims to insurance companies through ARMED by submitting case details (diagnoses, procedures) for pre-approval and final reimbursement that streamlines the entire business process management lifecycle.
- Registration of patient visits and services: those that are funded out-of-pocket by patients or by insurance companies. While medical organizations currently are not obliged to register visits of patients who pay for the services themselves or through voluntary health insurance policies, some medical organizations have chosen to use ARMED system, as it considerably increases the efficiency and effectiveness of operations. In addition, newly enacted amendments in the Law on Population Medical Care and Services impose mandatory requirements for all licensed healthcare organizations to submit patient visits into ARMED, including clinical data. These requirements ensure that Armenian residents have comprehensive EHR records within a centralized national platform and start benefiting from its usage.

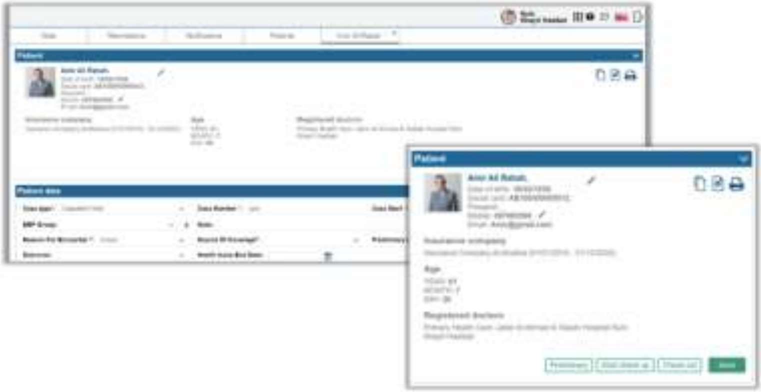

Fig. 32. Registered visits (adaptive interface design for screens of various sizes, mobile devices)

- Patient attachment to local primary care facility: Primary care services in Armenia are funded by the SHA. For this purpose, all Armenian resident citizens are enrolled with primary care facilities and physicians at their choice. Financing of these services is managed via ARMED, which manages the process of assigning, unassigning and transferring residents to polyclinics and ambulatories. The system ensures that no person can be assigned to more than one facility. For financing purposes, the system also ensures that facilities are paid for each assigned person on a daily accuracy level.
- e-Referrals: Referrals are an important function of primary care physicians (PCPs), who are responsible for initial screening of patients and deciding whether patients need to be referred to specialists or for additional tests. The SHA reimburses medical facilities for services, for which there are proper referrals from PCPs. Historically, these referrals have been carried out in Armenia in the form of preprinted papers, distributed across primary care facilities entitled to issue such referrals for free-of-charge services. However, those paper forms have periodically raised serious issues, such as:
  - (a) lack of standardization of information being filled into the forms by PCPs, with frequent rejections, caused by incomplete, erroneous or illegible handwriting;

- (b) uncertainty for patients with referrals regarding which medical organization to choose considering their capacity and government funding limits;
- (c) cases of misuse of the forms and lack of transparency, etc. In October 2019, ARMED launched a pilot program that allows several primary care facilities to send electronic referrals to selected hospitals. In the meantime, patients were provided with an online tool to search and book hospital services for their referral. Starting from January 2020, E-Referrals were rolled out across all primary care facilities.

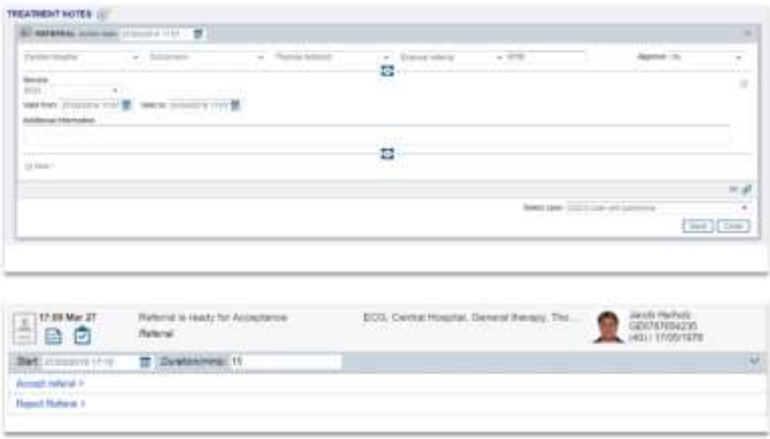

Fig. 33. Referral form for hospitalization

b. Services envisaged by concession agreement and/or roadmap such as those provided only by NEO/ARMED. These services are as follows:

- e-Booking: The first step for a patient to apply for medical services is to make an appointment with a doctor. This is a major problem in primary care facilities, where patients do not have any means for preliminary appointments, resulting in long queues at the doctors' waiting areas, or patients find out that their physician is not there when they arrive at the clinic. ARMED is equipped with comprehensive functionality for managing patient visits, including an electronic booking functionality. Since July 2019, the 'E-Booking' feature was implemented at the polyclinics of Yerevan, in collaboration with the Yerevan City Council. By the end of 2019, implementation was completed at all 23 polyclinics. In addition, NEO launched an online portal, where each citizen can easily register and book an appointment with his/her PCP. In May 2020, to restrict the spread of COVID-19, NEO prioritized and launched ARMED mobile app working on iOS and Android platforms. Initial version of the app allowed booking appointments with the enrolled PCPs that include physical visits to the doctors and telemedicine visits. The platform supports high quality video calls between patient and doctors. Such calls are registered in the eHealth platform as separate visits. By the end of 2020, e-booking and telemedicine services are expected to be implemented across the entire country. After logging into their personal account, patients can see the schedule of visits, in the form of a calendar. Using the "Schedule of visits" page, the patient can select a doctor from the list, an available time slot for the selected doctor, and make an appointment with doctors or request a home visit.

Fig. 34. Scheduled visits to doctors within a Patient Portal in the ARMED eHealth system

- e-Prescription: The major development in implementation of the eHealth system is the gradual adoption of electronic prescriptions (e-prescriptions) that will replace formal and informal paper-based prescriptions. The functionality has already been tested with several pilot pharmacies and is expected to be officially launched in the second quarter of 2020. Successful implementation of e-prescriptions is a prerequisite for the larger reform of expanding the list of medicine and drugs that can be released by prescriptions only. Currently the list is limited to several categories, such as opioids and antibiotics.

- Digitization of temporary disability leave certificates: Temporary disability leave certificates (TDLC) are issued by physicians to the patients who have temporary health issues for submitting to their place of employment in order to be paid for the period of sick leave. Currently TDLCs are paper-based, which creates several types of issues. First, its administration is time consuming for several parties involved, including physicians, patients, accountants of employers and tax authorities. It is easy to make various errors that would result in under- or overcharges. In addition, it has been largely viewed as an area with potential misuse risks. According to the draft Roadmap being developed by the MoH, it is planned to digitalize and automate the process of issuing TDLCs through the ARMED system. ARMED has integrated with the State Revenue Service information system, which provides access to employee-employer relationships, so that TDLCs can be registered by physicians directly with the employer's details. For TDLCs with longer durations, special approval is required by Disability Approval Committee, which operates under the Ministry of Labor and Social Affairs. Members of this Committee are also expected to access the EHR data of patients under consideration and submitting their resolutions.
- Implementation of register of medical specialists: One of the major problems in the healthcare sector of Armenia is the deficiency of the system of licensing and credentialing of medical professionals. Any graduate of medical school can get employed by a licensed medical organization and automatically get entitled to practice medicine. In the current environment, it is practically impossible to control whether practicing doctors have adequate level of skills and experience for given medical services. MoH has a program of licensing medical professionals, who will be allowed to practice medicine in their competent specialties. Starting from July 2019, MoH started eHealth training courses for PCPs and several specialty physicians to prepare them for using ARMED system, as well as granting of laptops. Physicians who attended trainings were requested to present their graduation diplomas for verification. Verified physicians were added into the Register of Medical Specialists maintained

within ARMED. This register is intended to grow further to become mandatory for all practicing medical specialists, before they can be allowed for employment for given roles.

- Implementation of disease registers: Registers of certain diseases that require special attention by the State are expected to be implemented through ARMED. Examples of such registers are patients who have been diagnosed with cancer or diabetes. Technical functionalities have already been completed within the system.
- Implementation of medical data analytical tools: Currently, ARMED is equipped with reporting tools allowing its users with various roles to generate both preconfigured and ad-hoc reports. Once the database grows with more comprehensive data, the government of Armenia intends to use ARMED more extensively for all types of information analysis purposes.

B. Additional services developed by NEO at its initiative:

a. Services offered by NEO to various organizations and general public. These services include:

- Image storing and analyzing: Imaging is one of the most important and intensively used diagnostic tools. Only state funded services involved over 225,000 imaging tests in 2019 (including MRI, CT, X-Ray and ultrasound). The total number of imaging procedures including those paid in cash or voluntary insurance policies is estimated to be about 3 times higher. While it is important to have these images within the patients' EHR records, it is also economically more efficient to store these images within a centralized data center that is managed by professional staff and has a backup and disaster recovery center. NEO proposed a new service for healthcare providers that stores the images they produce within its servers and makes these images available within the EHR of patients using DICOM standards. In addition to storing, current technologies allow further analysis of images by applying AI algorithms. Sylex and NEO are currently working with the world leading providers of healthcare technologies, to launch a joint solution that provides image analysis services integrated within ARMED. Proposed PACS services are also among commitments that the government of Armenia has undertaken.
- Diagnostic decision support solution (Dr. Lex): The World Health Organization (WHO) recently prioritized patient safety areas in primary care and included diagnostic errors as a high-

priority problem. Continuous professional development of primary care physicians, as well as introduction of artificial intelligence based decision support systems in their clinical practice that might support patients' diagnostic and triage processes are those largely accepted potential solutions for mitigating the underlying causes and effectively reducing diagnostic errors by PCPs. Terra Medicum and Dr. Lex are two integrated projects initiated by Sylex Group intended to focus on this problematic areas and offer solutions. Projects consolidate vast medical knowledge from the most trusted and up-to-date evidence-based literature and databases within a single expert system, capable of analyzing incoming health related information on a patient and suggesting possible health risks and actions to the physicians. NEO is planning to localize Dr. Lex solution for Armenian needs and integrate with ARMED, so that PCPs can use it to avoid most of the diagnostic errors.

Fig. 35. Dr. Lex – AI based diagnostic decision support system for primary care practitioners in the ARMED eHealth system

- Telemedicine consultations by primary care physicians: In the 2nd half of 2019, NEO implemented electronic booking system in polyclinics of Yerevan and is planning to cover all primary care clinics by the end of 2020. These services allow patients to take appointments online within the Patient Portal and then make use of expanded range of services. NEO has launched its first version of telemedicine services as a mobile application that combines e-booking services with telemedicine. Patients currently can take appointments with their enrolled PCPs for free-of-charge consultations. PCPs are equipped with platform functionalities to issue e-referrals for laboratory tests or specialty doctors.

Fig. 36. Portal for telemedicine consultations in ARMED eHealth system allowing patients to engage with doctors via voice and video conferences

- Vaccination inventory management: In 2019, NEO initiated the development of a solution that automates the process of inventory management for all vaccination materials imported into Armenia and distributed to clinics and hospitals. Currently, the solution is in pilot testing. The solution allows for:
  i. Full control over the flow of state-funded vaccines, medication and medical supplies;
  ii. Monitoring the effectiveness of vaccine consumption and waste reduction.

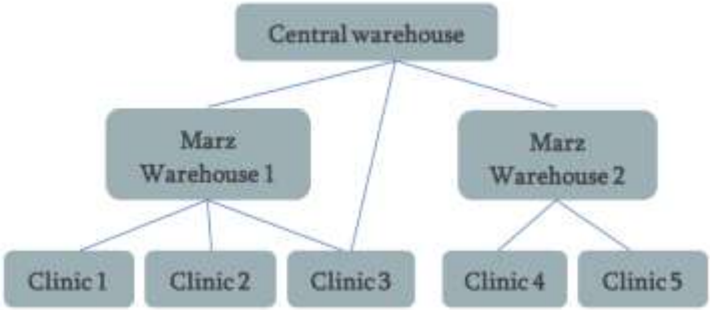

Fig. 37. Design of the vaccination inventory database

- Automation of clinical practice guidelines: The use of clinical practice guidelines allows healthcare providers to offer appropriate diagnostic treatment and care services to patients, variance reports to purchasers, and quality training to clinical staff. Such guidelines provide a locally agreed standard to which clinicians and the organization can work and against which they can be audited. By embedding guidelines into the patients' records and reporting, the use of guidelines may help to tackle a raft of other issues successfully, such as the reduction in junior doctors' hours, and the facilitation of shared care. It may also bolster the medico-legal robustness of the healthcare delivered. If the guidelines are sufficiently detailed, costing, coding and other resource usage information can flow directly from the clinical records. Such benefits may be maximized by using the guidelines within the framework of an electronic health record system. Currently, there are few such accepted clinical guidelines approved at the national level. However, it is inevitable for the regulator (MoH) to address this issue as it moves towards comprehensive health insurance. ARMED is equipped with modelling tools that enable easy implementation of automated clinical practice guidelines, guiding medical specialists through the procedures.
- Online real-time information services: In 2019, NEO launched two online services:
   i. Special webpage providing online information on government issued funding limits and remaining balances for each

healthcare provider by type of service. With the help of this service, patients can no longer be rejected by a hospital with the excuse of having reached their limit of state funding. Now all patients can check in advance, which hospitals have funds available for the month.

ii. Real-time occupancy of hospital beds allows patients to refer to, and emergency services to transport patients to hospitals, which have available beds. Emergency services will no longer waste time on looking for hospitals with available beds.

- Data portal for clinical trials: Armenia is seen as a country of significant potential for bringing major pharma companies into the country for conducting clinical trials and research. Especially interesting are patients with oncological problems, because Armenia has an above average rates of cancer prevalence and higher mortality rates. Second, Armenian population is quite homogeneous, representing a narrowly defined cohort. And lastly, the population traditionally is not accustomed to taking various medications on periodic basis, which otherwise distorts trial results.
- Big data portal management: Once legislative changes take effect in 2020, submitting patient clinical data will be mandatory for all licensed healthcare providers, and ARMED will start hosting a massive volume of highly structured medical data. ARMED is based on a timeline database and stores entire clinical information by standardized pieces and is expected to become a major data hub for various research projects. The artificial intelligence industry, especially in healthcare, is currently booming, which relies on big data, and so these services have a high revenue potential. NEO will consider the possibilities of providing access to anonymized data sets to companies developing solutions for healthcare.
- Genomic data storing: In December 2018, a meeting was held in the Prime Minister' office to discuss ways to expand the scope of genetic studies and the Armenian Genome project. The meeting decided to start a project called 'Armenian Genome', and to appoint the Republic of Armenia National Academy of Sciences – Institute of Molecular Biology as the main responsible for its implementation. The project seeks to increase the number of genetic findings in the field of healthcare through the

development of digital health facilities and related infrastructures. Participants of the project are General Partner, New Ventures Funds and Director of Republic of Armenia National Academy of Sciences – Molecular Biology Institute. This project is estimated at US$10 million, which was approved by the government. The authors proposed that genomic data generated from the project should be integrated and stored in the EHR of patients, and should therefore be managed within ARMED. Clinical data, together with sequenced genomic data, create unparalleled potential for scientific research by pharma companies and healthcare technology production companies. The vision is to make Armenia a global center for healthcare research projects by the leading companies.

Patient Portal of the ARMED eHealth system

The personal eHealth account has the following features [46]:

- Enrolment to Primary Health Care facilities: A resident's enrolment to a primary healthcare facility is based on data from the "State Population Register". On their personal page, a resident can review information about enrolment to primary care facility and a physician.
- Access to health records: A patient can see their health history according to the medical records completed by healthcare facilities where care was received previously. These include diagnoses, provided services, diagnostic tests as well as visit planning registration schedules.

Fig. 38. The Patient Portal in the ARMED eHealth system

National Integrated Disease Control Information Platform

This is a platform for governments to monitor and control the spread of COVID-19 and other epidemic diseases. The system represents an extension module to the base version of a broader national eHealth platform, offered in bundle, with the following features:

- Data capturing: The system allows distributed data capturing of predefined health, contact and address information of population from various types of sources, such as hospitals, laboratories, governmental agencies (e.g. CDC, country border protection services, etc.) and self-reporting by the patient via online tools. Data can subsequently be updated on patients' timeline by medical staff or patients themselves. The main focus is on patients who either experience symptoms, or test positive or have had direct contact with infected persons. The goal of effective data capturing is to have real-time centralized national repository of population that can be segregated into categories, such as exposed, infected or recovered for monitoring, modelling and subsequent decision-making purposes.
- Automation of business processes: Embedded workflow management tools allow the automation of cross-organizational processes, such as electronic referrals and bookings between emergency services, hospitals, laboratories, quarantine facilities and state agencies (e.g. National Center for Disease Control and Prevention – NCDC), or electronic booking services for patients to book appointments online with medical facilities. These workflows ensure that the processes between various parties are organized with maximum efficiency and are fast and free of human errors.
- Integrations with national registers: The effectiveness of the system is substantially increased when integrations are made with the "National Registry of Population" that allows accurate identification of patients and contacted persons. In case national registers are maintained for medical organizations (e.g. hospitals and laboratories), the information available on critical equipment, beds and professionals can be integrated for checking the availability when bookings are made. These and more other registers can also be created within the proposed system.
- Primary care physicians (family doctors): The system allows management of the enrolment process of population with primary care physicians (PCPs) or integration with existing systems. Such integration allows establishing of communication with PCPs, when their patients test positive or otherwise need to be quarantined. PCPs play major role in unloading the resources of hospitals and

involved national agencies, especially when dealing with a wide-spread epidemic.

- Geographic and trend analysis: Centralized data is analyzed and provided in the form of various reports and diagrams. Customized dashboards are being made available to senior government officials for real-time situation monitoring. Selected information can also be published on official websites.
- Visualization of information on country map is provided using addresses of patients.
- Data sourcing for modeling: The system can source necessary data for 'Quarantine-Isolation' models (e.g. SEIR – Susceptible-Exposed-Infectious-Recovered model, SIR – Susceptible-Infectious-Recovered model) to simulate and predict the impact of the healthcare decision making on an epidemiological situation.

COVID-19 Spread Control Module

As part of the effort to curb the spread of Coronavirus disease 2019 (COVID-19), a functionality was setup in the eHealth Platform.

When patient tests positive, the system notifies the enrolled primary care physician (PCP), who takes charge for subsequent follow up actions. All primary care physicians in the country have access to the system. This way, the process is decentralized, which allows distributing the workload across local PCPs. The system also allows patients to self-report their symptoms within the system, though this feature has not yet been rolled out. Comprehensive reporting features and dashboards provide instant information on current state and dynamics of the disease spread. Information is also visualized on the country map.

The module functions as follows: Positively tested patients are electronically referred to one of dedicated hospitals by authorized users under National Center for Disease Control and Prevention (NCDC). The ARMED system facilitates the process by identifying the patients and nearest dedicated hospitals with required services and bed availability and allows creating a referral with an appointment. Hospital users immediately see the incoming patient, so they can start preparations. Subsequently, the entire process of patient care is registered into the system, including the patient's medical conditions, severity level and outcome (no symptoms, mild, severe, recovered, death) for the statistics. The system also captures the details of the population who were identified as having contact with infected patients. The system allows real-time management of all locations and people placed there. Additionally, the system manages the processes such as collection of specimens for laboratory tests, specimen bar code marking, numbering, submission of results into patients' health records, etc. [43].

Fig. 39. Approach to the management of the COVID-19 pandemic in the ARMED eHealth system

Fig. 40. Dashboard of COVID-19 Module

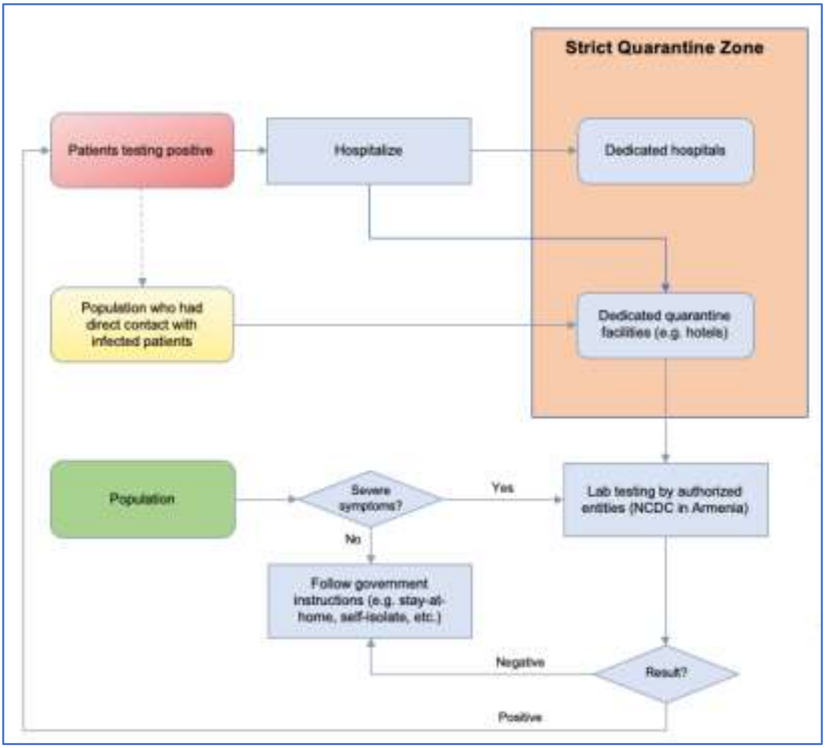

Fig. 41. Process workflow of the COVID-19 platform to control the spread of COVID-19 in Armenia

Distribution of State Sponsored Medical Services

An online tool on the budget allocation of state-guaranteed free and privileged healthcare and medical services to healthcare providers is available on the website of the National eHealth Operator (http://www.armed.am). This online tool gives the citizens the opportunity to get familiar with already provided state-funded healthcare services, available places and schedules by regions and service coverages. The coverages include the emergency healthcare services for socially vulnerable groups, servicemen and their families, as well as maternity care, consultancy services provided by family physicians, basic dental services, etc. It aims at ensuring the transparency of the queuing process, raising public awareness of the available places for state-funded healthcare services and excluding the cases of unsubstantiated refusals to provide state-funded healthcare services to citizens [46].

eHealth Academy

The goal of the academy is to teach the medical community the skills of working with the ARMED electronic healthcare system. The academy features the “Train the Trainers” program, where certified trainers are able to transfer knowledge to program users. In 2018, about 576 users of the eHealth system were trained, of which 43 were trained as trainers. The annual training program is approved by the Ministry of Health [46].

Sponsor, Funding, Business Model

The maintenance cost of the current eHealth solution in Armenia uses the subscriber fees mechanism. Subscribers of the system are the healthcare organizations (medical centers, polyclinics, hospitals, ambulatories, dental clinics, etc.), SHA, and insurance organizations. To become a subscriber of the system, the healthcare organization needs to sign a contract with the National Electronic Healthcare Operator. After signing the contract, the healthcare organization becomes a subscriber of the system and gets access to the system functions. The contractual agreement between subscribers and the operator is regulated by the terms of the concession agreement. Subscribers of the system pay a monthly fee composed of a monthly payment to the healthcare organization, the monthly fee for the functional users of healthcare organization, and the monthly fee for the factual records developed in the system.

Deployment, Adoption and Acceptance

Despite the successful steps in establishing the national integrated eHealth system, the adoption of the system is still an ongoing process in Armenia. Coherent and systematic steps are seen as the necessary approach for further implementation of the system. In 2019, the MoH conducted a series of surveys to reveal the barriers to adoption and usage of the system in the upcoming years.

The results of the surveys allowed the MoH to reveal the strengths and weaknesses of the system. The surveys also targeted a broader range of questions, including the appropriate environment where the system operates. The issues revealed during the surveys can be grouped into three categories – legal, organizational, and technical issues.

Although the eHealth system is implemented in the country, the legal framework supporting the system is yet to be developed and introduced. Since 2018, the MoH as the main regulator works intensively in this area. Recently the MoH achieved a serious milestone by passing the Amendment to the law on "Medical Assistance and Service to the Population," which defines in detail the electronic healthcare system, health-related databases, and disease registers. Following the adoption of the law, it will be necessary to develop and apply bylaws and regulations that will serve as a basis for carrying out the functions of this field as per the requirements of the law.

The operation of the eHealth system is regulated by the concession agreement between the Government of Armenia on the one side, and the National eHealth operator (NEO) on the another side. The contract is signed for 15 years. However, it does not provide the required level of the control and management procedures describing the concrete roles and responsibilities of relevant parties. The NEO has a broad range of functions, which is positive in terms of further development and modernization of the system. However, from the organizational perspective, the MoH needs more expertise and control over the lifecycle of system modernization and enhancements. Until 2018, the MoH did not have a unit to coordinate the functions of the electronic healthcare system and to monitor the activities of the operator. Understanding this gap, the MoH established a department for the implementation and enhancement of the electronic healthcare system in the Republic of Armenia within the scope of the National Institute of Health.

According to the results of the survey conducted in 2018 and early 2019, the users of the system experienced various technical problems, including slow system performance, accidental data loss and inaccuracies during the data entry process, the existence of unnecessary input fields, and frequent system changes. Given these facts, the MoH in close cooperation with the operator, undertook several activities that significantly improved the day-to-day operation of the system. However, there is still no effective system for testing the methodology and control procedures that will eliminate such technical problems when adding new features and functions. The following table show the adoption rates for the services offered by the ARMED system [43].

Table 6. Adoption rates of the services of the National eHealth operator [43]

Service	**Adoption Rate**
Registration of patient visits and services (funded by SHA)	100%
Registration of patient visits and services (private insurance companies within social packages funded by the state)	100%
Registration of patient visits and services (funded out of pocket by patients or by insurance companies)	5%
Patient assignment to a local primary care facility	100%
e-Referrals	Operational

e-Booking	Operational (Yerevan only)
e-Prescription	Operational
Digitization of temporary disability leave certificates	In progress
Implementation of register of medical specialists	In progress
Implementation of disease registers	In progress
Implementation of medical data analytical tools	In progress
Image storing and analysis	At inception
Diagnostic decision support solution (Dr. Lex)	In progress
Telemedicine consultations by PCPs	Pilot
Vaccination inventory management	Pilot
Automation of clinical practice guidelines	Not started
Online real-time information services	Operational
Data portal for clinical trials	At inception
Big data portal management	Not started
Genomic data storing	Not started

At present, the system is mainly used by the State Health Agency (SHA), healthcare providers, and insurance companies. The MoH, the National Institutes of Health, and regional health and social security departments use the system insufficiently. The reporting functions of the system primarily serve the purpose of financing state-funded services. Analytical and on-demand reporting tools and forecasting capacity are not utilized or have no practical application.

Currently, medical institutions mostly provide information on state-funded services. Therefore, the system does not ensure the collection of complete statistical information, which is still carried out by separate methodology and other toolsets.

Fig. 42. Adoption of the ARMED system services

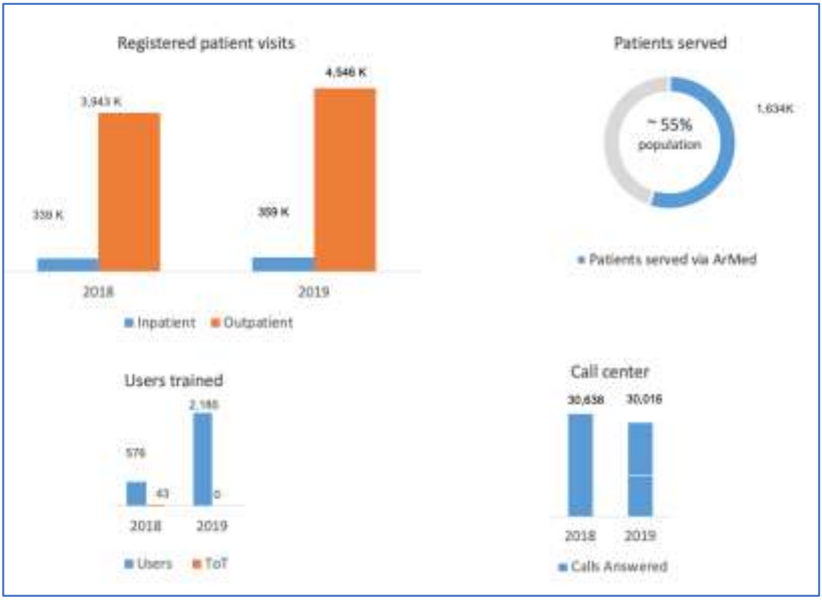

Fig. 43. Statistics on the services offered by the ARMED system

The system maintenance costs are borne out of system subscription fees. Initially, the subscription fees of the system were significantly higher than the average market price of similar IT services in the country, which caused discontent among medical facilities in 2017. To this end, the MoH started to provide full or partial subsidies for the subscribers in 2017 and onwards. In parallel, based on the agreement reached between the MoH and the operator, the principles of subscription payments were revised, and as a result, the service fees were reduced by approximately 50% since 2020, and the state subsidy for the system was mostly eliminated.

From a functional perspective, the system currently helps with the financing of state-funded services. At the same time, electronic subsystems of up to date disease registers, health statistics, and disability data sheets are not yet in place. The process of partial introduction of electronic referrals and electronic prescriptions has begun only recently. There is a need to develop and ensure nationwide implementation of these subsystems, providing both technical and all the necessary legal frameworks.

From the interoperability perspective, there is a need for extending the system features to exchange data with other information systems such as the State Revenue Committee, the Ministry of Labour and Social Affairs, the Ministry of Justice and the Police. Given the plans to introduce new subsystems, it is also necessary to enhance the technical capacity of the medical institutions and to provide ongoing system user training.

Upcoming and Future Developments

The 2020-2023 Program:

The Government of Armenia and the Ministry of Health set the key directions for the vision of development of the electronic healthcare system for 2020-2023 in the vision and roadmap document, which is under development now. These directions include:

1. Development and implementation of the legal regulations necessary for the operation of the eHealth system and the maintenance of healthcare databases.
2. Development of common standards for the operation of the eHealth system and maintenance of health databases in line with the digitalization standards applicable in the country and developed by the Ministry of High Technology Industry of the Republic of Armenia.
3. Increasing the cost-effectiveness of the eHealth system, improving existing functions, and introducing proper system monitoring functions.
4. Further development of the capabilities of the eHealth system through the development and introduction of disease registries, subsystems for electronic prescriptions, electronic referrals, electronic disability sheets.
5. Strengthening of the eHealth system, technical capacities of medical organizations and continuous training of users of the system.

6. Expanding the opportunities for the population to use the eHealth system.

Future Features of the EHR

Users of the EHR will have the following features in the future [46]:

1. For medical institutions:
   - Management system for human and material resources: Resource management through the system will allow better distribution of patient flows for available rooms, equipment and medical workers. This will minimize waiting time, avoid queues and use existing resources effectively.
   - Electronic system for booking visits of patients: Patients will be able to pre-book visits to the admission department. Pre-booked visits can be approved or moved to different time slot.
   - Implementation of a comprehensive Electronic Health Record (EHR): Implementation of a unique EHR and input of clinical data will allow a physician to review, search and analyze a patient's health history (including diagnoses and medical procedures), thus avoiding time and data loss for retrieving and researching previous records. Better access to information supports better diagnostic and treatment decisions. Another advantage is a built-in diagnostic decision support system that is based on predictive models. It is intended to use data from an EHR to evaluate potential risks and prevent possible complications.
   - e-Prescription module: This is the replacement of the paper-based prescription system by a paperless electronic one, allowing better control on prescribed medications and therefore minimize risks. The possibility of losing prescriptions will be eliminated as well.
   - Storage of medical documents in electronic format: All medical documents including laboratory and diagnostic test reports will be stored in the system in an electronic format and available for reference at any time they are needed.
   - Complete clinical statistics: Authorized users will have real-time, up to date statistical data. Thus, a realistic picture of the country's health system with morbidity statistics, resource data and possible problems will be available at any time. This will increase the effectiveness of the public health system in terms of prevention and resource distribution.
   - Telehealth service: A telehealth module will allow patients to access medical consultancy regardless of location.

- Armenia's electronic health record journey will be strengthened through membership in Systematized Nomenclature of Medicine (SNOMED) International and commitment to SNOMED CT's clinical terminology [47].

2. For insurance companies: The possibility of the transfer of voluntary health insurance business processes to the electronic healthcare system.

Upcoming Features of the Patient Portal

The upcoming features of the Patient Portal are as follows [46]:

- Launch of an online patient appointment scheduling (e-Booking): The e-Booking system is already developed and tested. It will be fully operational when subscribed healthcare facilities import the lists of services they provide and the schedule of medical personnel.
- Implementation of a unified electronic medical card: The introduction of a unified electronic medical card is intended to give the physician the opportunity to see the patient's medical history. It will help to make accurate decisions and raise the physician's responsibility for the diagnosis and treatment. The card will contain:
  - i. Information on patient's health status, past and present health issues,
  - ii. Essential information required for patient’s proper treatment about vaccinations, contraindications, allergies, etc.,
  - iii. Information about patient’s examinations, diagnostics, appointments and prescriptions.
- Launching a "Care Plan": With this documentation, the patient has the opportunity, regardless of location, to see a care plan for their treatment. This is an easy way to record and store treatment, measure health issues or disease conditions, keep the patient informed about medication schedules, guide what kind of actions to undertake, etc.
- Managing health records in a digital format: This includes a range of data, including demographics, medical history, medication, allergies, immunization status, laboratory test results, radiology images, vital signs, personal statistics like age and weight, and billing information. It eliminates the need to track down a patient's previous paper medical records and reduces the risk of data replication, as there is only one modifiable file, which means the file is more likely to be up to date, and decreases the risk of lost paperwork.

- Service quality ratings of healthcare establishments and diagnostic centers: Services provided by all healthcare facilities and diagnostic centers are available on the patient's personal page. This feature allows patients to comment on the service received, leave feedback as well as have access to other reviews given by other patients, which enables them to make a choice.
- Extension of Telemedicine services: A patient will be able to communicate with a physician, and the latter will be able to provide long-distance medical advice to the patient through video calling and online messaging. This will be beneficial to patients in isolated communities and remote regions, who can receive care from doctors or specialists far away without the patient having to travel to visit them. It can also eliminate the possibility of transmission of infectious diseases or parasites between patients and medical staff.
- Refilling a Prescription: The opportunity to prolong a prescribed medication usage period will be provided. This function is especially vital for patients with chronic diseases.

Armenian Digital Health Initiative

Among the most recent developments is the initiative to establish a cluster (an ecosystem) of modern Digital Health in Armenia that is currently being developed and conceptualized by the Armenian Association of Telemedicine (AATM) under the auspices of the Government of Armenia, and in collaboration with the global Digital Health community and with Armenian Diaspora in the United States, the United Kingdom, Germany, and other countries.

Background

The daily business of health in all its aspects – from individual patient care to systemic humanitarian action, relies on information and communication. The extraordinary advances and convergence in areas such as high-speed computing, telecommunications, and mobile and wireless technologies are driving this development, thus supporting the proliferation of advanced “Digital Health” systems. The Digital Health revolution is poised to make transformative strides in the global economy, improving the healthcare systems in both developed and developing countries.

Armenia, as a developing country, has attained accelerated economic and health achievements in recent years. However, there has been a gap in integrating technology into medical practice. For example, even though the country has seen major intake and penetration of mobile phone and Internet usage in recent years, such technological developments have not yet been utilized effectively within Armenia’s healthcare system. This gap in the era of local significant technological achievement has created an unprecedented opportunity to direct these resources towards exploring feasible solutions for the long-time challenges in the healthcare system including population health quality mapping, patient data transferring, and healthcare delivery disparities.

Approach

The Armenian Association of Telemedicine (AATM) has been challenged to design an approach to marrying these resources as a solution to the current healthcare challenges in Armenia – a key component of which is to build a Digital Health Center of Excellence that would serve this purpose. Overall, to deliver its potential, these national and regional Digital Health initiatives are guided by a comprehensive strategy that integrates financial, organizational, human, and technological resources.

Financial Resourcing

The overall funding and sustainability of the Center will be the responsibility of the Government of Armenia in partnership with the supporting academic institutions and industry partners.

Organizational Structure

The Center will have three main divisions:

i) Research and Training;
ii) Enterprise Innovations and
iii) Public Policy and Advocacy.

(i) Research and Training: Digital Health for Enhanced Medical and Health Education

The educational and learning theme of the center aims to establish a “Digital Health” educational cluster that can educate and train the current and the next generation of clinicians and health information officers in different areas of Digital Health and to create a new “digital healthcare services” sector in the country. This allows the delivery of affordable digital healthcare services to the wider population, particularly in the underserved and remote areas. The “Digital Health Specialists” (DHS) or officers trained at the Center will represent a new generation of digital-savvy clinicians and healthcare personnel working within the current secondary and primary healthcare systems, equipped with the knowledge and set of skills that do not currently exist. The training of these professionals is via a Postgraduate / Masters Diploma course provided by the Center. This requires a new study program and digital health curriculum to be offered by the Center along with participation of higher education institutions in Armenia and abroad. As part of this process, innovative blended learning techniques will be used, utilizing both e-learning and hands-on teaching methods. Few of such degree programs exist worldwide today.

The Center thus aims to create and teach this curriculum. The education cluster will be enrolling students not only from Armenia and Artsakh but also from abroad (including markets such as China, India, Indonesia, Brazil, and others). As was mentioned already, such innovative Master's in Digital Health (MDH) program is currently being established at the Russian-Armenian (Slavonic) University (RAU) in Yerevan, in partnership with the Deggendorf Institute of Technology (DIT) in Germany.

(ii) Enterprise and Innovation

The research and enterprise theme of the Center will develop the necessary infrastructure, supported by the technical and academic workforce, to create an innovative Digital Health Hub in Armenia. This Hub aims to be the focal point of improving healthcare in Armenia and Artsakh, the Caucasus region, and globally. In particular, this Hub will facilitate the provision of state-of-the-art translational solutions that are adaptable to the primary and secondary care services in Armenia. These will cement the public and private partnerships between the Center and the businesses by creating a new Digital Health Business Ecosystem within Armenia with global outreach.

(iii) Public Policy and Advocacy

Public Policy and Advocacy aims to create a spectrum of vital and much needed digital health delivery services database in Armenia and Artsakh. For example, a portfolio of mobile and digital health solutions and services for non-communicable disease monitoring and management, would be an essential starting place for competent public health systems. These outcomes will be created as a result of R&D and enterprise activities within the Center. These will be adopted and disseminated for use by public policy authorities and healthcare providers in Armenia and Artsakh, and subsequently internationally. Such digital health solutions will significantly enhance the existing Integrated Health Information System (eHealth system) in the country and will provide a complimentary added value of Patient-Generated Health Data (PGHD) that will optimize health services delivery with more cost-effective outcomes. It is expected that in the longer term, the Center will develop a specialized health data sciences center for Armenia with international outreach, supporting both the future of personalized healthcare delivery nationwide, in the region, and beyond.

Human Resources

The Center will constitute a structure of the leading team consisting of clinicians, scientists, businesses, and digital technology experts with the overall responsibility of operating the center. The center will be based in Armenia, in collaboration with partner institutions and to work with other Armenian academic institutions, NGOs, and business sectors in the country and abroad.

Technological Resources

The center will aggregate a variety of technological tools such as Electronic Health Record (EHR) database, research databases, medical mobile app data, electronic hardware, “Medical Workstation on Wheels” (WOW), clinical data analytical software, etc.

