

# Contributions to the History of Telemedicine of the TICs

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**Abstract** — The first use of tests of communications technologies applied to medicine is almost as old as the invention of the telephone. Within a very short time, the telephone was shown as an essential element to ask or exchange information of medical content between health professionals. The spectacular development of broadcasting in the first quarter of the 20<sup>th</sup> century brought about the interest to apply the radio communications in medicine. The development of telemedicine on a world level has not been uniform, with different introduction and implementation depending on various health services. The clinical specialty most benefited by Telemedicine is radiology, followed by cardiology, dermatology, psychiatry, house attention, pathology and oncology. Nowadays, a large increase of the communications systems for house attention, especially in the care of elderly and chronic patients has taken place.

**Index Terms** — Communications, health care, telemonitoring, biomedical signals,

## I. INTRODUCTION

The first use of tests of communications technologies applied to medicine is almost as old as the invention of the telephone. Within a very short time, the telephone was shown as an essential element to ask or exchange information of medical content between health professionals.

Worldwide, people living in rural and remote areas struggle to access timely, quality specialty medical care. Residents of these areas often have substandard access to specialty health care, primarily because specialist physicians are more likely to be located in areas of concentrated population. Because of innovations in computing and telecommunications technology, many elements of medical practice can be accomplished when the patient and health care provider are geographically separated. This separation could be as small as across town, across a state, or even across the world.

Trends observed nationally include:

- 1) Using telemedicine in correctional facilities and home health care settings, can significantly reduce the time and costs of patient transportation;
- 2) Fine-tuning the management and allocation of rural health care emergency services by transmitting images to key medical centres for long distance evaluation/triage by appropriate medical specialists;
- 3) Permitting physicians doing clinical research to be linked together despite geographical separation, sharing patient records and diagnostic images;

- 4) Improving medical education for rural health care professionals, where rotations are made possible by linking several community hospitals together with the sponsoring medical school.

In general, the numerous and ever expanding applications of telemedicine allows its users to reduce the burdens of inferior health care access through utilization of technology. Because of telemedicine, geographical isolation need no longer be an insurmountable obstacle to the basic needs of timely and quality medical care.

## II. CONCEPTS AND DEFINITIONS

The most common mode of healthcare delivery is through personal, face-to-face contact between a healthcare provider and a beneficiary (patient). There is, however, an increasing trend towards the provision of healthcare in the absence of a personal contact.

According to the World Health Organisation, Telemedicine is the use in consultation of the medical knowledge through communication networks when the distance is a determining factor. In essence, it means moving the health data instead of moving the patient. There are several connotations and developments of telemedicine that entail some complexity or confusion and they are developed in this work.

Broadly defined, telemedicine is the transfer of electronic medical data (i.e. high resolution images, sounds, live video, and patient records) from one location to another. This transfer of medical data may utilize a variety of telecommunications technology, including, but not limited to: ordinary telephone lines, ISDN, ATM, DSL, the Internet, intranets, and satellites. Telemedicine is utilized by health providers in a growing number of medical specialties, including, but not limited to: dermatology, oncology, radiology, surgery, cardiology, psychiatry and home health care.

Telemedicine may be as simple as two health professionals discussing a case over the telephone, or as complex as using satellite technology and videoconferencing equipment to conduct a real-time consultation between medical specialists in two different countries. Telemedicine generally refers to the use of communications and information technologies for the delivery of clinical care.

Care at a distance (also called *in absentia* care), is an old practice which was often conducted via post [1]. There has been a long and successful history of in absentia health care

which, thanks to modern communication technology, has evolved into what we know as modern telemedicine.

The terms e-health and telehealth are at times wrongly interchanged with telemedicine. Like the terms "medicine" and "health care", telemedicine often refers only to the provision of clinical services while the term telehealth can refer to clinical and non-clinical services such as medical education, administration, and research. The term e-health is often, particularly in the UK and Europe, used as an umbrella term that includes telehealth, electronic medical records, and other components of health IT.

#### A. Types of Telemedicine

Telemedicine can be broken into three main categories: store-and-forward, remote monitoring and interactive services.

