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Telemedicine: Teleeverything Phenomena (Part 2)

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Abstract— *Telemedicine, as practiced today, is a major new development in medicine. It allows healthcare practitioners to diagnose, treat, and monitor patients at a distance using telecommunications technology. It is a process, not a technology. It is not a new branch of medicine; it is integrated in many different medical fields. Telemedicine applications span the areas of telecare, telecardiology, teleradiology, telepathology, teledermatology, teleophtlalmology, teleoncology, telepsychiatry or "teleeveryting" in general. This paper mainly focuses on these applications. In each of these applications, the professional is remote from the patient. Based on our knowledge, these various applications of telemedicine are not covered in one place as done in this paper.*

Keywords—:telemedicine, telehealth, teleeverything, cybermedicine, ICT

I. INTRODUCTION

Applications of information and communications technologies (ICT) have become widespread due to the rapid development of microelectronics, computers, and Internet. One of the most important applications of ICT is its use to improve healthcare services and systems. Telemedicine (TM) is a technological response to bring health services to people wherever it is not possible or feasible to bring people to health services. TM will do for health care what the personal computer (PC) has done for the office.

Telemedicine is a fascinating new development that enhances the level of medical and health services. It can provide access to scarce specialist care and improve the quality of care in rural areas. It can increase efficiency of care delivery, reduce expenses of caring for patients, and keep patients out of the hospital. Telemedicine should support and enhance traditional face-to-face medicine. A strong doctor-patient relationship is the foundation for high-quality patient care and reducing health care costs.

Technological infrastructures are important for the implementation of telemedicine systems. The rise of the internet age brought with it profound changes for the practice of telemedicine. The key enabling technologies for telemedicine include digital communications, videotelephony, and information technologies.
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II. TYPES OF TELEMEDICINE

Practitioners from a various medical specialties have claimed success in their telemedicine pursuits. Telemedicine is a "teleeverything" (or tele-X) phenomenon as evident in various applications and services which include telehealth, telecare, telenursing, telepharmacy, telesurgery,teleradiology, telepsychiatry, teledermatology, teleconsultations, telenephrology, teleobstetrics, teleoncology, teledentistry, teleaudiology, telerehabilitation, teleophthalmology,teletrauma, teleneuropsychology, telecardiology, and telepediatrics,. Figure 1 summarizes a number of services that telemedicine supports [1]. The frequency of application of telemedicine to the various specialties is given as follows [2]:

- Radiology - 37%
- Emergency Medicine - 22%
- Pathology - 11%
- Cardiology - 9%
- Internal Medicine - 7%
- Dermatology 4%

Here are some of the most popular telemedicine solutions specialties [3-6].

- *Telehealth*: This is the use of information and telecommunication technology (ICT) to provide patients with healthcare at a distance. It is an opportunity to meet people where they are at, be it home, office, school, in an inpatient and outpatient setting, as well as scheduled and on-demand appointments. Telehealth programs can address the needs of patients in a way that traditional care delivery cannot. They provide opportunities to make health care more efficient, better coordinated, and closer to home.

- *Telecare:* Telecare allows home nursing services (especially for the elderly) to be delivered more cheaply. Home nursing visits by video are substantially cheaper than sending a nurse in person. Telecare may be used to provide support to care providers of older adults, thereby increase the quality of patient care.

- T*eleconsultation*: This is basically the provision of knowledge or experience of an expert across distance. Telemedicine technology enables virtual consultations between healthcare professionals and patients. It makes real-time medical consultation via two-way videoconferencing. It may also involve diagnosis at distance of a patient by a physician at distance (e. g. telecardiology). Provider-to-provider consultation may take place within the same healthcare system. It is estimated that the number of telemedicine consultations will reach 160 million cases by 2020.

- *Telemonitoring:* Remote patient monitoring (RPM) has become a popular form of telemedicine. Patient monitoring is the collection of personal medical data from a connected patient in one location that is transferred electronically to a caregiver at a different location for monitoring purposes. This involves the supervision of a patient and his data at distance, who is not in the hospital and/or clinic (e. g. diabetes patients, veterans, patients with heart insufficiencies). For example, a patient with diabetes can measure their glucose levels at regular intervals at home and transmit them to their doctor.