Current Status

The AATM has adopted a phased approach to introducing the initiative, demonstrating success in two aspects. First, an AATM team has been created consisting of experts who are global leaders of digital health. This plays a key role in the successful drive of the approach because digital health solutions are not limited to one nation or state, but are applicable globally. Secondly, it is essential to identify relevant parties, concerned public and private sector representatives in order to introduce them to the objectives of this initiative. These are the Minister of Health, medical school senior leadership and EHR developers. This is important to create a multidisciplinary vision for designing the approach. In order to facilitate this step in requiring continuous advocacy and raising awareness not only around the issue but also around the solution, the AATM has adopted multiple tactics such as individual meetings with representatives as well as group workshops and learning sessions. A successful outcome is the confirmation (obtained from multiple representatives) of the current issues that are in the process of being dealt with by the local healthcare system. Many informed experts have agreed that the disparities in healthcare delivery and fragmentation of Patient Health Information (PHI) have become a significant burden in improving not only the quality of care but also access to care.

One of the main challenges relates to the monetary and economic value in selecting and implementing such an initiative. This is true because there are very limited patient and clinical databases available, which could reflect the validity of the claim of the solution. In order to overcome this challenge, the AATM has been using case study examples to bring to the surface issues in healthcare and thereby convene in the soundness of the solution. Needless to say, the global burden posed by COVID-19 on healthcare systems has not been helpful in finding alternative approaches.

Future Steps

In the upcoming year, the AATM is aiming to move to the next steps focusing on finishing phase one and stepping into phases two and three. The focus of these phases will be on mapping the operations for the development of the Center, fundraising, and national and local policy advocacy.

During this time, the AATM also will adopt multidirectional approaches to expand the solution across the country and consequently engage local informed experts during each phase. One of the considerations that AATM has been discussing is to have a pilot practice prior to expanding the proposal. This would help to control the moving elements, monitor outputs, and adjust the necessary process changes. On the other hand, this may slow down the implementation phase.

Regardless of the approach, the main aim is to build the core sustainable and agile processes, which can be expanded and improved to address future needs.

Conclusion

The Republic of Armenia demonstrates great potential and success in the use of ICT to deliver healthcare services. Since the realization of the Spacebridge in the late 80s, telemedicine services to the Armenian population has had a widespread outreach.

A huge impetus to the development and utilization of telemedicine is portrayed by the workings of the Armenian Association of Telemedicine (AATM). Its services encompass the incorporation of technology into the promotion and deliverance of health services as well as continuing medical education and the development of educational programs.

As the health system of Armenia continued to advance, there was a commitment to provide the people with an eHealth platform. This concept was supported by a growing ICT infrastructure. As the idea continued to unfold, the success of various activities in telemedicine supported this move. It is also important to note that the legislative landscape developed along with the development of the eHealth system.

The introduction of the ARMED eHealth system in 2017 fulfills the promises of the provision of effective and efficient health services while empowering the patient. With the inclusion of various healthcare service tools, ARMED is pertinent to the development of a sustainable citizen-centered health system in Armenia. The nature of the ARMED system was demonstrated in the ability to install and manage a platform dedicated to the control of the spread of COVID-19 during the pandemic.

As a leader in ICT among the Commonwealth of Independent States (CIS) countries, Armenia is clearly a model to other countries. With the successful implementation of the ARMED system in Armenia, the National Operator for eHealth is set to implement a similar eHealth software platform in the Republic of Kazakhstan. The recent Digital Health Initiative in Armenia also holds a promising future in the capability of digital health for the people of Armenia and the world.

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Conflict of Interests

G. Chaltikyan is the Chief Medical Consultant for Global Virtual Clinics.

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Côte D’Ivoire
Telemedicine in Côte D’Ivoire

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Introduction

Ivory Coast (Fig1) is a country located [1] on the African continent [2]. Its borders roughly give it the shape of a square whose south side is at the seaside. This sea is the Atlantic Ocean and more precisely a small part of this immense ocean, on the African coast that is called the Gulf of Guinea. It is about the same distance from Brazil (in South America) and Spain (in Europe). Côte d'Ivoire is located between the third and eight degree (longitude West) and between the fifth and tenth degree (latitude North). It is located between the Tropic of Cancer and the Equator.

Côte d'Ivoire is also limited to the West by Liberia, whose borders with Côte d'Ivoire were established by international agreements in 1892 and in the northwest by Guinea and Mali.

With an area of 322 462 km² it represents 1% of the African continent. The economic capital, Abidjan, is on the banks of the Ebrié lagoon, open on the wide sea, with about 4 million inhabitants. The political capital, Yamoussoukro, is 240 km north of Abidjan, with an estimated population of 2,000,000 inhabitants.

The country has the general appearance of a plateau that gently rises from the South to the North. Its reliefs are concentrated in its western part, especially around the locality of Man.

Four major ethnic groups, which extend far beyond the borders of the country, share the Ivorian space: the Mandé, Voltaïques, Krou and Akan groups.

The main cities are Abidjan with, Bouaké; Daloa; Yamoussoukro and Korkoro.

Figure 1: Côte d’Ivoire location and flag

French is the official language of Côte d'Ivoire. It is estimated that more than two thirds of Ivorian’s over the age of 6 are able to express themselves in this language.

Ivory Coast is a Secular State. As far as religion is concerned, the country is characterized by a great diversity and a great tolerance. The most widely practiced religions are Islam and Christianity with Catholicism and Protestantism. A large part of Ivorian’s remain attached to traditional religions. Many others also are members of evangelical churches.

Early Stage

The history of Telemedicine in Côte d'Ivoire began in 1995 with the introduction of medical informatics at the Faculty of Medicine of the University of Abidjan. In May 1996, a European cooperation group organized telemedicine sessions, involving doctors from developing countries and European centers. This group demonstrated the technical feasibility of telemedicine at two major international conferences: the International Telecommunication Union (ITU) Conference on “Development of Telecommunications in Africa”, in Abidjan, Côte d’Ivoire and the G-7 (Groupe des sept) Conference in Midrand, South Africa, on “The Global Information Society” [3]. During these meetings, teleconsultation sessions, distance medical training and medical image exchange were conducted on real medical cases of dermatosis, pulmonary tuberculosis, neurological and trauma emergencies.

In Ivory Coast the first real telemedicine experience began with a distance medical training in 2004, thanks to the meeting between Dr Benjamin Gold and Professor Francis Somian Ehua who, at that time, was the dean in charge of pedagogy at the Abidjan Medical Sciences Research and Learning School. This meeting allowed Professor Ehua to join the Réseau en Afrique Francophone pour la Télémédecine (RAFT), created in Bamako, Mali. With Dr. Innocent Martial Nanan and Mr. Roger Kpon they immediately formed the RAFT local team and began with the first distance courses (reception and transmittion) formerly located at the Swiss Center for Scientific Research. Subsequently in 2005, distance-learning activities were relocated to the Yopougon University Hospital Center (CHU).

In 2007 the Ivorian Health Informatics Association, Société Ivoirienne de Biosciences et d'Informatique Médicale (SIBIM), was created by the three main actors indicated above with the participation of late Pr François Philippe Kassy Aka-Gblahn , Dr Mamadou Doumbia, Dr Lamine Konaté, Pr Guy Varango, Pr Allou Assa, assisted by two Dental students namely Tielourgo Koné and Myriam Anoma (Fig2).

Since its creation, SIBIM has promoted the implementation and development of telemedicine in Côte d'Ivoire through the organization of outreach activities in hospitals and health training. These include, but are not limited to:

- Incentive in 2008 for the implementation by the MSHP of the 1st Telemedicine Working Group;
- Organization in Grand-Bassam (2009) of the 6th African Conference on Medical Informatics (HELINA);
- Organization in 2010 of the 1st Ivorian Days of Telemedicine and Medical Informatics (JITIM);
- Implementation of the Pan African Network Project (2010);
- Participation in the validation of the National Plan for the Development of eHealth (2012-2016), which included two SIBIM projects, namely Interconnection Project of the 3 Abidjan CHU and also the construction and equipment of the National Telemedicine Center (CNT), inaugurated in 2015.

Figure 2: The SIBIM Team

Since 2014, through a bilateral partnership, SIBIM and the NGO Wake Up Africa (WUA) work together for the development and extension of the Tele-EKG project involving nine remote health centers plus an expert center. This project attracted new partners who intend to improve it with artificial intelligence and extend it to 20 remote centers from 2019-2020.

The Focolare Medical and Social Center in Man, led by Dr Carlo, has also contributed to the telemedicine development by carrying out teleconsultation activities with Heath facilities in Italy.

RAFT Network

Created in 2000 under the direction of Prof. Geissbuhler to bring an answer to the question of Dr. Cheik Oumar Bagayoko and his friends, about how they could continue to learn when they will finish their studies and be located in a rural area without any learning opportunities. This network aims helping professionals and students in places of greatest need like rural zones and remote hospitals.

With the support of RAFT top management, the local team bought computer and connection equipment and give them to the three University Hospitals for ELearning activities (Fig 3).

Figure 3: The RAFT eLearning equipment

The local team has to select doctors and support them to make a lecture without seeing any students or colleagues by using for their first time a laptop and camera (Fig 4). The courses were pre-recorded and PowerPoint supports uploaded on the server before the day and time reserved.

The platform used to deliver and follow courses is named DUDAL. This is a distant education software, developed for RAFT to operate with low-bandwidth connections (25kb/s). The platform allows the participation in the lectures either as a lecture or as a listener [4] (Fig 5).

From 2004 to 2015, national practicians and physicians delivered 56 courses through this Network.

Furthermore, the local team promotes courses produced by other countries member of the Network, and reserve a venue to allow students and doctors to follow together (Fig 6) or separately the courses through the platform after a login. The goals of this network, in addition to improving collaboration between health professionals, are also to improve the access to medical care and continuing training in rural and remote areas.

Figure 4: The first ELearning editing by Raft local Team in 2004

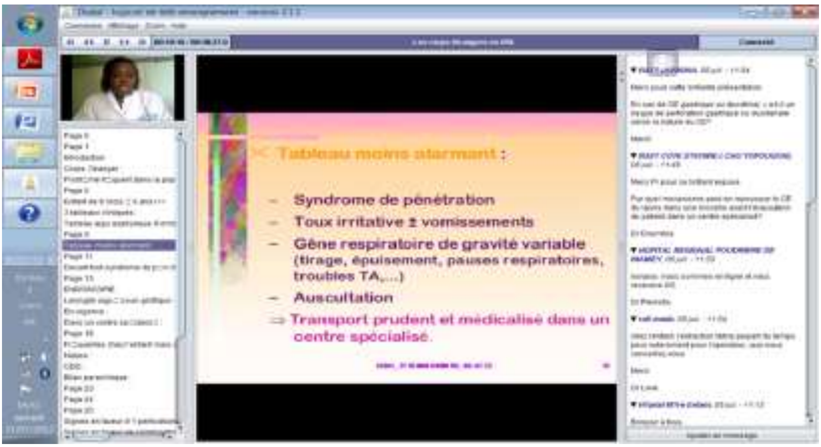

Figure 5: The RAFT ELearning platform DUDAL

Figure 6: Students following an eLearning course

Tele-Cardiology Project

Launched by RAFT local Team, SIBIM and WUA, the project named "Cardiologie pour tous or Cardiology for all" [5], aims to improve the diagnosis and management of cardiovascular diseases in Côte d'Ivoire by the use of telemedicine.

With the contribution of the RAFT Network and Agence Nationale du Service Universel des Télécommunications (ANSUT)**,** the health centers part of the project , were equipped with medical kits allowing collection of data, recording (Fig 7) and transmission of electrocardiograms (EKGs) and their analyses by a group of experts.

In the first phase of the project, ten centers received kits enabling them to carry out EKGs and transmit the waveforms by mail to specialists for advice and guidance in the management of living diseases in localities without specialists. This is a Tele-cardiology project that allows remote interpretation of EKGs by a pool of cardiology experts based in the cardiovascular and thoracic disease department of the Bouaké University Hospital.

Figure 7: Training for the use of EKG equipment and transmission of records

In addition to the indirect access to a cardiologist, the project has reduced the costs for patients in terms of examination fees, travel and accommodation costs, and travel-related risks. In addition, the centers involved in the project were able to raise their technical offer, prevent certain pathologies and further strengthen their final resources.

The success (Fig 8) of this project has aroused the curiosity and interest of external partners willing to finance its improvement and extension.

Figure 8: TeleEKG project poster at the "Semaine Ivoirienne de Promotion de la Recherche" (SEPRI)

AGA KHAN Foundation Tele-expertise Project

The project (Fig 9) aimed to help improving the quality of healthcare services provided to Industrial Promotion Services (IPS) /West Africa (WA) employees and their neighboring communities.

Fig 9: Aga Khan Tele-Expertise project main room

It was intended to strengthen the clinical skills of private and public health professionals in the field of Human Immunodeficiency Virus and Acquired Immune Deficiency Syndrome (HIV/AIDS), on the one hand, and to promote the Voluntary Screening Council (CDV) in the companies of the group, as well as in the neighboring communities of the subsidiaries [6]. It included an eLearning component and a Tele-expertise component.

Telemedicine sites have been installed at the medical centers of three IPS companies in Abidjan, Bouaké and Boundiali and an expert center at the Coalition des Entreprises de Côte d'Ivoire contre le SIDA (CECI) headquarters in Abidjan Plateau. These centers were equipped with computer and communication equipment and then connected to the high-speed Internet network. These electronic platforms have made it easier for local, public and private health professionals to access on-line training programs tailored to their needs, leveraging RAFT resources (BOGOU and DUDAL), from the Agha Khan University in East Africa and the University of Geneva in Switzerland.

The on-line training was initially focused on topics related to the prevention and management of HIV-AIDS and opportunistic conditions and comorbidities that influence its evolution. Tele-expertise made possible to link doctors and nurses, often isolated in their daily practice, with specialists of the "Service des Maladies Infectieuses et Tropicales" (SMIT) (Fig 10). Through a tutoring system, a pool of physicians or paramedics in a given geographical area solicited a specialist identified in the fight against HIV-AIDS for expert advice in the management of a patient or to ensure a collegial prescription. The transfer of information was done via Internet coupled telephone communication.

Figure 10: Visio-conference with Aga Khan Centers

The Growth

The Government has set itself the ambition of ensuring development through ITC, so as to create the foundations for the deployment of a digital economy that can sustainably impact the economy, profoundly change the functioning of the social economy, and create the fundamentals for a knowledge economy at the service of the Ivorian people. This ecosystem aims to enable Côte d'Ivoire to eventually have competitive and accessible ICT services for all [7]. ICT is a lever for the development of the country because of its considerable impact on all branches of the national economy in terms of innovation, productivity and growth accelerator.

From 2011 to 2016 the first eHealth National Plan called “Plan National de cyber santé” and the Pan Africa Network Project were implemented under the supervision of two services from the Health Ministry and the ICT Ministry, the”Coordination Nationale du Développement des TIC en Santé” (CNDTICS) for Health and ANSUT for ICT. The main actors to manage these two big projects were Mr. Jean Claude Yéo (ANSUT; Mr. F. Simon Bléhiri (CNDTIC) and Mr. Traoré Youssouf (ANSUT). Together in the right line of the plan, they help to build the National Telemedicine Center (Fig 11) and installation of servers, computers, and Visio conference materials. The pilot project, also equipped the three University Hospital (CHU) and 2 remote hospital with teleconsultation facilities to allow them initializing telemedicine activities and medical eLearning.

Figure 11: Inside one room of the “Centre National de Télémédecine”

A Medical Electronic Records project (e-Ivoire) has also been developed beside by CNDTICS to initialize the digitalization of patients’ journey in those hospitals before expanding the project.

Since 2015, the Ministry of Health and Public Hygiene (MSHP) has undertaken the work of the hospital reform, comprising six strategic axes, the fifth of which foresees the development of e-health.

Geographical disparities and low numbers of specialist professionals create medical deserts that limit people’s access to specialized doctors and quality care.

As a result, the integration of telemedicine into the healthcare offer panel of health facilities was seen by MSHP as a solution to provide populations with quality care regardless of their area of residence.

Thus with the support of the European Union through the “Projet d’Appui à la Redynamisation du Secteur de la Santé Ivoirien” (PARSSI) an inventory of telemedicine projects was carried out and resulted in a decree on telemedicine.

In accordance with the decree, with the support of the technical branch of Expertise France, the Health Ministry through “Direction de la Médecine Hospitalière et de Proximité (DMHP)”, benefited support from experts for the development of a national plan for the development of telemedicine called” Plan National de Télémédecine” (PNTLM). DMHP, through his Telemedicine unit lead by Dr Abdramne Berthé, in collaboration with the Health Information Department named “Direction de l’Information et de l’Informatique en Santé” (DIIS) are still struggling to get funds to lunch the pilot project of this second plan limited to telemedicine.

In 2017, in collaboration with the MSHP, specifically with the Institut National de Santé Publique (INSP), hosting the project, the Elizabeth Glaser Foundation fighting against pediatric AIDS (EGPAF) in Côte d’Ivoire, launched the Extension for Community Healthcare Outcomes (ECHO) project. This project is an eLearning and tele-expertise project to reinforce health professionals skills and allow them improve the quality of care. INSP also partnering with Université Numérique Francophone Mondiale (UNFM), who offers a Very Small Aperture Terminal (VSAT) (Fig 12) in 2019 to enhance the internet connection and support INSP for his Telemedicine activities and digital projects like digitalization of diabetics medical records pilot project called “Mobile Clinique du Diabète et de l’Hypertension (mCDH)”. This project is driven by UNFM and a pharmaceutical laboratory

Côte d'Ivoire is indeed in the innovation. Google Days, Social Media Day, Matinées Kacou Ananzè, Assises de la sécurité informatique, Fashion Geek, BEST, Africa Digital Weeks, Africa Digital Expo… The events and meetings dedicated to new technologies in general and particularly in health (Africa Health Connect, Africa Santé Expo, Medical Expo CI, Africa E-santé, etc.) follow and follow each other. The applications are also plentiful, like «Taxitracker» allowing tracking taxis, «Qelasy» an educational tablet; “Opisms” an electronic vaccination diary; “Health Pass mousso” the bracelet to stock basic patient data, «Môh Ni Bah» an application dedicated to the declaration of births; etc.

Digital health is in full evolution today in Côte d’Ivoire. In addition to SIBIM, WUA and Orange Foundation which are experimenting with social projects with the support of partners/ donors such as RAFT and UNFM, some NGOs and companies (Alive Digit, Africa Doc, REMA...) propose to healthcare professionals products and services covering the patient journey and professional collaboration.

Figure 12: INSP VSAT

With the commitment of the Health Ministry through its technical structures like Centre National de Télémédecine (CNT), Direction de l'Information et de l'Informatique en Santé (DIIS), Coordination Nationale du Développement des TIC en Santé (CNDTICS), Direction de la Médecine Hospitalière et de Proximité (DMHP), with the support of Agence Nationale du Service Universel des Télécommunications (ANSUT), the implementation of telemedicine could improve the Ivorian health system. To reach this goal, the previous eHealth development plan must be revised and updated to integrate Telemedicine as part of Hospital's Information System.

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Pakistan
Journey of Telemedicine in Pakistan

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Introduction

Population, Geography and Demographics

Population in Pakistan is expected to reach 220.86 Million by the end of 2020 [1], making it world's fifth most-populous country, behind India and ahead of Bangladesh. The population is spread over four provinces, Punjab, Sindh, Khyber Pakhtunkhwa and Baluchistan, and federally governed Gilgit Baltistan [2].

Figure 1. Pakistan

As per the Pakistan Demographic and Health Survey (PDHS) 2017-18, the total fertility rate has dropped from 3.8 percent in 2012-13 to 3.6 percent in 2017-18. The total fertility rate is still higher in Pakistan compared to other neighboring countries. Iran and China have lowest fertility rates in the region with 1.6 percent each, while Bangladesh and India stand at 2.1 percent and 2.6 percent respectively [3].

Urban- Rural Divide

Pakistan is considered as an agriculture country where the greater land is rural. In the census of 1998, 68% of the total population was declared to be rural, while 32% was found to be residing in urban area. In the last census of 2017, a little change is found with 64% of the total population as rural and 36% as urban [4].

Demographics- Age

Pakistan is not only one of the youngest countries in its region, second youngest in South Asia after Afghanistan, but also in the world. Sixty-four percent of the country's population is under the age of 29, with some 30 percent between the ages of 15 and 29. For at least the next three decades, Pakistan will continue to be a younger country.

With the mortality rate slowly declining and life expectancy rising, the country's current median age of 22.5 is expected to hover at around 31 years by 2050. Pakistan's current population pattern follows the conventional pyramid structure – a large base and narrow peak. This will start transforming into a cylindrical shape in 2030, and by 2060 Pakistan's population will have a uniform age structure, see figure 2 [5].

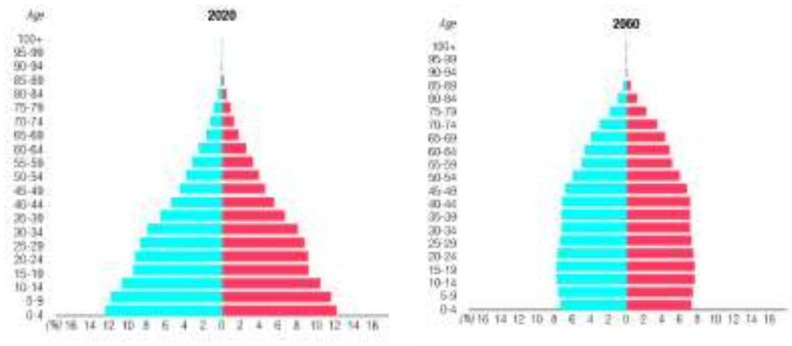


Figure 2. Source: The 2017 National Human Development Report (NHDR) of Pakistan

Health System

The health system of Pakistan is divided into public sector and private sector. The public sector provides outreach health facilities at the primary, secondary and tertiary level. The primary health care services are provided through rural health centers (RHC) and basic health unit (BHU). District headquarters hospitals provide secondary health care services and the rest of the population is catered by tertiary health care facilities which are affiliated with teaching hospitals in the urban cities providing specialized care. Furthermore, the functions of private health sector in Pakistan can be divided into formal and non-formal health sector. Overall, the health care expenditure share by the public sector is approximately 75% whereas; the private sector has 25% of its share in health care spending. Moreover, there are also small dispensaries, maternity care centers, specialized centers for heart diseases and kidney ailments, eye care centers established by the government in few areas of the country to support the traditional public health system [6].

By the year 2018, the number of public sector hospitals has increased to 1,279, Basic Health Units (BHUs) improved to 5,527, Rural Health Centers (RHCs) were increased to 686 and dispensaries to 5,671. These facilities together with 220,829 registered doctors, 22,595 registered dentists and 108,474 registered nurses bring the current ratio of one doctor for 963 persons, 9,413 persons per dentist and availability of one hospital bed for 1,608 persons [7].

Health Indicators

Pakistan is considered among the low-income countries (LMIC) where 24.3% of people live below the poverty line (falling from 50.4 percent in 2005-06) which is defined as an income of less than $2 per day [8].

While there has been noticeable improvement in some health indicators over the years, on the whole, considerable room remains for improvement. Overall, life expectancy in Pakistan remains lower than many in its peers in the region, while infant as well as maternal mortality rates are amongst the highest. Infant mortality stands at 61.2 deaths per 1,000 live births in 2019, compared to 86 per 1,000 live births in 1990. During the same time period, under-5 mortalities has markedly declined from 112 to 74 deaths per 1,000 live births. Neonatal mortality declined from 55 in 2012 to 42 deaths per 1,000 live births. Maternal Mortality rates stands at 178 out of 100,000 mothers. Childhood wasting declined slightly from 11 percent to 7 percent, while the prevalence of underweight children declined from 30 percent to 23 percent. Childhood mortality rates have declined since 1990 [7].

In terms of Human Development Index (HDI), Pakistan’ position is 150 out of 189 countries in 2017. Slight improvement has been witnessed, as in 2012-13, 45 percent of children were stunted which dropped to 38 percent in 2017-18 [7].

Health System of Pakistan - Post Decentralization

Health has constitutionally been the provincial government's responsibility; however, in practice, the federal ministry took lead in health planning, service delivery programming and monitoring, aid coordination, human resource, funding and management of the larger health hospitals and drug licensing and regulations. Provincial governments had a passive role of administration of health facilities and programmes. Devolution was preceded by a radical change in federal – provincial resource and responsibility distribution in April 2010. By June 2011, the functions of health planning, legislation, service regulation, financing service delivery, human resource production and service delivery programming were devolved to the provinces and country also saw abolishment of the Ministry of Health (MoH) at the federal level. A very superficial discussion and planning undertook between the federal ministry and provinces and provinces were overnight confronted with additional responsibilities with resourcing and planning yet to be worked out [2]. Ministry of National Health Services, Regulations and Coordination (NHSRC) was also constituted in 2011 to provide national and international coordination in the field of Public Health, oversight for regulatory bodies in health sector and enforcement of drugs laws and regulations [9].

In 2019, NHSRC developed a strategic document 'Action Plan' prioritizing actions of the new government to transform the health sector of Pakistan by addressing the challenges, health sector reforms and thus improving the health outcomes of people of Pakistan. This action plan augments current health sectoral and sub-sectoral strategies and plans in the country and will support the progress towards achieving Sustainable Development Goals (SDGs), Universal Health Coverage (UHC) and International Health Regulations (IHR) agenda in the country [7].

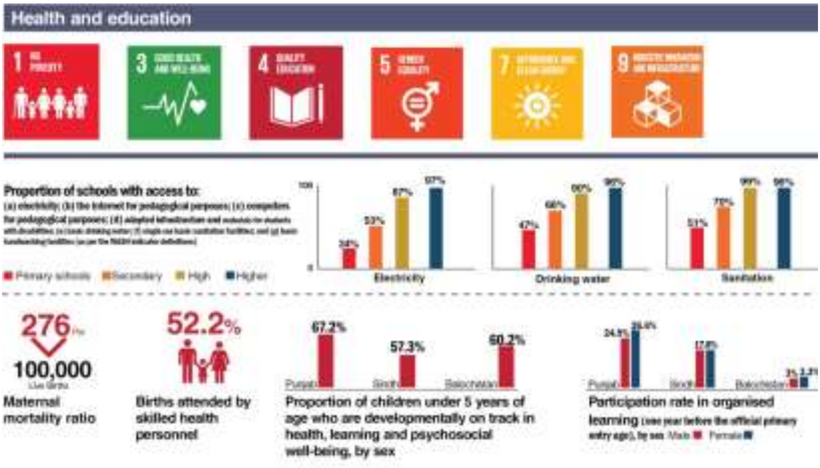
Progress against SDGs

On a national level, Pakistan was one of the first countries in the world to endorse the 2030 Agenda for Sustainable Development. The country carried forth that commitment by a formal ratification in the country's Parliament in February 2016 [10]. A National SDGs Framework was launched in 2018 envisaging a national vision, plan and strategy to optimize, prioritize and localize the full potential of SDGs in Pakistan [11].

Regarding SDG 3, 'Good Health and Well-Being' Pakistan has made some progress; stunting and malnutrition have decreased between 2013 and 2018 by 6 and 9 percentage points, respectively. The prevalence of skilled birth attendance has improved by 17 percentage points while the neonatal mortality rate has fallen by 10 percentage points during the same period. A new universal health coverage initiative, the Sehat Sahulat Programme, was launched in 2019 to provide health insurance coverage for those in need.

Health sector reforms are underway, entailing a centralized integrated disease surveillance system and a strong inter-provincial information sharing mechanism.

To achieve Pakistan's sustainable development targets, effective coordination is required among all the stakeholders – including the Government, private sector, civil society and academia – in terms of devising and effectively implementing policies. The 2019 SDF progress report identifies a key aspect of country's implementation strategy is strengthening existing alliances and forging new ones, while leveraging technology and mobilizing finance [12].



Source: Dawn News 2017

Health Systems Gaps

Pakistan health system follows the pattern of a typical health system of a developing country. Suffering a double burden of diseases; inadequate health infrastructure and equipment; and silos of care resulting in duplication of efforts (vertical and horizontal healthcare system augmented by post 18th amendment scenario. Health system of Pakistan is also confronted with problems of scarcity of resources, inequity, insufficient and untrained human resources, structural mismanagement and gender insensitivity. Accessibility and affordability for health services especially for rural population of the country is a big issue because of severe shortage of healthcare professionals and inadequate allocation of funds for Primary Healthcare sector. Reliable Health Information Management system is not available at Primary and Secondary level to evaluate and improve the services. Lack of medical research and technology at national level is one of reason to deliver substandard services. The Pakistan health system is also straining to deal with increasing cost and demand pressures [13].

Improving the health system requires a fundamental change in approach to the way health care is delivered in this country. There is a need to move to a system where every interaction between consumers and care providers achieves maximum impact on health outcomes and where scarce financial and human resources are deployed as effectively as possible. This change will require a fundamental shift in the way information is accessed and shared across the health system. eHealth offers a process of closing the above gaps by harnessing Information and Communication Technology for improved healthcare delivery in addition to other ongoing efforts.

Need and Benefits of eHealth in Pakistan

eHealth (the term mainly used in this document) or Digital Health with its different dimensions (Telemedicine, Mobile-Health and Health Informatics), offers ways to improve access and quality of care, with direct benefits not only to the communities and patients in need, but also to the healthcare providers working in different levels of health system.

eHealth interventions represent a strategy for potentially addressing problems with access to and quality of health care through telehealth. eHealth can play a major role and an alternate model in provision of essential services to remote areas, such as specialized maternal and child health to support basic services in the communities, availability of clinical and administrative data to enable the planners to take timely and appropriate decisions, access to the specialists for emergency and difficult cases. eHealth (through m-Health) can also play a crucial role in Behavioral Change Interventions.

Role of eHealth in improving the quality of information and its management has also been proven globally. Lack of timely and reliable data is often cited as a serious impediment to successful delivery of health services. eHealth provides platform for electronic management of health management information systems (HMIS) to improve efficiency and effectiveness of health system. An effective HMIS system at the district level will carry both epidemiological information (health prevalence, incidence, mortality, and morbidity statistics) and administrative information (resource inputs and service utilization).

eHealth Readiness in Pakistan: Technology, Human Resources, Policy

While the circumstances in Pakistan justify the use of Telemedicine for improving health services, it is also important to see how prepared the system is for using such solutions. “e-Health readiness” can be defined as “the degree to which users, health-care institutions, and the health-care system itself, are prepared to participate and succeed with eHealth implementation” [14]. It is critical to assess the readiness of the overall system and organizations participating in the eHealth program to facilitate the process of change for individuals and organizations to adopt eHealth programmes and avoid disappointment. Such tools are expected to minimize the chances of failure and help all stakeholders in achieving their desired goals. In this section, we have focused on readiness of health system and the technology to support Telemedicine initiatives.

Readiness of Health System

Generally, a huge difference can be observed between Public and Private hospitals in terms of readiness for Telemedicine and eHealth initiatives. In a study, several health institutions in Pakistan were assessed in both Public and Private sectors using validated eHealth Readiness assessment tools. The results are described under the following categories:

a) *Benefits for Health Providers*

Health providers in Pakistan are generally highly supportive of the use of ICT for improving performance of their institutions and increasing their ability to provide better services to the population. Health providers from tertiary care institutions need better networking between departments in order to share information and improve decision making. They also supported telemedicine as the source of addressing professional isolation of remote health-care providers. They also highlighted gaps in radiology and lab services in remote areas, which can be partly filled through telemedicine services.

b) *Benefits of Patients and Communities*

Health providers supported the use of telemedicine to benefit their patients and communities through better continuum of care, saving travel-time for clients, facilitating referral procedures, and reducing cultural barriers to healthcare access.

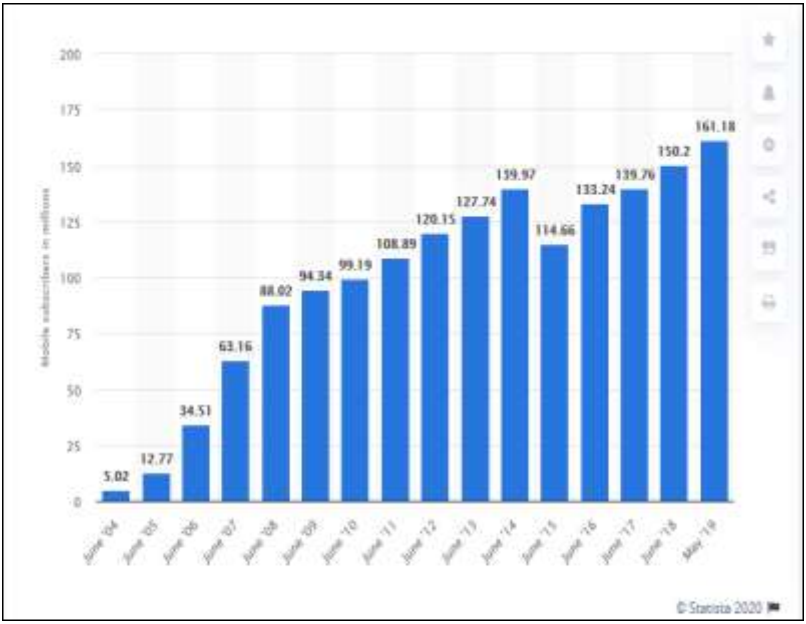
c) *Barriers to Telemedicine in Pakistan*

Health providers also highlighted the need for addressing barriers for scale-up of telemedicine programmes in Pakistan. These include a lack of homogenous ICT growth in different parts of the country and healthcare institutions, lack of willingness to share information between institutions, lack of computer and internet literacy among clients, and lack of physical access to ICT [15].

Technological Readiness in Pakistan

Pakistan has progressed a great deal over the past decade in both mobile and internet availability to most parts of the country. The data shared in the report "*A Digital Future*" published by the Global System Mobile Association (GSMA)**,** confirms that the internet coverage in Pakistan has grown at a tremendous pace due to investments in 3G and 4G services. The report estimates that around 90% of the population will have access to 3G and 4G internet by 2020.

Other reports describing mobile growth in Pakistan also suggest that there are over 160 million mobile subscriptions in the country of approximately 220 million people. This shows ubiquitous nature of mobile coverage in the country, which is converting fast into 3G and 4G services.



The above section shows that Pakistan has grown in readiness in terms of health system's, health providers' and well as the technological readiness. However not much data is available in terms of Policy readiness since the governments and regulatory bodies have still not adopted telemedicine as the part of their main services. eHealth Association of Pakistan has been trying to create awareness among the policy makers for such adoption and policy formulation [1, 6].

History of Telemedicine initiatives in Pakistan

Similar to other developing countries, realizing the need for eHealth technologies and solutions, Pakistan started with eHealth pilot projects and programs, mainly in telemedicine in early 2000s. These pilots, supported by international donors to prove success of eHealth/telemedicine solutions in the local environment. Although the projects were successful in demonstrating relevance and application of the technology, these were not designed to produce research evidence to convince the policy-makers, industry and academics to support eHealth/telemedicine at a larger scale. Moreover, no serious efforts were made, from the government side to harness the use of technology in healthcare at a broader level.

The main developments in eHealth came from the private sector and autonomous organizations working in public sector where organizations like COMSATS institute Islamabad, Aga Khan University Hospital Karachi, Holy Family hospital Rawalpindi, Jinnah Post Graduate Medical Institute Islamabad, Mayo Hospital Lahore came forward with successful pilot projects particularly in telehealth and telemedicine.

In terms of health informatics, again no serious government effort came across in either electronic medical records (EMR) or automation of health information. There are few examples where hospitals have developed in-house EMR software; Pakistan institute of Medical Sciences, Aga Khan University Hospital, Shaukat Khanum Memorial Hospital and Indus Hospital are few notable ones.

With respect to eHealth advocacy, policy and strategy development, creation of eHealth Association of Pakistan in 2008 has been a concentrated effort of all key eHealth stakeholders in the country. The idea was to bring all eHealth experts in Pakistan together; to create an eHealth advocacy group to convince government and other policymakers for broader implementation and policy support.

Pakistan has seen several Telemedicine initiatives adopted in Public and Private sectors, achieving various degrees of success. However, none of them has been able to successfully scale to a large population. These initiatives can be categorized as:

1. Improving health services in remote health facilities;
2. Improving referral system between primary care facilities and Tertiary hospital;
3. Providing telemedicine services to people on phone;
4. Institutional Collaboration for learning.

1. Improving Health Services in Remote Health Facilities

Several telemedicine initiatives have been initiated to improve health services in health facilities in remote areas of the country. Some examples are as follows:

Telemedicine Services in Gilgit Baltistan Using Satellite Connectivity

The Commission on Science and Technology for Sustainable Development in the South (COMSATS) started a Telemedicine initiative in northern area of Pakistan, also called Gilgit-Baltistan, in 2004. Gilgit Baltistan area is located in Hamalayan ranges and is one of the remotest and most disadvantaged regions of Pakistan. Due to the shortage of health services, people suffer as a result of late diagnosis and treatment. The area had limited information and communication facilities and the overall infrastructure was also very poor.

The project used Very-small-aperture terminal (VSAT) links between Skardu and Islamabad and between Hunza and Islamabad at an initial bandwidth of 128 kbit/s. A detailed needs assessment was carried out in the health facilities to understand the need of specialized health services. The project ensured that all the required health services are regularly scheduled, and the medical equipment required to assess the patients is available.

Teleconsultations were planned in five specialties: general medicine, cardiology, gastroenterology, dermatology and nephrology. Initially both synchronous and asynchronous modes were used, but late synchronous telemedicine mode was mainly used. Five medical specialists and a telehealth consultant were employed at Islamabad. Consultation services were operated for a test period, and then later run operationally for patients in Skardu. A total of 361 patients received specialist consultations in the first 4 months of operation. Dermatology was the most common specialty. Women benefited greatly from the service and showed confidence and satisfaction. Feedback received from the specialist doctors at Islamabad, as well as project staff at Skardu, called for increased bandwidth to improve the quality of the service. Over 1000 consultations were done in the period of 2 years [17].

Problems and Corrective Measures

Connectivity: Low bandwidth and poor connectivity were the major impediments to telehealth services. Various measures were taken to overcome these difficulties. The videoconferencing system was adjusted to make the calls at 128 kbit/s so that packet loss could be minimized. This greatly improved the audio quality during consultations.

Unavailability of human resources: Infrequent availability of general physicians or well-trained paramedical staff has been one of the major problems in providing the telehealth service at Skardu. A doctor dedicated to the telehealth service at the Abdullah Hospital in Skardu was employed for telehealth. The doctor’s role was to present accurate and detailed information about the patients (e.g. the history and basic physical examination results) to the specialist doctors. Having detailed medical data is important for successful tele-consultation. In view of the large number of female patients seen by telemedicine, a female doctor was also hired [16].

Telemedicine in Southern Pakistan - A project of Jinnah Postgraduate Medical Center

A telemedicine project was initiated around the same time in the Southern parts of Pakistan in the province of Sindh. A Telemedicine hub was established at the Jinnah Postgraduate Medical Center (JPMC) in Karachi while spokes were established at four rural secondary hospitals in the province. Connectivity was provided through Satellite by Pakistan's Space and Upper Atmosphere Research Commission (SUPARCO).

The project was launched in March 2005 in districts Nawabshah, Hyderabad, Larkana, Badin and Sukkur Engro Chemicals supported the project financially. Services were provided in the area of telecardiology, telepathology, teledermatology and telesurgery. Later, telepediatrics and telegynecology were also included. Doctors were trained at both hub and spoke facilities in the use of telemedicine. Videoconferencing facilities were used for synchronous teleconsultation, while several examination cameras were used to make objective diagnosis.