1) Store-and-forward telemedicine involves acquiring medical data (like medical images, biosignals etc) and then transmitting this data to a doctor or medical specialist at a convenient time for assessment offline. It does not require the presence of both parties at the same time. Dermatology (cf: teledermatology), radiology, and pathology are common specialties that are conducive to asynchronous telemedicine. A properly structured Medical Record preferably in electronic form should be a component of this transfer. A key difference between traditional in-person patient meetings and telemedicine encounters is the omission of an actual physical examination and history. The store-and-forward process requires the clinician to rely on a history report and audio/video information in lieu of a physical examination.

2) Remote monitoring, also known as self-monitoring/testing, enables medical professionals to monitor a patient remotely using various technological devices. This method is primarily used for managing chronic diseases or specific conditions, such as heart disease, diabetes mellitus, or asthma. These services can provide comparable health outcomes to traditional in-person patient encounters, supply greater satisfaction to patients, and may be cost-effective.

3) Interactive telemedicine services provide real-time interactions between patient and provider, to include phone conversations, online communication and home visits. Many activities such as history review, physical examination, psychiatric evaluations and ophthalmology assessments can be conducted comparably to those done in traditional face-to-face visits. In addition, "clinician-interactive" telemedicine services may be less costly than in-person clinical visits.

### III. HISTORICAL MILESTONES ON TELEMEDICINE

*Distance medicine* occurs when the patient and care giver are at different locations but still communicate by audio and video - or sometimes without any personal contact. A face-to-face contact is often a necessary prelude to rendering health care.

This, however, may not be necessary for care; in fact current technologies permit with no prior or concurrent contact. Some

people argue that this type of medical care may derail the traditional sequences of examination, diagnosis and treatment, and that such a detour may challenge existing values of modern medicine.

#### A. Ancient Practices

Ancient Egypt emphasized a tripartite system which exists even to this day. This system called for listening to the patient, before an examination. Only after an observation, or an examination, did a diagnosis follow. Treatment was undertaken as the last component [2]. Observation and examination before treatment had a central role that could not easily be circumvented. This sequence has been passed on as a tradition to us through Hippocrates and Galen [3].

Galen (129-200 A.D.) chose, at times, to prescribe to patients without ever seeing them. Apparently, Galen was so skilled in understanding symptomatology that there were times when he preferred to diagnose *without* questioning the patient. He then went on to prescribe by mail with confidence [4]. His elevated status permitted him to offer consultations by letter. He would receive generous rewards for his postal consultations: in one instance, it is said that he had received 400 gold pieces for curing a woman in this fashion.

In its early manifestations, African villagers used smoke signals to warn people to stay away from the village in case of serious disease.

#### B. More recent historical Practices

Distance healthcare has probably existed for more than 1500 years. This enduring practice owes its longevity to need fulfillment, convenience and - in some cases - the greed of the physicians. When viewed in the context of slow travel, healing in absentia was perfectly suited to fulfill a need of patients who could not travel to see a doctor in person. Famous healers, from Galen to Cullen, engaged in mail order practice even though they generally saw people face-to-face. They had used the technology of their day to help them make diagnoses quicker and more easily, and to reach persons from further away - no different from what we do today. To arrive at a diagnosis, physical examination itself was seen as less important than hearing the patient's story. Thus, personal contact, while desirable, may not have been essential.

William Cullen (1710-1790) of Edinburgh, Scotland had engaged in a flourishing mail order practice. In his early years of practice between 1764 and 1774, Cullen wrote approximately 20 consultation letters per year. This number jumped markedly to almost 200 a year from 1774 till his death in 1790 [5]. He had used an amanuensis and an early version of a copying machine to make it quicker and easier for him to respond. If he did not know the condition well, he cautiously avoided making a diagnosis. For the acutely ill, he preferred hospital admission and personal care.

