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TECHNOLOGY AND TELEMEDICINE

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ABSTRACT: Telemedicine, telehealth, or e-health is the remote diagnosis and delivery of healthcare using telecommunications technology. This paper focuses on the importance of technology for the delivery of healthcare in this venue, for the training of professionals, and the future major for undergraduates. Several of the technologies in use for telemedicine today are discussed.

KEYWORDS: technology, telemedicine, education.

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1.INTRODUCTION

Technology is critical for the delivery of health care at a distance. Although the terms, telemedicine, telehealth, and e-health are often used interchangeably, there is a distinction between telemedicine and the latter two. Telemedicine is concerned with a healthcare professional providing care to a patient. This might entail a remote video visit, sharing medical information with a patent or consulting with another healthcare professional. There is often a sense of urgency as part of telemedicine. Telehealth or e-health on the other hand is a means of providing services using technology. This can include educating someone via video or having a support group online as well as delivering a diagnosis. One can say that telemedicine is an integral component of the field of telehealth or e-health. The most critical aspect of e-health, though, is the providing of healthcare to many in an affordable manner, particularly to those who may not be in a geographic locale where there is a medical caregiver. (eVisit, 2017; Ben-Jacob et al., 2017).

Technology and the Delivery of Health Care

Telemedicine has many great cost saving features when compared to face-to face medicine. The fact that health information and care is the focus of telemedicine dictates that technology must stay up-to-date and advance if this medical milieu is to be accepted on a wide-scale basis.

Some of the more recent technologies that have been integrated into the field include the following:

- On-site kiosks situated in a clinic or job site. They usually consists of a computer interface and some type or types of medical devices to measure vital signs, e.g. blood pressure. The computer provides communication with a physician if required.
- Mobile Apps that can be accessed from a smart phone or mobile device. These are often used to track weight, and sleep patterns. A physician can be contacted via 2-way videos on these apps as well.
- Secure email provides a way of receiving reminders about preventive care and appointments. If the transmission is secure, it is often used for sharing patient medical data as well.
- The Internet has websites, e.g. WebMD that provide vast information about symptoms and diseases and medical treatment.
- Online Video Conferencing allows a patient to have "face-to-face" visits with a healthcare provider remotely.
- The telephone is a technological tool that should not be ignored even though we have been using it for some time already. Patients can speak with physicians, physicians can speak with pharmacists, and physicians can consult with each other using this device (evisit, 2017)

Future technologies will probably include wearable trackers that can interact with other devices. As a relatively simple example, these could measure weight gain, calories consumed, and calories burned (Sherwood, 2016).Recent trials have demonstrated that the use of video is a valuable tool to engage, educate, and recruit patients. Experiments using innovative technology to enable Healthcare Professionals (HCPs) to record patient visit data through voice recognition and natural language processing are ongoing. The benefits of using this technology include more efficient data entry and an improved experience for both the patient and the healthcare provider (QuintileIMS, 2017).The basic components of an effective telemedicine are the following: an interface for patients, an interface for professional caregivers, and a network for connection. At the beginning of the treatment or healthcare interaction, authentication of the user is required. The users, particularly the patients need to be comfortable with the system. This may entail a course for the users or at

After security, another important factor is network speed or bandwidth, which is the number of bytes/second that can be sent over the network. A slow network speed will hinder the success and acceptability of telemedicine (Davidson & Santorelli, 2009). Different devices that are presently used in telemedicine require different data rates to be satisfactory. As an example, a digital bold pressure monitor requires less than ten kilobits per second (kbps) to transmit the information successfully, whereas a mammogram requires 24 MB to transmit the image, and a compressed and full motion video, e.g. for an ENT scope requires a rate of 384 p to 1.544 Mb/s (Ackerman et al, 2002).

Consider the following comparison of encryption algorithms:

	Single Churning	**Triple Churning**	**Galois Counter Mode/Advanced Encryption Standard**
Speed	Fast	Fast	Fast
Security Level	Low (14 bits key)	Low (48 bits key)	High (128 bits key)
Implementation Complexity/Cost	Low	Low	High

(Yan & Dittmann, 2014)

Reliability of the transmission and maintainability are critical as well. Factors of industry standards, cost and technical sophistication are involved. (McLain, 2014).Technology and telecommunication is expanding but for it to excel in usage in the medical field it is imperative that image quality and moving images need to be of the highest caliber (Minh et al, 2012). Some of the more popular telecommunication systems now used in telemedicine include Digital Video Transport Systems (DVTS) and Multipoint Control Units for DVTS, H.323 Video Conferencing Solutions, and Vidyo. Each system has its pros and cons that we will discuss.DVTS is not complicated and is a relatively inexpensive system that sends and receives digital video using broadband Internet. The system does not use a compression process, which would lower the quality of the transmission. To compensate, its requirements for usage are a minimum of 30 Mbps of bandwidth and a public IP address. It is the least expensive of all the telemedicine systems, but the caveat is that is requires the appropropriate Internet capability. It is the most popular system today (Minh et al, 2012).