The project continued for over two years providing more than two thousand consultations in several specialties. Despite showing success in-terms of reaching rural health facilities, the program could not be continued once the donor funding ended [18].

2. *Improving Referral System Between Primary Care Facilities And Tertiary Hospital*

Several telemedicine initiatives were implemented in Pakistan for improving referral system. An example is given below:

Telemedicine Services for Rural Punjab Provided by Holy Family Hospital

Telemedicine Project was initiated by Holy Family hospital, Rawalpindi for providing a range of triage and referral services to five primary health facilities in the province of Punjab. These services were provided in the areas of pre-operative planning and follow-up; cardiology; ophthalmology, dermatology, radiology, infectious disease, and peri-natal evaluations; and medical triage for traumas and acute illnesses. The project also focused on building capacity for healthcare services via virtual clinical grand rounds for medical education.

The service provided video conferencing services along with peripheral devices including portable ultrasound, digital cameras, EKG, stethoscope and X-ray machine. Wateen Telecom and Motorola were engaged to provide WiMAX enabled wireless broadband access, allowing the exchange of massive amounts of information between the Holy Family Hospital spoke facilities [19].

3. Providing Telemedicine Services To People On Phone

Several telemedicine projects were initiated in Pakistan to provide direct consultations to patients. Some of these include:

TeleDoctor - Telemedicine Call Center

TeleDoctor service was started in March 2008 by the Telenor Tele-Communications Company, owned by the Telenor Group of Norway [19, 20]. TeleDoctor aims to connect anyone in Pakistan to a doctor by dialing one number. Callers have the convenience of being able to call 24 hours a day, 7 days a week. TeleDoctor provides secondary medical advice only, but promotes discussions regarding lab investigations, treatment, symptoms, and health awareness. Service launched in eight local languages [20].

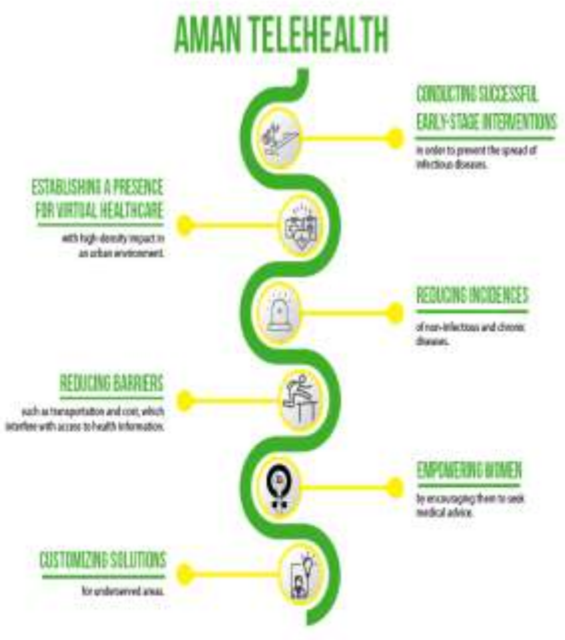
In the first eighteen months of inception, 500,000 unique users used this service. TeleDoctor focused on saving customers, especially those living in rural areas, travel time and cost to see a doctor. It also offered accessibility and convenience through the use of multiple languages and direct access using a regular cell phone. The program was advertised through Telenor's mobile service advertisements, while Bill payments were shared through Telenor's cell-phone usage payment structures. TeleDoctor charged callers 8 PKR ($0.05 USD) per minute. These charges were in addition to the customer's basic calling fee.

TeleDoctor's main strengths include:

a) Personalization of services, particularly by connecting patients to medical specialists who speak a variety of languages. For gender-specific medical questions, women may be more comfortable speaking with a female doctor.
b) The 24-hour access to the system was also of great value, particularly for those who are unable to travel long distances to an emergency room or hospital after hours

Aman TeleHealth Call Center

Just like TeleDoctor, Aman TeleHealth was also started as a 24-hour healthcare helpline, which provided easy and timely access to diagnostic services, basic medical advice, mental health and family planning counselling over the phone. The service was started initially for the city of Karachi, but further extended to other parts of Pakistan. Aman TeleHealth also mapped thousands of health services out on its system enabling callers to access information about the relevant facilities in their location. The model is explained in the figure below.



Key strengths of Aman Telehealth were its 24/7 TeleHealth advice and use of triaging platforms to screen patients who can be satisfied by providing advise on phone from others who may need referral to a health facility for further support. These interventions reduced the disease burden at early stages, ensuring proper triaging of medical ailments to the point of lowest treatment costs and preventing over-burdening of the tertiary care system. Unfortunately, despite reasonable acceptance the program had to shrink substantially because of the lack of effective revenue model. Above is the business model adopted by Aman Telehealth [21].

4. Institutional Collaboration for learning

Projects lead by Aga Khan University – Afghanistan and Northern Areas of Pakistan

Aga Khan University (AKU) has been one of the leaders and pioneers in implementing low cost eHealth/telemedicine solutions in the north of the country. AKU also houses, The Aga Khan Development Network Digital Health Resource Centre (AKDN dHRC) established in 2011 to provide strategic digital health support to the AKDN health agencies and their partner health institutions with managing their digital health operations [22].

Cross Border Telemedicine- Pakistan and Afghanistan.

The eHealth/telemedicine program between Pakistan (Aga Khan University-AKU) and Afghanistan (French Medical Institute for Mothers and Child-FMIC) was initiated to improve access to quality healthcare to patients living in rural areas and providing hospitals/health centres with real-time access to specialist diagnosis, treatment and training expertise.

In June 2007, teleradiology setup was established between FMIC and AKU. The project was used for diagnostic services for CT scan studies and medical education. For making this project a sustainable model, various organizations contributed from technical, financial and logistic ends. These organizations include Roshan, CISCO and Al-Moyed Group [23].

Improving Health Services in Northern Pakistan Through eHealth

Northern Areas of Pakistan, now officially referred to as the Gilgit-Baltistan (GB), has a population of 1.9 million as per the 2017 census. The government of Pakistan and the Aga Khan Development Network (AKDN) are the major players in providing basic health facilities to this population, where the geography and severe weather conditions make it extremely hard for people to travel to specialized health facilities. To overcome these problems, an eHealth project was initiated to support diagnosis (patient management, triage and referral of patients), enhance capacity and manage information in Gilgit Baltistan.

Hundreds of people, particularly women and children living in far-flung areas of Gilgit-Baltistan benefited from this innovative project, which uses low-cost, store and forward technologies to improve health services. Since its beginning in January 2010, the project has significantly increased local community's access to quality healthcare, improved quality of services and information, and enhanced knowledge of healthcare providers to deal with maternal and Child health issues.

The project was based on hub and spoke model and connected multiple spoke, sub-hubs and hub sites. Nearly 70% of these cases were reported within 24hrs, while 100% of the cases were reported within 72 hours. Project showed high percentage of patient satisfaction and decrease in professional isolation of healthcare providers. Project also showed cost saving of approximately Rs1000-Rs5000 (US$ 8-40) per patient. The results from the project also showed nearly 68% of patient avoiding traveling through this system. The project proved that using low cost technologies can provide access to specialized care to the community but can also been used for building capacity of healthcare providers at the remote sites.

The project continues to provide teleconsultantions to a wide range of patients. Since 2015, the project has provided consultations to 2424 patients, provided training through eLearning to 719 healthcare providers and is now connected to nine sites in the Gilgit Baltistan province [24].

PANACeA Initiative for Building Telemedicine Evidence and Capacity

The Pan Asian Collaborative for Evidence-Based eHealth Adoption and Application (PANACeA project) was established by the International Development Research Center, Canada. The project was headquartered at the Aga Khan University, Karachi and involved health researchers from 12 Asian countries [25]. Several programs were also introduced in Pakistan, which include:

i) Economic evaluation framework for computerization of hospitals;
ii) A framework to identify gaps in the use of ehealth in primary health care settings;
iii) Online TB diagnostic committees for clinically suspect sputum negative patients in the TB-DOTS program;
iv) Community-based ehealth promotion for safe motherhood: Linking community maternal health needs with health services.

The key objectives of PANACeA include:

- To support a set of multi-country research activities to address core research questions;
- To create a theoretical model for evaluating good practice in eHealth programs in Asia;
- To build research capacity amongst Asian researchers to evaluate and adopt appropriate eHealth technologies and practices and influence policy and decision-makers;
- To disseminate research findings widely in the regional and International research communities.

PANACeA initiatives continued during the period of 2007-2010. Achievements made by PANACeA are described under the following activities:

i) Enhancing awareness about Telemedicine and eHealth projects: PANACeA projects involved institutional and country-level leadership from health sector in Pakistan and other countries to create awareness about Telemedicine and eHealth. All projects under PANACeA finalized their reports and disseminated their findings using variety of forums.
ii) Capacity Building: The network organized 44 online weekly seminars to build capacity of its partners and other stakeholders, and also provide opportunity for disseminating activities within the network. The network also arranged two face-to-face workshops to share the results of the projects and plan for the next cycle of PANACeA.

iii) Cross-border collaborations for Evidence building in Telemedicine: PANACeA built long-lasting collaboration among participating institutions, resulting in several other initiatives and networks emerging after the end of the project funding.

Current Telemedicine Initiatives

Several new Telemedicine initiatives have been introduced in both Public and Private sectors. These new initiatives draw learnings from the past projects and have the potential to scale all over the country and last beyond the duration of project funding. Some examples of such initiatives include:

Telemedicine to Support Primary Health Facilities in Rural Areas of Khyber Pakhtoonkhwa

Providing specialist health care in rural areas has been a long-standing issue in the provision of health services, resulting in travel of patients to hospitals and clinics in urban centers. The problem gets further complicated in regions like the province of Khyber Pakhtunkhwa (KP) where difficult geography, weather, security, socio-cultural barriers and poverty may result in delays or complete avoidance in seeking specialized care. The problem requires out of the box thinking and innovation to address this need of the people [26].

The government of KP has taken a bold step to introduce telemedicine in rural health facilities of the province using highly innovative, relevant and cost-effective technologies. The telemedicine program connects the laptop computers placed in rural facilities with a telemedicine software through internet, which allows sending patient information and images to the specialist doctors. The rural doctors can also take appointments for live online consultations with the specialists and connect for a video consulting session where several cameras and diagnostic machines like digital stethoscope, ultrasound, ECG and digital microscopes can assist in the diagnosis. The KP government is using a highly recognized telemedicine platform MDConsults for connecting these facilities.

The program connects health facilities in five districts, namely Karak, Battagram, Chitral, Nowshera and Swabi with the Services hospital in Peshawar. In addition, a mobile telemedicine facility has also been set-up for using telemedicine during the times of disasters. Telemedicine services will be provided in a variety of specialized areas including Pediatrics, Obstetrics and gynecology, Dermatology (Skin), ENT, Ophthalmology (Eye), Cardiology, Mental health, Medicine, Surgery and Radiology. People from both genders and all age groups would be able to benefit from the telemedicine services.

The program has huge potential to improve health services in the province by providing specialist care to population closer to their homes, saving time, cost and the trouble for patients and their families to travel to the large urban centers. The project would also allow learning opportunities for health providers in rural facilities where they would benefit from the teaching provided by the specialists. The program will be replicated to other districts in the future, thus making it a flagship initiative for the entire province and an example of innovation for the entire country.

Telemedicine Projects Rollout by Government of Punjab- Pakistan

In 2019, The Punjab government, Pakistan Launched a telemedicine service for citizens through which they will be provided free healthcare facility online, where senior doctors and surgeons will be available via the online service. The project uses the concept of health information and communication technology to overcome geographical barriers and provide standardised healthcare to areas where corporeal medical facilities are unavailable. The medical specialists will first diagnose patients after which they will be prescribed medication. The project follows, the success of pilot project in two districts of Punjab Province, i.e. Dera Ghazi Khan and Taunsa Sharif. The roll out will be across the province in all its districts gradually [27].

Promoting Preventive Care at Early Age Using Telemedicine in School Health

eHealth, with use of internet and handheld devices has opened new avenues for making health care assessable for population living in remote communities. Many of these technologies are currently being used in developing countries all around the globe [28].

Realizing the importance and usefulness of initiating eHealth program for remote communities of Pakistan, an innovative school eHealth project been initiated at the Government Girls Lower Secondary School, Deh Chuhar, adopted by Rural Educational Promotion and Development Society (REPDS) with the support of Aga Khan Development Network (AKDN). The proposed school eHealth project is the one, which offers a linkage between local school health nurse and specialists at the remote next level health facility in terms of the following services:

1. Tele-consultation for children attending Deh Chuhar School for diagnosis, treatment and referral services.
2. eLearning services for parents in form of online health education sessions, where expert nurses and physicians conduct a series of online awareness sessions once a month for parent at the school.

For this initiative, a ‘Hub and spoke model’ in the form of a complete Telemedicine solution, MDConsults, is used where Deh Chuhar School, Gaddap Town, Karachi Pakistan has been taken as spoke and is connected with the Paediatric Department of Aga Khan University Hospital (AKUH), which is next level of care, serving as the hub for providing Tele-Consultation Services (TCS) for children and eLearning health awareness sessions for parents. Tech4Life Enterprises as technology partners for these initiatives has been contributing with zeal and enthusiasm in order to promote the acceptance of Telehealth all over Pakistan, by providing health care access to children attending Deh Chuhar School and offering the learning session to parents of these children.

The Telemedicine project looks forward to reducing the financial and geographical limitation of the community for the access to required health services, and referral centres and lack of awareness among parents about children health problem.

DoctHers – An Innovative Business Model for Telemedicine in Pakistan

DoctHERs is an innovative healthcare initiative that connects female doctors in Pakistan to millions of under-served patients in real-time while leveraging the power of Telemedicine. DoctHERs tries to address the sociocultural barriers that restrict women health providers to their homes, denying their inclusion in the workforce. By enabling them to practice Telemedicine, these health providers can help fill the huge shortage of women health providers in Pakistan to provide health services to women for reproductive and other health related issues [29].

The program aims to increase the participation of women in the workplace. It also aims to provide quality health care to underserved population in rural communities. The vision is to reduce neonatal, maternal and medical mortality rate by 50% in the target community using video consultation and CMW-assisted telehealth services.

Through their initiatives, DoctHERs provides employment opportunities to female Health providers and enable telemedicine consultations via trained trusted Community Health Workers in rural communities. The program conducts active community mobilization in each target community (recruiting 10 lady health workers/CHWs in each community) and creates primary health care centers equipped with appropriate medical health care services tools.

The program also provides clinical and specialized software training to clinical management personnel, nurses, doctHERs and community mobilizers on how to use peripheral diagnostic tools. The program staff regularly monitors clinical processes, data entry procedures, and conduct audits to maintain optimal performance. doctHERs has created a tertiary health care referral system with a tertiary care hospital around each respective community, equipped with a lab collection point, visiting sonologist, family planning lab and a mini pharmacy.

Sehat Kahani

Sehat Kahani is a TeleHealth platform that connects at-home, out-of-work-force female doctors to underserved patients in low and middle-income markets providing access to quality health care, launched in 2017. The start-up created a network of e-Hubs (walk-in clinics) that use telemedicine to connect users to qualified women doctors online, while qualified nurses or health workers act as intermediaries in selected communities. Sehat Kahani has also developed a mobile and web-based telemedicine solution that gives users direct access to virtual consultations, as well as general preventive and mental health information. Sehat Kahani currently has 26 telemedicine e-Hubs spread across three of Pakistan's four provinces: Khyber Pakhtunkhwa (KPK), Punjab and Sindh. Sehat Kahani has served to more than 150,000 patients directly through its digital health care services until date [30].

COMSATS – Telemedicine Projects

Commission on Science and Technology for Sustainable Development (COMSATS) started a first of its kind healthcare delivery mechanism in 2001. Tele-medicine was used for consultation in the earthquake of 2005.

This mechanism includes linking of a TeleHealth clinic at any rural area located remotely with the COMSATS Resource Centre in Islamabad (urban area) through internet. From 2001 onwards, COMSATS continues to provide healthcare through its TeleHealth clinics located in various rural areas in Pakistan like Gujjar Khan, Skardu and Zhob in collaboration with its partner organization [31].

Aga Khan University Projects

The Aga Khan University (AKU) continues its efforts to implement eHealth projects and solutions in the country. AKU continues to support the Aga Khan Health Services facilities in Gilgit Baltistan region through telemedicine and eLearning. It also is working with Sindh Provincial Government in number of small eHealth initiatives. Few of the prominent AKU projects are described below.

Teeko

In 2015, the Aga Khan University (AKU) in collaboration with the Sindh government's Expanded Programme on Immunization conducted a research project titled, "Improving Routine Immunization Coverage through Health Systems Strengthening" to help boost routine immunization coverage in the Tando Mohammad Khan (TMK) district of the Sindh province.

Teeko, is an Android-based application and a web portal, to assist with vaccinator and immunization tracking and monitoring. *Teeko*, meaning vaccination in the local language, provides real-time data on a vaccinator's field movements through GPS tracking and on the number of children being immunized [32].

Bolta Parcha

Bolta Parcha is another mHealth project aimed to assess the effectiveness and acceptability of Prescription Interactive Voice Response (IVR) Talking Prescriptions (Talking Rx) in increasing medication adherence and health literacy in Pakistani patients with vascular diseases. The Aga Khan University Stroke Service and Baylor College of Medicine collaborated to develop and pilot a Talking Prescriptions IVR and a SMS reminder system. The system allows patients to access tailored voice messages while customised SMS medication reminders are sent to increase medication compliance and health literacy [33].

Centre for Innovation in Medical Education

The recently established Centre for Innovation in Medical Education at AKU is providing access to quality healthcare by connecting the people in Afghanistan and Northern Pakistan to AKU faculty via tele-medicine clinics. It also has a e-Health virtual ward (telemedicine room, a Doctor's Viewing Room, and a physician's office, reception/waiting area, patient education room and examination room), a digital library and a Simulation Research Unit. Inpatient e-Health Suite is established with a vision to portray a 'Next generation hospital ward [34].

Impact of Telemedicine in Pakistan

Although Pakistan has seen several Telemedicine initiatives over the past two decades, not too many initiatives have claimed to measure long-term impacts. Few projects have made certain claims on the outcomes, which can be categorized as follows:

a) Impact on Health Systems

Several initiatives described above have reported impact on the performance of Health Systems in Public and Private Sectors.

Improvement in Continuum of Care

Earlier Initiatives, such as the COMSATS initiative in Gilgit Baltistan, Holy family initiative in Punjab; HOPE project in Sindh, and PANACeA Network have all reported better screening and triaging at the primary care level, resulting better coordination between different levels of service and improvement in continuum of care.

COMSATS project in Gilgit Baltistan showed high acceptance of the service was that people from rural areas came pouring in to receive specialist consultation. No promotional campaign was run to inform people from outlying areas, and word of mouth seemed to be enough. The consultation data show that in the first few months more consultancies were provided for people from urban areas, while in the later months more consultancies were provided for people from rural areas.

Initiatives like Holy Family Telemedicine initiative and HOPE project specifically focussed on better screening and triaging of patients in the secondary care hospitals in the provinces of Punjab and Sindh respectively. Many of these patients got their procedures done at the tertiary care facilities and then followed regularly through telemedicine, thus improving continuum of care.

Projects undertaken under PANACeA, such as screening expectant mothers in rural areas and Tuberculosis screening also reported improvement in continuum of care between community-based health facilities and the specialized centers for these specialties.

Among the recent telemedicine initiatives, Khyber Pakhtunkhwa telemedicine project directly measures improvement in care in the rural health facilities and continuum of care in health programs. Other initiatives, such as DoctHers and AKU's initiatives also measure improvement in Continuum of Care.

Improvement in Referral System

Telemedicine Initiatives in both public and private sectors have reported improvement in Referral system between different levels of health care facilities. Earlier initiatives, such as Holy Family telemedicine, Project HOPE, and PANACeA network specifically focused on improving referral system in Public and private sector initiatives.

Holy Family Telemedicine initiative and HOPE project specifically measure improvement in referral services between Public health facilities. Patients were effectively triaged and referred from Secondary hospitals to the tertiary hospitals for better services.

Projects undertaken under PANACeA, especially screening expectant mothers in rural areas and Tuberculosis screening also reported referral services. Maternal health project promoted referrals from community directly by involving community-based health providers. On the other hand, the tuberculosis project connected primary care facilities to specialized tuberculosis centers in the country.

Among the recent telemedicine initiatives, Khyber Pakhtunkhwa telemedicine project, Sehat Kahani, DoctHers and AKU's initiatives also measure improvement in Referral system.

Better Monitoring of Care

Some Telemedicine Initiatives reported improved services in remote health facilities through regular monitoring of care using Telemedicine solutions. Earlier initiatives, especially AKU projects, and PANACeA network measured improvement in the quality of care in rural health facilities.

Projects undertaken under PANACeA, such as Health Information Systems and Tuberculosis screening focused on improving quality of care and regular reporting of efficiency in diagnosis at the level of primary and secondary care facilities.

Among the recent telemedicine initiatives, Sehat Kahani, DoctHers and School Health initiatives also measure improvement in quality of care and better monitoring of regular services.

b) Impact on Health Professionals

Telemedicine initiatives have also shown to improve the quality of service provided by the health professionals in the Hub and Spoke facilities. The outcomes reported in these projects include:

Better Support for Health Professionals

Several Telemedicine Initiatives in both public and private sectors have reported provision of better support from senior physicians. Initiatives, such as COMSATS Telemedicine in Gilgit Baltistan, Holy Family telemedicine, and Project HOPE reported increase in support for remote health providers.

All these projects reported that the health providers in remote communities could depend on the specialists from Tertiary hospital for better diagnosis of their patients and ensuring timely provision of care to these patients. They also reported discussion of difficult cases with senior health providers at the tertiary care facilities, thus improving the quality of diagnosis and care provided to patients.

Among the recent telemedicine initiatives, Khyber Pakhtunkhwa telemedicine project, Sehat Kahani, DoctHers and School Health Project emphasize on the support provided by senior health providers to Frontline health providers and rural physicians.

Learning and Empowerment of Health Providers

Formal and informal learning of health providers working in remote areas is a commonly reported outcome of Telemedicine Initiatives, resulting in higher capacity and Empowerment of health providers. Earlier initiatives, such as Holy Family telemedicine, Aman Telehealth and PANACeA network specifically focused on capacity building of health providers and their empowerment.

Although Telemedicine related training was reported by all the projects, Holy Family Telemedicine initiative and Aman Telehealth reported regular formal trainings of health providers through in-person and virtual sessions. These projects also monitored improvement in capacity and empowerment of health providers in their evaluations.

PANACeA network was established with the basic aim of improving capacity of all the researchers and health providers involved in the projects. Thus, several in-person and online training sessions were organized and validated tools were used to report improvement in capacity and empowerment of health providers. The project reported 30-50% improvement in the capacity and ubiquitous empowerment of remote health providers.

Among the recent telemedicine initiatives, Sehat Kahani, DoctHers and School Health initiative are specifically working on capacity building and empowerment of health providers.

c) Impact on Patients and Communities

Several projects also reported impact of Telemedicine use on the patients and communities. These can be described under the following headings:

Improved Access to Care

Telemedicine has been in important method for improving access to health services for people living in rural or remote areas with shortage or absence of health services. Initial projects focused more on improving access to rural and remote areas however several new initiatives have focused on improvement in access other groups, such as, the inner-city poor and the urban and suburban people with limited mobility.

Almost all of the earlier initiatives, such as COMSATS initiative in Gilgit Baltistan, Holy Family telemedicine, Project HOPE, TeleDoctor, Aman Telehealth and PANACeA network measured improvement in access to care. Several factors were reported as contributors to access to care:

- Significant distance from health facilities;
- Poor transportation suitable for transferring patients to health facilities;
- Shortage of financial resources, particularly insurance coverage or directly subsidized services;
- Family, educational, and cultural factors, such as illiteracy, distrust of technology and
- Interaction of these factors.

Most of these projects reported improvement in access for patients in rural areas, especially focusing on physical distance, transportation and cost of care, however projects like TeleDoctor, Aman Telehealth and PANACeA also reported addressing Cultural factors for improving access to care.

Among the recent telemedicine initiatives, Khyber Pakhtunkhwa telemedicine project, Sehat Kahani, DoctHers and AKU’s initiatives have all focused on improving access to care in both urban and rural populations by addressing physical and social barriers.

Reduced Cost

Telemedicine Initiatives in both public and private sectors also reported savings in cost of care for patients and communities as one of the key outcomes. Earlier initiatives, such as COMSATS initiative, Holy Family telemedicine, Project HOPE, TeleDoctor, and Aman Telehealth reported cost reduction in qualitative terms, however and PANACeA network also included frameworks for measuring cost-saving in quantitative terms.

Most initiatives reported effective triaging though telemedicine, online diagnosis and treatment, follow-ups for services provided in-person and better preparation and arrangement of in-person services as the key areas for saving costs for the patients and communities.

Projects undertaken under PANACea, reported significant saving in costs of care for patients in the range of $10-1000 through telemedicine services. The higher savings were reported for cases where travel to tertiary facilities were avoided from very remote areas, especially for diagnosis and treatment of tuberculosis.

Among the recent telemedicine initiatives, Khyber Pakhtunkhwa telemedicine project, Sehat Kahani, DoctHers and AKU's initiatives also report cost saving as key indicators.

Key Learnings

Providing health care using eHealth Technologies in Pakistan has already shown some promising implementations, producing substantial amounts of information and knowledge. The eHealth projects have gradually increased in the country, while most projects are in the private sector, public sector support and projects for eHealth have also been seen on the rise in the past five years.

The digital divide between rural and industrialized areas of Pakistan is still prevalent, as connectivity is extending, though at a slower rate, into rural areas facilitating eHealth implementations. Internet access in Pakistan with a population of 220 Million, stands at around 35 percent, with 78 million broadband and 76 million mobile internet (3/4G) connections. According to the Inclusive Internet Index 2019, Pakistan fell into the last quartile of index countries, ranking 76 out of a 100, and was particularly low on indicators pertaining to affordability [35].

Key learnings for eHealth implementation in Pakistan can be analyzed using the theoretical model and major challenges of implementing eHealth solutions for Developing Countries proposed by Harry 2014. The eHealth implementation challenges for Pakistan can be analyzed on following six areas [36]:

a) Lack of Skilled Stakeholders

This includes technical illiteracy and issues around qualification standards for ICT-knowledgeable health care professionals, even though professionals are expected to have a certain degree of extra knowledge, lack of knowledge about patient data security is very poor and weak among healthcare providers, especially in rural areas.

b) Inadequate Infrastructure

Successful adoption and use of ehealth systems depend on the suitable infrastructure, which includes hardware, network infrastructure and connectivity. The infrastructure in Pakistan in terms of technology, connectivity and hardware remains weak. Pakistan is a country which still faces power shortages and lack of power generators makes it difficult to put the right eHealth solution in place [37].

c) Lack of Acceptance and Missing Legislation

Low levels of comfort with the use of technology in Pakistan may have to do with, for example, affordability, fear of technological use, as there could be a perception of risk, including concerns about safety, validity and reliability of the technology, but especially privacy, security and confidentiality concerns. Lack of legislation pertaining to eHealth solutions in Pakistan also leads to low level of acceptance by the community and country at-large [38].

d) Limited Resources, Mainly in Terms of Government Funding

Bilateral and multilateral donors mainly support the eHealth projects in Pakistan. However, for long term, donor funding poses a challenge for sustainability of eHealth projects and programs. Also, in attempting to scale-up eHealth services, programs may be hampered by reliance on donor funding, highlighting the need for a transition to alternative and diversified resources. Public funding and support for health system and healthcare remains low in Pakistan, therefore funds allocation for a broad-scale eHealth projects implementation remains less [39].

e) Inadequate Information and Communication

Pakistan is a good example of a country where even though there is adequate technology in place at different levels of health system, it does not necessarily mean that it can be used for appropriate information sharing among different stakeholders of the broader health system. This includes lack of information sharing between agencies, lack of relevant content of applications, lack of information in a culturally and linguistically appropriate format and information exchange hindered by non-interoperability of heterogeneous databases [36].

f) Inadequate Process Guidance on How To Implement Ehealth Solutions

Pakistan in its efforts for a more harmonized and country wide eHealth adoption and implementation may become even further isolated from its benefits because of isolated lack of strategic roadmap and fragmented policies that are formulated in a parochial manner [40].

Following suggestions, learning can be summarized considering eHealth development in Pakistan, in the last two decades:

- Move towards a National eHealth strategy and policy with provincial level strategies;
- Improve knowledge and create awareness regarding eHealth modalities among policy makers and health care providers;
- There is a need to improve capacity of healthcare providers, district and provincial healthcare managers to implement eHealth programs;
- Improvement in eHealth infrastructural (technology, hardware and software) for smooth eHealth implementation particularly in the rural and disadvantage areas of the country;
- Improve investment in eHealth by government and private sector;
- Strengthen legal and regulatory framework for eHealth in the country;
- In low-resource settings, cellphone-based health education and consultations, personalized health tracking devices, and mobile diagnostic technologies can be extremely useful and provide real-time information to improve both individual and public health.

Future Direction

Telemedicine in Pakistan has gone through almost two decades of pilots and small-scale implementations, however none of the initiatives have survived enough duration to demonstrate impact on health systems and health of the population. Following suggestions are made for the future of Telemedicine growth in Pakistan:

a) Need for National eHealth Strategy and Policies;
b) Measuring impact and sharing results;
c) Leadership in eHealth.

a) Need for National eHealth Strategy and Policies

Pakistan lacks commitment from government on developing a National eHealth strategy and policies. Several forums have been established over the past 15 years, but the recommendations from these bodies could not translate into a National strategy. Now with the devolution of Health ministries to the provinces, it requires all provincial governments to reach a consensus on such strategy.

It is highly recommended that the National government should form a body for formation of eHealth strategy in the country. This body should include stakeholders from all the provincial ministries along with Public sector, IT industry and eHealth. Recommendations from this body should be discussed largely with experts from Health and IT sectors, which can be translated into a long-term strategy and road map for eHealth in Pakistan.

b) Measuring Impact and Sharing Results

Collecting evidence for the actual impact of telemedicine and eHealth initiatives in Pakistan, both on improving health of the population and the efficiency of health systems, is extremely critical. Government and large academic and research centers in the country should take responsibility of collecting building capacity of implementers of telemedicine programs to collect the required evidence for measuring impact of these programs and disseminate the results that can be used by various stakeholders.

Collection of critical information to measure the impact of telemedicine and eHealth programs should be made compulsory through National eHealth policy. This will ensure that every initiative plans for collection of such information and proper analysis and dissemination. Revival of a learning network, like PANACeA, for building research capacity and evaluating Telemedicine and eHealth programs would be highly beneficial.

c) Leadership in eHealth

There is a severe vacuum of leadership in the field of eHealth in Pakistan. eHealth Association of Pakistan had emerged as a National leader in 2015 and continued to dominate the landscape for 7-8 years. However, due to the lack of support and commitment from the government, this body has lost its effectiveness. It is extremely important to revive the eHealth Association of Pakistan and support this body for building evidence, strategy and roadmap of eHealth in Pakistan.

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Tunisia
Telemedicine and e-Health in Tunisia: Towards Digitalization and Interconnected Health

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Introduction

Tunisia experienced huge changes in demographic, social, economic and political fields over the last six decades since independence. Until now, it is still a country of huge contrasts. Important progress on political transition led to an open democratic system of governance, whereas, economic field has not known the same fate [1].

Tunisian population accounts 11,839,475 people on August 30, 2020, according to the last update of the United Nations data, which corresponds to 0.15% of the worldwide population. Median population's age is about 32.8 years. Population distribution by age was detailed in Figure 1 and showed a stationary type pyramid with declining birth rate and relatively low death rate. According to last previsions, Tunisia's population will continue to grow until 2058 reaching a plateau of 13.96 million people [2]. Life expectancy is continuously increasing since 1955 in both sex (Figure 2). Population density in Tunisia is about 76 per Km2, with a total land area of 155,360 Km2. Almost 70.1% of Tunisians live in urban areas distributed in many sizable cities (Figure 3) [2, 3]. The largest one corresponds to the capital of Tunisia, Tunis in the North east, including a population of about one million. Sfax, located in the South East, is the next largest and populated city following the capital with a population of 330,000. Other cities are distributed in different areas of the Tunisian territory with populations over 100,000 including mainly Sousse in the Center East, Kairouan in the Center, Gabes in the South East, Bizerte in the extreme North, Aryanah in the North East and Gafsa in the South West [4, 5]. Thus, it's obvious that major cities are scattered randomly on the Tunisian territory with unequal access to healthcare. Although better sanitary conditions, these urban areas could not totally ensure support to the healthcare needs of the neighboring regions whether urban or rural.

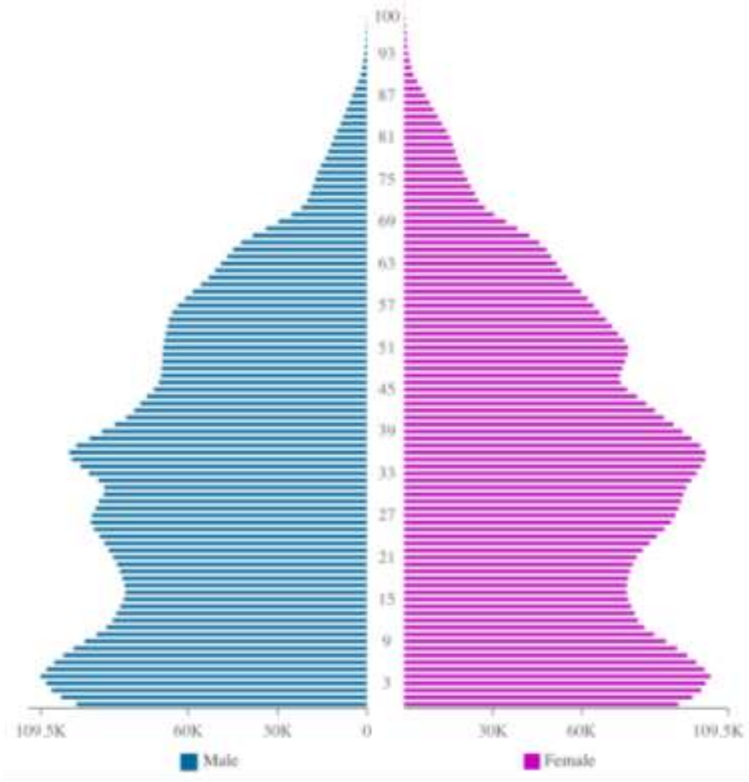

Figure 1: Tunisian population pyramid 2020 [4]

The Tunisian health care system is mainly based on public health care providers. There are additional private services based on insurances and service fees. Tunisia is organized into territorial health centers. The health sector is divided as follows into University hospital center (UHC), regional hospitals (RH), local hospitals (LH) and dispensaries. Specialists are mostly working in UHC and larger regional hospitals.

Regulation of the healthcare system needs and expenses are provided by government and ministerial departments, professional health organizations and the National Health Insurance Fund (CNAM). Distribution of health establishments and access to healthcare remain uneven between the different regions of the country. This situation has driven the first thoughts and uptake of telemedicine in Tunisia.

Telemedicine Initiatives’ in Tunisia came back to the 90’s, three decades ago. Efforts were shared between governments, civil society and some groups or indicative initiatives. In this chapter, we reported the Tunisian history of telemedicine development with strategic and national guidance, and the main achievements and perspectives.

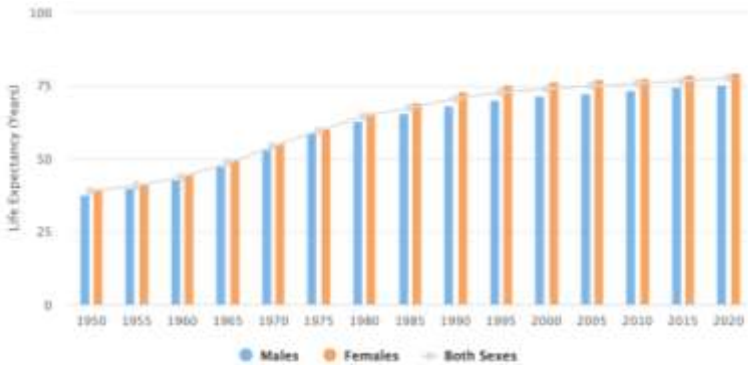

Figure 2: Life expectancy in Tunisia from 1955 to present

(Males, females and both sexes combined) [5]

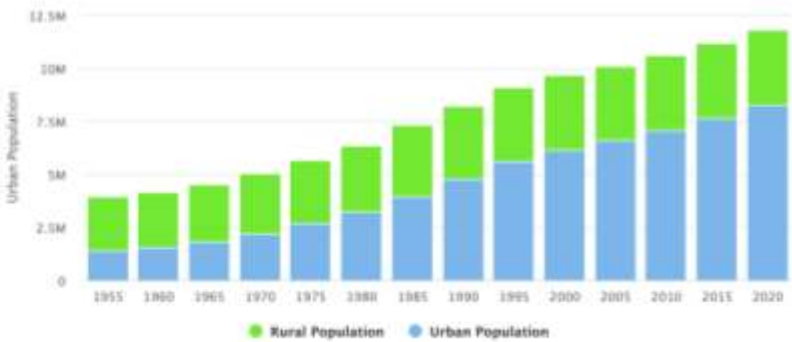

Figure 3: Tunisia Urban versus rural population from 1955 to 2020 [5]

When reviewing the history of Telemedicine in Tunisia, we found that this field knew times of leaps and recession over the last decades. Its development was based on initiatives conducted by Government bodies, academic hospitals, non-Governmental organizations and civil society. Moreover, many foreign collaborations helped to make accomplishments in Tunisian Telemedicine.

In 1992, the Computer Center of the Ministry of Health (CCMS) was created [6].

In 1995, the Tunisian medical informatics society (STIM) was created and was the first Tunisian organization dedicated to the dissemination of computer literacy in the medical and sanitary field. Its main objective was to enable Tunisian health professionals to better master the communication and information tools to practice a modern medicine [7].

One year later, in 1996, telemedicine started in Tunisia by local and international experiences initiated by some pioneers working in public health structures. The same year, the Ministry of Health (MoH) took the decision to include telemedicine in its strategic projects and to create the National Telemedicine Committee whose members were official departments representatives (The General Director for Health, The General-Director of the Computer Center of the Ministry of Health and others ministry representatives) and some physicians involved in telemedicine activity.

In 1997, several telemedicine stations linking university hospitals to district ones and to hospitals abroad (in France and Italy for example) were established.

The following year (1998) was typified by the organization of the International Telemedicine Symposium for the Arab World, Africa and Europe by the National Medical Council in collaboration with the Arab Medical Union.

In the following year, the Arab Telemedicine Society was founded in October 1999, under the umbrella of the Arab Medical Union and after the recommendations of the First International Telemedicine Symposium for the Arab World Africa and Europe [8]. The fundamental mission of this organization was to promote the development of telemedicine, telecare and telehealth as part of e-health.

The Tunisian Society of Telemedicine and e-Health is a non-governmental association (NGO) and was officially founded in September 2000 mainly by physicians interested in the development of this promising field. In fact, it is one of the oldest telemedicine associations in Africa and the Middle East. It is playing a complementary role to that of public offices, private sector and international institutions. The main goals of this foundation were to promote telemedicine and e-health in Tunisia and to establish relationships and cooperation with regional and international similar associations. It became very soon an ex-officio member of the National Telemedicine Committee. Then, it became a national member of the International Society for Telemedicine and e-health (ISfTeH), an institutional member of the European Society of Telemedicine and e-Health and an official partner of CATEL (Club des Acteurs de la TéléSanté), which is a Center for e-Health Resources and Expertise in France. Afterwards, the Tunisian Society of Telemedicine and e-Health organized annual meetings and symposia locally and participated at international meetings [9, 10].