Even as early as the 1830s, there was an attempt at reducing the subjectivity of findings and narrations. Julius Herisson, an early inventor of sphygmomanometer (blood pressure

measuring apparatus) in 1834, recommended that numerical aspects (quantitative data such as beats per minute) of pulse were more informative than their descriptive characteristics. He had realized that actually seeing the patient was not an absolute requirement for reaching a diagnosis. This may well have been what led up to the data exchange that is now a common practice on the internet.

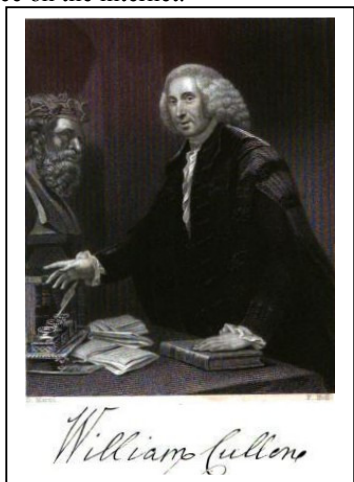


Figure 1. William Cullen (1710-1790) of Edinburgh, Scotland had engaged in a flourishing mail order practice

C. XX Century and Radio arrived

Not all in absentia diagnoses were based on intentions: in the period 1900-1930, radio advertising arrived. Radio, much like the internet now, presented new opportunities for technophiles of that period. In the early 1900s, people living in remote areas in Australia used two-way radios, powered by a dynamo driven by a set of bicycle pedals, to communicate with the Royal Flying Doctor Service of Australia.



Figure 2. Radio advertising arrived in the period 1900-1930.

Along with motorised flight, another new technology was being developed that could replace the complicated means of communication by telegraph. Together with Alfred Traeger, Flynn began experiments with radio in the mid 1920s to enable remote outposts to contact a centralised medical base.

The pedal radio was the first result of this collaboration. These were distributed gradually to stations, missions and other human residences around Cloncurry, the base site for a 50-watt transmitter.

The idea of performing medical examinations and evaluations through the telecommunication network is not new. This area has the first background in the biotelemetry and the first uses of the telephony for the distance transmission of physiological variables.

They can be found in the trastelephonic estetoscopes or first estetophones that allowed telemonitoring and telediagnostic at the end of the 19<sup>th</sup> century. Shortly after the invention of the telephone, attempts were made to transmit heart and lung sounds to a trained expert who could assess the state of the organs. However, poor transmission systems made the attempts a failure.



Figure 3. Estetoscopes

D. First Uses of Telemedicine

The first experiences of telecardiology were carried out in 1903 sending electrocardiograph (ECG) from a hospital to a laboratory. ECG can be transmitted using telephone and wireless. Einthoven, the inventor of the ECG, actually did tests with transmission of ECG through telephone lines. This was because the hospital did not allow him to move patients outside the hospital to his laboratory for testing of his new device. In 1906 Einthoven came up with a way to transmit the data from the hospital directly to his lab.

In addition, Electronic stethoscopes can be used as recording devices, which is helpful for purposes of telecardiology. Because the sounds are transmitted electronically, an electronic stethoscope can be a wireless device, can be a recording device, and can provide noise reduction, signal enhancement, and both visual and audio output that are helpful for purposes of telemedicine and teaching [6].

The spectacular development of broadcasting in the first quarter of the 20<sup>th</sup> century brought about the interest to apply the radio communications in medicine. In 1924 a distance diagnostic examination to children, with direct image, could be made, being defined as one of the first conceptions of telediagnostic and televisit as they are fully used today.

Help for ships Telemedicine dates back to the 1920s. During this time, radios were used to link physicians standing watch at shore stations to assist ships at sea that had medical emergencies.

The first exposition of Telecare perhaps it was the cover showed below of "Radio News" magazine from April 1924. The article even includes a spoof electronic circuit diagram which combined all the gadgets of the day into this latest marvel.

Some systems based on radio communications for health and the first transmissions of radiological images among hospitals could be made in 1950. Of that age is also the first use of telemedicine in psychiatry.

The Nebraska Psychiatric Institute was one of the first facilities in the country to have closed-circuit television in 1955, as Telepsychiatry. In 1971 the Nebraska Medical Center was linked with the Omaha Veterans Administration Hospital and VA facilities in two other towns.