- *Teleradiology:* This is the practice of radiology from a distance. It is the ability to send radiographic images (X-Rays, CT, etc.) from one location to another. Digital imaging modalities include computer tomography (CT), magnetic resonance imaging (MRI), single-photon emission computer tomography (SPECT), and positron emission tomography (PET). Teleradiology may require three essential components: an image sending station, a transmission network, and a receiving-image review station. Today the Internet enables the use of new technologies for teleradiology.Teleradiology solutions offer providers at one location to send a patient's x-rays and records securely to a qualified radiologist at another location. Teleradiology is the transfer of radiological images. X-Rays, MRIs, and CTs, which may be used for consultation, diagnosis or interpretation. They can be transferred through satellite connections, local area networks, or even telephone lines. Teleradiology is the most popular use for telemedicine.

- *Telepsychiatry*: This allows qualified psychiatrists to provide treatment to patients remotely. It basically usesvideoconferencing for patients residing in underserved areas to access psychiatric services. It is undertaken in real time (synchronous) or asynchronously. Telepsychiatry can connect patients and mental health professionals, allowing effective diagnosis, treatment, consultation, and transfer of medical data. It is incredibly popular, in part because of the nation-wide shortage of available psychiatrists. It offers wide range of services to the patients and medical practitioner such as consultation between the psychiatrists, educational clinical programs, diagnosis and assessment, medication management, and routine follow-up [7].

- *Teledermatology*: This allows the practice of dermatology over a distance using communication networks. In clinical teledermatology, dermatologists evaluate video or still images of skin disorders along with patient information. Teledermatologysolutions are usually store-and-forward technologies that allow a general healthcare provider to send a patient photo of a rash, a mole, or another skin anomaly, for remote diagnosis. They have been found to improve efficiency. Applications comprise health care management such as diagnoses, consultation and treatment as well as (continuing medical) education. The dermatologists Perednia and Brown were the first to coin the term "teledermatology" in 1995. Mobile teledermatology refers to the use of mobile telemedicine in dermatology [8].

- *Telepathology:* This allows pathologists to share pathology at a distance for diagnosis, research, and education. Telepathology is a relatively new experimental application of telemedicine. Two essential techniques currently used in telepathology are static imaging and dynamic imaging. In static telepathology, one or more microscope images are captured and transmitted to a pathologist for interpretation. In dynamic telepathology, the pathologist receives real-time pictures from the remote microscope.

- *Telerehabilitation:* This is the delivery of rehabilitation services over communications networks such as the Internet. This allows medical professionals to deliver rehab services (such as physical therapy) remotely. Telerehabilitation also allows experts in rehabilitation to engage in a clinical consultation at a distance. Telerehabilitation practice embraces other areas such as neuropsychology, speech-language pathology, audiology, occupational therapy, and physical therapy. For example, a physician might use telerehabilitationas therapeutic interventions for persons with disabilities. The use of telerehabilitation has grown over the years.

- *Telepharmacy:* This refers to the provision of pharmacy services to the patients with the use of communication technology. Telepharmacy services include drug therapy monitoring, prior authorization and refill authorization for prescription drugs. Telepharmacy services can be delivered at retail pharmacy sites, through hospitals,

nursing homes, or other medical care facilities. Remote dispensing of medications by automated packaging and labeling systems is a typical example of telepharmacy.

- *Telepathology:* This is the practice of pathology at a distance, using telecommunications technology to transfer pathology data between distant locations. A pathologist, Ronald S. Weinstein, coined the term "telepathology" in 1986, when he published the first scientific paper on robotic telepathology. Telepathology has been successfully used for many applications including tissue diagnoses, education, and research.

- *Telesurgery:* This is also known as remote surgery, where the physical distance between the surgeon and the patient is immaterial. This is the ability for a doctor to perform surgery on a patient at a distant location in telesurgery, a surgeon carries out an operation at a distance from the patient. Telesurgery combines elements of roboticsand communication technology. The US military have been using telesurgery, mainly for improving surgery on the battlefield. A major limitation is the speed, latency and reliability of the communication system between the surgeon and the patient.

- *Teleophthalmology*: This is a branch of telemedicine that delivers eye care through medical equipment and telecommunications technology. Teleophthalmology solutions allow opthamologists to examine patients' eyes from a distance. It also allows disease screening, diagnosis, and monitoring. The importance of visual information in ophthalmology makes it obvious that telemedicine will offer benefits in terms of ophthalmological consultations. Teleophthalmology can be practiced, for example, between primary health care practitioners and specialists. A typical example is an opthamologist diagnosing and treating an eye infection [9].