Since the date of its foundation, 23 stations had been placed in different public hospitals (8 university hospitals, 5 specialized centers or institutes and 7 regional hospitals). Some departments have been had regular links with foreign hospitals such as those in Marseille, Toulouse, Nice and Rome. In 2005, Picture Archival and Communication System (PACS) was installed in some hospitals [9, 10].

However, in 2009, it was estimated that only 4 of these stations were still operating.

Since 2012, the dynamic relating to telemedicine has resumed with interest from the ministries of health and Information and communication technologies (ICT), who affirmed their desire to relaunch telemedicine in Tunisia. An official meeting took place on July 4, 2013 between the office of Tunisian Society of Telemedicine and e-Health and the Managing Director and representative of CATEL to sign the partnership agreement between the two organizations within the framework of the "Franco-Tunisian Alliance for Digital" project.

In February 2015, the International Seminar on National Strategic Program: Tunisia e-Health was organized by the MoH and Information and Communication Technologies and the Digital Economy Ministry.

Since 2016, an International Forum on Digital Health is organized every year in Hammamet, Tunisia. This regular meeting aims to exchange novelties in this field, to talk about experiences of the various stakeholders and to advance telemedicine projects in Tunisia [11-15].

Organization and Structures

Telemedicine activities are mainly carried out by the Tunisian Society of Telemedicine, the Computer Center of the Ministry of Health and the Tunisian medical informatics society.

Current Members of Tunisian Society of Telemedicine Board

For more information please refer to the website www.telemedecine-tunisie.tn [16].

The Computer Center of the Ministry of Health (CIMS)

The CIMS is a non-administrative public establishment which was created in September 1993 following the creation of Law No. 92-19 dated February 03, 1992 (updated 98-96 of November 23, 1998) and whose main activities are consulting, execution, monitoring and computer control for the benefit of the Ministry of Health and its Public health structures. The current workforce is made up of 200 agents, headed by the General Director, Mr. Faiez Khelia [6].

The Tunisian Medical Informatics Society (STIM):

The STIM is an organization involved in the intersection of informatics and digital health. The founding office included Dr Mohamed Rached Haj Romdhane, Dr Sofiane Zribi, Dr Maher Fourati, Dr Khaled Ben Amor, Dr Yassine Ben Cheikh and Dr Mamoun Ben Cheikh. The office was presided in the following terms by Dr Ali Harmel.

Since its foundation, the STIM had been interested in both clinical work, teaching and research in the field of informatics. Founders aimed to promote the medical informatics as a basic medical discipline. They planned to continue the unification of data in the different components of healthcare (administrative, transactional and medical).

In this way, patient's information could be available at the right time and in an appropriate form so could be used most appropriately [7]. Also, the STIM contributed to a large and well attended annual conference in national, regional and international meetings such as the Francophone meeting of medical informatics.

The STIM was particularly active between 2001 and 2005 with the organization of several training workshops in different governorates of Tunis in collaboration with the information system of the Ministry of Public Health and several other learned societies or regional health directorates. Several topics were discussed including internet bibliographic research, software and creation of sites [6].

Sites and Links

Currently, the Tunisian network consists of 23 public telemedicine stations in:

- 8 university hospitals (Tunis: Charles Nicolle, La Rabta, Aziza Othmana, Habib Thameur, Mongi Slim, Razi; Sousse: Farhat Hached; Sfax: Habib Bourguiba),

- 5 specialized centers and institutes (Children Hospital, Oncology Institute, Neurology Institute, Orthopedics institute, Ophthalmology) and
- 7 district hospitals (Le Kef, Jendouba, Mahdia, Gafsa, Gabès, Tozeur and Kebili) (Figure 4).

Bilateral links are functional with French hospitals in Marseille, Toulouse and Nice and Italian ones in Rome and Naples. Moreover, Tunisian centers are connected to international networks:

- Euro Mediterranean network promoted by the European Union within the framework of Eumedis project: Emispher, Emphis, BurNet, Genetics…;
- Afro-Arab network, promoted by the International Telecommunication Union (ITU): Afro-Arab Telemedicine Network;
- Francophone network sponsored by Geneva University Hospitals and Health on the Net Foundation: Telemedicine Network in Francophone Africa (RAFT).

Telemedicine projects between Tunisia and Spain, Italy and India are in progress.

Figure 4: Telemedicine sites in Tunisia

University hospital

Specialized institutes

District hospitals

Achievements

Many sectors have been involved in the development and advancement of various applications of telemedicine in Tunisia. In fact, information technology (IT) providers, engineers, administrative managers and healthcare professionals are working together to serve the medical requirements in rural and distant Tunisian areas and the development of exportation of healthcare services. Moreover, initiatives to provide possibilities of e-Learning among the country were made. All these activities are elaborated via a national network of telemedicine with the involvement of private and public health sectors.

Projects to ensure the advancement of telemedicine in Tunisia were elaborated with main purposes:

- Judicial and deontological framework necessary for telemedicine development and adequate remuneration of telemedicine procedures;
- Institutionalization of telemedicine within the organization of health cares;
- Protocols and codifications of procedures of telemedicine.

Legal Framework for Telemedicine in Tunisia

Efforts have been made to legalize the deontological code of this new way of working in health field. The law giving health professionals the opportunity to exercise their medical and dental activities as part of telemedicine was signed in July 2018 [17]. However, the political and economic circumstances in the country and other priorities froze these activities.

Patient Monitoring and Tele-diagnosis

Since the first telemedicine activities, sites have been set up mainly for teleradiology, telepathology and videoconferencing. Those sites communicated with each other using a satellite network or a digital integrated service network (ISDN) or the Internet.

A MoH Working Group was established to develop TeleMedicine Protocols in several fields: TeleRadiology, TelePathology, TeleUltrasound, TeleCardiology and TeleOpthalmology. This need, suggested since years, is confirmed during the current COVID-19 pandemic.

The project to set up Universal Health Coverage for all Tunisians started in April 2019. Over the 2019-2020 period: 22 university hospital centers were digitized. A new version of the national health system (RNS) is planned for a total investment of 34 million Tunisian Dinars. The pioneer experience was with Habib Thameur Hospital, which is 100% digitized [18].

The digital hospital is the priority of public health in Tunisia in order to fight corruption and ensure good governance. The digitization of health services is a solution to organize this sector. A huge work is being done to fight against mismanagement and favoritism in the health sector. The issue of the Computerized Medical Record (CMR) confirms this trend. For this, the first medico-economic information system in Tunisia and Africa was set up by the Ministry of Public Health in partnership with the European Union within 16 public health establishments. This project consisted in providing training relating to the activities and the real costs by pathology and serving as a basis for invoicing the services provided by the health structures. It allows ensuring a more rational allocation of budgetary resources and measuring the performance of each health institution [18].

The CIMS began to generalize the use of software in laboratory, provision of medicines and medical imaging. The CMR is one of those softwares recommended since years by various stakeholders mainly the CIMS and the STIM. It is about having a single medical record per patient. It concerns the development of diagnostic follow-ups, treatments, but also more generally all written exchanges between health professionals. It therefore contents nominative administrative and medical information. It allows the exchange of information necessary for the best care of patients.

Contributions from telecommunications operators in Tunisia such as subsidiaries of Telecom an Orange Groups were interesting. Orange Health Care is the subsidiary of the Orange group specializing in the health sector. Elie Lobel, Orange general manager specializing in the health sector, confirmed that his subsidiary is putting all its knowledge to help Tunisia progress in the field of digital health and the implementation of technology in order to resolve the faced challenges of public health.

Telecom operators are a major player in the Tunisian digitization process. They support the various hospital units in the digitization and storage of data. Indeed, Tunisia Telecom currently manages the national network of public health, e-health and the hospital connection project covering a large percentage of Tunisian health services especially in large cities [18].

The upgrade of a national infrastructure of the telecommunication network (New Generation National Health Network) was made by the CIMS in partnership with Tunisia Telecom. It established a modern network infrastructure with a national network coverage, from the 3rd to 2nd then to the 1st line. The National health network is a multi-service broadband network. It is secured, administered and supervised by the CIMS. This Network covers 280 institutions connected to CIMS via dedicated lines and fiber optic links whose speeds are between 2 and 50 Mbit/s. Also, it carries data relating to applications developed by CIMS, Internet protocol telephony, national applications, internet and messaging services, Telemedicine, etc.

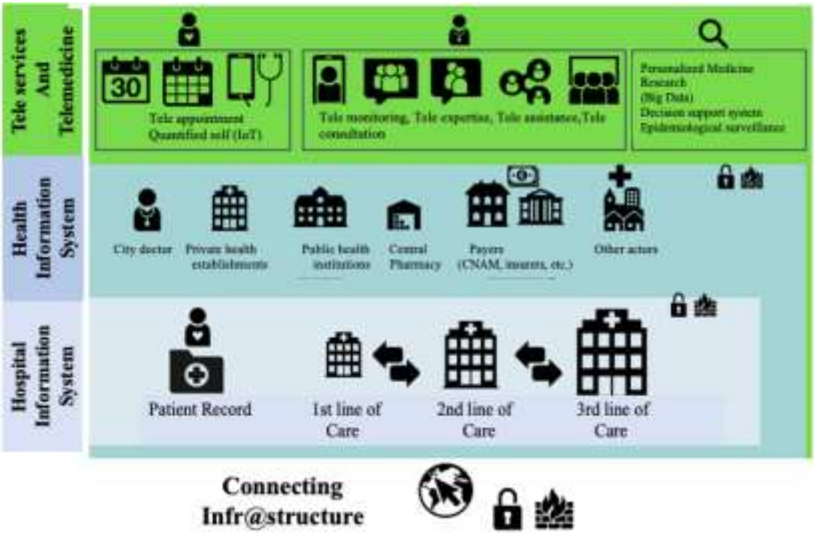

Figure 5: Summary of telemedicine concept in Tunisia

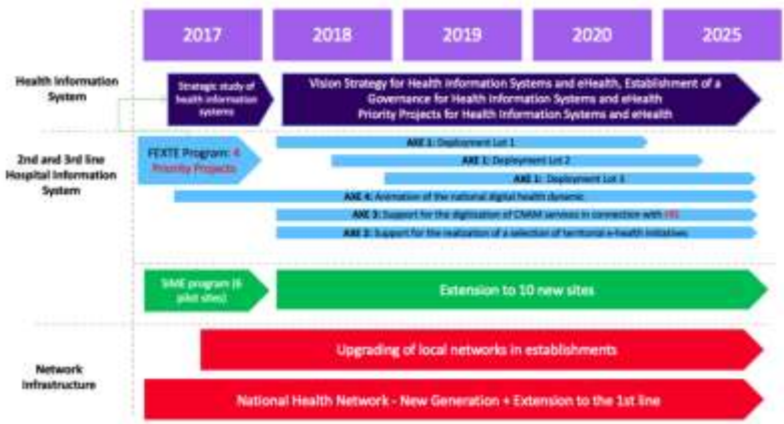

Figure 6: Macroscopic view of the interactions with the main informatics systems projects carried out in the ministry of health

This program aimed to establish a connection flow for all related sites according to their needs (Figures 5 and 6). Moreover, it focused on reinforcing security, robustness and high availability of services [18].

E-Learning and Virtual University in Tunisia

Since January 2002, the Virtual University of Tunis (VUT) aimed to develop Web-based and Internet-based courses and university curricula. It's a multidisciplinary public institution, which represents the first experience of public distance university in Africa based on the use of the new teaching and learning technologies [19]. The UVT provides each university, with an online course space on its platform, ensures the registration of teachers and students and the e-learning of cross section modules for all the students in Tunisia.

Medical studies have greatly benefited from the virtual university's contribution to distance teaching in medical and paramedical courses. Several masters and professional formations are taught via dedicated platforms like the professional Master in Neuro-Radiology and Neuroimaging Diagnosis, the professional Master in epileptology, etc. [20-22].

Perspectives

In Tunisia, where Telemedicine and e-Health project is still until now on its first steps, a hard effort is awaiting. The COVID 19 pandemic has confirmed the fragility of the health sector in Tunisia and even in the most powerful countries in the world. A need for telemedicine as an interface not only between patients and between physicians but also between physicians is becoming urgent.

With the exception of university hospitals, medical facilities with specialists from all fields are limited. Medical infrastructure and communication networks remain insufficient. The majority of telemedicine experiences worldwide-shared difficulties encountered in this field.

In his report about telemedicine in Tunisia in 2008, Dr Salah Mandil suggested some solutions to overcome these difficulties such as:

- Distance tele-education for teaching and research as well as its applications in health.
- Suggested the operation of the "Gate-Keeper": the organization chart and its Information System.
- Suggested a solution for interfacing the "Gate-Keeper" with other organizations such as the CNAM, the Central Pharmacy, Blood Bank, etc.
- Adopt digital security (certificate-based);

He also defined the areas of predilection where telemedicine should be developed to improve the performance of the health system:

- Oncology: remote reading of cytology slides, images mammography, etc.
- Radiology: reading and interpretation of ultrasounds, Magnetic resonance imaging, CT, etc
- Neurology: reading and interpretation of electroencephalogram, electromyography, Video nystagmography, etc.
- Ophthalmology and other fields.

A detailed analysis of the telemedicine situation in Tunisia has given rise to several criticisms, in particular the poor use of the equipment already acquired, the centralization of telemedicine in certain health centers, and not achievement of some basic goals until now.

For that, since 2017 a new national strategic program was planned with collaboration of MoH to prioritize telemedicine areas to be developed in Tunisia and to bring more to the patient and boost the health system (Figure 5 again).

This program included many steps.

First of all, updating a regulatory and legal framework is a real emergency. A discussion started as to whether the implementation of telemedicine was legal. Available articles related to the medical practitioner's law were the article number 2018-43 of July 11, 2018, supplementing the previously reported number 91-21 of March 13, 1991, relating to the exercise and the organization of the profession of doctor and dentist. These articles stated that

> *"By telemedicine is understood the remote medical practice using information and communication technologies making it possible to connect, between them or with a patient, doctors or dentists and doctors, other health professionals, including necessarily a doctor, ... to establish a diagnosis of a disease, the collection of a medical opinion, surveillance or monitoring of a patient's condition, or other medical services and acts"*

and added

> *"With the exception of medical emergencies ……., the attending physician or dentist must not carry out any act in the context of telemedicine only after having informed the patient and, where applicable, his legal guardian and having obtained his informed consent, and this, by any means leaving a written or electronic record".*

Moreover, the physician who had not met the patient in person and not himself observed him may not treat the patient or distribute a written diagnosis or a prescription [17]. Legality of telemedicine in Tunisia as well as in many parts of the World remains an issue of interest and still raises a long discussion.

Besides, a national strategy for management seems very important to be implemented. The idea is about setting up a "unique identifier patients" and a national and local governance to pilot new programs. The unique patient identifier would be a tool that the patient will use to identify his medical record in the system but also at the time of purchasing his treatment or carrying out exploration. This may also allow the doctor to consult the patient's entire consultation history.

The third important project is about the upgrade of a national infrastructure of the telecommunication network and it was in partnership with "Tunisie Telecom" as explained previously. The CIMS, an important pillar of the Telemedicine organization in Tunisia, stated on its strategic axes the strengthening of the digital infrastructure, improving the application catalog and generalizing digital health services and developing digital health skills and providing assistance and support to public health structures. Main items related to several axes were detailed in the following table [6].

In the Fifth and last edition of the International Digital Health Forum entitled "Telemedicine and Digital Health, from Concept to Practice" (February 27 to 29, 2020 in Hammamet, Tunisia), 12 priority projects for the introduction of the hospital information system announced to be budgeted and already started. Moreover, the collaboration of the French Development Agency planned a budget of more than 32 million euros to find these projects [15].

Table 1: Strategic axes of The Computer Center of the Ministry of Health

Axes	Items
Strengthen the digital infrastructure	Finalize the National Health Network Migration Project: Provide broadband to 280 sites connected to the national health network. Extend the coverage of the national health network to centers of biotechnology; Extend the connectivity of 600 basic care centers to the national health network; Upgrade local IT networks in public

	establishments of health (PEH) and regional hospitals (RH); Develop IT infrastructure in the health sector; Program the acquisition and renewal of large-scale IT equipment to support the uses of digital health; Strengthen IT security; Establishment of a general IT security policy; Establishment of an operational IT security center and CERT Santé; Modernize PEH and RH machine rooms; Modernization of engine rooms for the benefit of all public health establishments and regional hospitals; Data hosting center; Have a health data center.
Improve the application catalog and generalize digital health services	Set up and operate the unique health identifier; Participate in the development of a health interoperability framework; Develop a specific information system for the first line.
Modernize the second and third line information system and develop digital health skills and provide assistance and support to public health structures	- Set up an e-learning platform; - Develop digital content; - Develop digital health skills.

Conclusions

In Tunisia, Telemedicine has been developing slowly and achieved important and basic steps since the year 2000. Links with several foreign institutions in Europe, Arab and African countries are of high interest. All of these efforts and projects lacked stakeholder and coordination of different actors. The lack of infrastructure, the high costs of advanced technologies and legal issues are the most identified limitations. Insufficient achievements until now constitutes a challenge in the future toward telemedicine and e-Health development in Tunisia.

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Prof. Riadh Gouider (Corresponding	Prof Riadh Gouider received his medical degree in 1993, a Diploma of Neurology in 1994 from the Faculty of Medicine of Tunis. He is currently General Secretary of the Tunisian Society of Telemedicine and E-Health. Prof. Gouider is: - Head of Department of Neurology at Razi University Hospital since 2002 and the Alzheimer's center since 2010 and the MS center since

author)	2018; - Head of Multimedia production unit in the Faculty of Medicine of Tunis 2001-2005; - Head of Informatics and Multimedia committee in the Faculty of Medicine of Tunis 2005-2010; - Representative of the University Tunis El Manar for the Tunisian Virtual University 2002-2005; - General Secretary of the Tunisian Society for Medical Informatics since 2006; - President of the Organizing Committee of the meeting Internet and Medical Pedagogy (IPM) in 2006; - Coordinator of EMISPHER project and the president of Organizing committee of the EMISPHER International Seminar “Hôpital virtuel, Enseignement à distance” in 2004; - Member of Telemedicine Committee in the Tunisian Ministry of Health; - Member of "e-Health Technical Advisory Group (eTAG) of the World Health Organization (WHO), 2013-2019; - Member of the e-Communication Committee in the World Federation of Neurology (WFN) since 2018. Prof. Gouider received several awards from International Societies: International Conference of Deans of faculties of Medicine in French speaking countries Award in 2003 (Nancy, France); American Academy of Neurology (Foreign Scholarship Award on 1994); European Academy of Neurology (EAN Special Service Award on 2018); Pan Arab Union of Neurological Societies (PAUNS Award (WCN Dubai, UAE):2019); Maghrebian Federation of Neurology.

United Kingdom
The History of Telemedicine in the United Kingdom

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Preamble

This chapter is concerned with the history of 'telemedicine' in the United Kingdom. And whilst the term 'telemedicine' is consistently used, different sources, notably those of Adam William Darkins and Margaret Ann Cary, bear testimony to their preference to speak of 'telehealth' within which it can be recognised that telemedicine is a sub-set [1]. 'Telehealth' is also the preferred term of this author. In writing this chapter, however, he has found that telemedicine generally 'fits' - provided that it is taken to include what others may regard as 'telehealth' and with both terms including 'telecare'.

Use of the term 'telemedicine' could especially appeal to many clinicians. Its use may help in telling the story and positioning both them and other health and social care professionals and practitioners for the debate regarding telemedicine's (or telehealth's) adoption.

The opportunity to offer a definition of telemedicine at this juncture is eschewed in view of these having tended to either focus on technologies rather than services (and, therefore, be technology-led); or to reflect top-down perspectives by reference, for example, to service 'delivery' (a one-way term if ever there was) rather than service 'provision' (a term which allows for greater involvement of the patient or service user). But whilst we must guard against telemedicine services being technology-led, it is recognised that technologies are 'tools of the trade'. Those tools include devices, their software and, necessarily, some form of communications link. Technologies are always, therefore, in the mix. Elsewhere (e.g. Darkins and Cary [1]) the reader will find definitions that include a distinction between telemedicine in real-time or which operates on a 'store and forward' basis. The latter, though widely established, e.g. for the sharing of images between clinicians, feature only occasionally in this chapter.

An outlier within the range of definitions is that which sees telemedicine as focused around electronic or personal health records. This perspective is not adopted within this chapter. Indeed, Electronic Health records (EHRs) feature only in a few places. Having said this the issue of health and personal data, that lies at the heart of such records, is touched upon, especially as the chapter moves towards the current phase of telemedicine's history. The fifth phase is the last of five phases identified. It alludes to an ongoing decentralisation of health services and, in the area of data, mentions the increasingly prominent place taken by artificial intelligence (AI).

Operational detail of telemedicine technologies is not to be found herein. The chapter is not concerned with the technical minutiae of matters such as bandwidths or signaling protocols. However, issues of interoperability and the technological necessities that underpin service provision or people's access to services (in e.g. rural areas) are, to some extent, included. This reflects the importance of the accessibility and affordability of the technologies and the relevance of these to service providers, procurers and users.

Some more recent technological developments are only lightly touched upon. Robots of the anthropomorphic kind are not considered, largely because the evidence base for their efficacy in the realm of health and social care is, at present, laughably small. Only a small nudge is, however, necessary for this author to speak well of robotics in the sense of 'assistive technologies' (AT) where the technologies are, and will continue to be, useful and hopefully usable by us all when we need them. Also going unaddressed in this chapter are digital games and virtual reality, albeit that both may have some merit that is worthy of further investigation.

The dimension of ethnicity deserves more attention than is given because of the health deficits that can be disproportionately experienced by some ethnic groups in the UK. The issue is not, however, well addressed in telemedicine research. But the issue of gender is more apparent in this chapter – relating first to gendered roles in service provision (especially evident in the early phases e.g. for doctors and nurses); and second to the matter of age, where, in view of their relative longevity, women are disproportionate users of health services (with higher numbers experiencing poor health). The link to women's particular disadvantage in this context (including, very often their relative poverty) must be borne in mind throughout. The lack of attention to ethnicity, whether in relation to telemedicine or health more widely, is brought into focus in the fifth phase (heralded by the COVID-19 pandemic) by virtue of the disproportionately high health impact of the virus, even allowing for different social and economic factors, on BAME (black and minority ethnic) communities (*Endnote No. 1*).

There are two further omissions. The first concerns carers. The omission is deliberate and essentially arises because of time constraints. This is despite the (often absolutely crucial) importance of carers' roles; the fact that many telemedicine technologies and services work for the benefit of carers as well as the people for whom there will be health and/or support needs; and the fact that carers' roles must be taken into consideration when assessments of need are made or technology choices are offered.

The final omission is of the environmental impact of telemedicine. Such impact is far from trivial and cries out for further investigation. It arises, in the main, out of people's reduced need to travel in order to get to locations where health care is provided. The converse also, of course, applies where health and social care professionals and practitioners may have less need to visit people (who may live in remote locations) or where telemedicine may substitute for some tasks where 'hands-on' care is superfluous. The evidence base around the environmental impact of telemedicine is improving – but much of it is in the form of 'asides' or incidental measures of time or travel saved within usually small telemedicine projects or initiatives.

Nearly a decade ago this author who is, incidentally, an enthusiast for the right kind of telemedicine (read on for a greater understanding of what the 'right kind' is), published a short article for a European audience. It was entitled 'A Win, Win, Win, Win for Telehealth?' [2]. The fourth 'win' was the help that would be given through telemedicine's use in meeting Europe's environmental targets. This particular win was in addition to the benefits around telemedicine for better health and well-being outcomes; lower service costs; and the commercial opportunities that could be exploited by European Union (EU) companies. Note the question mark in the title of that article. This, at least, was a signal that this author recognised there are further debates to be had, and deeper understandings gained, around telemedicine's impact. This chapter, together with the unwelcome intervention of the COVID-19 virus, is helping to stimulate these debates.

Finally, within this preamble, it is necessary to note that the historical context, of at least the earlier phases of telemedicine's development in the UK, means some of the resource material quoted uses gendered language that is now inappropriate. This is, for instance, the case for the American Stanley Joel Reiser who consistently referred to physicians as male. It can be noted, nevertheless, that this author notes Reiser's views on telemedicine (as set out in his 1978 book) as 'prescient'. He continues to work in this field. Inappropriately gendered language is also true for some other work that is referenced and is indicated with the notation '*sic*' where this is the case.

Introduction

The United Kingdom (UK) is located on the north-west extremity of the continent of Europe. In 2018, it had a population of 66.4 million people [3]. The UK is an island nation comprising Great Britain and Northern Ireland. Great Britain is made up of the three countries of England, Scotland and

Wales. Northern Ireland is part of the island of Ireland to the west of Great Britain.

The UK was the world's first highly industrialised country. This industrialisation largely took place in the eighteenth and nineteenth centuries and was characterised by scientific advances in agriculture, manufacturing, shipping and other sectors. Relating to these was the occupation (or colonisation) of various territories across the world and the position of the UK as a major player in international trade. The 'British Empire' brought considerable wealth to the UK as well as political and cultural influence.

The UK has subsequently experienced significant decline. However, links with many of the occupied territories remain within a grouping, established in 1931, known as the Commonwealth. These territories have been the source of much inmigration to the UK and have increased the UK's ethnic and cultural diversity. The Commonwealth is described as a 'voluntary association of 53 independent and equal sovereign states' (*Endnote No. 2*).

This is the context within which the UK is re-defining its place in the world. Its industrial, political and cultural prowess has diminished, leaving a legacy that includes both wealth and relative poverty - with the latter often co-existent with social problems, poor housing and health inequalities [4]. Aspects of this legacy may be exacerbated by the UK having left the European Union [5].

And whilst the scourge of some earlier poverty-related health challenges in the UK (such as tuberculosis and scarlet fever) have been largely overcome, for many people today there are health challenges that relate to relative poverty, low incomes, poor housing and unhealthy lifestyles; and some illnesses, long-term conditions and disabilities that are associated with what has, until recently, been steadily increasing longevity.

But despite the extent of inequality and the persistence of relative poverty within the UK, its economy in 2017 (in terms of Gross Domestic Product, GDP) was the 6th largest in the world (*Endnote No. 3*). With regard to government expenditure on health and well-being, this comprised 9.8% of the UK's GDP in 2018. The UK's National Health Service (NHS) consumed the largest portion of this spending (*Endnote No. 4*).

Coming specifically to telemedicine in the UK, its history and its impact are interweaved with the country's industrial development and decline, together with (since 1948) both the enthusiasm and the angst associated with the advent, progression and role of the NHS. The history can be described as fitting within five phases, the fifth (associated with and triggered by the COVID-19 pandemic) having already been mentioned (see Figure 1 below). The phases bear testimony to a 'stop-start' development of telemedicine that took place over a period of more than a century.

A number of themes become apparent in the phases of telemedicine's development. Two are highlighted here. The first is the 'fact' of telemedicine facilitating a decentralisation or 'devolution' of services. During the earlier phases, this decentralisation was instrumental in bringing greater service accessibility throughout the UK. Such decentralisation is seen as an ongoing process, which necessarily created (and creates) stresses and strains for pre-existing frameworks – raising important questions about the role of the main institutions of healthcare, most notably hospitals.

Telemedicine is disruptive. It joins, therefore, other disruptive aspects of health and medicine such as that which relates to workforce change as pointed to in the work of Christensen et al [6]. But Lynch and Fisk [7] noted their work as failing 'to extend the logic of their argument to points of care that were beyond the local clinic'. In other words, decentralisation was seen by Lynch and Fisk as needing, facilitated through telemedicine, to go further – with the process ending with individuals. Us.

The second theme is concerned with the ways in which we are empowered through telemedicine and, emboldened by greater self-awareness and health knowledge, are able to take a bigger role in our healthcare. With empowerment comes changing relationships between health professionals,

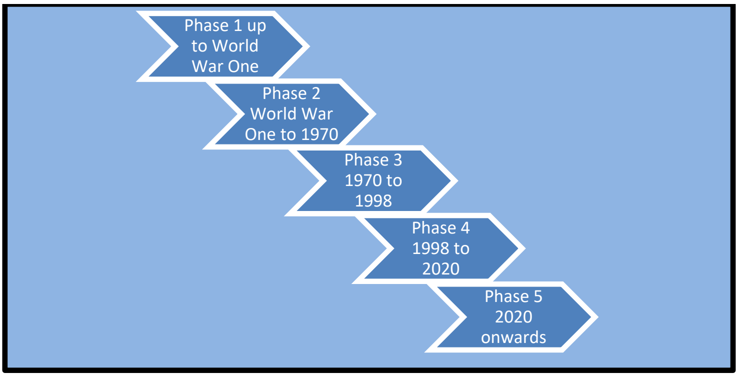


Fig 1. Phases of Telemedicine Development in the UK

practitioners and 'their' patients. Here, the word 'their' is used reluctantly (and is, in fact, superfluous) because part of the change in relationships is one where empowerment means that the transactions between patients and their service providers will, in the future, need to be recognised as one of greater equity.

Is 'empowerment', in any case, the most apt of themes? Morley and Floridi argued instead for 'enablement' and suggested that 'promoting digitally enhanced, empowered health care as a techno-utopia is misleading' [8]. But this chapter suggests that enablement is not enough. Empowerment is considered to give us something more. Empowerment speaks to the way in which we must configure our health services (and a lot more in terms of public education) in order to help build people's health literacy and motivate us all in relation to the adoption and maintaining of appropriate lifestyles. This chapter calls, therefore, for telemedicine to take a recognised and meritorious place within the range of the UK's health services, part of which requires a further shift in the balance between, what Morley and Floridi refer to as 'agency and patiency in (the) doctor-patient relationship' [8].

Finally in this introduction, it is very worthy of note that the two main themes identified for telemedicine echo two of the United Nations Sustainable Development Goals (SDGs) - Goal 3 (Target 8) which focuses on 'access to quality health-care services … for all'; and Goal 10 (Target 2) which seeks a reduction in inequalities and to 'by 2020, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or any economic or other status' (*Endnote No. 5*). It can be noted, at the same time, that NHS Digital (a branch of the NHS) is concerned to 'empower the person' through 'improved digital access to health and care information and transactions' and by 'developing digital technologies that put people in charge of their own health and care' with apps and 'personal health records' part of their focus (*Endnote No. 6*).

The Five Phases

The **first phase** of telemedicine's development in the UK extends from a starting point around the 1840s to the outbreak of the First World War in 1914. It was, in large part, a period of rapid industrial development with (for industrial entrepreneurs, engineers and technologists) innovation taking place in multiple sectors – from textiles to transport. But the period, whilst bringing wealth to the UK, was accompanied by the twin scourges of poverty and ill health. Hence, it would be surprising if some element of the entrepreneurship and industrial endeavour did not address (poor) health and consider the means of its amelioration.

The stimulus for endeavours in this direction were not, however, just philanthropic and/or commercial. They were also self-serving. Many diseases were not respecters of geographical boundaries. The wealthier and generally more educated classes (amongst whom were most of the entrepreneurs) were not immune to having some contact with the poorest, nor to the foul miasma (perceived as carrying infections) that might drift into their neighborhoods from squalid areas nearby.

The **second phase** extended from the end of the First World War (1919) to around 1970. It covers the whole of the interwar period (including the period of the 'Great Depression') and the main period of economic recovery after the Second World War.

After the First World War it was still the case that much of the UK population lived in insanitary housing – whether in urban or rural areas. It was with the promotion of better health in mind, therefore, that the then Prime Minister, Lloyd George, called (in reference to the returning soldiers) for 'habitations fit for heroes'. This heralded a municipally-led house-building programme with accompanying attention to ridding the country from at least some of its slums.

But for telemedicine, the inter-war years in the UK (from 1919 to 1939) can be regarded as 'fallow'. There was little or nothing that might be viewed as a stimulus for telemedicine development. Rather it is the reverse. The health focus was on regularising the roles of doctors and nurses; and establishing and embedding service norms that we see to this day around hospital and GP services. Meeting the needs of patients, furthermore, revolved around the ways that people interacted with the services rather than how the services reached out to them. Besides, telephony networks were poorly developed and telemedicine, if it were to have been considered, could have only involved communication from clinician to clinician or with those patients able to pay for services.

The Second World War meant, of course, that attention to public health issues were put 'on hold'. But the years that followed the war (from 1945) were very important from a health perspective. They were characterised by an optimism that brought the UK, not just its now iconic NHS, but also other welfare reforms including a national insurance scheme and planning reforms that underpinned the development of 'new towns'. Such reforms were associated with a sincere and urgent belief among politicians that the people of the UK, after the deprivations of the war, deserved to be able to live better lives and, importantly, access better health services.

The impact of the NHS, from the date of its foundation in 1948, cannot easily be overstated. It brought access to health services for all. Its establishment opened a relatively 'settled' period for health services where even the most enlightened entrepreneur and innovator might have seen little merit in devoting energy on developing technologies that resembled what we now recognise as telemedicine. The focus of health practitioners was on the establishment and operation of new administrative arrangements in a context of benefit for families and individuals, rich and poor alike. Hospitals became focal resources in every city and GPs became integral to life in every community - with the latter especially being romanticised or immortalised in literature and film.

The **third phase** starts around 1970. Significant from the health perspective was the fact that along with expanded telephone networks, telephony based warden-call ‘systems’ (later more generally known as social alarms, then featuring a part of telecare) were becoming a feature in schemes of municipal housing for older people. These enabled wardens (supervisors and ‘good neighbours’) to be alerted, normally through the pull of a cord, in urgent situations – e.g. after a fall [9]. The image of the ‘fallen’ woman was commonplace at this time in the literature of the companies who marketed such systems (see Plate 1).

In this phase, with the ensuing advent of ‘carephones’ (that could be installed in any home with a telephone line), older people could link, with

Plate 1: The ‘Fallen Woman’
Brochure promoting the private Aid Call service, Moreton Hampstead.

the pull of a cord or the push of a radio trigger, to monitoring (call) centres. Systems that had operated within housing schemes became more community-oriented ‘services’.

The number community (or social) alarm services increased quickly in the public sector with 301 operating in the UK by 1990. These were driven mostly by the need to give ‘out of hours’ cover for wardens [10]. There were just a handful of services in the private sector. The more recent evolution of such services (see Phase 4) started to bring such services into the wider world of telemedicine.

Commencement of the **fourth phase** can be pinpointed to 1998 – with the publication of the NHS strategy report for England and Wales, ‘Information for Health’ [11] and both the ‘Information Management and Technology’ report and the ‘Acute Services Review Scotland’ [12]. These key reports heralded the greater use of information technology (IT) within the NHS – including promoting the taking of initial steps to develop electronic health records; facilitating the transferability of images and data between hospitals; and the overcoming of what were referred to as ‘data islands’ (i.e. silos). The reports also presaged the establishment of NHS Direct (from 1999), NHS Direct Wales (from 2001) and NHS24 (from 2001) in Scotland. The date of 1998 happened, in addition, to be the fiftieth anniversary of the foundation of the NHS.

The public telephone network was, by this time, extensive - though it was several years before the Internet begun to make its mark on businesses, let alone being accessed by large numbers of people from their homes. It is, nevertheless the time at which there were new, and strong, stirrings around telemedicine. The transfer of images was, for instance, an aspect of telemedicine that was increasingly in use, albeit that this novel aspect of telemedicine was not in ‘real-time’ and did not involve access by patients.

NHS Direct (and its variants in the UK) was, by contrast, a new ‘real-time’ telemedicine service - though perhaps not widely recognised as such. It directly responded to patients with an almost infinite variety of concerns. It was proving a success.

This fourth phase steadily became characterised by many, many more telemedicine pilots and initiatives in the UK. These related to a range of different health conditions. A key focus was on services specifically responding to the needs of older people - seen as those for whom interventions might give the biggest ‘wins’ in terms of time and cost savings. And while attention, in the evaluations of such pilots and initiatives, was given to the financial ‘gains’ arising from e.g. fewer hospital visits and admissions, shorter ‘bed days’ in hospitals and sometimes reduced death rates; less attention was given to broader well-being gains and/or the greater convenience for patients through the reduced need for *them* to travel or for them or others (e.g. carers) not needing to take time off work. In addition, but with notable exceptions - see, for instance, Wootton et al [13], little or no attention was given to the potential environmental benefits though reduced travel.

Telemedicine pilots and initiatives did not, however, take place without opposition. The oppositional positions of some clinicians and other health service professionals and practitioners were not to be easily changed. What had been little less than a magnificent contribution of the NHS in the foregoing five decades went, after all, hand in hand with bureaucracies and associated mindsets that were unaccustomed, resistant to, or fearful of change. Telemedicine was a threat to the established order. The NHS was, generally speaking, not ready to consider this threat. Besides, established NHS practices, even with their manifold inefficiencies, carried substantial public support.

The **fifth phase** started with the COVID-19 pandemic. The shape of the NHS and of telemedicine within (or outside of) the NHS is still in large part, therefore, to be determined. Crucial will be the manner in which UK health services, the NHS in particular, responds not only to the numbers of infections (and the death toll) but also to the *ongoing* repercussions for many of those who have struggled to recover from the virus (i.e. relating to 'long-COVID'). Herein lies, not so much an opportunity to be grasped by those who favour telemedicine's further development, but rather a context in which there is growing realisation of it offering another, complementary way forward – linking with public health imperatives that have necessitated a reduction in the extent of personal contact with patients.

What is certain is that we are at the early stage of a transition that will represent the biggest and most profound since the establishment of the NHS. Old affiliations and loyalties will be tested. Some will be broken. New ways of working that hold onto some of the caring and personal nature of our traditional health services, albeit mediated through IT, will be found.

Finally, with the NHS facing a time of dramatic change, it can be anticipated that the 'balance of power', as health services are further decentralised, will shift away from clinicians. New service norms, that hold on to what is good in the NHS *and* which include telemedicine, will become established. In the meantime, this chapter attempts to do justice to the multi-faceted nature of telemedicine's emergence … from its technological roots through the embedded nature of the UK's health services, to an uncertain future that may be very different to that which has been previously envisaged.

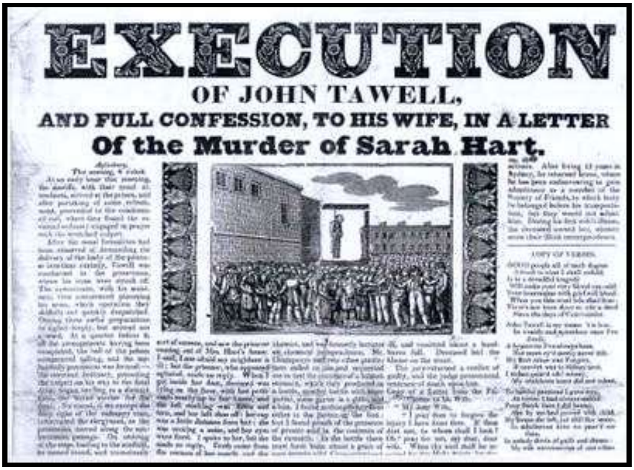
Phase 1 (Before 1914): 'Bridging the Tyranny of Distance', Telegraph and Telephone

Setting the Context

Any accolades that relate to the origins of what we now recognise as telemedicine in Europe must be given to innovators outside of the UK. This is despite the UK's history including nineteenth century innovations from safety lamps and steam locomotives to, more relevant to the field of communications, the electrical telegraph.

The electrical telegraphic device was invented by Englishmen Charles Wheatstone and William Cooke. Experimental communications using their telegraphic device took place in the 1840s via a wired connection from London along the railway line to the town of Slough, 24 miles to the west.