Figure 4. "Radio News" magazine, April 1924.

In the mid-Sixties, the first experiences of telemonitoring or medical telemetry within the spatial programmes of NASA and the first teleconsult project took place. Projects that used satellite systems for medical tele-education also began to be developed.

In Massachusetts General Hospital was established in 1967 to provide occupational health services to airport employees and to deliver emergency care and medical attention to travellers.

In Europe, the first experiences were begun in Scotland, in the remote health attention to workers of the oil platforms of the North Sea in the Seventies. National programmes in other countries, such as Norway, were also begun to develop help to isolated rural centres.

In the seventies Satellite telemedicine Via ATS-6 satellites started. In these projects, paramedics in remote Alaskan and

Canadian villages were linked with hospitals in distant towns or cities.

#### IV. POSSIBILITIES OF THE CURRENT TELEMEDICINE

The development of telemedicine on a world level has not been uniform, with different introduction and implementation depending on various health services. The clinical specialty most benefited by Telemedicine is radiology, followed by cardiology, dermatology, psychiatry, house attention, pathology and oncology. Nowadays, a large increase of the house attention, especially in the care of elderly and chronic patients has taken place.

Contemporary technology allows the transmission of videos, photos, and data to distant sites. It is not yet clear if this will eliminate the need for a physical examination. Remote viewing of images and data are acceptable, but are no substitute for physical contact. This is especially the case with telemedicine, when a physician may consult with a remotely sited consultant. Here, however, a patient-physician relationship already exists between two parties. Indeed, data exchange serves as latter day equivalent of a third party physical examination in such instances.

Technology permits this kind of healthcare without any primary contact with a qualified caregiver. This type of care, "between strangers," is of uncertain merit. It is cheaper, quicker, and more convenient at a time when - some might say - that traditional health insurance and the cost of drugs are straying beyond the reach of many. The worried-well may seek care for discomfort that past generations would have dismissed as trivial or inevitable.

The same electronic information technologies that aid the health-providers also empower the health-seekers who can gain easier access, whilst remaining anonymous.

Monitoring a patient at home using known devices like blood pressure monitors and transferring the information to a caregiver is a fast growing emerging service. These remote monitoring solutions have a focus on current high morbidity chronic diseases and are mainly deployed for the First World. In developing countries a new way of practicing telemedicine is emerging better known as Primary Remote Diagnostic Visits whereby a doctor uses devices to remotely examine and treat a patient. This new technology and principle of practicing medicine holds big promises to solving major health care delivery problems in for instance Southern Africa because Primary Remote Diagnostic Consultations not only monitors an already diagnosed chronic disease, but has the promise to diagnosing and managing the diseases a patient will typically visit a general practitioner for.

There are still several barriers to the practice of telemedicine. Fear of malpractice suits is another consideration for physicians, as is acceptance of the technology and lack of 'hands-on' interaction with patients, although most patient satisfaction studies to date find patients on the whole satisfied with long distance care [7].

Many potential telemedicine projects have been hampered by the lack of appropriate telecommunications technology. Regular telephone lines do not supply adequate bandwidth for most telemedical applications. Many rural areas still do not have cable wiring or other kinds of high bandwidth telecommunications access required for more sophisticated uses, so those who could most benefit from telemedicine may not have access to it.

## V. CONCLUSIONS

New broadband telecommunication systems, new applications and new designs of electro medicine equipments adaptable to Telemedicine must currently permit the rank of growth in use to become exponential. The success of the introduction of Telemedicine techniques will depend on the quality of the service provided, ease of access and acceptance of the system by doctors, health personnel generally and by patients [8].

Over time, barriers to access such as cost, inconvenience or embarrassment have encouraged patients to seek out in absentia care. The ultimate "balance sheet" of risks and benefits of remote care is yet to emerge. What is clear, however, is that in absentia care is not by any means a new phenomenon: e-doctors practicing telemedicine is simply a technological variation on a theme as old as medicine itself.



Figure 5. A doctor uses communications devices to remotely examine and treat a patient

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