- *Telenursing:* This refers to the use of information technology in order to provide nursing services when a large physical distance exists between patient and nurse. As a field it is part of telehealth, and has many points of contacts with other medical applications, such as teleconsultation, telemonitoring, etc. Telenursing may help solve increasing shortages of nurses; to reduce distances and save travel time, and to keep patients out of hospital.

- *Teletraumacare:* This helps improve the effectiveness of the delivery of care in a trauma environment. Using telemedicine, trauma specialists can interact with personnel to determine the severity of injuries just as a trauma specialist located physically with the patient. The trauma practitioners can watch a live video stream from the patient's bedside. For example, trauma surgeons can observe and consult on cases from a remote location using video conferencing.

- *Telepediatrics:*   This is a technological tool that is improving the health of children around the world. It enables pediatricians to use telemedicine for a broad range of applications such as teleeducation, teleconsultation, telepractice, and teleresearch. Using this technology overcomes the barriers of time and distance, allowing specialists to bring their skills to the bedside of the child in need [10].

- *Teleneuropsychology:* This is another form of telemedicine. It is the use of telemedicine technology for the remote administration of neuropsychological tests, which are used to evaluate the cognitive status of individuals.

- *Telenephrology:* This is nephrology practiced at a distance. Telenephrology solutions are most commonly used interprofessionally, when a family physician needs to consult a nephrologist about a patient with kidney disease.

- *Teleobstetrics:*This allows obstetricians to provide prenatal care from afar. A typical example may involve recording a baby's heart at one location and forwarding it to an obstetrician for diagnosis at another facility.

- *Teledentistry;*This is the use of ICT for dental care, consultation, and education. It can be used to assist general dentists and improve services to underserved populations. It can also be used to help children with dental screenings, treatment, and referral.

- *Teleaudiology:*   This is the application of telemedicine to provide audiological services and practice. Teleaudiology program can be combined with an existing hearing care practice.

- *Teleoncology:* This provides more accessible and convenient care to patients with cancer. Teleoncology can enhance both access to and the quality of clinical cancer care.

Implementation of teleoncology should be based on the needs of local communities and introduced to potential stakeholders.

- *Telementoring:* This involves the use of video and telecommunication technologies to offer individual guidance. For example, a physician may telementor a local healthcare provider who is new in the field.

- *Telecardiology:* This involves real-time transmission of an ECG from a patient to a cardiologist. Telecardiology has the potential to change the way cardiac care is being delivered in the primary care setting. For example, the monitoring center can dispatch a mobile intensive care unit if necessary.

- *Tele-learning*: This involves education and training of patients and/or professionals at distance. Telemedicine can also facilitate medical education by allowing workers to observe experts in their fields and share best practices easily. For example, some trauma centers are delivering trauma lectures to hospitals and health care providers worldwide using video conferencing.

Other clinical applications of telemedicine include telestroke services, teleburn services, intensive care unit, emergencies, abortion, obesity, otolaryngology, cardiovascular disease,disaster medicine, and tele-epidemiology. The nonclinical applications of telemedicine include continuing medical education, online healthcare information resources, coordinating research at multiple sites, and video conferencing for administrative meetings. Telemedicine makes it easier for providers to follow-up with patients. Telemedicine can help patients adhere to their medication regiments.

III. CONCLUSION

Telemedicine is not a single technology. Instead, it is an integration of many communications and information technologies with medical education. There are great opportunities for telemedicine to improve diagnostics, therapeutics, and education in healthcare. Although telemedicine is still medicine at a distance, the technology and range of applications have changed it considerably. Appropriate deployment of telemedicine technologies can provide and enhance quality care, improve efficiency, and reduce costs. With the related fields of mobile health and health IT, telemedicine is changing faster than ever before. It is rapidly expanding to serve millions of consumers.

Top health organizations (such Beacon Health System, Southwest Medical, and Adecco) across the country have built robust telemedicine programs to meet their organizations' objectives. In the United States, the American Telemedicine Association (http://www.americantelemed.org/) and the Center of Telehealth are the most respectable places to go for information about telemedicine.

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