Special attention to the usefulness of the telegraph came when, in 1845, it led to the arrest of a criminal, John Tawell who murdered his former lover, Sarah Hart with a preparation of 'Steele's Acid' then, a medication for varicose veins, at least part of which was 'prussic acid' (or hydrogen cyanide) (*Endnote No. 7-8*). Tawell's attempted escape involved him catching the train in Slough to London (*Endnote No. 9*). He was, however, recognised at the station. Railway staff alerted the police in London via a signal transmitted through the telegraph. The police were waiting. Tawell was arrested; put on trial; and finally hanged in front of a crowd of 10,000 people (see Plate 2).



EXECUTION
OF JOHN TAWELL,
AND FULL CONFESSION, TO HIS WIFE, IN A LETTER
Of the Murder of Sarah Hart.

Plate 2: Report of the Execution of John Tawell
British Transport Police

It was the invention of the telegraphic device that first heralded the *possibility* of telemedicine as we know it today. Hence, during the American Civil War in the 1860s, such devices were used to 'transmit casualty lists and order medical supplies' [14]. And by 1874 in Australia, 'the newly constructed telegraph played an important telemedicine role, not only in enabling care for a wounded person, but also in uniting a dying man with his wife 2000 kilometres away'. The 'tools at hand' were reported to have 'proven … effective to bridge the tyranny of distance in the delivery of health care' [15].

It was the invention of the tele*phone*, however, that was to make the real difference in view of its ability to transmit sounds and, therefore, the human voice as well as electronic signals. The invention is generally accredited to Alexander Graham Bell, born in Scotland in 1847 then moving with his family to Canada in 1870 and later to Boston in the United States. Whether Scotsman Bell or a rival inventor Elisha Gray should be accredited for the invention of the telephone is a matter of contention, given that patents were submitted by each of them to the same office on the same day in 1876 (*Endnote No. 10*).

Bell received plaudits, whilst Gray is a historical footnote. His plaudits could came no higher than that from the British Queen Victoria to whom he demonstrated his device in 1878 (see Plate 3) Indeed, she was reportedly 'much gratified and surprised' and wanted to buy two such devices (*Endnote No. 11*).

Plate 3: Alexander Graham Bell demonstrates the Telephone
The Telegraph 13th January 2017

It would not be until the beginning of the twentieth century that the radio telegraph, invented by Italian Guglielmo Marconi and manufactured at his company in the UK, joined the telephone as a further medium of communication (*Endnote No. 12*). Marconi was to achieve a 'heroic' status in 1912 because it was his radio telegraphy equipment on the RMS Titanic (a Royal Mail Steamer built in Belfast, Northern Ireland) that enabled communication by radio to the RMS Carpathia and resulted in the saving of over 700 lives after the ship sank, having struck an iceberg on its maiden voyage to New York (see Plate 4) (*Endnote No. 13*). We might speculate, in addition, that equipment designed by SG Brown (whose importance is set out later in this chapter) may also have been 'on board' the Titanic in view of his international reputation in the maritime industry for navigation instruments [16].

But regardless of the merits of the innovations in communication that had taken place around 1900, the emergent medical 'profession' in the UK was generally unready for such 'gadgetry'. But at least, by this time, 'profession' was an appropriate title one to use - with the medical journal 'The Lancet', having been established in 1823, avowing its aim 'to work for medical reform, the abolition of quackery … and the education of the [medical] profession' [17].

Many in the medical profession at this time were wary of change. But they will have been increasingly aware of a number of different, albeit non-

Plate 4: The Marconi Wireless Room on RMS Titanic
Columbia Amateur Radio Club SC – w4cae.com

medical, inventions that might have relevance to their trade. The telephone was, of course, amongst these. But as far as medical innovations are concerned, the 'stand-out' event was the discovery of X-rays. This discovery, by German Wilhelm Röntgen in 1895, brought with it the astonishing ability to see the inner body. Not only, therefore, did an existing technology (the stethoscope) help physicians to hear sounds from the inner body; but a new machine would help them to see it! This, according to Reiser, 'directly challenged the use of touch in diagnosis' [18]. X-rays were, in fact, international news. Their discovery gave rise to an urban myth that, in one example, was capitalised on by 'a London company (that) advertised X-ray-proof underwear', believing that such garments would appeal to the 'guardians of public morality' [19].

With the arrival of X-rays (and the increasing role of technological tools), therefore, a pillar of medicine by which the physician's mastery of 'his' craft by touch, hearing and smell, was undermined. A new era of more technology-based medicine was heralded. Those who, a century before, had plied their trade as 'healers' (and whose tools were their hands, ears and senses), were increasingly displaced. Physicians or doctors were, in fact, not only seen as professionals but also were becoming 'men' of science - albeit that their new profession was joined by a small number of women [20]. One of the women who joined the 'profession' was Florence Nightingale, the UK's most famous nurse and social reformer. She was reported as having made representations to the effect that 'doctors' should have 'the status of gentlemen' [21].

The medical sciences were developing. Rivett, who is an important reporter for the UK's health history, reported for London that at this time there were over twelve general hospitals with 'medical schools' that included laboratories and theatres [17]. There had been, in addition, a 'vast improvement in care … as a result of anaesthesia, antisepsis and the introduction of trained nurses'. The number (probably a figure for Great Britain) of doctors had risen from 14,415 in 1861 to 35,650 in 1900 (*Endnote No. 14*). However, the number of women in the medical world remained few (at less than one in a hundred) – except for nursing (*Endnote No. 15*).

The health consequences of poverty were, however, a long way from being properly addressed. Health issues, in fact, were a driver (in common with other parts of Europe) for people's emigration to the 'new world' (essentially the Americas and Oceania) and for 'internal' migrations such as those from Ireland to Great Britain. These 'escapes' from poverty were, however, often unaffordable for the poorest who remained *in situ* and in severe deprivation. It is in this context of substantial health challenges that technological innovation had a role to play.

The Beginnings of Telemedicine

Noted elsewhere in the volumes published by the International Society of Telemedicine and eHealth is the work of Willem Einthoven, a Dutch physician. He, probably correctly, has been credited with being the originator of 'modern telemedicine applications in Europe' when in 1905 he combined a galvanometer 'with the emerging telephone technology to transmit heart sounds' from a hospital to his laboratory [22]. The transmission was over a distance of 0.9 miles. The product was referred to as a 'telecardiogram'.

The technological failings of Einthoven's innovation were reported by Reiser as making it 'unsuitable for general practice'. But despite this, his medicinal innovation generated international interest among physicians and engineers alike [18]. The attraction for (some) clinicians was to the idea that the devices could provide them with accurate measurements (rather than the fact of their transmission). Having access to such technologies would, furthermore, give greater credence to their desire to be recognised as 'men of science'.

The range of hospitals, meanwhile, was growing throughout the UK. These were provided by municipal authorities, charitable and private bodies, with the latter two being categorised as 'voluntary'. Access to the voluntary hospitals was not, however, necessarily open to poorer people. The 1911 National Health Insurance Act, however, created a compulsory scheme that gave workers in some industries access (though not their dependents) to a doctor, 'pharmaceutical drugs and cash benefits during sickness and disability' [23]. Working people could also pay into mutual aid funds and medical clubs that offered similar benefits [24]. The Tredegar Medical Aid Society (featuring later in this chapter as influential in the formation of the NHS) is an example of these. Otherwise, the poorest relied on 'municipal hospitals and Poor Law infirmaries'. Richer people received their treatment at home (*Endnote No. 16*).

Some idea of the tools of the doctor's trade (at least those doctors who worked in the wider community) is given in the contents of the doctor's bag, in 1910, held at the London Science Museum (see Plate 5, *Endnote No. 17*). It was the property of John Hill Abram, a Liverpool physician. The contents include a stethoscope (by this time standard) and there are also a thermometer and syringes. There is neither sphygmomanometer (for measuring blood pressure) nor other devices that were soon to become available.

Plate 5: The Doctor's Bag in 1910
License to use image (Ref 10326188) provided by the London Science Museum

Regardless of the limited range of technologies in the typical doctor's bag towards the beginning of the twentieth century, the notion of a 'good' physician or doctor was increasingly linked with a scientific basis that related to claims being made for medicine. There appears no evidence, however, at this time in the UK, of physicians (mostly men, of course) using the telephony or any other communication network to transmit health related data (i.e. the product of measurements they were increasingly making) to or between members of their 'fraternity'.

At the same time, what would become a precipitating factor in bringing about the more systematic organisation of health services in the UK, was the publication in the United States in 1910 of the Flexner Report. That an American publication should have impacted the UK is, perhaps, initially surprising – but it carried the backing of the Carnegie Foundation (established in 1905 by Scotsman and 'steel magnate' Andrew Carnegie) and was distributed widely in Europe (*Endnote No. 18*).

Abraham Flexner (an American educator with a strong interest in medicine) arrived in the UK later in 1910 (see Plate 6). He was a proselytiser in the cause of health – making clear his 'concerns over British backwardness in laboratory study and scientific research' when compared with Germany or the United States [25]. The UK health 'system' (whether or not worthy of that moniker) Flexner considered 'not an organic whole'.

Plate 6: Abraham Flexner
Hektoen International Journal – hekint.org

He pointed to its need for drastic surgery in order to create a ‘university model’ with ‘medical professors’ to spearhead research and break away from the then ‘existing level of mediocrity’. Meanwhile the notion of a ‘national medical service’ was suggested in a paper published in 1911 by the Fabian Society, an organisation promoting ‘the cause of democratic socialism’ [26].

The hospital services and health schemes, regardless of their efficacy, and whether or not in the cause of ‘socialism’, helped to seed ideas that chimed with the need, with government help where necessary, for further endeavours in the area of sanitary reform and public health. That there was some urgency to the matter is undeniable, with Rivett noting, at that time, that many of the voluntary hospitals were in financial difficulty at what was a time of growing need [17]. On the matter of technologies, furthermore, a number of congresses and conferences took place in the UK during the first decade of the new century on health and medical innovations. These drew participants from around the world. And it is not fanciful to suggest that a certain Englishman, S.G. Brown, would have attended one or more of these.

It follows that, by the time of and following Flexner’s report, some health concerns were beginning to be addressed in the UK and there was a nod, at least, towards the potential role of technologies. But with the outbreak of World War One in 1914, attention necessarily moved abruptly to the ‘war effort’. Matters of healthcare and hospital systems reform would have to wait.

Sidney George Brown

Sidney George Brown was born in 1873 in Chicago (United States) to English parents. His family, having accumulated considerable wealth in the building trade after the 'great Chicago fire of 1871', then returned to a grand home (that 'befitted their elevated status') in Bournemouth on the south coast of England [16]. Sidney Brown's interests led him first to focus on submarine telegraphy and then on 'apparatus for the medical profession' supporting the administration of anaesthetics [16]. He set up his company, SG Brown Ltd., in 1911 in North Acton (west London).

From a telemedicine perspective, it is his invention of the electric stethoscope that commands attention (see Plate 7). Scientific American on June 18th 1910 reported the device as able to 'amplify the sound of heart and lungs' and transmit these over 'several miles of telephone line'. Brown had demonstrated this by sending heart signals from his home in Kensington (west London) to doctors in various other parts of the city - who affirmed that the sound quality was 'as good and clear as when heard locally' [16]. Longer distance transmission by Brown's invention was reported elsewhere as 'over 50 miles' [26] and '100 miles (to) the Isle of Wight' [18].

Whether Brown's telemedicine invention enjoyed any success in practice is not known. But after part of his company went into liquidation, he concentrated on his domestic wireless business. He died in 1948 [16].

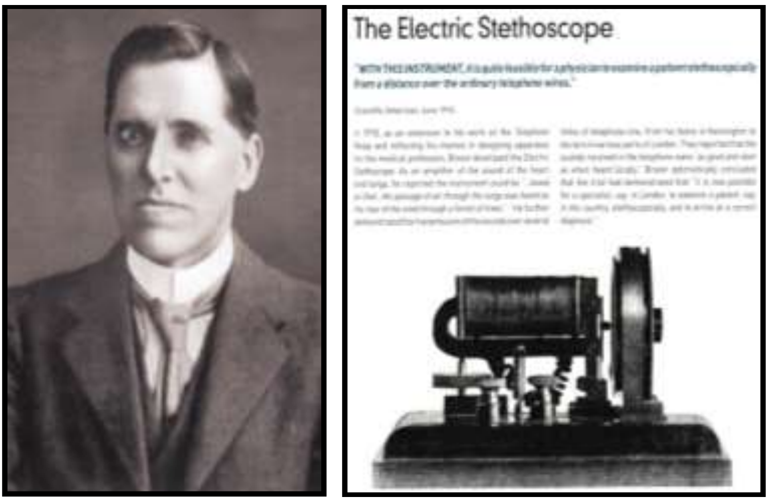


Plate 7: S.G.Brown and his Electric Stethoscope
Sanders (2016)

Phase 2 – World War One to 1970: ‘A Spirit of Endeavour’, Towards the Founding of the NHS

With the ending of World War One, a marker was put down by the UK coalition government led by Lloyd George through the creation, in 1919, of a Ministry of Health. The Ministry was not universally welcomed with, according to Rivett, some clinicians fearing it as ‘a first move towards a state hospital scheme’. Such a scheme was seen by many as an aspect of ‘socialism’ [17]. But regardless of opposition, a report commissioned through a committee established by the new Ministry helped maintain some momentum towards health service reforms. The committee recommended the ‘linkage of hospitals into a single system’; the alignment and bringing together by general practitioners ‘preventative and curative medicine’ via their surgeries or in people’s homes; and ‘domiciliary services of a district … based on a primary health centre’ (*Endnote No. 19*). It was, according to Rivett, ‘inherently controversial for district [i.e. more localised] organisation would only be possible if hospitals sacrificed some of their autonomy’. Such a loss of hospital autonomy would not have been liked by many clinicians [17].

But, on the whole, neither at this point nor in the ensuing decade, were the fears or opportunities of more systematically organised health services realised. Health services muddled on even though the need for change was becoming increasingly urgent. The urgency was especially great for voluntary hospitals – with for instance, in 1931, King’s College Hospital in Denmark Hill (London) reported as in financial ‘dire straits’ and other hospitals reported as likely to be ‘on the rocks within 12-18 months’ [17].

With regard to some institutions of health, however, Peterkin referred to an initial ‘burst of activity’ following World War One [27]. This ‘burst’ led to the construction of multiple ‘memorial hospitals’ that were paid for by public subscription or from philanthropy. An example of these was the Peace Memorial Hospital in Watford, north of London (see Plate 8). Philanthropic engagement had, in fact, been evident during the war through the work of volunteers such as those within the Red Cross and the Order of St John of Jerusalem - working together in many hundred ‘auxiliary’ hospitals for injured returning soldiers.

The government naturally welcomed such benefaction, especially because the country was in substantial debt as a consequence of the war. The philanthropic endeavours made sure there was positive progress towards the greater accessibility of health services, at least for some. The introduction of anaesthetics, furthermore, meant that ‘for the first time surgery could be carried out close to home in local communities’ [27].

Plate 8: Peace Memorial Hospital, Watford (England) 1925
www.ourwatfordhistory.org.uk

Community-run schemes had, furthermore, continued. These included the Tredegar Medical Aid Society mentioned earlier. It was established around 1890 in a coal and iron-mining valley of South Wales. The author A. J. Cronin worked there for a time. And it can be noted that his novel, 'The Citadel' (about the public and personal health challenges of a GP Dr Andrew Manson), was influential in determining the shape and scope of the NHS [28]. The novel and the scheme itself certainly would have influenced Aneurin Bevan (born in Tredegar in 1897) to whom the accolade of establishing the NHS is primarily attributed. The local scheme in Tredegar required workers to pay small weekly payments that gave them access to comprehensive 'medical, surgical and dental services … according to need and free at the point of care'. The Society also contributed to the building of a local hospital (*Endnote No. 20*).

Seeds had, therefore, been sown. The issue of organisational change would not go away. And whilst nothing of note appears to have happened that can be construed as telemedicine, at least as noted by Rivett, 'methods of clinical investigation and surgical techniques improved, radiotherapy became accepted in the management of cancer and there were several major advances in therapeutics' [17]. Organisational change then came with a jolt when, with the outbreak of war. The 'Emergency Medical Service' was brought 'into being and a regional form of organisation was established overnight' [17].

It was not until after World War Two, stimulated by the horrors of that conflict (and the injuries of and trauma to returning soldiers), that sufficient reforming energy was re-ignited and adequate public funds were found to support the establishment of the NHS.

Developments in Communications Networks

Going back to the beginning of this second phase, World War One can be noted as important for developments around communications technologies. The war saw ‘wireless sets, telephony systems and other devices attached to a range of communications channels: cable, wireless and visual’ within, to and from the trenches and front lines maintained by the warring forces (*Endnote No. 21*). For military reasons, there was urgency, of course, for developments that could increase the portability and reliability of communications devices. These favoured the telephone – because it ‘seemed to offer precise and timely two-way exchange of information [that] contrasted with rigid, one-way at a time communications made possible by telegraphy’ *(Endnote No. 19).*

Following this, the developments in both cable and radio communications networks were rapid thanks, in large part, to the government-owned Post Office working with UK companies such as the Automatic Telephone Manufacturing Co and Cable & Wireless (*Endnote No. 22*). The Post Office takes the credit for leading the way in laying cables that linked UK towns and cities and remarkably, through submarine cables, to Russia and Canada. It’s ‘greatest departure’ from its main business of dealing with letters and packages had been, in fact, its ‘acquisition of the telegraphic system of the Kingdom’ [29]. This acquisition was, however, not deemed a success in view of successive governments seeking to protect the revenue it received from letters by ‘hindering’ the development of telephone communication.

Meanwhile, with regard to radio communications, the Marconi Company played a leading part. It experimented in 1920 with broadcasts from their factory in Chelmsford (east of London). Their broadcasts had an ‘enormous impact’ on the listening public after their wartime deprivations. The impact was enhanced when Dame Nellie Melba, the famous Australian operatic singer, took part (*Endnote No. 23*). But despite such initiatives for the UK’s communications networks, many innovations were hampered by a slowing down of the economy between 1929 and 1932 as a consequence of the US stock market crash – creating a ‘colossal social problem’ of unemployment in old industrial areas of the UK, reducing the potential for investment and having adverse implications for people’s health [30].

Towards the NHS

For the inter-war period, it is interesting to note the observation of Sir Alan Garrett Anderson PM (Member of Parliament, MP) and who was the son of Elizabeth Garrett Anderson who, in 1875, had become the UK’s first practicing woman doctor. Anderson (the MP) summed up the position for hospitals as one when they ‘could do more but afford less’ [24]. For hospitals at least, he affirmed that ‘the financial strains were exaggerated by a challenging postwar climate, increasing demand and ever greater technological requirements in hospital medicine'.

Calls for a national medical service with medical care to be available to 'all classes', in a context where the lack of ability to pay fees would not be a barrier, were growing [24]. It is here that Aneurin Bevan must be re-introduced (see Plate 9). He had been, before becoming an MP, a committee member of the Tredegar Medical Aid Society. His roots in Tredegar meant that he knew all about poverty and deprivation. Crucially therefore, when appointed as Minister for Health in the post war government, he had the authority of his knowledge and experience to champion the improvement of health services for the UK. Hence the idea that he put forward of a 'national health service' that would do for the UK what the Tredegar Medical Aid Society had done for 5000 people in a small Welsh community.

To build that 'national health service' required what was described as an 'audacious campaign'. Bevan's energy and bravado is almost something of legends. He is to have remarked of those clinicians who opposed reform that 'we are going to Tredegar-ise you' (*Endnote No. 24*). The National Health Service (NHS) was established in 1948. This chapter notes several elements within its evolution that have been important to telemedicine. The paradox was that it was 'the angriest and most passionate opponents of the National Health service [who] were the very people needed to make it work – the dentists, the surgeons and, most of all, the doctors' (*Endnote No. 25*). But the nascence of the NHS had to be the focus of their attention.

Plate 9: Aneurin Bevan MP and Minister of Health 1946-1951
Gosling (2017)

It also became the focus of attention of those who developed or supplied the technologies that could become new 'tools of the trade'.

The NHS quickly became the central thread to which all matters relating to health and medical care in the UK have related for the ensuing seven decades – as people's primary source of care and as a very sizeable market for medical technologies. But at this time there were a few signals regarding technologies that we would now relate to the notion of telemedicine. One signal, the advent of (closed circuit) television, was noted by Zundel as beginning to be used 'in clinical settings' [14]. Clearer and more numerous signals would emerge in the 1960s.

Rivett has provided the full story of the NHS up to 1970 in his history written for the Nuffield Trust (*Endnote No. 26*). He does not signal the beginnings of telemedicine but he does point to the 1960s for innovations around anaesthetics, radiology, pathology and psychiatry; and to the recognition that grew regarding the complementary roles of centralised hospital services and decentralised GP networks.

The context for the NHS was, however, inauspicious. The demand for health services was increasing – not just because of demographic changes that brought an ongoing increase in the number of older people (in part, the consequence of the NHS's success) but also because of the growth in people's general awareness of health issues. At the same time, conditions in some of the hospitals and GP surgeries remained poor. Rivett noted, for instance, a 1961 report from the Birmingham Regional Health Board that testified to 'hospital slums' that were often over a century old, fit only for demolition and replacement (*Endnote No. 27*)!

When hospital replacements took place these normally took the form of 'district general hospitals' the planning for which was initiated at central government level. This 'acknowledged the opposing pulls of centralisation and accessibility to patients' but, as reported by Rivett, it was 'considered that the benefits of grouping [specialisms and expertise together] outweighed the disadvantages of patients having to travel further' (*Endnote No. 28*). In other words there was, regardless of the element of service decentralisation, an expectation of the willingness and ability of patients to travel what were, in some cases, substantial distances in order to access as least some of the health services they might need. Hence, not for the last time would the objective of service cost-efficiencies override any extra costs and inconvenience to patients – this issue later emerging both for telemedicine pilots and emergent telemedicine services.

However, by the 1960s (as noted by Rivett) there was some initial consideration being given to 'computers in medicine' by which there could be immediate benefit for, at least, the accomplishment of some administrative tasks. Computers would, of course, later become essential analytical tools within telemedicine services. Notable, in the context of what we now speak of as AI, is a discussion at a Royal College of Physicians meeting in 1965 that signalled the capacity (albeit at that point unfulfilled) of computers helping diagnoses to be made through revealing ‘associations [of data] previously unrecognized’ albeit at the price of considerable time being expended through the use of ‘punched and magnetic cards and tape’. A parallel call was made at the meeting for the ‘standardization’ of inputted data, this seen as an essential prerequisite to subsequent analysis.

Seven regional health boards were reported (at the Royal College of Physicians meeting) as having ordered computers with, according to the then Chief Medical Officer Sir George Godber, the promise of ‘statistics [being] available to any hospital doctor who needed a regular feed-back of information’. Perhaps a signal was also given by Godber regarding the potential resistance to the adoption of computers by clinicians who had been in practice for long periods when he remarked that ‘computers were the technology of the younger man’ (*sic*) (*Endnote No. 29*).

But though there may have been reservations among the older ‘men’, Barber noted the ensuing launch, by the Department of Health, of an ‘experimental computer programme to develop healthcare systems for hospitals’ [31]. And whilst some of the biggest and well-known hospitals in London and other metropolises were included, one such experiment was ‘to be set up linking doctors’ surgeries to Exeter Hospital in the south-west of England. This may, in fact, have been the stimulus for the first computer in a GP consulting room noted for Exeter in 1970 (see Phase 3). Clark et al (2017) reported that this programme led to ‘widespread use of computers throughout the NHS’ [32].

Finally, as this description of developments in Phase 2 draws to a close, it can be noted that for GP services Rivett reported positively on the then new trend towards the formation of group practices. In such (larger) practices nursing staff, midwives and health visitors were increasingly being recruited in order to support more comprehensive community-based services. At the same time, GPs were able to delegate more work, undertake ‘reduced visiting’ and cut out ‘routine calls to elderly patients whose condition seldom changed’ (*Endnote No. 30*). The ‘pooled’ expertise would, furthermore, reduce the isolation that may have been felt by many GPs as they adjusted to a more technology and measurement oriented way of providing their services.

Phase 3 – 1970-1998:
'The Creeping Amoeba of Automation', Towards the Modern Era of Telemedicine

Computers came into the UK health services in the 1960s. And though broader possibilities were noted at the 1965 meeting (noted for Phase 2) of the Royal College of Physicians, their immediate potential was seen for administrative tasks – a key aspect of which was patient records. That their role in storing health records would appear attractive at this time was signalled by Reiser who noted that many personal medical records had become 'dinosaurlike by the 1960s and seemed fatally encumbered by proportions grown too large … sometimes over 100 pages long' [18].

Just coming into view was the electronic health record (EHR) that would become something of a 'holy grail' for computing and health information systems - this being seen as helping overcome the complexity and confusion of paper records; giving accessible information; and helping to reduce clinical errors. But, although by the 1970s a 'computerised' vision was starting to take shape for both primary and secondary NHS services, the best that could be immediately aimed for were systems within the less complex environment of the GP.

The first GP practice reported to have a computer in the consulting room was that of a Dr John Preece (Devon, west of England) in 1970. The Ottery St Mary practice near Exeter became the first in the UK to be paperless [33]. Crucially, the practice system was 'fully integrated with the local hospital, allowing general practitioners and hospital staff to share the same information, subject to access controls'. Alas, it seems that neither this nor other UK initiatives were further developed. Benson remarked, with regard to the use of computers, that 'over many years, general practice computing … prospered, whereas hospital clinical computing has not' [33].

Hence, in the UK in the 1970s, except for the adoption of the new means of data storage, there was limited health-related innovation around computing. But at least a government focus initially remained on improving those parts of NHS that still needed attention. This included GP practices, many of which were in poor condition. This was especially the case in some industrial areas where, according to the well renowned Dr Tudor Hart, they offered 'squalid conditions … incompatible with the standards of clinical practice taught in medical schools, denying self-respect and limiting the imaginations of GP and patient alike' [21]. For his own practice in Glyncorrwg in the South Wales Valleys (a coal mining area), Hart reported that ill health meant that GP consultation rates were double the norm for England and Wales, with hospital admission rates 76% higher [34]. More broadly he lamented the fact that the availability of good medical care 'tends to vary inversely with the need for it in the population served' – captured through the term that he attributed to this, viz. the 'Inverse Care Law', a concept that is well recognised half a century later [35].

Staying in community settings, the reference point of social alarms should not be overlooked. Such devices had become, by the 1970s, an integral part of 'sheltered housing' (essentially rented bungalows and flats provided my municipal authorities) specifically for older people in their later years. Bells and buzzers were an integral part of the 'schemes', these quickly morphing into social alarms that enabled residents to get help in an emergency or urgent situations such as a fall. An on-site 'warden' (supervisor) provided both reassurance and assistance when needed [9]. These ways of sending 'alerts' to a warden or later via the public telephone network to a monitoring centre, were added to through the use of pendant triggers - linked by radio to a 'home hub'.

Plate 10, from 1984, captures perfectly the image that manufacturers and suppliers of social alarm technologies wanted to convey – one of peaceful domesticity. As noted by Fisk, however, this was sometimes accompanied by references to the threat, not just of a fall or sudden illness (as signalled earlier in this chapter by reference to the 'fallen woman', see Plate 1), but also of break-ins [9]. The domestic scene in Plate 14 (issued to the Press for publicity reasons) was a text that read 'at her time of life and living alone *in a progressively uncertain society*, [my emphasis] Dorothy needs to be assured

Plate 10: Domesticity with a Social Alarm Pendant
Tunstall Telecom

that help would be at hand in a crisis'. Having said this, the fact of the matter is that social alarms, whilst having a primary purpose around falls and health needs, also had (and retain) a valid role around security. Dorothy and her family will have been given 'peace of mind' (another *leitmotif*, like the fallen woman, of the social alarms business).

Of significance for community (social) alarm service providers are their operational frameworks (at least for some of their members) being guided by a voluntary code developed by the then Association of Social and Community Alarms Providers [36]. This organisation, along with service evolution, later changed its moniker to the Telecare Services Association (and, more recently, to TSA). The voluntary code evolved culminated in a 2013 'Integrated Telecare and Telehealth Code of Practice' and its successors [37].

For a wider thinking around health and early initiatives that can be linked to telemedicine in the 1970s, it is arguably necessary to look across the Atlantic – where both Darkins and Cary [1] and Zundel pointed to the exploration, by NASA, of health in space [14]. Zundel noted that NASA scientists were concerned with the effects of zero gravity on astronauts, this involved 'constant monitoring of physiological functions: heart rate, blood pressure, respiration rate and temperature'. It followed that there was, internationally, growing awareness around the *potential* for the remote monitoring of Earth-bound (older) people with regard to their health and wellbeing. Slowly improving communications systems were seen as likely to be able to facilitate this and be conduits for the sending and receiving of health-related data – whether it be a call for help based on the simple activation of a trigger or data that offered a record of vital sign measures.

With regard to data, however, as the end of the 1970s approached, fears remained about their potential volume. Reiser remarked that 'even if clinically applicable machines to perform continuous readings of body functions were perfected; doctors lacked the time to evaluate the mass of data thus produced' [18]. The notion that data were a route to e.g. diagnosis was, however, recognised. But the potential technological changes were not welcomed by all within the health domain. Reiser noted that 'doctors spoke of the creeping amoeba of automation' when discussing the power of computers and of other devices that might take over some of their roles! [18]. But, he affirmed, 'such developments made the possibility seem real that … one day a decentralization could occur that would allow a highly scientific medicine to be practiced in regions distant from specialists and the technology of modern hospitals'.

Reiser's prescience is indisputable [18]. He wrote of a potential 'new wave' of technology that might engulf medicine. This new wave was not just about a particular device or diagnostic technique; it represented a threat to the increasingly ordered world of health – as exemplified in the NHS, its structure, its culture and the established nature of doctor-patient relationships. But Reiser warned that 'if physicians in general come to accept a fundamentally mechanical view of human beings, in a world that is more and more enamored of technology, the prospect for the future of medicine is extremely disquieting' [18]. He added that 'machines inexorably direct the attention of both doctor and patient to the measurable aspects of illness, but away from the human factors that are at least equally important'… and can 'tend to estrange him (*sic*) from his patient and from his own judgment'. Roberts et al echoed Reiser's concern in the context of telecare and older people (though with a specific focus on health) when pointing to the 'pathologisation of old age and an associated view of 'the telecare user as beyond therapy and unable to interact meaningfully with the installed system' [38]. It can be noted at this point that potentially useful data gathered through community alarm services (e.g. regarding service use) was generally not sought by clinicians. This largely remains the case.

It was, therefore, an uncertain context around data and their potential that underscored the emergent thinking of clinicians and others in 1970s and 80s. At the same time, the UK started to toy with the notion of telemedicine (albeit that the term itself was not in common usage). It did not, however, appear a 'good' time for telemedicine to be promoted. Day and Klein reported that an enquiry of that year (the Griffiths report on NHS Management) referred to the NHS as 'suffering from institutionalised stagnation' with health authorities 'swamped with directives without being given direction' [39]. The invocation for telemedicine would have been seen by many clinicians as a directive too far. Day and Klein added that the 'NHS would seem to be an instrument for the mutual frustration of all those working in it, whether as clinicians or as administrators or as politicians' an accusation that must have carried some authority in view of it being published in the British Medical Journal (with roots extending to 1840)! In any case, information regarding any UK telemedicine initiatives in the 1980s seems to have been lost in the mists of time. And so, again, a sideways glance at social alarms is necessary in order to see some forward momentum.

A good reference point for social alarms at this time was offered for Scotland by Malcolm McWhirter, then a senior registrar in public health. He was an advocate and proselytiser for 'community' (or dispersed) alarms - in effect social alarms that could be connected via telephone or radio networks to a central monitoring centre. Some of these services benefited not just from the online monitoring (through whom family or other responders could be contacted) but also had mobile responders. McWhirter, in his evaluation of what was, in the early 1980s, a pioneering service (MECS, Mobile

Emergency Care Service operating in the Central Region of Scotland) found ‘clear evidence regarding the merits of the technologies for users who fell, were stuck or who had urgent medical needs’ [40]. It can be noted that the service was financially supported by the regional health board with a monitoring service based at a hospital [41]. Initial resistance to the service from some clinicians had been overcome - with 97% level of support found in survey of 100 GPs [40].

The wider UK picture is of community alarm services that were less oriented towards the medical but were assuredly concerned to support often vulnerable older people to live (stay) at home. The typical marketing of community alarm technologies and services would invariably set out the benefits of monitoring ’24 hours a day’. The message is clearly signalled in the brochure (‘for those at risk’) in 1985 for a planned but never launched British Telecom service (Plate 11). The system, it affirmed, ‘allows staff to maintain essential contacts while reducing unnecessary routine visits. It can take the pressure off hospitals too and enable those at risk to recuperate from minor mishaps whenever possible in the comfort and familiarity of their own homes’ adding that ‘experienced British Telecom operators … ‘can react in seconds and alert necessary relatives or services’.

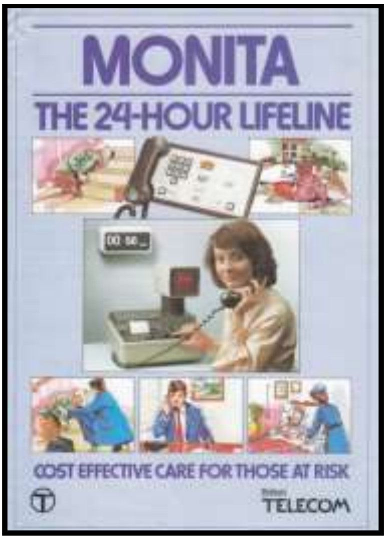


Plate 11: MONITA Planned Service from British Telecom (now BT)
British Telecom Flyer around 1985

In the ensuing decades, as technologies developed, it is interesting to note that community alarm services or their successors in Scotland retained a health as well as welfare perspective. That they should have been seen, in the UK, as part of 'packages of care' and their contribution to health recognised was alluded to in much of the research and related reporting on their role [9, 42]. The position in Scotland, however, contrasted with England and Wales where the 'rapid' development of such services was more emphatically within the realm of housing - although in most cases, similarly to Scotland, they were provided by municipal authorities [9, 43].

Early Telemedicine Services

Telemedicine trials were noted in all the countries of the UK by 1998 – with GP links to A&E (Accident and Emergency) departments in Scotland; telecardiology trials in London; and experiments in teledermatology in England, Wales and Northern Ireland [44]. However, the first pilot telemedicine *service* in the UK, that accords with our current understanding of their role and purpose, was pointed to by Debnath [45]. It was established in Scotland in 1992. He had searched, assisted by the Telemedicine Information Exchange database (see below), for projects in the period up to 2003. What is surprising is that, at that time, Debnath found as many as 216 initiatives in the UK – albeit that some of these were community alarm services [45]. The main foci of the services were for 'dermatology, elderly care, education, emergency medicine and mental health'.

Debnath's 'first' service was the 'pioneering' use of video-links by the University of Aberdeen to 'support the paramedics on oil rigs in the North Sea' [45]. This is the SAVIOUR initiative noted later. Ibbotson reported of another study at roughly the same time, and also in north-east Scotland, pioneered by the Grampian Health Board and which served substantial rural and mountainous areas [46]. Her interviews with ten clinicians and managers for the initiative indicated three main reasons for the UK's 'slow, haphazard' telemedicine implementation, viz. that of it was driven by enthusiasts who had a limited vision of how it might be integrated within the mainstream; the technological development being driven by industry; and the lack of training for health professionals. Managers of health services, according to Ibbotson, were 'relatively pessimistic about the prospects for a long-term approach [to telemedicine] being taken in the [then] current managerial climate' [46].

During this period, the UK was a member of the European Union (it left on 31st January 2020). European Commission funded programmes of research, often with UK partners, were beginning to become significant. One project funded until 1990 focused on monitoring the well-being of the unborn child for pregnant women. This was taken forward in Wales through the 'Cardiff Domiciliary Fetal Monitoring' project. Gott explained that 'monitors are used by pregnant women, in their own homes, and [foetal and uterine] signals are transmitted' over the public telephone network 'to an obstetric unit for interpretation' [47]. It operated both in the city of Cardiff and two areas in south Wales' valleys. The monitoring was noted as done by community midwives 'as part of their normal caseload' with the service seen as potentially more 'cost-efficient … for high risk pregnant women than hospitalization, with its attendant in-patient costs'.

When making the link with more generic forms of monitoring in the home (and linking with the world of social alarms and telecare) Gott deemed it 'possible' that 'remote home care … could reduce the number of visits health workers make to people's homes, potentially compounding social isolation for an already disadvantaged group' [48]. In this context she warned (similarly to Reiser [18]) that the 'scale and scope of the growth' of 'telematics in medicine' needed to be challenged because of the danger of bio-pathology and the accompanying loss of sight on 'the health and well-being of the whole person'. She pointed (reflecting a theme of this chapter) to the need for such technologies to be configured in ways that would 'empower' people – so that they were supported in their health knowledge and more able to play a part in their (or their children's) health care. Where Gott was entirely wrong, however, was in her assertion that the impact of telemedicine and telehealth had 'moved beyond the research stage' [47]. This was far from the case. Much further research, many more pilots (over a quarter of a century), and a pandemic would be necessary to convince the (mainly clinical) doubters that telemedicine should have a place, at least for some tasks and conditions, as a standard part of health services.

Overall, therefore, during this phase (that takes us to the end of the 20th century) UK hospitals and GP services found their complementary places within the NHS. Both had overcome the stumbling uncertainties of the post-war years and were becoming used to computers and the fact that communication technologies had a part to play. More than this, as observed by Rivett, the technologies presaged the kind of 'clinically effective intervention … [that could] reduce or eliminate the need for hospital admission' [17]. Looking further ahead (and taking us into a particular area of data and preventative medicine), he added that 'in future, genetic techniques would enable the identification of people at risk of developing a wide range of diseases' (*Endnote No. 31*). In any case, the presence of those technologies was, in 1998, at least suggestive of a time where, in the UK, telemedicine would find its place.

Phase 4 – 1999-2020:
‘Blindingly Obvious’, The New Era of Telemedicine

1998 marked the fiftieth anniversary of the NHS. It was able to celebrate what was, by many measures, a great achievement in providing free access for all to a wide range of health treatments. With the complementary positions of secondary and primary care services having been, broadly speaking, settled, a period of technological development might have been expected. Indeed, the UK Department of Health had just the year prior released a White Paper that signalled a plan to create telemedicine services and a new 24 hour advice line (NHS Direct) ‘staffed by nurses’ to ‘enable patients with acute health problems to contact a nurse by telephone … (to direct) the patient to the most appropriate place for care, using clinical protocols’ [48]. The White Paper pointed to the role of the ‘internet to bring patients quicker test results, on-line booking of appointments’ … ‘providing knowledge about health, illness and best treatment practice to the public through … (e.g. digital TV) [and] developing telemedicine to ensure specialist skills are available to all parts of the country’.

All the signs were that this period was an appropriate one to begin to believe in a modern era of telemedicine. With the arrival of the Internet, the period would represent, according to Bashshur et al, a ‘radical departure from the past’ because ‘the technology is cheaper, more ubiquitous, and accessible to an ever-increasing user population’ [49].

Alas, however, the foundations for telemedicine remained less than solid because the evidence of its effectiveness remained elusive. In 2000 Darkins and Cary pointed out, for instance, that ‘there is no good evidence in the telemedicine / telehealth literature to show that telehealth is cost-effective and can produce better clinical outcomes in primary care than conventional methods of practice’ [1]. At that time the author of this chapter would not have been in a position to challenge the correctness of this affirmation, but was nevertheless arguing the potential benefits of telemedicine to patients through their being able to access services in new ways (at lower cost and inconvenience *to them* rather than the service providers).

The next development that offered a forward positive perspective for the NHS and which gave attention to technologies (and drew together both telemedicine and telecare), was signalled in the outcomes of a 1999 Royal Commission on Long Term Care [50]. In its wake, more specifically with regard to health data, as noted by Sixsmith, was a new NHS information strategy [51]. This strategy included the goal of ‘lifelong electronic health records for every person in the country; round-the-clock on-line access patient records … and genuinely seamless care for patients through general practitioners, hospitals and community services sharing information across the NHS information highway'. One section of the strategy, Sixsmith reported, affirmed that 'telecare technology will be used to provide reliable but unobtrusive supervision of vulnerable people who want to sustain an independent life in their own homes' adding that (with a more telemedicine perspective) 'video-links with electronic monitoring will allow community health and social care workers to 'visit' patients at home more easily' [51].

Overall, the context was one where, at the turn if the millennium, Barlow et al estimated that there 'may have been 5000 remote care users … with around 50 local authorities across the UK running small pilot projects involving up to 100 users' [52]. Things were, it seems, beginning to change, at least in terms of the awareness at governmental level, of telemedicine. At the same time, and taking a wider view (in respect of the care of older people) Fisk opined that 'a careful eye must be kept on … agendas of technological development that include intelligent (or smart) homes' [53]. Such initiatives, he noted, were increasingly giving attention to health. The question arose, therefore, as to whether this would be a context within which telemedicine might take its next evolutionary step?

Smart Homes

Zallio and Fisk pointed to the origins of smart homes as lying in 'intelligent buildings' where attention was given, in the main, to automation and energy savings [54]. This focus is clear from an early UK overview by Atkin who stated that 'the notion of the intelligent building is linked increasingly with big business, where being a part of a worlds market demands considerable inter-organisation communications and buildings that can deliver them' [55]. Within the intelligent buildings envisaged by Atkin were networked computers that also linked with 'external locations'. But throughout his edited volume there was no attention to the relevance of intelligent homes to people's health. Powell's contribution can, however, be seen as offering a valid warning about the potential implications of intelligent buildings where 'the tendency is for building designers and managers to try to socially engineer people's behaviour – treating people as … a non-thinking object' [56]. He added that the intelligence in question might be utilised in ways that disempower - becoming 'a serious invasion of privacy, providing possibilities for continuous, but discrete surveillance and control at a distance' with a 'frightening potential for abuse'.

Interest in the role of intelligence in relation to health and social care at home was, in the context of such buildings, quickly awakened. That this should be the case in the UK relates, in part, to the widening use social alarms and the increasing 'intelligence' that was beginning to be built into such systems. Projects including those for smart *homes* were, in addition, being funded by the European Commission through their TIDE (Technology for the Socioeconomic Integration of Disabled and Elderly People) programme. But Moran noted, in relation to this programme, that early smart home initiatives were ‘largely the result of technology push’ with no ‘clear conceptual paradigm’ to underpin them [57]. What is more, as noted by Fisk and Gann et al, standards for such homes were ‘painfully slow’ to emerge and the technologies lacked interoperability [58, 59].

At this time the best known UK smart home initiative developed with older people in mind was that developed in York (northern England) by a charitable body - the Joseph Rowntree Foundation. They championed what were known as ‘Lifetime Homes’ – the idea of which had been originally set out by the Helen Hamlyn Foundation [60]. These ‘smart homes’ were designed to enable people to live their whole lives independently, excepting for those with the highest levels of need for medical care.

Gann et al referred to these initiatives as ‘prototypes’ because they represented a ‘start of a revolution’ … with ‘this technology a godsend to people with disabilities … (living in) tower blocks, terraced houses, stately homes, crofts [older, humble dwellings with a small amount of land, characteristic of rural Scotland] and cottages as well as newly built homes’ [59]. But they noted a ‘fragmented’ and ‘immature’ market (for smart homes) where ‘consumers are ignorant or sceptical about potential benefits’. ‘Medical applications’, they suggested, ‘could include the provision of advice and remote monitoring or [the] diagnosis of medical conditions’ with continuous monitoring identifying ‘changes in health status, automatically triggering an appropriate response from local community services or medical professionals’ [59]. Aside from the ‘prototype’ in York, Fisk noted initiatives in Portsmouth (with the needs of severely disabled people in mind); and developments for older people in Gloucester, Northampton and Watford (England); Edinburgh (Scotland); and Derry City (Northern Ireland) [58]. The Northampton, Derry City and Edinburgh developments focused on older people with dementia.

Fisk [9] echoed some of the ethical concerns pointed to by Gann et al. He suggested that smart homes carried ‘the danger that associated technologies may be promoted according the medical models of older age’. ‘Users might, in other words’ he added ‘be regarded as dependants and/or patients. And while there might be clinical and practical benefits in terms of their compliance with regimes of treatment, there might be fewer gains in terms of engagement, social inclusion and wider notions of independence’.

A little later in the decade and striking a more clinically-oriented tone is struck in the work of Raille et al [61]. They stated that ‘smart homes may be seen as environments designed for patients, but they can also be designed for people of all ages and with all kinds of special needs'. Significantly, they saw smart homes as 'capable of providing intelligent interaction with the occupants by means of electronic devices'. They called for 'schemes to urge patients and caregivers to take control of the technology' noting that 'empowerment of patients and frail people at home has been achieved in a few projects'. Raille et al, in fact, offered the most thoughtful description of a smart home as 'a far-reaching concept that encompasses two distinct … dimensions: person-centredness for individual and familial convenience and medico-social-centredness for social and public health purposes' [61].

For smart homes, therefore, the first decade of the new millennium was one characterised by lessons being learnt – perhaps the most prominent and frustrating (for developers and service providers) being that of the lack of interoperability between devices and/or systems, this, in turn, reflecting the lack of standards or agreed protocols. More attention, furthermore, was beginning to be given to the ethical agendas recognised by Powell, Gann et al and Fisk around surveillance and privacy [9, 56, 59]. A particular area where such ethical matters came to the fore was in the context of homes for (older) people with dementia (noted later in this chapter in the telemedicine and telecare context).

The technological advances noted for smart homes have clear relevance to telemedicine. Some community alarm schemes and services (here onwards labelled 'telecare') fall into this category. The ethical matters meanwhile, remain important as progress is made within our 'modern era' of telemedicine. They link with questions about lifestyles and activity monitoring – discussed by Fisk with pointers to issues around the 'intrusiveness' of technologies and the related services; and the extent of the 'control' afforded to people (patients) seen as the potential beneficiaries [62, 9]. In fact, the discussion below takes behaviours and lifestyles as its focus … and, therefore, endeavours to detach the thinking of the reader away from particular types of building (like sheltered housing or 'smart homes') and towards people's needs and choices. This broader context enables a clearer perspective around telecare and telemedicine to emerge.

Finally, for this brief note on smart homes, it can be noted that Zallio and Fisk made a clear link between smart homes and the Internet of Things (IoT) [54]. An exploration of the IoT is not made in this chapter but, as with intelligent buildings, there is a fairly clear path that relates to its provenance that relates to the use of communications technologies. Taking things a step further, Mittelstadt pointed to the IoT 'increasingly spreading into the domain of medical and social care'. He examined this in relation to the 'health-related internet of things (H-IoT)' that 'promises many benefits' but 'also raises a host of ethical problems stemming from the inherent risks of Internet enabled devices, the sensitivity of health-related data, and their impact on the delivery of healthcare' [63]. Some of these ethical and related issues pertaining to the IoT (and the H-IoT) are noted in Phase Five.

Behaviours, Lifestyles and Activity Monitoring

The notion that technologies could provide 24 hour monitoring with the care and support needs of older people in mind had been championed for several years - not just in the context of specific smart home initiatives or, more recently, the IoT. Doughty and Costa were early proponents [64]. They averred that 'every patient's home could be converted into an intelligent house with sensors fitted for monitoring activities from the flushing of the toilet to the opening of the refrigerator' this enabling a profile to be built up of 'the patient'. They added that 'changes of habit would then be detected and might indicate mishap or illness'. Sensors could, they considered, measure respiration, pulse, tremor, body temperature, hearing, response time and pallor'. But having said this they acknowledged that 'to be effective, the system could not be switched off by the patient and might be considered intrusive' thereby signaling the relevance of at least two ethical issues – one regarding privacy, the other regarding choice, consent and control.

Lifestyle' monitoring was, and remains, a concern for the author of this chapter in view of the actual or implied 'intrusion' on individual privacy (see Fisk [62]). The same intrusion on privacy can apply to 'activity' monitoring, though simply changing the term (from 'lifestyle' monitoring) can reflect something very important about the approach being taken – especially when activity monitoring can relate to e.g. just one simple daily act of, for example, feeding the cat, putting a foot on a pressure mat or cancelling or acknowledging some kind of alert. The monitoring of such simple acts, normally within a service framework that carries the consent of the user can, of course, be regarded as minimally intrusive. A 'big question' Fisk therefore asked was about 'the extent to which it is legitimate to gather the range of information considered necessary to facilitate the interventions that might be deemed appropriate' [9]. Subsequently he would go on to explore ethical and practical issues, with Florez-Revuelta, for the 'ultimate' in surveillance viz. cameras in care homes - where, as is now the case throughout the UK, many residents have dementia [65, 66]. In relation to this, perhaps Fisk's 'big' question should have been rephrased as 'when information should be gathered?' rather than being about the 'extent' of information gathering.

<u>THE BT and Anchor Trust Trial</u>

It was lifestyle monitoring (titled as such) that was at the core of an important British Telecom (BT) and Anchor Trust (a housing association that developed and managed housing for older people) initiative that operated from 1997 to 1999. This initiative was entirely separate from the planned development of the MONITA service (noted earlier). The primary aim of the initiative was to 'harness the application of new technology in a non-intrusive way to service the needs and wishes of older or vulnerable people, central to which is that of maintaining independence and choice' [67].

The 'lifestyle' (activity) monitoring service was trailed with 22 households in Newcastle upon Tyne, Ipswich, Knowsley and Nottingham (all England). Each home was installed with temperature sensors, PIRs (passive infra-red sensors) in every room and magnetic switches on entrance and refrigerator doors [58]. The intention was that the pattern of activity the sensors revealed would, according to Porteus and Brownsell, be 'identifying situations as they occur' thereby 'enabling people to be 'treated before the situation worsens and consequently we move from a reactive to a proactive system that should result in a reduction in healthcare costs per head' [67]. Part of an expected cost reduction they saw as a consequence of earlier hospital discharges.

The lifestyle (activity) data collected by the sensors was sent, via a home hub, to the British Telecom laboratories near Ipswich (eastern England). Altogether, Rose et al reported that 'over 5,000 person-days' of data were collected and 'over 5 million individual sensor events' recorded [68]. 'Alert' situations (where measures of activity were outside expected patterns) triggered calls with automated messages to service users. Service users, in turn, would key in '1' on their phones if all was well. Keying in '2' or a non-response would result in 'cascading' automated calls to nominated contacts, most of whom were family members who would provide assistance if needed. Of course there were questions that needed to be addressed regarding sensor settings in order to avoid too many false positive activations (with consequent disturbance to residents) – with Rose et al pointing out the 'adaptive' (though not automated) process that was used so that the 'time threshold adapts to each client for a specific sensitivity' [68].

Porteus and Brownsell's report on the project was noted as 'eulogistic' by Fisk [58]. Their study had found just a modest level of support - with 47% agreeing that the system 'helps me stay living at home' and where the initiative had, in any case, found 'some difficulties in recruiting volunteers'. Sixsmith's report, that directly related to his work on the project, was more circumspect – noting limitations around the reliability of call activations (triggered by the sensors) and the number of 'false positives' [69]. Sixsmith and Sixsmith reported that the value of the system had not been tested sufficiently in urgent or necessitous situations, and that a sizeable number of users had apprehensions about it [70]. Sixsmith noted, furthermore, that 'positive opinions about the system reflected the clients' beliefs about what the system could do, rather than their actual experience' [69].

There is, therefore, more than a hint of uncertainty here regarding the outcomes of the project. Illustrative of this is the fact that an evaluation of the trial, commissioned through the Lancaster University Management School, was compromised [71]. The evaluators' eventual report explained that that 'due to imposed changes to the timescale' it was not possible to include 'exploration of the views of four distinct stakeholder groups' as had been called for in their study brief. It was noted that 'the pilot was effectively completed by the time we were able to begin our research' and that 'some participants in the pilot felt themselves similarly disenfranchised'. As a consequence the School's evaluators offered a view that the technology was 'in some sense presented as a solution in search of a problem' [71]. Those who felt disenfranchised included 'many initially enthusiastic stakeholders' for whom there was a perceived lack of support 'in managing their existing workload alongside the introduction of these innovations'. They added that 'it is only as the pilot reaches its conclusion that the myopic vision … becomes clear' – around telecare's detachment (at least in the context of this pilot) from mainstream services.

The very limited evaluative work undertaken was in their words, therefore, 'more detached and retrospective' [71]. Within this retrospective view they noted telecare as being 'different things to many different people', this being 'arguably the pilot's most significant weakness' at least with regard to any potential for mainstreaming in Liverpool.

On the more positive side, however, the Lancaster evaluators observed (though it is not clear if this indication came from their direct work or other sources) that during the period of the pilot 'the technology was largely overlooked by the users and carers' [71]. This, they affirmed, 'could be taken as a mark of success of the unobtrusive nature of the technology, as it appears to have little negative impact upon the user's day-to-day lives'. They also suggested that 'users were more than happy with the service on offer' and that 'the idea that someone was watching over them was comforting' with 'users and carers who have used the [pilot] service … overwhelmingly pleased with it and view it as a great success'. Overall and perhaps most positive from the point of view of the potential usefulness of such systems (with regard to their monitoring function) is Sixsmith's affirmation that 'evidence of the field trials did not support a 'Big Brother' view (and) most people felt very comfortable with the system' with 'on the whole, issues relating to privacy and intrusiveness not perceived as problems' [69].

NHS: Early Strategic Approaches for Telemedicine

The tentative developments towards the end of Phase 3 and the first decade of this century make the period around and immediately after the millennium a special time for telemedicine. Telemedicine services were being developed for particular specialisms, notably dermatology and radiology. Clough et al, for instance, reported on the transmission of X-rays and CAT (or CT, computed tomography) scans [72]. They also noted telemedicine applications concerned with cardiology where hand-held devices could be used by patients to record and transmit ECG readings. Furthermore, at the interface between health and social care, some community alarm and telecare services and initiatives were experimenting with a vital signs monitoring device called SAFE21 (see later).

Other initiatives saw technologies as having particular applicability for people with dementia. The discussion of smart homes (earlier in the chapter) is relevant here but, in the context of dementia, a higher level of surveillance can be seen as carrying justification (e.g. for those who are prone to 'wandering'). Of note is the work of Woolham who, following research within a European Commission funded project, undertook a detailed study of the use of AT (including telecare) for people with dementia in Northamptonshire, central England [73]. Notable was the number of people with dementia that were involved (over 200); the inclusion of a well-matched control sample from another English county; and the 21 month evaluation period. His most striking findings were regarding potential cost savings (arising from keeping people with dementia out of care homes or hospital care or delaying their admissions) and the notably higher death rate for the control sample. An up to date overview of AT that relate to cognitive impairment is offered by Sixsmith et al [74].

There had been much going on more widely in the European Union, too – where research 'Framework Programmes' from the early 1990s through until 2002 focused on the role of 'telematics' in the context of older and disabled people. One project of interest, ending in 2001, was ATTRACT which sought to develop 'home medicine services based on broadband pilots'. Out of this, a platform supporting video-conferencing was developed and trailed (including in Belfast) and for which 'medium acceptance' was found 'for telehealth services to support speech therapy and elderly people living at home' [75].

There were, in fact, converging areas of knowledge for health related technologies (including computers), communications networks, early telemedicine, telecare and smart homes – with the latter two specifically focused on older people. And at least for some specific health applications, the NHS communications infrastructure in the UK (developed with British Telecom in the mid 1990s) became important to facilitate 'eventually … the rapid growth of telemedicine applications and their ultimate role within a modern computing and communications healthcare infrastructure' [76].

As noted earlier, it was 1998 when telemedicine (including telecare) suddenly featured as an important element within UK government policy documents. It can be noted, furthermore, that following the Department of Health White Paper [48] and ahead of the Royal Commission on Long Term Care [50], the NHS Executive [77] issued a strategy document 'Information for Health' (IfH). This was echoed by the NHS in Scotland (NHSiS) issuing their strategic report on 'Information Management and Technology' [11]. With such stirrings Darkins and Cary were moved to remark that the UK's telemedicine programme was 'notable', albeit that a similar direction was being set in the US, New Zealand, Australia, Hong Kong, Canada and France! [1]

The new NHS strategy document stated that 'telemedicine and telecare options *must* [my emphasis] be considered routinely in … health improvement programmes and associated service strategies'. Such services, it affirmed, were seen as allowing 'specialist care to be brought closer to the patient … offering reductions in travelling costs and time' and facilitating skills transfer and the creation of 'new professional roles' [77]. Likely benefits of the technologies they pointed to as the transferring of 'radiology reports and discharge summaries'. And in the context of interoperability a call was made about the need to overcome 'data islands' (i.e. silos) and to remove duplication [77]. Sixsmith noted that the Royal Commission on Long Term Care (reporting a year later) stated that 'one of the ways in which life could improve for older people is [through] the harnessing of new technology' with environmental control and activity monitoring being specifically mentioned [51].

NHS Direct and Its Equivalents

The NHS Direct service became operational in England by the end of 1999. It was noted by Larner as 'the largest telemedicine system in the world, dealing with 3.5 million calls in 2001-02' [78]. Parallel services were established in Wales (2001) and Scotland (NHS24 in 2002). NHS24, established as part of NHS Scotland, was 'demand driven' to 'deliver national telehealth and online services whilst working in partnership with local NHS boards' [79].

By 2008 NHS Direct was taking over 5 million calls a year, these being handled through 36 centres (*Endnote No. 32*). At that time it was also considering making 'outbound calls to people in deprived areas' as part of a planned bid to become a Foundation Trust (in essence, going forward as a private enterprise) (*Endnote No. 33*). Become such a Trust was, it can be surmised, seen as a possible route to survival – because the service was axed in 2010 at a time when (though the time period is not stated) it was reported as dealing with 27,000 calls a day. Of these calls 12% were sent directly to

Accident and Emergency; and a further 22% were sent to the caller's GP as 'urgent next-day cases' (*Endnote No. 34*).

The demise of NHS Direct was not a surprise. The writing had been on the wall for some time for what Larner had described as this 'hugely popular medical telephone helpline' [78]. The main problem was that initial hopes that the service would reduce demand on hospital and GP services proved to be ill-founded. Larner noted, in addition, that 'many GPs and hospital A&E departments disliked NHS Direct since it referred (too many) callers to them – a typical caller telling them that 'I rang NHS Direct and they said to go and see my GP / go to A&E')' [78]. He affirmed that 'triage for same-day appointments in general practice by NHS Direct takes longer and is more costly than practice-based triage' and reported that there was low usage 'among those whose need for medical advice is greatest such as older people, ethnic minorities, people in low socio-economic groups and people with established ill health'. NHS Direct was replaced by a NHS111 enquiry service. The new service, by virtue of employing fewer medical staff, was envisaged as operating at a lower cost.

NHS Direct in Wales had, it can be noted, been deemed a priority by the main executive body for Wales [80]. It offered a bi-lingual service in English and Welsh. No mention, however, was made of telemedicine, telehealth or telecare in the strategic document that brought about its establishment. From 2007, it was an 'operational arm' of Wales NHS Ambulance Trust and used the same clinical assessment software and NHS England and NHS24. The service operated from three centres and some 100 wte (whole time equivalent) nurses were employed. In 2008, the average call time was between 10 and 12 minutes with a normal maximum time of 5 minutes before, where needed, a call handler passed the call to a nurse (*Endnote No. 35*).

NHS Direct in Wales was, some years later than its equivalent in England, brought together with GP 'out of hours' services to create a new NHS111 enquiry service for the country. NHS24, meanwhile, continues its work as 'Scotland's national telehealth and telecare organisation' (*Endnote No. 36*).

Regardless of the (mis)fortunes of NHS Direct, the NHS strategy around the turn of the millennium was noted by Detmer as one for which its success was subject to 'changes in attitude and behaviour and the willingness of professionals to communicate with each other across professional boundaries' [11]. The fact that telecare (building on community alarm services) was seen as 'in the mix' was a reflection of this intent. The strategy affirmed that all local health services were to have facilities for telemedicine by 2005 – with NHS Direct being implemented; pilots running for digital TV; teledermatology services being taken up; and GPs having video-conferencing capability.

There was, however, much unrealism in the strategy. May et al referred to it as an ‘e-topian vision’ [81]. In any case, the reality was that, in 1999, less than 1% of hospitals and GP practices in the UK had video-communication equipment and only 60% of the latter had basic internet services. Detmer noted, furthermore, ‘cultural resistance’; and an inadequate telecommunications and information technology infrastructure ‘for quality health care’ [11]. Debnath added to the list of barriers by reference to financial constraints and ‘medico-legal issues’ [45]; with Wootton and Patterson noting ‘some criticism … for telemedicine in general’ [82].

It is unsurprising, therefore, that in the first decade of the new millennium, May et al considered realisation of the NHS strategic vision as unlikely [81]. They saw ‘telemedicine systems (as) fragmented (and) experiments as running parallel to *real* services’. They also recognised absence of ‘powerful policy sponsors’. Wootton and Patterson reported on telemedicine successes in radiology and psychiatry but for video-conferencing (at least with teleneurology in mind) they opined that although ‘it can be made to work successfully … it is still not as reliable in practice as it should be’ [82]. In other words, achieving the desired rate of telemedicine adoption might have needed the political push and leadership of a character such as Aneurin Bevan - noted earlier as the key visionary and driver for establishing the NHS.

Nevertheless, attention to the ‘possibility’ of telemedicine (or, rather, its further development – building on the embryonic services that were beginning to be established) was increasing. Debnath [45] reported on the impetus that came in a review of the then current literature - where Loane and Wootton found (after investigating over 100 articles using the term ‘telehealth’ and over 3,700 articles for ‘telemedicine’) early evidence of telehealth to be ‘commercially viable when travel distance is substantial’ [83]. They argued that telemedicine ‘allows a more patient-centred approach … in contrast to the traditional doctor-based model of health care’.

Elsewhere Wootton and Patterson referred to some of the benefits of telemedicine as ‘like that of a parachute, blindingly obvious’ [82]. Such signals (especially when pointing to possible cost savings), and the active operation (as noted in the review by Loane and Wootton) of telehealth services for neurological and psychiatric assessments, would have raised many an eyebrow among those UK strategists and policy-makers who were concerned to make savings for an NHS service that, year on year, was consuming a larger and larger budget.

Quickly following IfH was the 2002 National Programme for IT (NPfIT). This, as noted by Clarke et al, ‘aimed to deliver a single EHR [electronic health record] for every patient in England’ by 2010 [32]. Sixsmith would not, at that point, have held his breath in anticipation [51]. He pointed to the fact that the existing policy framework fell short of that which would be desirable – with ‘no clear development strategy or targets … mapped out’; ‘very little concrete evidence about the cost-effectiveness’ and with initiatives reflecting technology- rather than user-led approaches.

Perhaps unsurprisingly, NPfIT was dismantled in 2013 after a review concluded it was unable to deliver on its aims. Evaluations of both the IfH and NPfIT programmes (per Clarke et al [32]) criticised them for a ‘centralized approach’… resulting in ‘fragmented systems’; and noted that the ‘decision to contract three main suppliers for electronic records … constrained the development of next generation systems (and) hindered the supplier market and *increased* [my emphasis] costs’.

In the same year as the NPfIT was ‘dismantled’ the care.data programme arrived. It was announced by NHS England and the Health and Social Care Information Centre – with the latter designated as the ‘safe haven’ that would, for England, ‘extract data routinely from all GP practices as well as hospitals’. The promise was made that medical records used (would be) ‘stripped of information that could identify patients’ (*Endnote No. 37*). Roberts et al noted the intention of the care.data programme to ‘create a data set capable of supporting data-intensive biomedical research’ [38].

The care.data initiative went wrong. People were concerned, regardless of reassurances, about the potential sale of their personal data to commercial organisations. Many GP practices opted out. Two reports (by the National Data Guardian and the Care Quality Commission) in effect administered the *coup de grâce* when they called for ‘far greater transparency over what happens to the information’ and pointing to the need for ‘opt-outs for patients who want their data seen only by those directly caring for them’ (*Endnote No. 38*). After being paused in 2014, the project was abandoned in 2016.

The Policy Push and Early Telecare Developments in England

From around the millennium, the world of telecare, at least for England, began to spin with speed. Barlow et al had noted that the NPfIT expressed a wish that ‘what is described as home telemonitoring’ (taken to mean telecare and telemedicine) should be ‘available in 10% of homes requiring it by December 2007 and 20% … by December 2010’ [84]. This was in a context where, they observed ‘there is almost no research on the processes underlying the introduction of telecare’ and ‘only one telecare scheme in the UK that can be described as a mainstream service, with approximately, 1200 users in West Lothian, Scotland’. The West Lothian initiative is noted later in this chapter.

There had been an estimated 1.29 million people in the UK with community alarm services in 2003, albeit ‘poorly targeted in relation to the support needs of many older people’ and ‘at odds with their counterparts in other countries’ [9]. In 2005, the Department of Health estimated that there were ‘around 1.4 million’ for England alone (though this can be considered likely an over-estimate in view of later figures).

More important than any debate about numbers, however, was the issuing, by the Department of Health of what can be regarded as a ‘seminal’ report ‘Building Telecare in England’ [85]. Not mincing its words (and in a paragraph comprising a single line) it pointed to a future in which people ‘have greater control over their own lives’ with telecare as ‘vital to unlocking this future’.

Accompanying the ‘Building Telecare’ report was a new funding framework – the Preventative Technology Grant (PTG). The PTG was to be used ‘to increase the numbers of people who benefit from telecare by at least 160,000’ between 2006 and 2008. Remarkable is the fact, as noted by Dobrev et al, that there were ‘no specific conditions’ for the PTG. It was ‘only to develop telecare, including within this telemedicine’ [79].

An important message is provided in the label of the PTG viz. ‘preventative’. The initiative, regardless of its merits, was concerned with promoting the use of technologies and related services that supported health in its wider wellbeing sense. In consideration of this, telecare’s role can be considered as having significance as at least an adjunct to telemedicine (and within the broader umbrella that is suggested by the term telehealth).

There is little doubt that the PTG was well intentioned especially (from the point of view that favoured closer integration of health and social care services) in view of the invocation for recipient municipal authorities (that controlled social care budgets) to used ‘pooled’ (i.e. shared) funding arrangements and to ‘work with partners in … health, voluntary and independent sectors and service users and carers’. Telemedicine was, in fact, seen as part of telecare (though it is easy to have an inconclusive debate on such labels) and needing to be ‘part of the local health and social care pathway for managing long term conditions’.

A contribution to discussions was provided, for 2008 (the final year for the PTG), by Ross and Lloyd [86]. They used English Longitudinal Study of Ageing data to investigate ‘the prevalence of telecare users and potential users in England’. They found that ‘personal alarms’ were used by ‘just over 2% of individuals aged 50 and above … whilst just over 4% had an alerting device fitted to their property’. This equated to 1.1 million people – at least providing a good benchmark figure for the year in question. Their other findings are unremarkable but at least point with some authority to the effectiveness, at least in part, of targeting - in view of telecare users being ‘far more likely to have had a fall or multiple falls in the last 12 months compared to non-users’ (an average of 1.5 as opposed to 0.8); and with disproportionate numbers having a range of diagnosed conditions such as angina (23% as opposed to 14%), coronary vascular heart disease (3%, 1%), heart murmurs (10%, 6%), lung disease (15%, 6%), osteoporosis (22%, 12%) and cancer (7%, 4%).

Finally for this first decade of the new millennium, it can be noted that the 'Building Telecare' report alluded to a new body, NHS Connecting for Health, as remitted to create 'the necessary infrastructure to support the development and implementation of telemedicine and telecare applications … including the establishment of a national broadband network and a national NHS Care Records Service' - to be implemented by 2010 [85]. 'We need', the report added, 'to consider how best to integrate (telecare) with the NHS Care Records Service'.

And yet another report, this time from the Department of Health and Social Care in 2006, added to the momentum by heralding a new programme funded to the tune of £31 million, known as the Whole System Demonstrators (WSDs) [87]. This was, upon its conclusion, intended to quell the concerns of those who doubted the efficacy of telemedicine by gathering 'evidence in a UK context by deploying telecare and telehealth services covering a resident population of more than one million across three areas of the country'. Its outcomes are noted later in this chapter. That it would capture attention follows from the fact that the WSDs would be 'the world's largest pilot project of its kind'.

Initiatives in Scotland

Very relevant during the first decade of the new millennium, not for the first or the last time, were initiatives that were taking place in Scotland. And although the overall number is not high, more such initiatives were to be found in Scotland than in other parts of the UK. The easiest explanation of this lies, of course, with that country's rurality and, therefore, the particular benefits that telemedicine would have been seen as bringing. A higher historic level of involvement of health professionals and financial support provided by Scottish social work authorities for warden services in sheltered housing and the development of community alarm and telecare services is also relevant.

A 'Scottish Telemedicine Action Forum (STAF) comprising clinicians, academics, managers and technologists' was set up in 2000 [45]. STAF's role was to 'oversee' and 'promote' telemedicine initiatives - with the latter including 'encouraging health boards to consider the application of telemedicine' in their health improvement and implementation plans [88].

Telemedicine's 'diffusion' in Scotland was, however (as proved to be the case elsewhere), problematic. Ibbotson noted technological challenges that included a lack of 'compatibility' (i.e. interoperability) – something that, for commercial reasons including customer 'lock-in', some 'companies may not have tried to reduce' [12]. Other problems or concerns around telemedicine she noted as around data security; the neglect of training; difficulties with scheduling; and a 'lack of organisational rules about how to initiate a telemedicine session'. Ibbotson also noted (based on over 80 hours of observational fieldwork and responses to postal questionnaires to over 300 clinicians, GPs, nurses and other health professionals) that there was, for some professionals, an 'alien element' in the clinical encounters where 'some (non-clinicians) held positive views and welcomed the greater patient agency which they saw possible in a tele-consultation' [12].

One study within Ibbotson's purview will have been the provision of a link between the network of minor-injury units in community hospitals to A&E (Accident and Emergency, equivalent to ER or 'Emergency Room') at the Aberdeen Royal Infirmary – enabling the latter to give remote advice via a video-link to nurses, paramedics or others at remote locations. The potential use of digital stethoscope, auroscope, ECG 'and other tools' were to be explored in this initiative [27]. In relation to this, Sidney Brown, introduced earlier in this chapter, would have been amused or amazed that it took ninety years for such an initiative to take place since his invention of the 'electric stethoscope' and his experiments in transmitting the sounds of the heart via telephone lines [16]!

Overall Ibbotson reported (with authority given the size of the sample in her survey) the disruption resulting from 'telemedicine applications developed at a different rate' [12]. For example, in A&E and radiology, telemedicine was being integrated into routine care whereas she saw other applications (e.g. dermatology and tele-psychiatry) remaining at the 'experimental stage'. She concluded that 'at present there remains continuing uncertainty about which and in what ways [telemedicine] applications will be eventually integrated into routine practice'. Finally, Ibbotson opined that 'the potential capabilities of the technology are greater than the sum of its parts' noting that 'the processes by which people create that new capacity have not yet been fully explored' [12].

Overall UK Initiatives up to 2004

Whilst this chapter has noted some early telemedicine initiatives, 1998 saw the establishment of a UK National Database of Telemedicine – hosted and maintained by the University of Portsmouth. The database was re-launched in 2001 as the UK Telemedicine Information Service (TIS), renamed in 2004 as the 'Telemedicine and eHealth Information Service (TEIS) before its closure in that year [89].

At the time of its closure at the end of March 2004, the TEIS database held information on 224, mostly UK, telemedicine projects involving 205 companies (this figure excluding projects that were solely concerned with education or training). However, despite what could have been a rich foundation for understanding the roots of 'modern' telemedicine, the data were neither accompanied by much detail, nor evaluative outputs. A list of the projects [89] simply notes project names, the 'host' organization(s), specialisms, start and (where known) finish dates. Explanatory information sometimes provided to the project was not published.

The earliest record on TEIS was dated 1992. This is a project in Scotland called SAVIOUR ('Study of the Application of Video Image Transfer: Orthopaedic up to Rehabilitation'). This provided emergency medical cover and related services for workers on the oil platforms in the North Sea (and some on-shore locations). There was no indicated end date for the project. The second eldest is the University of Wales 'TEAM Project' around dentistry and dermatology that operated from 1993 to December 1995.

Following after these is a spate of other projects. Analysis by the author of this chapter of the TEIS listing gives a total of 195 telemedicine projects operative in the UK in 2004 or having been operative in the period from 1992. Further information on some of the projects has been divined from un-collated and unpublished information found online (*Endnote No. 39*).

The TEIS listing, and the analysis based on this, comes with provisos. No database of this nature can be absolutely complete. There will have been initiatives that were not found or reported to TEIS. Also there is blurring at the telemedicine boundary – this often relating to services involving older people and which could come under the heading of social alarms or telecare (albeit that this chapter 'accepts' these as part of telemedicine). The database includes, furthermore, initiatives that were narrowly focused on health data; and others that were 'aspirational' and may not, by 2004, have reached the stage of field trials.

The TEIS database was used by Debnath in his earlier analysis (together with searches of other databases and targeted inquiries). He found 216 UK telemedicine initiatives at September 2003 [45]. The analysis of the TEIS database by the author of this chapter is for the end of the TEIS project. It excludes initiatives where entries relate only to training or 'simply' to academic research (not seemingly linked to a particular initiative). Some (separate) entries that related to different project *phases* were counted as one; and some were 'telescoped' into one where different specialties were indicated as being addressed within the same timescales. In all, this means that the total number of entries on the basis of which this analysis is done is 29 fewer than those finally recorded on the TEIS database [89].

More could be revealed by further research into at least a sample of the initiatives listed. This chapter can only provide a taste. The picture that emerges is indicative of the 'starting point' for contemporary telemedicine in the UK. It is a picture similar to that found by Debnath [45]. For instance, there is a good spread of telemedicine initiatives across the four countries, this reflecting the policy direction taken by respective governments and increasing number of journal articles reporting on telemedicine. By 2004, therefore, awareness of telemedicine was increasing across the medical and to some extent nursing and other professions.

Debnath's work [45] and the 'new' analysis undertaken by the author of this chapter give an indication not just of the spread but of a higher number of initiatives in relation to their respective populations in both Scotland and Northern Ireland. The figures are included in the Table below. The disproportionately high number of initiatives is explained for Scotland by (as noted earlier) its many rural and remote parts. It is also explained by the earlier championing of telemedicine in that country. For Northern Ireland the explanation probably lies, similarly to Scotland, in the number and extent of its rural areas.

Table: UK Telemedicine Initiatives in 2004

	England	**Scotland**	**Wales**	**N. Ireland**	**Total UK**
Cardiology	5	0	0	0	5
COPD and Respiratory	4	0	1	1	6
Dementia Care	6	1	1	0	8
Dental Care	5	1	1	0	7
Dermatology	17	2	1	1	21
Diabetes	2	1	2	0	5
Elderly Care and Telecare	24	5	0	4	33
Generic	16	4	0	6	26
Primary Care	3	0	1	1	5
Injury, Trauma and A&E	19	1	2	0	22
Natal, Pre-natal and Paediatric	11	0	1	1	13
Neurological	0	1	0	2	3
Obstetrics and Gynaecology	2	1	0	0	3

Ophthalmology and Vision	5	0	0	0	5
Orthopaedic	3	0	0	0	3
Psychiatry and Mental Health	15	2	0	1	18
Radiology and Radiography	7	1	0	0	8
Other	2	1	0	1	12
Total	**146**	**21**	**10**	**18**	**195**
Percentage (%) of Total	74.9	10.8	5.1	9.2	-
Percentages (Denbath, 2004)	79.6	13.0	2.8	4.6	-
Overall Populations (2004) (*Endnote No. 40*)	83.7	8.5	5.0	2.9	-

The number of initiatives directed at older people (including telecare) together with those concerned with dementia (altogether totalling 41) is notable. This was signalled earlier as relating to the 'blurred' boundary of telecare with telemedicine. More central to health services are the initiatives indicated as generic (mostly hospital based) and linking with primary care (totalling 31). Initiatives concerned with injury and trauma also are notable, often involving ambulance services (22). Dermatology (21), psychiatry and mental health (18) feature strongly with both of these seen in the literature as particularly likely specialisms where telemedicine would be of importance. The 'other' category hides yet more specialisms. These included palliative care (1), rehabilitation (2), burns and plastic surgery (2) and various specialisms where the likely focus was, as with radiology and radiography (8), on the transfer of images.

Part of the remainder of this chapter will indicate, for the UK, where the potential of telemedicine has been realised or stands to be realised. At this point, however, the position can be summed up as 'experimental' in a context where, as far as telemedicine was concerned the UK (as reported by Debnath [45]) had a 'relatively late start'.

With such initiatives, and the changes in perspective indicated for the NHS, it was natural that manufacturers and innovators were eager to position themselves for the new market. One of them, Tunstall Telecom (now Tunstall Healthcare), then as in 2020 the UK's leading telecare company, joined an ambitious European project to develop a telemedicine service platform through the 'integration of medical technology into the community alarm monitoring system' [90]. The project was called SAFE 21 with the acronym deriving from 'social alarms for Europe'. The ambition was to 'show how simple monitoring can be carried out at home and how it can be incorporated at marginal cost by exploiting the existing social alarm infrastructure' (*Endnote No. 41*).

Tunstall Telecom (SAFE 21)

Trials of the SAFE 21 system took place during 1998-99 in Newcastle upon Tyne (north-east England) – both with the community alarm service managed by the municipal authority; and 25 miles away in a hospital in Durham. It was reported on by McIntosh and Thie [90]. Twenty-three patients (9 with Muscular Dystrophy, 14 with respiratory conditions) were involved. Parallel trials took place in Spain and The Netherlands (Plate 12). The system gathered data (heartbeat, blood pressure, temperature, breathing rate and amplitude) from bedside patient monitors and entered these to an electronic record – these being accessible to doctors and nurses at any time. The data were automatically checked against the 'patient's monitoring plan' with an alert 'raised for the centre operator if limits are exceeded or if non-compliance is detected'. User satisfaction levels were reported as high [90].

Plate 12: SAFE21
Tunstall Telecom

Other trials using the SAFE 21 technology subsequently took place, linked with an assortment of service providers mostly in the north of England. In Carlisle, for instance, the needs of patients with COPD (Chronic Obstructive Pulmonary Disease) were specifically addressed – the trial indicating a sizeable saving in hospital 'bed days' through more timely discharges and the provision of support at home. Prominent was the adoption of SAFE 21 by WYMAS, the West Yorkshire Metropolitan Ambulance Service (in the north of England). The measures, where needed, were assessed by trained nursing staff at the monitoring centre. These staff also, it can be noted, had responsibility for the regional NHS Direct service (*Endnote No. 42*).

The attempt to bring telemedicine and telecare together on a common platform can be regarded as laudable. SAFE 21 succeeded in doing this. It was disadvantaged, however, by the size of the device and its cost. Financial viability necessitated, it was suggested, partnership approaches to have been adopted that enable an element of cost sharing. This, however, went against the 'siloed' norms of service provision (*Endnote No. 43*).

The SAFE 21 product was shelved in 2006 with its lack of commercial success in part lying, it is suggested, in those siloed operational practices at the interface of housing, social care and health. Technologies could be changed and improved but the bureaucracies and cultures could not.

DERA / QinetiQ

Another initiative noted in the TEIS database is the DERA study that operated from the prestigious John Radcliffe Hospital in Oxford (west of London). DERA stood for the Defence Evaluation and Research Agency (part of the UK's Ministry of Defence). The project (with fourteen elements) aimed, over a two year period, to establish the merits of UK's first 'virtual' hospital. It was publicly funded to the tune of £10.8 million.

Video-links from the hospital, with doctors carrying out 'cyberspace ward rounds with patients, chatting to them on email and on television screens' would enable patients to recover at home (*Endnote No. 44*). Two hundred and fifty patients were to be enrolled and provided with devices to take heart readings, temperature and blood pressure. Treatment was to be focused on conditions including heart disease, stroke and cancer – with the TEIS database adding emergency medicine, oncology, telecare, medical imaging, trauma and surgery, antenatal cardiology, paediatric cardiology, intensive care and histopathology to the list. It was possibly the largest project listed on TEIS [89]. Ambitiously it was claimed that not only would hospital costs be cut but there would be better morale and quicker recovery for patients (*Endnote No. 45*).

The project was taken over in 2001 by QinetiQ, the company established on the privatization of DERA. According to the TEIS database, it ended in March 2002. Elements of the QinetiQ project, as reported to TEIS, echoed the SAFE 21 initiative of Tunstall Telecom.

What became a QinetiQ initiative, placed great emphasis on prediction – with two 'predictive alarm systems' having been developed in collaboration with the ICU (Intensive Care Unit) of Frimley Park Hospital south of London. Such systems would provide ‘advance warning of patient health deterioration; [and facilitate] improved health care resource allocation’. With prescience, information submitted by QinetiQ to TEIS pointed to their project applying ‘data mining and knowledge management techniques to develop an objective analytical database through trend analysis’ (*Endnote No. 46*). Other aspects of QinetiQ’s initiative related to breast cancer (through computer assisted mammography); heart abnormalities in the unborn child (through foetal heart monitoring); and echocardiograms (with image compression) – in each case involving transmission and sharing.

The size and scope of the work undertaken by DERA / QinetiQ is difficult to overstate. Published outputs were, however, limited – this in all probability linking to the commercial potential that related to several of the initiatives in question. One small output is that of Varga et al who reported on a system that enabled the sharing of medical images and the making of ‘clinical decisions based on the images found’ [91].

Interesting is the written evidence that QinetiQ gave in 2005 to the UK Government’s House of Commons Select Committee on Health (*Endnote No. 47*). This lamented the fact that the ‘great enthusiasm [in the Department of Health] for new technologies that could revolutionise patient care and service delivery’ was not being translated into practice. Things were, the company pointed out, hampered by there being ‘no national standards for connectivity, qualification or accreditation of new systems’.

QinetiQ’s pithiest criticism, however, was the assertion that the NHS was frequently ‘too balkanised’ to provide the necessary model of care provision that would embrace the ‘world of practical patient care’ and enable health professionals to ‘work from home or the High Street’. ‘Building a new hospital’ they stated ‘may replace crumbling Victorian buildings, but it does not slow down the stream of patients. Nor does it reduce by much the secondary care costs of treating chronic disease, or help to maintain a healthier working population’. QinetiQ’s apparent withdrawal from the emergent telemedicine market reflected such concerns.

The above examples of telemedicine initiatives provide the context that brings us closer to the present day. The UK, in the post-millennium period, was characterised by great ambition but little fulfillment for telemedicine. Where telemedicine was beginning to make its mark was only within particular and limited areas of health service provision. The extent of the government’s ambition for telemedicine furthermore, whilst initially strong, would wax and wane; but nevertheless there were at least intermittent reminders about the importance of technologies in general and/or telemedicine more specifically.

In some respects, as signalled by DERA / QinetiQ, those who were championing telemedicine were, for the most part, swimming against a tide of NHS bureaucracy and narrow thinking. Advocates were unable to progress very far forward in the face of waves of opinion that carried concerns about telemedicine's efficacy – reflecting the fact that many clinicians could not see (or were predisposed not to see) what was 'blindingly obvious' to Wootton and Patterson [82].

Taking the Agenda Forward

At this time (around 2005), even though progress was limited, at least telemedicine was beginning to take a clearer form in the minds of some policy makers, clinicians and others. This reflected the fact that *all* were becoming more accustomed to the varied facets of our digital world with new 'mindsets' or ways of thinking increasingly adopted.

The new mindsets were associated with an awareness, not just of the operational 'basics' of telemedicine, but of its wider potential - facilitated by the expanding capacity of communications networks, including for service improvements and decentralisation; and for people's (patient's) empowerment. The consequences of this awareness, with its implications for the largest of (centralised) hospitals, will have been the cause of additional anxiety for some clinicians who may already have been sceptical of, or in opposition to, the encroachment of telemedicine within their domains. But the improved and more extensive digital communications networks meant that such awareness became necessary.

At one extreme, new weight could be attached to arguments that would see the demise of some hospitals in favour of more localised or home-based service provision. Relating to this, over twenty years ago Valins and Salter had argued for more efficient and effective primary health services where 'large scale hospitals may become a thing of the past' [92]. Christensen et al had more recently described the continuum of scientific progress taking us from intuitive to empirical and now to more 'precision medicine' – but, they opined, whilst 'we will always need hospitals, we will just need fewer of them' [6].

For telecare, and reflecting a more community-oriented perspective, Barlow et al had pointed to how technologies, by reaching anyone with a link to communications networks, undermined the kind of institutional thinking that had delivered sheltered housing (for older people) and its variant of 'extra-care' [84]. This echoed the long argued perspective of the author of this chapter, that, aside from access to health services, the crucial thing to support people's autonomy and facilitate independent living was good housing design (with technologies as appropriate), not 'schemes' [43].

As the first decade of the new millennium progressed, endeavours to prove the worth of telemedicine initiatives continued. But small projects and initiatives didn't really cut the mustard. Barlow et al in a more review of some of these noted that, although there were 'individual patient benefits' that could be identified 'across all our cases … pilot projects did not translate when attempting to implement remote care more widely' [52]. That lack of translation (from initiative or pilot to practice) resulted from, they observed, a failure to achieve an adequate level of integration between organisations. They called for 'joined-up' approaches 'from inception' – something that was, as noted earlier in this chapter, clearly lacking from the BT initiative with Anchor Trust. However, though initiatives were mostly small and outside of the mainstream, at least their number and range were such that there was the realisation that telemedicine was not just a minority pursuit for physicians in the Scottish highlands.

Below are set out a number of further examples of what can be regarded as more contemporary telemedicine initiatives for the four countries of the UK. These date from the middle of the first decade of the new millennium and offer an overall picture in which it appears that, whilst there is a wide range of specialisms, initiatives in England *may* be disproportionately low in number when seen in relation to its population size. Appearances can, however, deceive. It must be borne in mind that much telemedicine (e.g. radiology) was taking place unremarked, having already reached the 'mainstream'. Other initiatives had struggled to progress from the embryonic to the nascent.

In considering these examples, it must be emphasised that these are not 'exemplars'. They should not, therefore, be necessarily held up as 'good practice'. There are important lessons, nevertheless, that can be (and, in some cases, have been) learned. In the section below, a small selection of initiatives is noted alongside the one that 'stands out' as of exceptional importance viz. the English Whole Systems Demonstrators (WSDs). A preliminary note is, however, necessary regarding the nature of evaluations that were often undertaken for such large scale and time-consuming initiatives. The issue is particularly relevant for the WSDs the evaluation of which was based on a randomised controlled trial (RCT) methodology. The note also has broader applicability in view of ongoing concerns about telemedicine's efficacy.

In sum (a detailed discussion is not appropriate here), one of the main reasons for opposition to telemedicine among many clinicians, as noted earlier in this chapter, has been the lack of evidence regarding its cost effectiveness. In this context, it can be noted that the 'gold standard' for evidence normally looked for by them was, and remains, RCTs. These require relatively large sample populations together with a 'comparator' sample not ‘benefiting’ from the technologies or treatments concerned [93]. But there are problems with RCTs as potential tools by which the efficacy of telemedicine should be assessed. Four of the problems are noted below:

- RCTs take time to undertake because large samples are difficult to assemble (including a comparator group). The work with the patients (people) and subsequent analysis of data regarding their experience, consumes further time. This, of course, is true for telemedicine initiatives and for studies that relate to other areas of work.
- RCTs require different elements within the studies to be fixed. But for telemedicine, patient needs and people’s circumstances change. They may defy easy ‘fixing’ and not be neatly categorised to satisfy a particular study requirement. Zabor et al noted ‘narrow inclusion and exclusion criteria may lead to a homogenous patient population, thus limiting generalizability of the results’ [93].
- It is not just the patients (people) who change. The world of telemedicine is characterised by fast changing technologies. What is used in the initial stages of an initiative (whether or not an RCT) may, as noted by Goodwin, be obsolete at its end [94]. The changes in the technologies can, furthermore, impact on the level of their acceptance, to their efficacy and their cost – each of which will impact on RCT outcomes.
- RCTs carry ethical concerns. The main ethical question is regarding the legitimacy, when benefits to health and/or well-being are anticipated, of depriving patients (people) in a comparator sample of the technologies (and related services) that are integral to the telemedicine initiative. This issue was noted for teleneurology by Wootton and Patterson [82].

With these matters in mind the question arises as to whether those clinicians (or others) who opposed telemedicine on methodological grounds were hanging their hats on the wrong hook. Alternative methodological approaches can involve recognition, subject to *their* robustness, of the outcomes of smaller scale studies and evaluations – many of which offer (albeit not in large quantity) both quantitative and qualitative data. Some such smaller studies are noted in this chapter. When taken together with other studies of similar service initiatives (i.e. they are ‘triangulated’) they can provide a body of evidence that may be of equal or even, by virtue of drawing on a wider range of information, *more* robust than that which might be expected from an RCT.

An interesting example of one such smaller study (specifically chosen because of its focus and the *very* small number of service users involved) concerns medication compliance and the use of automated programmed to prompt their users. More generally, only limited evidence relates to the use of such dispensers even though they are relatively commonplace within telecare services. A study in Newport (South-east Wales) afforded important insights using limited quantitative information. It was based on the operation of the service for just seven service users as ‘case studies’ [95]. The Newport study was included in a wider review by McArthur which, through the bringing together information from a few other (small) studies, was able to establish a ‘convergence of views’ about the main beneficiaries for such devices [96]. These were, in particular, ‘people with early dementia, family carers who are supporting family member with medication, people with Parkinson’s disease and other long term conditions combined with memory issues, and also dexterity problems and visual impairment’. Needless to say, the study costs were minimal when compared to those that would have been incurred in a RCT.

For the seven potential users in Newport it appears that the dispensers were only suitable for three of them. But there was, as with the broader study by McArthur [96], valuable information about the dynamics (within households) of their use and where such devices could make a contribution that would afford better health and support many people living at home. The three for which the dispensers ‘worked’ may have been representative of a much larger population about whom, with other triangulated information, robust conclusions might have been able to be drawn.

It follows that if a different perspective is needed for telemedicine (on the evidence base and the methodology used to evaluate its efficacy) then an ‘escape’ from over-reliance on RCTs may be possible through approaches that mix quantitative data with more qualitative information (including from case studies). This would not so much change what Greenhalgh et al referred to as the ‘evidence based tail wagging the clinical dog’ [97], rather it would change the nature and content of the evidence so that, in the world of telemedicine, it could carry greater relevance.

The arguments around the methodologies by which telemedicine initiatives should be evaluated continue. But the work of Greenhalgh et al [97, 98] and Devlin et al [99] send a clear message about the need for wider approaches. The rigid structure around the RCT ‘gold standard’ has, as a consequence, at least been shaken. It can be noted, in addition, that the author of this chapter offered his three penn’orth (added to in this chapter) by affirming that there is a need to ‘avoid narrow quantification that fails to do justice to complexity and/or overlooks the rapidity of change, not just in communications technologies but also in the way that people are using them’ [100]. In other words new and/or more nuanced (and mixed) approaches are required.

It follows that the next tranche of telemedicine initiatives, regardless of their size, should give greater attention to the methodological approaches that are used. The current signals, partly drawing on the evolving position of NICE, suggest that a wider approach may be hoving into view - at least in terms of the size of projects and initiatives and, at least in the area of telemedicine, any over-rigid requirement for RCTs. Added to this, for social care, NICE guidance reported that whilst RCTs are 'normally the most appropriate study design for judging the efficacy of effectiveness of interventions' they 'may not always report all important outcomes' (*Endnote No. 48*). The social care guidelines add that 'because of the complexity of social care provision and the context of its delivery, the findings often have to be supplemented by data from other study designs' – with the latter including 'qualitative studies or practitioner views and experience'.

Below are examples of telemedicine services in each of the four UK countries that have taken place in the last 15 years. The WSDs are included. These are followed by a description of the UK-wide DALLAS programme.

<u>Telemedicine Initiatives: England</u>

In the most recent fifteen years, the general pattern for telemedicine has remained a patchwork of initiatives and projects. The ongoing caution about or rejection of telemedicine in the context of some clinical concerns and perceived methodological shortcomings in their evaluations (as noted above) is understandable. An unfortunate consequence of these, however, is the general overlooking of the people (or patient) perspective and the potential benefits to them (and often reported *by* them) of telemedicine in terms of service accessibility, choice and, occasionally, the sense of empowerment (though the research rarely explores this in any detail) that they gained.

The NHS remained in this period, despite its blemishes, much loved by many, if not most people, in the UK. Its norms around service provision remained reassuring to patients, who would often access its services at times of anxiety, distress and loss. Real or imagined organisational change for something that was often portrayed as an innovation (such as telemedicine) could therefore only by countenanced by clinicians subject to the right evidence being in place.

And so, in this period of ongoing telemedicine experimentation, a number of further initiatives at varying scales can be noted. One project of relevance (especially when considered in relation to the new and uncertain world of AI, noted later in Phase 5) is Sarhan et al's retrospective work (over a year) around the interpretation of digital images of pressure ulcers (gathered by Stoke Mandeville Hospital, Aylesbury – north west of London) [101]. Over 400 images for 50 patients, detailing sore location and allowing the viewing of surrounding skin condition, were examined. This found a 'high' though unspecified percentage of assessments that could be performed in the community without the need to travel to specialist clinics.

Staying in the south of England and linking with the PTG (noted earlier) was an evaluation of the South West Surrey Safe at Home Project (bordering on the south of London) where six service approaches with different 'packages' of technologies were explored by Horton and Anderson [102]. The foci included hospital discharge, medication management and monitoring for COPD. Overall findings broadly speaking and, albeit based on small samples, echoed those of other telemedicine studies with high levels of satisfaction among service users.

Significant in the South West Surrey study was the level of engagement of health and social care professionals and practitioners in the planning of the interventions and the framework for its evaluation. Focusing on the monitoring of COPD, this part of the project used the SAFE 21 product noted earlier – with daily monitoring being undertaken by service users for 'physiological parameters (including) oxygen saturation, pulse and respiratory rate' [102]. Outcomes found some concerns about the aesthetics of and some problems with the equipment. But there was a general positive view among staff and service users that this technology 'provided a firm basis for planning future remote monitoring services'.

A third project, this time in central England, is worthy of attention in view of the focus on motivational coaching. This was the Birmingham OwnHealth programme commissioned by the Birmingham East and North NHS Primary Care Trust. Pfizer, the international pharmaceutical company, were the main contractors and NHS Direct (featured earlier) were subcontractors. The programme operated from 2006 to 2012 and provided 'telecoaching' that included 'guidance, signposting and motivational interviewing from a trained healthcare professional' [103].

This programme represented telemedicine at its simplest, at least in terms of the technology used (i.e. the telephone). It aimed to promote self-care and behaviour change among people who had been identified as suitable by their GPs (with long-term conditions including diabetes, heart failure, coronary heart disease and COPD). The programme is remarkable for taking, following the establishment of an initial rapport with patients and determining behavioural targets, the lightest of light touches to motivational coaching with, as noted by Nymark et al, an average of just one call per patient per month being made [103].

Year One findings for OwnHealth suggested that people participating in the programme were supported and 'empowered to initiate and maintain behaviour change' - with 'statistically significant quantitative increase in self-efficacy scores' that related to salt intake, smoking and medication concordance. Clinical metrics showed 'change for the better' in HbA1c measures for diabetes; in measures of cholesterol and blood pressure; and, for those who were overweight or obese, BMI measures [104]. Similarly positive outcomes were maintained in the ensuing year with (from the service user perspective) 73% of over 400 respondents saying that 'telephone calls continue to be an acceptable and effective way of communicating with their care managers' [105].

The last word on 'OwnHealth' was in the evaluation by Nymark et al [103]. This included consideration of a comparator (or control) group, also patients of the Trust, 'who were eligible but did not enroll in the program'. They concluded that the 'program is an effective method of reducing the number of secondary care spells for large groups of patients with long-term conditions and lowering the resultant cost of care'.

A fourth study can be noted that explored needs around technologies for people with dementia. The ATTILA (Assistive Technology and Telecare to Maintain Living at Home for People with Dementia) project was an RCT [106]. It involved a total of 495 people with dementia, 248 of whom received AT (including telecare) that directly related to assessments and a well-matched control sample of 247 who received a more restricted 'package' (comprising pendant alarm and non-monitored smoke and carbon monoxide detectors). The 'other' devices (i.e. over and above the restricted package) included reminders and prompting devices, fall detectors, extreme temperature sensors, safer walking (wandering) devices and movement detectors. The study was undertaken in 2016.

A key outcome of this trial was a pointer to the sheer complexity of the range of devices that were seen as needed in order to respond to the needs of service users. Clearly, in this context, extreme care was necessary to ensure that appropriate assessments were made by staff (in consultation with family carers) who necessarily had requisite skills and good knowledge of potentially applicable technologies. Having said this, the trial identified that 'assessment recommendations were routinely disregarded at the point of installation', adding that 'it is, therefore, unlikely that assistive technology is being deployed in a way that will result in benefits for recipients'.

The four studies above (together with those noted for the preceding period - for England and the rest of the UK) represent just a few of the telemedical *hors d'oevres* in advance of or alongside the main dish of the decade – the Whole System Demonstrators (WSDs). The WSDs were promoted by the UK Department of Health for England and served up from 2010. This and, later, the UK-wide DALLAS programme, are explored below. Broadly speaking DALLAS represented a moving on from the WSDs. It at least, in part, it signalled recognition of the potential inappropriateness (for evaluation of telemedicine initiatives) of the RCT-based methodological approach. The inclusion of a further study below, this time of 'Flo', an app, signifies how technologies, through their operation via mobile, as well as fixed, devices are now transforming the very nature of telemedicine – with some now starting to deliver more fully on its largely unfulfilled potential for patient empowerment.

The Whole System Demonstrator (WSD) Project

The WSDs were planned in order to establish, for once and for all, an evidence base that would prove telemedicine (or, rather, telehealth and telecare) to be cost effective and, therefore, an appropriate service approach for mainstreaming (see Plate 13). The WSDs were to (according to Liddell et al) 'gather evidence … by deploying telecare and telehealth services covering a resident population of more than 1 million across three areas of the country with funding of £31m' [107]. The patients and service users lived in three areas – the London Borough of Newham (an urbanised and ethnically diverse area) and the counties of Kent (with an urban and rural 'mix' Southeast of London) and Cornwall (mostly rural and at the south-western extremity of England). The conditions embraced by the study were diabetes, coronary heart disease and COPD.

Professionals concerned with the place of telemedicine (including telecare) within England's range of health and care services awaited the outcomes of the WSDs with bated breath - hoping that these would echo the findings of

Plate 13: Whole System Demonstrators
Department of Health Brochure (2008)

many methodologically mixed and generally smaller, project evaluations. Liddell et al reported that ‘local services are to a certain extent holding back until its results are published’ [107].

Doughty was one of several commentators to report on the WSDs. He noted that outcomes had at least been positive in terms of reduced emergency hospital admissions, but there (literally) was a high price to pay for the technologies [108]. Subsequent reductions in the cost of the technologies would, he intimated, have improved the cost-benefit equation. Steventon et al and Bashshur et al also noted the outcome relating to reduced hospital admissions, with the former opining that impact depends on the type of technology and how it is used, as well as the nature of care that is subsequently provided’ [109, 22].

In sum, it can be stated that the outcomes of the WSDs, in not strongly evidencing cost benefit of telemedicine (telehealth and telecare), were a disappointment for many of those who had waited and *expected* something different. A follow-up study in Northern Ireland by McElnay et al [110], noted below, broadly echoed the WSD findings.

This meant that the position of telemedicine in the UK, at least from the point of view of clinicians, was little changed from 2010 when the WSDs began. As was the case for telemedicine throughout all of the UK, it was generally speaking a matter of carrying on, very often with precarious funding, with localised initiatives.

Why didn’t the WSDs provide the expected outcomes? The points made earlier in this chapter regarding RCTs are relevant here. In addition, a response to this specific question in respect of telecare was sought in a study named UTOPIA viz. ‘Using Telecare for Older People in Adult Social Care’ [111]. This took place from 2016 to 2017. It involved surveys with senior staff of the municipal authorities in England that were responsible for adult social care. The responses (from over 100 providers) found variation in the emphasis that they placed on the ‘needs telecare is intended to meet’, though expected priorities were stated around managing risk / promoting safety (61%); delaying and reducing the need for care and support (58%) and enhancing people’s quality of life (55%). A mixed picture was found regarding who undertook assessments (for telecare provision) and where these took place.

But whilst providing much detailed information on services, the central observation made by Woolham et al was the answer to the question noted above about the expected WSD outcomes [111]. They affirmed that the fact of the WSDs not finding the expected benefits may have lain in ‘the ways in which telecare was used’. In helping explain this they observed that the WSD ‘trial did not control what devices were installed’ and that it was concerned with the 'usual telecare' deployment where each of the three areas sites were required to 'design and procure their own telecare systems'. The focus of the WSDs was, they opined, on a 'rapid up-scaling rather than achieving a better understanding of how existing telecare technologies are adapted and used, and how to support their use'.

The WSDs were done. Their outcomes served to support the perspectives of those who opposed the further development of telemedicine. Telecare, meanwhile, continued to be in the mix for social care service provision – where providers who were aware of the WSDs in most cases *and based on their direct experience* generally (as found in the UTOPIA study) continued to believe in its efficacy.

In the background during this uncertain phase, there were, furthermore, some telemedicine successes. But much of the 'news' around these remained unannounced and unnoticed because telemedicine, in the areas concerned, was already accepted practice – in the way that the telephone was used by GPs to consult with their patients; that hospitals routinely were sharing and transferring images (e.g. within radiology services); and in the use of video-consultations to consult with people in grouped settings (such as care homes or prisons) or individually for e.g. telepsychiatry and speech and language therapy. Telemedicine had at least in part, therefore, already quietly penetrated the bastions of the NHS. Telecare services, meanwhile, carried on more or less as they had been for the prior decade.

<u>Telemedicine Initiatives: Scotland</u>

Telecare, since its early inception in the form of social alarms, had an important place in Scotland. And, as noted earlier in this chapter, by the early years of the new millennium Scotland had established its position as the foremost within the UK for a wider range of telemedicine initiatives. The fact that this was the case reflected the activities of a number of clinicians and others who were pioneers. Their motivations, in large part, stemmed from the challenge of providing health and support services (as noted earlier) to the country's rural, remote and island communities.

A pioneering telecare service example was noted earlier in this chapter (MECS in the Central Region). And the first specifically telemedicine service (noted in the TEIS database) was also reported for Scotland. What is more, telecare in Scotland from its outset (and in contrast at least with England and Wales) was noted in this chapter as having in many cases endeavoured to develop in a way that addressed issues of health. Illustrative of this was the MECS service, in 2004, which was exploring the use of devices in the home that could both improve people's safety (e.g. with smoke, heat and gas detectors – devices that would become commonplace for telecare) *and* enable the monitoring of wellbeing through both active and passive devices (including fall detectors) and temperature sensors (helping guard against hypothermia). A further element of the service that can be noted was its utilisation of bed epilepsy sensors to identify and provide alerts when a user experienced a tonic-clonic seizure (*Endnote No. 49*).

Notable also, to the west of Edinburgh, a service restructuring had been going on in West Lothian. Part of this included the development of new grouped housing developments that involved what was labelled as 'smart technology'. The first of these was completed in 2002. The project, 'Opening Doors for Older People', linked with the notion, relatively newly promoted in the UK, of 'housing with care' – i.e. a form of sheltered housing built to good space standards, with a range of built-in (telecare) technologies and on-site care social care and health support. Practically speaking, the West Lothian initiative offered little that was new – but it was glamourised in the promotional material of telecare companies whose wares were installed (or 'on offer' to residents).

An evaluation of the merits of the initiative was timely and useful. Welcome therein was the pointer to its endeavour to create a culture that was very different from that traditionally encountered in care homes and sometimes echoed in sheltered housing. That culture, in the new initiative, involved staff as catalysts as well as support workers – with older people encouraged to adopt active lifestyles. It resonated with the theme of (and recognition of the importance of) 'empowerment' that is a key theme in this chapter.

Bowes and McColgan reported that the aim of the West Lothian project was to 'promote independence … and provide support rather than care' [112]. Assessments of the needs of residents, reflecting the empowerment objective, were noted as (aside from relating to some basic telecare technologies) always considering what other technologies might be helpful and respond to people's needs and choices. Their work involved personal interviews. And, as is the norm for such evaluations, the overwhelming response of residents was positive [112]. This follows what the author of this chapter has pointed to as reflecting a methodological fallacy [9]. After all, residents within 'schemes' that provide them with support (and which offer accommodation that may be more suited to them than their previous home) will have chosen to move there and would not, in their responses to questions, be likely to 'bite the hand that feeds them'.

Most important among the conclusions of Bowes and McColgan was, perhaps, their assertion that 'the technology was only part of a much broader change in their [the users'] lives' - though, they indicated that its *specific* impact was hard to isolate [112]. The question arises as to whether similar changes in people's behaviours or service outcomes would have been equally achievable in other housing contexts (whether or not within 'schemes').

Somewhat remarkably, and possibly tarnishing the 'Opening Doors' legacy, is that a subsequent Scottish initiative that reported (in 2018) the West Lothian Health and Social Care Partnership as having 'an initial *lack of appetite* [my emphasis] for HMHM [home and mobile health monitoring] in primary care' with staff turnover … [being] problematic at times' and a reluctance to 'navigate complicated equipment purchases through the NHS procurement systems' [113].

More emphatically within the arena of telemedicine, was the King et al study of telemedicine adoption in rural GP practices in Scotland, during the first decade of the new millennium [114]. This noted, following a postal survey and interviews with 19 GPs and 10 nurses, 'widespread scepticism' about potential clinical applications of telemedicine with it being felt that it 'would not fit easily into organisational routines of the practice'. 'Slow and piecemeal' uptake of telemedicine was evident, despite what the researchers regarded as its relevance to primary care being 'arguably greatest in the remote and rural context'. At least, however, they found some positivity among GPs regarding the use of computers - though nurses were 'more likely to find (them) intimidating and time-consuming' [114]. Overall resistance to or wariness of telemedicine among both groups was evident in their attesting to the extra benefit of physical proximity (smell, touch, etc.) when consulting with or treating patients.

But a decade after the King et al study, and in the aftermath of 'Opening Doors', a momentum in Scotland towards service integration (health and social care) was being maintained. And by 2015 (not without some justification) claims were being made for the country, even within the wider European context, as 'a recognised leader in the fields of telehealth, telecare and eHealth' with Scotland 'playing a lead role in the spread and adoption of ICT-enabled integrated care' [115]. Adding to the momentum was, in 2016, the Scottish Government legislating for the integration of health and social care within single bodies (*Endnote No. 50*). In so doing it followed the lead of Northern Ireland where such integration, at least in terms of that country's governance (and as noted later), took place in 1973.

A notable Scottish telemedicine initiative in the more recent years is the tele-ophthalmology service that operates in the NHS Forth Valley region. Trials started in 2018 and it 'became part of usual practice' in both a hospital and a minor injuries unit. Crucially, however, the service was developed with the support of 12 tele-optometry practices including the furthest possible location within the country of the Shetland Islands (110 miles offshore from mainland Scotland) (*Endnote No. 51*). The ongoing evaluation is considering the merits of real-time and 'store and forward' approaches using different visualization techniques' [116].

Of current importance (in November 2020) is a comprehensive evaluation of the Near Me (Attend Anywhere) video consulting service that was introduced in two of Scotland's health board areas in July 2019. The context was one that related, regardless of particular clinical benefits that might ensue, to the desire to 'improve connectivity and reduce isolation for Scottish citizens'. The service was subsequently rolled out to other health board areas such that (per Wherton and Greenhalgh) it was the medium for almost 7000 consultations 'across approximately 35 different clinical specialties involving 180 clinical departments and 64 GP services' [117]. 94% of the activity involved a link with hospitals. The fieldwork for the evaluation, it should be noted, was undertaken before the COVID-19 pandemic (see Phase 5) and before further evaluative work was undertaken that related to the scaling-up more widely of the service.

The research, undertaken in seven of Scotland's health board areas, was essentially qualitative though combined with 'descriptive quantitative data' [117]. The qualitative element included 140 interviews with 'doctors, nurses, allied health professionals, healthcare and third sector support workers, clinician and non-clinician managers, administrators, IT support staff, patients and their relatives'. In other words, a truly wide range of stakeholders was reached.

A few of the many findings from this study are reported here. Wherton and Greenhalgh noted, for instance, that the technology and related services were 'most readily implemented' for follow-ups of patients with chronic but stable conditions [117]. There were challenges, as expected, for some patients who had low digital literacy or were hard of hearing; but a key advantage for them lay in the reduced travel. A minority of interviewees were opposed to video-consulting on principle (though these were noted as having little or no experience of the technology) with the strongest support being evident in areas (Grampian and Highland) 'which had a longer history of using video consultations'. In conclusion the service was 'generally (but not universally) seen as enhancing the existing service'. The model of care, Wherton and Greenhalgh averred, worked best where there were pre-existing relationships of trust.

<u>Telemedicine Initiatives: Wales</u>

For telemedicine in Wales, four 'applications operational or planned' in 1997 had increased to 27 in 2001 and 40 in 2002. Just 10 such initiatives were, however, reported in the TEIS database in 2004. A 'comprehensive telemedicine study undertaken by the Welsh Development Agency' around that time was ambivalent. It asserted that 'the pattern of adoption of telemedicine … is driven by benefits to clinicians in urban areas. Benefits for patients in rural areas is … currently, not a significant direct driver' … with 'benefits for patients … not one of the highly rated advantages for telemedicine' [118]. Hence the early period of the new millennium was (for telemedicine) one of uncertainty.

Important, however, was a telemedicine project that focused on cancer and launched in 2005. It used web-cameras and laptops to foster clearer patient pathways and integrated team working in south-west Wales. The strategic context was set by the launch (by the National Assembly of Wales, the country's main governing entity) of their 'Informing Health Care' initiative. The first phase of the work in relation to cancer was pre-occupied with the technologies (essentially video equipment) provided to different sites and overcoming challenges around its usage [119].

By 2008 this project was reported as 'pivotal to the infrastructure of the tumour sites (linking with) specific … multidisciplinary teams' It had expanded into 'non-cancer services'. A specific store and forward teledermatology service (for skin lesions) was launched and there were aspirations to develop a palliative care service [90]. Overall, a range of benefits were reported for the project including 'reduced waiting time for specialist opinion'; the 'secure transmission of pathology images both within and outside the [NHS] Network; support to single-handed clinicians in remote sites; … reduced prescribing errors on chemotherapy'; plus better reporting and the increased ability for the health trusts concerned to meet 'targets and standards'.

Meanwhile, although grant funding in Wales was provided in the period 2006-2008, telecare languished on the sidelines. The overall number of telecare service users in Wales was far less *per capita* than Scotland and there was a distinct lack of partnership working (*Endnote No.52*).

Plate 14: Teledermatology Service
Welsh Government (2015)

A strategy launched by Welsh Government in 2015 placed more emphasis on health and social care service integration [120]. This was backed up with duties around joint planning that was enshrined in Welsh Government legislation. The strategy explored the merits of telehealth and telecare in the broader context of AT, with specific mention being given to apps, the IoT and video-consultations. A successful teledermatology service in Cardiff that enabled GPs to exchange images with consultant dermatologists for advice was cited (see Plate 14). In 2013-14, this had been utilised by 65% of GP practices in the city and the adjoining Vale of Glamorgan area.

While the number of telemedicine initiatives noted in the strategy is small, the ambition is clear, with different initiatives subsequently being put in place during the ensuing period. Notable is the impetus given, in the context of closer integration between health and social care, to people's empowerment in a 'Wales where citizens have more control of their health and social care, can access their information and interact with services online as easily as they do with other public sectors or other aspects of their lives, promoting equity between those that provide and those that use our services'.

An example of subsequent developments is the 'Connecting with Telehealth to Children in Hospital and Healthcare (CWTCH Cymru)' initiative in south east Wales launched in 2019 (*Endnote No.53*). This provided video-consultations between children and adolescents and mental health service providers and had, even on the basis of just one year of operation, 'demonstrated that telepsychiatry in [mental health services] is a highly suitable adjunct to routine ways of working, once people became familiar with this way of holding appointments … rated as acceptable and satisfactory by patients, families and clinicians' [121]. Aneurin Bevan, noted earlier in this chapter as being the primary mover in establishing the NHS, would have been especially proud – this initiative having been put into operation in the health board are that carries his name.

Also a step forward for Wales was its establishment of a national video-consultation service. This was a direct response to the COVID-19 pandemic (that is the starting point in this chapter for Phase 5).

Telemedicine Initiatives: Northern Ireland

In Northern Ireland, the benefits of telecare in the context of a hospital discharge scheme (the 'Going Home, Staying Home' project in Derry City; and the 'Tyrone and Fermanagh Telecare Project') were reported on by Fisk [122]. The first of these (Derry City) involved the use of SAFE21 (described earlier) and was concerned to facilitate early hospital discharges for COPD patients. A saving of 85 bed days over 9 months (for 15 patients) was reported.

For the counties of Tyrone and Fermanagh (in the west of Northern Ireland), following personal interviews made with 100 telecare service users, Fisk reported the significance of the technologies used, not so much in relation to their improving the home environment and facilitating independent living, but in simply the maintaining of the *status quo* at a time when the (older) people concerned were particularly vulnerable (to e.g. a potential move to a care home) [122]. A key point was also made regarding the intrusiveness of the technologies as a factor influencing user (non)acceptance, an issue previously explored by Fisk [62].

That there should have been closer integration between telecare and health agendas would, perhaps, have been signalled by the fact that Northern Ireland was the first of the four UK countries to legislate for integrated health and social care services (these commencing in 1973). However, as noted by Ham, albeit not specifically with telecare and telemedicine in mind, Northern Ireland was the slowest of the UK's four countries to exploit the potential benefits of that integration [123]. One factor militating against a bringing together of such services was the location of the country's main telecare service providers (housing associations) not being coincident with the health and social care trusts.

Possibly relevant, in addition, is the fact that there was limited cross-border influence (from the Republic of Ireland) where, whilst community alarm services were relatively widespread (though not generally having evolved towards telecare), issues around telemedicine had only been lightly touched on. The Republic of Ireland's 'Positive Ageing Strategy', however, called for 'recognition that the new technologies can offer new ways of supporting people with a disability or chronic illness … and can play an important role in prevention and self-care'. It added that 'telecare and telehealth services are becoming increasingly recognised as an effective way to prevent or manage some health conditions effectively' [124].

Returning to Northern Ireland, a project of note related to medical abortion through online telemedicine. This service was not without controversy in a country where a sizeable part of the population has roots in Catholicism. Aiken et al reported the success of the initiative (for all-Ireland) over the three years to 2012 [125]. Women could obtain the necessary medication online, have 'real time instruction about how to use the medication, … help and support during the abortion process', more widely benefiting from support via email or instant messaging. This was in a context where 'normal' visits to the doctor's surgery or hospital consultations were often not appropriate because of both legal restrictions on abortion and, for many, the stigma that pertained. The efficacy of telemedicine for abortion services can be noted as having increased in the context of the COVID-19 pandemic (see Phase 5).

Finally, in this more recent period, the follow-up study in Northern Ireland (to the WSDs in England) is of particular relevance [111]. It was framed similarly to the WSDs. Telehealth was recognised in terms of devices linked to 'telecare' services that would 'allow care providers to monitor information on patient vital signs' – where deviations from the 'norm' would alert the 'healthcare provider to the possible need for intervention'.

The study took place during 2015 and 2016 and focused on just under 4000 patients with diabetes, heart failure, COPD and hypertension. But the 'indifferent' (in terms of cost-benefit) findings from the WSDs were echoed. There was, according to McElnay et al, 'no evidence within the dataset of any marked impact of telehealth services on hospitalisations and hospital based service usage' [111]. Poor targeting of the project was seen as a factor in this, with it being affirmed that any programme of telehealth service development 'should include strict protocols for patient selection so that only those who are likely to gain benefit … receive the service'. There was, however, a 'positive impact on mortality'.

Overall, and to its credit, the study used a mixed methods approach. It had recognised, therefore, that over quantification (as signalled earlier in this chapter) could result in an inaccurate picture. Data for patients included in the study were added to through focus groups and personal interviews. But the sample sizes for the focus groups were small and hence little credence should be given to the fact that 15 people, in total, for groups held in five Health and Social Care Trusts, were 'unanimously positive about telemonitoring'. Interviews with many professionals, furthermore, foundered because of their ignorance of tele-monitoring. Finally, a claim made about patients being 'empowered to be more active in their own self-care' rings hollow in view of the limited attention given in the study to patient behaviours [111].

Ringing more true, and based on experience elsewhere, is the fact that doctors (eleven of whom were interviewed) 'called for some published evidence of telemedicine before the system was developed'. Similarly echoing other findings was the, sometimes unbridled, enthusiasm of some 'health professionals' who had developed new skills and who cited the 'convenience' of telemedicine for both them and their patients.

Maybe the Northern Ireland initiative (in the wake of the WSDs) and its evaluation helped raise awareness and to signal further progress towards the use of telemedicine and the fulfillment of the vision of service integration. But it was almost certainly the last study of its kind in the UK to have this particular focus. Overall, however, uncertainty abounded and much of the focus in the ensuing period was on developing the electronic care record - embracing health and social care and reflecting, therefore, that integrated vision that had begun to be shaped half a century ago (*Endnote No.54*).

Three Million Lives (3ML) and the DALLAS Programme

After the WSDs, more attention was given by the Department of Health to telemedicine through a misguided and numbers-driven campaign that carried the title '3 Million Lives' (3ML). It was initiated in early 2012 and sought to capitalise on the positive WSD 'headline' findings around e.g. lower mortality rates and reduced emergency hospital admissions. The '3 million' was in reference to the estimated number of people 'with long term conditions and/or social care needs who could benefit' from 'telehealth and telecare'. Responsibility for leadership of the 'campaign', aside from the Department of Health, was assigned to industry linked bodies (The Association of British Healthcare Industries, Intellect, and Medilink UK) and, the body including industry and service provider members, the TSA (*Endnote No.55*).

The initial chutzpah associated with the 3ML initiative was short lived as ambivalent results were emerging from the WSDs. These reports of the lack of clear benefits for telecare and telehealth (contrary to the initial 'headlines') called for sober reflection. The foundations of the 3ML campaign were, as a result, immediately cracked. According to a briefing given to a committee of the National Assembly of Wales, the claims of 3ML were reported as incorrect by the British Medical Association; the approach was 'very top down'; and, being industry led, it was a perceived as a 'sell to care practitioners and service users/patients, with positives over emphasised and negatives glossed over' (*Endnote No.56*).

Following the abject failure of 3ML, the Department of Health quickly shifted its attention and earmarked funding for the DALLAS programme (to 'deliver assisted living lifestyles at scale'). This £37million programme operated from 2012 to 2015 and was funded by the Technology Strategy Board (therefore England) and the Scottish Government. It was about 'scaling up the learning from the Whole System Demonstrators, but *widening the scope* (my emphasis).' (*Endnote No.57*). Significant was the fact that the DALLAS methodology was strongly qualitative - including 'semi-structured e-Health Implementation Tool-kit-led interviews' and, on a periodic basis, the use of observational data and quarterly reports.

A wide variety of stakeholders were engaged and four major projects were funded [100]. The projects fell under the umbrella notion of assisted living. They experimented with consumer engagement and co-design. Two of the projects, one in England, one in Scotland, linked with NHS bodies and had particular significance for telemedicine.

Areas of challenge for DALLAS were anticipated. Devlin et al reported on 'perceptions of inertia and resistance to change in the NHS (when) compared to the speed of change in the business world' [100]. These included the 'need for resilience in the face of challenging socio-political and economic factors in the external environment' (e.g. with austerity measures, economic recession, and the difficulties faced by NHS England at a time of restructuring which 'resulted in uncertainty and disruption along with a fear of role redundancy'). Devlin et al added the 'inherent tension between embracing co-design and achieving delivery at pace and scale' within a programme where emphasis was placed 'on more personalized tools and services … viewed as part of the solution to the challenges in current healthcare and well-being provision' [100].

Within the DALLAS programme, was the Mi ('More Independent') project in the north west of England (see Plate 15). This linked with the Liverpool NHS Primary Care Trust and explored the consumer market for assisted living products. One aspect of the philosophy underpinning the project considered people's greater awareness of new services and technologies that would help to drive growth 'in the market'. It was imagined, therefore (and subject to scaling up much more widely than the city of Liverpool), that telemedicine could at some point be carried forward on a tide of consumer demand.

Plate 15: Mi Liverpool – DALLAS project
dhaca.org.uk (2015)

The outcomes of Mi Liverpool are of importance to telemedicine. One key point, noted in a summary report on its implementation, was made by one of the staff (and is inserted on Plate 15). This affirmed that 'our lead clinicians stopped asking about the evidence-base because they'd heard citizens say the technology and self-care makes their life easier!' The report on the project's implementation put this into context [100].

That the DALLAS programme had some success is undeniable. For telemedicine, however, it may only have made a small dent in the carapace of the NHS. Therefore the 'the next step [made] toward deployment of … technologies for health and well-being at scale in the UK' (reported by Devlin et al [100]), may have been just a short one. Having said this, the ambition was important. Implementation 'themes' of each DALLAS project were associated with substantial challenges. These started with the desire to implement 'new, multi-agency, heterogeneous partnership models' and ended with the desire (reflecting the underpinning community asset based approach) to pursue co-design methodologies with a range of stakeholders, including end-users. Somewhere in between these were challenges around technical interoperability (often lacking) and information governance systems (often not geared to new ways of working).

It is unsurprising in this context that, with the programme funding coming to an end, it is 'lessons for consideration' (providing 'rich learning') that are offered for DALLAS rather than definitive conclusions [100]. Two of these stand out as preconditions for other initiatives. They are concerned with project resilience; and having the time to 'navigate' the landscape of 'socio-technical change against a backdrop of challenging wider uncertainly'. A strong pointer was also made towards greater integration between health and social care.

End of Phase 4: To 2020

As the end of Phase 4 approached and, as signalled in some of the initiatives noted above, the UK telemedicine landscape was beginning to change. An attempt was made by the Department of Health to renew energy around the digital health, not just from the technological perspective but also from a viewpoint that was concerned to empower patients [126]. The affirmation made in its 'Next Steps on the Five Year Forward View' was that the NHS needed 'to leverage the potential of technology … enabling patients to take a more active role in their own health and care' [127] (*Endnote No.58*). It also reiterated a call (made in the original 'Forward View' published in 2014) for 'triple integration of primary and specialist hospital care, of physical and mental health services; and of health and social care' – echoing approaches, therefore, that were increasingly evident throughout the UK.

Important from the point of view of the changing landscape, however, was the pointer by the Department of Health to the growing role of apps [127]. They announced the opening of a 'NHS Digital Apps Library' and the intention to test and give recognition to apps 'assessed by a process developed by NICE'. The NHS Apps Library is now managed by NHSX. The number of assessed and approved apps, had exceeded 70 by the beginning of 2019 [128] stood at 97 at the time of writing (*Endnote No.59*).

<u>Flo (Florence)</u>

One of the apps that will have come within the Department of Health and NICE's purview was 'Flo' (or 'Florence', after Florence Nightingale whose key early role in nursing was noted earlier in this chapter) and its use in relation to mindfulness-based cognitive behavioural therapy (CBT) and smart messaging. A study, in 2018, of the app's use in the cancer care context, was undertaken in the East Midlands region of England. It engaged with 51 patients and sought to address what had been their high levels of depression and anxiety. Parallel analysis was undertaken for 21 patients who declined to take 'advantage' of the messaging service [128].

A reduction was found in symptoms of depression for the patients who followed the sessions over a period of eight weeks. There was also a significant difference, using appropriate statistical tests, when compared with the symptoms of non-users. Having said this, some caution needs to be exercised in view of sample sizes being small. The researchers were, as a consequence, circumspect about their findings, affirming that the 'results *suggest* [my emphasis] that those using smart-messaging have significantly better completion rates [for the programme] and improvements in depressive symptoms'; and that in respect of CBT, 'the study suggests that integrating smart messages … is a promising, cheap method worthy of further investigation in improving clinical effectiveness and efficiency' [128].

'Flo' is relatively well-known in other clinical contexts and is seen as offering a number of benefits. Cund et al, for instance, reported on the first six months of an initiative in Nottinghamshire (also in the East Midlands of England) [129]. In their study the views of 37 patients with diabetes, COPD, hypertension and Asperger's Syndrome were obtained, together with those of 33 community nurses. The study reported a remarkably positive outcome. 94% of patients felt 'that the system was already helping them to manage their conditions better'. This was on the basis of their sending regular (daily) vital signs readings and having contact with a nurse or doctor in the 'general practice team' on average (and respectively) 1.2 and 0.6 times a month. A majority of clinicians (84%) in their study considered that 'Flo helps their patients manage their own health and well-being'. The positive outcome for the 'light touch' aspect of this initiative can be noted as echoing that which was indicated for Birmingham OwnHealth, described earlier in this chapter.

More generally, some specific challenges and opportunities around mHealth (i.e. using mobile devices, including through apps) were explored by Lynch and Fisk [7]. Their study focused on the security of the personal data that were exchanged via such technologies and the associated issues of people's consent in an 'ever-evolving digital environment'. Certainly such matters, they affirmed, must not be taken lightly, nor the associated matter of who owns the data in question – with Lynch and Fisk asserting that 'health data (that relates to the body and its functioning, medication and therapies – current or past) ownership must reside with the person (patient), albeit entrusted to the providers of mHealth services' [7]. They added that 'ownership of any mHealth device that is used to store or transmit data, in this context, is, arguably, immaterial'. Roberts et al have more recently stated that 'questions of who owns the data are still very much matters of contestation' [39].

Overall, as 2020 approached, and following the uncertainties arising from the WSDs, it is considered that moves towards telemedicine's wider adoption started to regain momentum. Further interesting and increasingly suggestive studies were undertaken, 'suggestive' in the sense that there were more pointers to telemedicine successes - notably in relation to low-cost interventions such as messaging or the use of apps (such as that relating to 'Flo' above); and the wider availability of service platforms that included the capacity to undertake video-consultations (e.g. Near Me in Scotland). And whilst the use of apps would continue to gain momentum, video-consultations would soon become of crucial importance (see Phase 5).

The two decades from the turn of the millennium were, therefore, important years. This chapter has shown how early ideas and experiments at last were giving rise to potentially viable telemedicine services. But linked with these and some of telemedicine's areas of operation remained the question of service viability. The evidence base had left much to be desired.

In sum, Greenhalgh et al averred, in respect of just one specialism viz. heart failure, that the literature on telehealth … is a policymaker's nightmare: vast, fragmented, heterogeneous, of variable quality and with no clear answers to the question of what technologies, supported by what service infrastructure, to provide for whom' [130]. Different reviews of studies found little evidence of telemedicine's efficacy. Wootton, for 22 systematic reviews relating to five chronic diseases viz. asthma, COPD, diabetes, heart failure and hypertension, regarded the lack of evidence of telemedicine's efficacy as 'surprising and disappointing' [131] But at the same time he pointed to methodological shortcomings not just because of factors already noted earlier in this chapter but also on account of 'publication bias' (where there is a greater predisposition to publish positive study outcomes). He called for longer evaluative periods.

Greenhalgh et al studied six technology-supported programmes ('case studies') that signalled the range of approaches within telemedicine [130]. These included 'video outpatient consultations, global position system tracking for cognitive impairment, pendant alarm services, remote biomarker monitoring for heart failure, care organizing software, and integrated case management via data sharing'. From among these, the planned case study that related to video outpatient consultations is noted here - this including a 'nurse-led heart-failure run from 4 community hospitals, using predominantly FaceTime. But 'in a busy and financially stretched' organisation, they reported that progress 'was slow and required multiple organizational workarounds'. Technical challenges abounded e.g. 'forgotten passwords, poor connectivity' and outdated software [130]. Ultimately video-consultations for this group were put 'on hold' but have, it can be noted, have been reintroduced in the COVID-19 context (*Endnote No. 60*).

For telecare, during the period from the millennium, telecare services began to succeed in addressing health agendas at least in some ways. There is no denying, after all, how health issues were (and remain) important to increasing numbers of people wanting to stay at home but who may benefit from services accessible through telecommunications networks.

Unfortunately, however, the path of telecare services has often tended to be one that has been, as signalled in the thinking behind 3ML, technology led. It has, therefore, danced more to the tune of commercial interests rather than responded to the changing aspirations of people (patients), failing to adequately explore how new technologies could work for *them.* Many clinicians, meanwhile, as well as retaining their doubts about telemedicine, have been cautious about any *real* fusion of health with social care, let alone countenancing new relationships that might truly empower their patients.

Towards the end of this period, the NHS Long Term Plan represented another invocation for clinicians to take on board the telemedicine agenda - lamenting, from a clinical perspective, that 'the way we deliver care remains locked into the service model largely created when the NHS was founded in 1948' [126]. The Plan noted, perhaps in anticipation of the outcomes of the Topol Review (see Plate 16) the release of which was at that point imminent, the breadth of innovations and ideas under the umbrella term of 'digital health' - including different kinds of 'home based and wearable monitoring equipment'; the merits of video-consultations; and the notion of 'digital-first primary care' where patients would have new choices about how they would engage with their local health services. For hospitals, 'Technology', the NHS Plan stated, 'means an outpatient appointment is often no longer the fastest or most accurate way of providing specialist advice on diagnosis or ongoing patient care' [126].

The Topol Review, led by Dr Eric Topol (a US cardiologist), did not pull its punches [132]. It offered a picture of healthcare services for the immediate future and was informed by rapid developments around telemedicine – which was, in itself, first on Topol's 'top ten digital health technologies' (ahead of health-related technologies such as smartphone apps; sensors and wearables; AI; robotics and genomics). Central to Topol's work was the implications of such technologies for the health workforce. But, importantly, he also gave a nod to their relevance for those working in social care.

Plate 16: The Topol Review
Chaired by Dr Eric Topol (2019)

In respect of that aspect of AI concerned with 'deep learning' (that is being operationalised step by step in the telemedicine context) it can be noted that Topol had previously pointed to its ability to diagnose some forms of cancer 'as well as or perhaps even better than board-certified dermatologists; to identify specific heart-rhythm abnormalities like cardiologists; to interpret medical scans or pathology slides as well as senior, highly qualified radiologists and pathologists respectively; to diagnose various eye diseases as well as ophthalmologists; and to predict suicide better than mental health professionals' [133].

Important were Topol's three 'principles' that should, he considered, underpin future service approaches. These, aside from affirming the need for suitable training and guidance 'grounded in real-world evidence', called for patients to be regarded as partners – empowered, supported in their health knowledge (literacy) and with assurances about 'equitable access' [132]. The third principle related to a matter that, in the context of telemedicine, has been largely overlooked. It is the fact of telemedicine (and other digital health) tools facilitating better and more meaningful contact between clinicians (and others concerned with service provision) and their patients. He called this 'the gift of time' which 'could be turned back to patients … to use the future to bring back the past' – i.e. countering what might otherwise be a greater distancing of health care providers from patients that could arise from the use of technologies [132]. This, it is suggested, can be linked to the kind of contact that is not just concerned with hands-on care (though this is part of the mix) but also with such matters as motivational coaching and the support for and conveying of knowledge to patients, carers and others.

At this point, despite a growing number of services and the futuristic 'spin' that was often adopted, it could not, in early 2020, be truly stated that telemedicine in the UK had found itself a fully 'established' place - either in the NHS or more widely. But more hearts and minds were being won over and there was, of course, the demographic reality of growing cohorts of technology savvy and more demanding patients of all ages that were beginning to call for change. Why couldn't, many of them were asking, it be possible to contact health services in the same way as banking services? Why do some clinicians still hold so vehemently to the old ways of doing things when we now have (and *they* now have) new and very different digital tools to use.

And although the answers to such questions have not been fully given, at least some technological barriers are, as indicated in this chapter, being overcome with e.g. expanding communications networks and the increasing sophistication of devices used within telemedicine services. And as noted earlier, telemedicine has been quietly embedded in some parts of the NHS; and there has been (through e.g. the recognition given to 'Flo') increasing use of apps. How the COVID-19 has, or may, push things further forward is addressed in Phase 5. And so things are changing in UK telemedicine. A decentralisation of services is certainly taking place. Maybe also, a little justice is also beginning to be done to the matter of people's empowerment and greater equity being attained between patient and physician.

Looking back over a period of more than four decades (to the early part of Phase 3), a reminder is needed regarding how some of the arguments in favour of telemedicine were being rehearsed. Notable was Reiser, in 1978, when he pointed to the way that telemedicine could enable physicians to gain prompt access to specialist knowledge and gain through the potential for speedier diagnoses; better use of medical resources. He noted that 'in a decentralized medical environment he (the physician, *sic*) might well exercise and trust his own judgment more, conduct a more personalized practice in which he was really mindful of his patients' human needs, and even settle his practice in regions shunned because of their isolation from medical centers' [18].

Reiser's prescience was noted. His remarkable words included the possibility, through technologies, of the clinician becoming 'free to develop his (*sic*) medical skills to their highest point, to increase what is … a positive balance of benefits over harms'. There was, however, a linked warning about what Roberts et al pointed to as the way that, through the use of technologies to gather data, 'health can be parameterised in terms of norms – of body temperature, cholesterol levels, cortisol levels, heart rate, blood pressure and so on' – with a consequent loss of understandings that can come from lack of consideration of the 'whole person' [38]. Reiser was, however, ahead of them [18]. He opined that 'if physicians in general come to accept a fundamentally mechanical view of human beings, in a world that is more and more enamored of technology, the prospect for the future of medicine is extremely disquieting'. He added that 'machines inexorably direct the attention of both doctor and patient to the measurable aspects of illness, but away from the human factors that are at least equally important'… and can 'tend to estrange him (*sic*) from his patient and from his own judgment'. Tudor Hart, in 1988, expressed his concern that doctors 'measured what they saw and did, not what they didn't see and therefore couldn't do' [134]. Topol would agree - with his invocation to the 'gift of time' intended to counter such concerns [132].

On the matter of telecare, this chapter, perhaps anomalously in relation to other chapters in ISfTeH volumes, has made much of its role. Such services, of course, were and remain primarily aimed at supporting (often older) people in their own homes. Telecare has been signalled as increasingly relevant to health – both for clinical health and broader well-being. But because of telecare's general lack of recognition by clinicians, it has only made a modest contribution to the world of telemedicine. As clinical health matters are increasingly devolved to people's homes, however, telemedicine is intruding into the world of telecare (rather than *vice versa*). .

The terms of the intrusion have yet to be agreed. Bashshur et al noted the role of telemonitoring (home telecare) as 'part of a larger chronic care model' [22]. They took a clinical view that linked to the idea of the 'medical home' … 'in which patients assume a greater role in managing their health, while having ready access to their providers who have up-to-date information on various parameters of their health'. The idea of the 'medical home' resonates, of course, with the notion of smart homes, explored by Zallio and Fisk [54] earlier in this chapter.

Those with a perspective of well-being that is concerned to support people's empowerment would shudder at the implications of the 'medical home' – not because of the way in which people (patients) could access medical assistance but because of the implied level of surveillance of the purported beneficiaries. Only a limited sense of relief, from what otherwise might be construed as a ‘Big Brother’ scenario, is afforded by the fact that patients would, in this model and as noted by Bashshur et al, have ‘ready access to their personal health records including long-term trends in their functional status, symptoms and benchmarks’ and ‘tools for participating in shared decision-making together with their [service] providers’ [22].

But with the convergence (or collision) of telemedicine with telecare there is no doubt regarding the need for accord or accommodation. The nature of the ‘accord’ will impact on both the technologies (the devices that people use and the platforms that underpin services) and the roles of professional and practice staff. In both cases old norms must be questioned and some old roles must be discarded or re-shaped. And it is in the current Phase of the UK’s telemedicine history (Phase 5), that a sense is given of the further steps that must be taken.

A Mixed Picture

There is a mixed picture for Phase 4. There have been varied, sometimes conflicting views about the use of telemedicine in its different contexts. Many health professionals and practitioners were wary of or opposed to the encroachment of telemedicine into some of the hallowed service domains of the NHS. Some will, with justification, have been fearful of the organisational impact that could or would ensue. A minority, by contrast had had direct but mixed experiences of the telemedicine pilots and initiatives – relating to which there was a limited evidence base regarding their challenges, failures and successes.

Many people (patients) have also been wary of telemedicine, too. They valued ‘their’ NHS and almost all had cause to be grateful to it at some point in their lives. Its very existence contributed to a sense of secure familiarity that meant it had to be treated with utmost respect – its accolades applauded and many of its foibles and some failings forgiven (albeit with notable exceptions – not explored in this chapter).

But the sands were shifting. Not only was the very fabric of many of the NHS’s great old hospitals crumbling (crumbling again, when we note the reportage of Rivett [1], but so were any excuses that sought to avoid adopting and adjusting to the opportunities that new technologies could bring. The impact of technological developments was, after all, unavoidable. More ubiquitous and capacious broadband networks meant that good quality video-communications became more achievable. And mobile technologies were accompanied by a sky-rocketing number of apps that, whether or not NHS approved, brought access for millions of users to information and services in a way that had been hitherto unforeseen.

Telemedicine in this context (regardless of levels of understanding about it) was gathering new momentum. The NHS and any other health or social care provider in the UK, would have had to be blinkered, ignorant or perverse not to at least to have begun to think about the implications for their services – albeit that some changes based on the technologies could be disruptive. The NHS Long Term Plan, meanwhile, carried the promise of 'digital-first primary care' by 2024 – where 'every patient will have the right to online digital GP consultations' and similar options when using outpatient services [126]. These services will, it affirmed, go 'mainstream'.

It was never a matter of telemedicine replacing what had gone before. But Reiser affirmed over 40 years ago that 'today's physicians must rebel' … [by] 'a refusal to accept bondage to any one technique … He (*sic*) must regard [the technologies] all with detachment, as mere tools, to be chosen as necessary for a particular task' [18]. Whether today's physicians will rebel against the possible overuse of telemedicine is a matter for debate. They *should* rebel if necessary. After all telemedicine must find its *proper* place - complementing and working in harmony with and within health services where the personal 'touch' (and the 'gift of time') are valued.

As we move forward in Phase 5 differences in points of view will come into clearer focus as telemedicine is adopted more widely. But what is increasingly clear, as affirmed by Martin-Khan et al, is that we have been, at least for some conditions and specialisms, 'moving into a period where we are beginning to understand how to appropriately integrate telehealth as a part of mainstream healthcare without losing what makes (it) innovative and vital' [135].

Phase 5 – From 2020: 'Sinking the Titanic?' Into the Future

By any measure, Phase 5 in the history of UK telemedicine will be different. COVID-19 is wreaking havoc with the established order for health services and for the whole fabric of UK society. In this context, we are *all* thrown into an uncertain future where our imaginations and visions for health services more generally, and for telemedicine in particular, are thrown into new relief.

Of course, there is the established framework of health services that is embodied in the NHS. This lays justifiable claim to strong support from the service's users. Furthermore, the history, charted in this chapter, has shown that there are elements of telemedicine already operating within the range of health services provided. Questions now arise as to how wide a place for telemedicine will ultimately be found, or rather as to how further aspects may be integrated within the NHS.

In the first place, it is important to note that, regardless of ongoing debates about the methodologies used in the evaluation of telemedicine initiatives, the NHS will maintain an absolute commitment to service quality. NICE has played an important part in this since 1999 when it was established (and, since 2013, in respect of both health *and* social care). In this context, it can be noted that, whilst not addressed as a topic in its own right, NICE is taking increasing note of telemedicine for a range of different conditions.

NICE, in fact, refer to the challenge of their ‘third decade’ needing to take account of the ‘rapidly increasing’ number of new technologies and the need for them to advise clinicians and other professionals and practitioners regarding their use (*Endnote No. 61*). Hence NICE guidelines for consultations in the context of (e.g.) cystic fibrosis, post-traumatic stress disorder and managing medication in care homes have all pointed to telemedicine, in the form of tele- or video-consultations, as an option to be (respectively) ‘considered’, ‘offered’ or able to be used ‘in exceptional circumstances’. For abortion care guidelines the NICE guidelines recommend ‘community services and telemedicine appointments because the evidence showed they improve access’ to the services in question (*Endnote No. 62*). And for behaviour change (see below) the guidelines (whilst not directly mentioning telemedicine) are clearly cognisant of digital health - including giving consideration to the role played by brief interventions through e.g. the use of apps and online consultations. (*Endnote No. 63*).

Reflecting the new realities for COVID-19, multiple NICE guidelines around service operation now, in fact, point to the need to ‘minimise face-to-face contact by offering telephone of video consultations’ (*Endnote No. 64*). Pertinent to and referenced in these are other guidelines for undertaking ‘remote assessment in primary care’ as put forward by Greenhalgh, Koh et al [136]. Yet further guidelines for video-consultations in the context of COVID-19, not directly linked with NICE, were put forward for mental health services by Johns et al [121]; and around diabetes, cancer and heart failure by Shaw et al [137]. The last of these is particularly interesting by virtue of giving particular attention to the impact of video-consultation on the ‘way in which patients and clinicians interact’. This and related matters led them to affirm that ‘care is needed on the part of health care providers, commissioners and policy makers in rolling out this new service model’.

For NICE, therefore, telemedicine (at least in the form of tele- and video-consultations) is ‘on the map’. The 2020 guideline on behaviour change is an important pointer to this in view of its completion as the COVID-19 pandemic was entering its second ‘wave’ in the UK [138]. Its importance is heightened on account of being concerned with an area of preventative health where telemedicine, in narrow (tele- and video-consultations) and wider understandings around AT (including telecare), resonates loudly with the areas of technological and service developments that are addressed in this chapter. The focus of the guideline is on ‘eating more healthily, becoming more active, stopping smoking, reducing alcohol intake (and) practicing safer sex’. It clearly recognises, therefore, ‘digital and mobile health interventions as options for behaviour change’.

Finally of note with regard to the NICE perspective, with its certain influence on national health policy, is the clear invocation within the guideline on behaviour change that service providers should, whilst giving consideration to digital options, at seek to address risks around ‘digital exclusion’. This gives welcome recognition of the fact that many people who exhibit inappropriate lifestyles may be poor, not be digitally literate, and may lack ‘access to the internet, phone signal and data networks’ (*Endnote No. 65*).

Staying briefly on the topic of guidelines and maintaining something of a forward view, a note on telemedicine related standards and codes of practice that are potentially applicable (all are voluntary) is apposite. The full extent of their adoption, or the level of influence they have achieved, would need to be a matter of further research. But for the TSA Code, noted earlier, there were, until recently, in excess of 100 telecare services ‘accredited’ by that body. The TSA, furthermore, can be noted as having been involved in developing the European Technical Standard CEN/TS 17470 (2020) ‘Service Model for Social Care Alarms’ (*Endnote No. 66*).

With a wider remit and notable internationally is the new ISO standard that replaces TS13131 (the 2014 Technical Standard for ‘Health Informatics – Telehealth Services – Quality Planning Guidelines) (*Endnote No. 67*). This focuses on risks and service quality in relation to ‘healthcare activities’ supported by telehealth. ‘Telemedicine, telecare, mHealth (healthcare supported by mobile devices), medical apps, tele-monitoring, tele-diagnostics and virtual care’ are all included and there is a requirement therein to ‘protect the confidentiality of health records’. Of note is the fact that the ‘quality characteristics’ addressed in the technical standard give attention to (among other things) transparency, accessibility (including the ability of care recipients to make informed choices), and inclusivity (taking account of ‘potential barriers … such as access to computers or telecommunications). Case studies include teledermatology, multi-speciality video-consultation and telemonitoring at home.

Added to these is the ‘International Code of Practice for Telehealth Services’, strongly oriented towards the empowerment of patients (people) and originally framed by the Telehealth Quality Group as a European standard [139]. This now comes under the auspices of the International Society for Telemedicine and eHealth (ISfTeH) and its ‘Standards and

Accreditation for Telehealth Services (SATS) Working Group' (*Endnote No. 68*).

This, therefore, offers some of the context for 2020 (and Phase 5 in telemedicine's UK history). The announcement of the COVID-19 pandemic on March 12th was, of course, the true marker of this phase's commencement. It signalled the beginning of the disruption that ensued.

'Disruption', noted in the Introduction to this chapter, was a term used by Christensen et al in relation to technological developments in precision medicine [6]. For Christensen et al at that point, it was moves towards 'precise diagnosis and, subsequently, predictably effective therapy' that had the 'potential to transform healthcare through disruption'. But, be that as it may, Christensen et al (as was the case for most of us) did not foresee the disruption arising from a pandemic.

Wootton et al, though not using the term disruption, opined that 'in many ways, the last step to widespread adoption [of health technologies] – bringing about organizational change – is the most difficult in healthcare, where organizations tend to be large and to have huge inertia' [140]. They added that 'it may be recalled that the *Titanic* was an 'organizational unit' that had great difficulty in changing direction when faced with an unexpected problem'. The COVID-19 pandemic was not quite, we surmise, what Wootton and his colleagues had in mind when talking of the problem encountered by that doomed ship, but the pandemic might now prove to be the iceberg that sinks many of the dated attitudes and bureaucracies that underpinned the resistance to telemedicine – as evidenced throughout much of this chapter.

The UK Response to COVID-19

The 'backdrop' for COVID-19 in the UK is one that will, for all time, be associated with excess and sometimes avoidable deaths. 'Every death', Horton stated was 'evidence of systematic government misconduct – reckless acts of omission that constituted breaches in the duties of public office' [141] (*Endnote No. 69*). The UK was not helped 'after 2010' he noted because the NHS had been a 'victim of resource cuts at a time that demand [for services] was increasing. The infrastructure of public health, meanwhile, had been dismantled'.

That the UK was relatively slow in its response to COVID-19 was noted by Fisk et al when they examined the response to the pandemic in Australia, the United Kingdom and the United States [142]. Notable in the context of this chapter was their pointer to the pandemic in 'forcing changes', arguing that the momentum generated was 'such that telehealth will almost certainly find a stronger place within health frameworks for each of the three countries *and* [my emphasis] is likely to have increased acceptance among both patients and health care providers'.

The government response to the pandemic included an invocation, issued by NHS England on 17th March, for health service providers to 'support the provision of telephone-based or digital- and video-based consultations' with 'face to face appointments' only to 'take place when absolutely necessary'. The Scottish Government on 10th March, typically taking a lead over other parts of the UK, announced that it had decided to 'accelerate' an investment of £1.24 million plus assign £8 million 'implementation' costs to support video consultations (that were already used in Scotland's rural areas) including for GP consultations [142].

That GP, out-patient and other health services in the UK were able to rise to the occasion is to their great credit. It also reflected the fact that the necessary tools (the telephone and video-communication systems) were either already to hand or could quickly be brought into play (by buying into suitable platforms). From the service user perspective, however, things were a bit different - with the 'reach', for instance, to older people (many of whom were less digitally equipped or adept) being uncertain. Some areas, furthermore, suffered from poor (or no) connectivity'. Doughty and Livingstone had noted the significance to people's inclusion, of 'not-spots' (without coverage) in the UK [143].

This issue (around digital exclusion) will carry greater importance when there is a reckoning regarding the UK governmental response to the pandemic and its health impact (that ongoing part of which has been labelled 'long COVID'). Part of that reckoning has started in the inquiry established by The Health Foundation (*Endnote No. 70*).

Long-COVID, Maxwell noted, is characterised by both 'fluctuating' symptoms' and 'significant psychological and social impacts' that appear likely to impact on people of all ages [144]. She, in exploring 'long COVID' drew, in part, on the work of Wade with the latter reporting COVID-19 as affecting 'the respiratory system … the heart and cardiovascular system, the brain directly (encephalitis) and indirectly (e.g. secondary to hypoxia or vascular thrombosis), the kidney and renal function, blood clotting and the gastrointestinal tract' [145].

Further evidence about COVID-19 and its (long-term) impact on health will, of course, emerge. But it is of interest to recall the 'Inverse Care Law' set out by Tudor-Hart and noted in Phase 3 [35]. This pointed to the poorest people receiving the poorest health services. A maintaining and even a deepening of the 'divide' is a real danger in our digital world.

The issue of digital exclusion was highlighted by Topol in his review. And around this issue, it is already evident that COVID-19 has killed a disproportionately high number of (older) people in UK care homes. Bell et al noted, for instance, that for the three- month period to June 26th, half of deaths attributed to COVID-19 were of care residents in Northern Ireland (51%) and Scotland (50%); with the figures for England (39%) and Wales (34%) not greatly better [146]. There are further disparities for deprived urban communities (where social distancing can be a particular challenge), including those where there is a greater number of people from minority ethnic communities. The disproportionate impact on the UK's BAME population has been signalled by The Health Foundation (*Endnote No. 71*).

Regarding the matter of ethnicity and drawing on (albeit limited) data from a Public Health England review on disparities, Khunti et al reported that deaths from COVID-19 'among people from ethnic minorities are two to four times higher than in the white majority population'. They noted that contributory factors to the high rate were 'comorbidities, overcrowded housing, income inequality and occupational risk' and called for a 'programme of action' that would include more effective data collection and in-depth research in order to get greater clarity on the matter [147]. This call (and its urgency) is strongly endorsed by the author of this chapter.

The challenge for telemedicine now, therefore, is not just around its use directly in the context of COVID-19, but is about how it will be seen as a 'tool of the trade' in the post COVID order of health services. And in respect of the further decentralisation of services and the empowerment of patients, the question arises as to how effective telemedicine can be in making a positive and meaningful contribution to the needs of people who may be, on account of many factors noted in this chapter, disadvantaged.

A New Place for Telemedicine?

As UK health services grapple with the multi-faceted challenges that have arisen from the COVID-19 pandemic, this final discussion simply touches on telemedicine's place in the 'new order'. With regard to the two themes noted at the outset, it is clear that a process of decentralisation is continuing to take place, albeit slowly. An element of that decentralisation links to the second theme - of people's (patient's) empowerment - seen as gathering momentum. After all, empowerment is facilitated by increasingly available low cost technologies in a context of growing and higher capacity digital networks. Decentralisation, by contrast, is sometimes encumbered by a reluctance to relinquish old working practices and an infrastructure of buildings and professional bodies that can be predisposed to defending the *status quo*.

And yet there may be an increasing appetite for change. After all, COVID-19 was a huge wake-up call. Part of this related to how, as Horton noted, the roles of 'key workers who saved the lives of the sick and protected the lives of the poor and vulnerable' were highlighted [141]. These people (including both health and social care workers) he affirmed had been ‘so often overlooked and taken for granted … [but, in fact] are the real foundation for public order and public safety. We truly do owe them our lives’.

Furthermore, there is more evidence *in practice* of telemedicine working, at least with regard to the element concerned with tele- and video-consultations where its usage dramatically accelerated at the outbreak of the pandemic [142]. And this chapter has noted the operation of telemedicine in the background – often unnoticed and unsung.

The efficacy of video-consultations in the immediately pre-COVID period was pointed to in evaluative research by Wherton and Greenhalgh in Scotland [118]. Relevant also, early in 2020 (and reported by Fisk et al [142]), the question was asked of Trish Greenhalgh (who is a leading exponent of telemedicine) in a webinar as to why telehealth had not, to date, been further developed in the UK. Her telling response was that many clinicians didn’t have ‘*a particular reason to use [telehealth]. They didn’t see a clinical need*’ adding that ‘*running a service with video-consultations as a main component involves major changes in workflows and also changes in professional interactions. And it feels a bit weird to be consulting either by telephone or video when you could just bring the patient in and look at them as you were taught’*.

With regard to particular specialisms where telemedicine is now (because of COVID-19) playing a larger part, are abortion care and mental health services. These are offered as examples. The work of Aiken et al on telemedicine helping to facilitate abortion care in Ireland was noted earlier [125]. Now, on account of COVID-19, access to abortion services is much easier because of what was a legal restriction on the use of the necessary medication at home being (temporarily) waived. This meant that pills were able to be sent by post or packaged for collection from a clinic, meaning, on collection there would be minimal contact with any staff. Associated consultations (by phone or video) were scaled up. Travel was reduced or avoided for women needing service access and a higher level of privacy has been maintained. The initial indications from ongoing research show a rapid increase in the uptake of this service. High levels of satisfaction are also clear from the feedback that is being systematically collected (*Endnote No. 72*).

With regard to mental health there are similar indications of telemedicine’s especial efficacy in the COVID-19 context. There may be, it is considered, a common thread in this because of the sensitivity of (and stigma attached) to mental health *and* abortion. But other evidence from research that includes the UK, has demonstrated how telepsychiatry services ‘have promoted changes to facilitate access’ with ‘home-based treatment … key to future service configurations to prevent the spread of infection and perhaps as a more acceptable alternative to inpatient treatment for some service users and their families' [148]. Crucially the research (by Moreno et al) noted that 'to fill gaps in face-to-face care, telehealth was rapidly adopted, with remote video or phone conferencing … blended or coached therapies, and self-help therapies provided through apps'. The researchers found 'some evidence of short-term success'; stating that 'remote service delivery could also have longer-term advantages' albeit that there are potential disadvantages for those with the highest levels of need.

The issues for those with the highest levels of need apply, of course, to most medical conditions. Many of these necessitate 'hands-on' care, albeit not necessarily to the extent and frequency previously considered appropriate. Hence, the affirmation by Greenhalgh et al that video consulting to patients' homes is unlikely to be appropriate 'for severely ill patients, when a full examination or procedure cannot be deferred, or when comorbidities (e.g. confusion) affect the patient's ability to use the technology (unless relatives are on hand to help)' [149]. Shaw et al, with a somewhat different emphasis, pointed to the potential benefits of 'video-mediated clinical consultations … in terms of access, convenience and sometimes cost' for 'patients selected by their clinician as *appropriate*' [their emphasis] [137]. The provisos are clear for both Shaw et al [137] and Greenhalgh et al [149], as is the obvious fact that some patients will need physical examinations whereas others (who are often the 'candidates' for telemedicine) do not.

Will telemedicine services bring cost-benefits? This remains to be seen and, in any case, the nature and extent of such benefits will vary between geographies, specialisms and conditions. There is, however, some certainty that cost savings will be made for patients (and carers) where their travel is reduced – with *their* perceptions of quality of care potentially increased. But for GP services there is a danger, as indicated by Salisbury et al, that costs may grow because of any increase in the time that is taken for digital consultations (whether via telephone, video or online) [150]. Much depends, they indicated, on the 'duration of the initial digital consultation and the proportion of these … that result in the patient needing a subsequent face-to-face consultation'; and whether, in the future, the level of demand for such consultations will change with what should be better accessibility.

As the nature of the challenges ahead is better understood (because of or despite COVID-19) there are now positive signs for telemedicine in the UK in relation to many conditions. A range of these has been touched upon in this chapter with indications of a growing evidence base relating to them.

Those areas of health services in the UK that appear to have the most potential for telemedicine (in some cases already 'mainstreamed') include GP and outpatient consultations; services to care homes; telecare (including for those mainly older people who are frail and/or with mobility and sensory impairments); and to support behaviour change (through e.g. motivational coaching). Adding to these, two particular conditions or circumstances have been pointed to in the COVID-19 context as suited for telemedicine viz. abortion and mental health services. And already, in the background is telemedicine's use (mainly between clinicians) for radiology, dermatology, and a host of other conditions of both hospital in- and out-patients.

Further, more anecdotal, information for UK telemedicine services relates to its benefits for providing speech and language therapy; for services to prisons; for links to A&E and minor injuries clinics; for supporting medication compliance; and in relation to the needs of those who may be 'remote' not by virtue of where they live, but by their places of work (e.g. on board ship, on oil rigs or abroad with the armed forces).

In this context, and with COVID-19's ongoing impact, telemedicine's integration (as a real service option) within the UK's health services is inevitable. Importantly, that integration could contribute, as noted in the introduction, to UN sustainable development goals concerned with service accessibility, reducing inequalities and empowering and promoting 'social, economic and political inclusion'. Now it is necessary to facilitate this integration through both further changes in our service frameworks and in ways of thinking.

End Notes

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65 NICE. See End Note 61.
66 Online dialogue with Frederic Lievens 7th January 2020 and ensuing dates.
67 https://www.isfteh.org/working_groups/category/standards_and_accreditation_for_telehealth_services - Accessed on 18th October 2020. The author of this chapter declares his interest here as the primary architect of the code and as a member of the ISfTeH Working Group.
68 https://standards.cen.eu/dyn/www/f?p=204:110:0::::FSP_PROJECT:67639&cs=100986BAF8F22DDF4996B89DAFBCB80D4 - Accessed on 18th October 2020.
69 Richard Horton, it can be noted, is Editor of *The Lancet*.
70 The Health Foundation. See Note 1
71 The Health Foundation. See Note 1.
72 Online dialogue with Dr Patricia Lohr, British Pregnancy Advisory Service 16th October 2020 and ensuing dates. Outcomes from initial data for the research cited were reported to the 2020 Annual Conference of the British Society of Abortion Care Providers. The research is being undertaken collaboratively and involves the University of Texas, the British Pregnancy Advisory Service, Marie Stopes UK and the National Unplanned Pregnancy Advisory Services.

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Malcolm has a long track record as a writer and speaker, not just on digital health, but in the wider domains of technology and ageing. He led two recent European Commission funded projects (TeleSCoPE and PROGRESSIVE) relating, respectively, to telehealth and ICT standards for active and healthy ageing. Within the UK he is an expert on a standards committee for the National Institute for Care and Health Excellence (NICE). Previously, Malcolm was the first Chair, appointed by Welsh Government, of the National Partnership for Older People in Wales and, more recently, of Chair of Age Cymru (Wales' main charity of and for older people).

On 1st January 2021, he has been awarded a personal Chair and is therefore; carry the title 'Professor of Ageing and Digital Health'.