There are two Multiple Control Units (MCUs) for DVTS systems used at present. This type of multi-point control unit allows for the bridging of video conferencing as DVTS software originally supported only two sites. The Quatre system is the most frequently used one between four to seven stations. One of its drawbacks it that it is compatible with the National Television Standards Committee (NTSC) color system, the video system used in North America and most of South America as opposed to the Phase Alternating Line (PAL) system, the video system used overseas. The latter group would need to purchase either an NTSD system or a converter. Its competition is DVTS-Plus that is a multi-part conferencing system as well. It supports up to twenty sites. Participants view a thumbnail of each site and can select any one site to view a large image with digital video quality. It is also compatible with only NTSC but research is being done for a PAL version (Minh et al, 2012). Another system worthy of note is the H.323 Video Conferencing System. This system is self-contained in the sense that all the required video and audio equipment is built into hardware that takes care of compressions of audio and video streams in real time. It easy to use and yet has not gained in popularity in the field of telemedicine because the quality of video streaming it supports is not adequate. Multiple connections of up to six different sites can be supported.At present,

there is a software version of the H.323 video conferencing system that requires only a normal PC and webcam. This is well suited for personal remote meetings but clearly not for telehealth in general (Minh et al. 2012).

Vidyo, a relatively new company that has developed its own videoconferencing system, is based on the most effective compression technology as opposed to other protocols. Those using Vidyo need to be able to connect with Vidyo hardware devices and other components of the Vidyo system as well as H.323 using VideoGateway. Vidyo supports low latency and high quality video conferencing over the Internet. A major drawback to this system is that support is available only from the Vidyo Company. Independent centers of healthcare cannot use Vidyo, i.e. it supports its own group of users (Minh et al, 2012).

The following table summarizes a comparison of the three systems. (Minh et al, 2012)

Training Courses in Telemedicine

There are on-site and online seminars for caregivers to become familiar with the technology involved (HFMA seminars, 2017; Arizona Telemedicine, 2017). As with any online course, there

System	DVTS	H.323	Vidyo
Cost	$2,000	$5,000-$20,000	$15,000-$30000
Camera	DV	HD	HD, Webcam
Voice	External	External or Integrated	External
Transmitted Contents	Uncompressed SD	Compressed HD and SD	Compressed HD and SD
# Engineers Necessary	1 or 2	1	1
# Multiple Connections	Quatre: max 7 DVTS-Plus 20 or more	25 or more	25 or more
Privacy Security	VPN routers required for IPsec	Integrated by vendor	Integrated by vendor
Network Requirements	30 Mbps	384-1024Kbs for SD 1-8 Mbps for HD	512 Kbps for SD 1-8 Mbps for HD
Time Delay	200-400 ms	300-400 ms	150-300ms
Video Input	1-1:NTSC,PAL Multiple:NTSC only	NTSC, PAL	NTSC,PAL
Audio Input	1-1 all formats 1-1Quatre: 16 bit at 48 kHz	All formats	All formats
Vendor Support	No	Yes	Yes

is a technology platform involved. One such example is *Blackboard*, which has the following characteristics:

- Supports assessment
- Allows work to be uploaded and graded immediately or held for future review
- Allows for surveys, tests, quizzes, and electronic submission of assignments
- Allows for grading of discussion postings and instructor's comments

Another tool that is good for evaluation of scenarios and case studies is *Iclickers* With the use of *Iclickers*

- Each participant has an individual clicker with specific ID connected to the participant's account
- Multiple-choice questions are presented and participants utilize clickers to respond
- There is a time limit for responses to be tallied
- Statistics associated with the responses, e.g. mean, mode, and median, are available
- Individual scores are tabulated

Future Undergraduate Major in Telemedicine

The future will see colleges and universities offering an undergraduate major in telemedicine. The field will explode with professional opportunities and the competition for students at different institutions will increase. Innovative scientific fields are encouraged in the United States as can be seen from the Federal government's support of STEM (science, technology, engineering, and mathematics) fields (NSF, 2017). Another example is the field of cyber security
which developed from the growth of technology and the need to guarantee the security of computer systems. (WhatIs, 2017).The academic major of telemedicine should require courses in biology, chemistry, nursing, and computer science. An undergraduate degree in telemedicine would be the precursor to medical school, nursing school, or graduate school in computer science or human resources (Ben-Jacob et al, 2017).

CONCLUSION

As progress is made, some considerations need to be addressed. Will the future of wireless and broadband technology meet the needs for telemedicine to be accepted on a wide scale basis? Will the cost of sufficient progress make the future technology a deterrent or can we rely on competition to keep the cost down? Will the technology insure the privacy needed for the future? Will the quality of service be of the utmost? (Ackerman et al. 2002) Will society be amenable to accepting telemedicine as a viable alternative to face-to face medicine. Healthcare coupled with fast and secure technology is the future of medicine. Many proponents of telemedicine contend that as more people get onboard with this venue, the acceptance will grow. Whereas this is true, the role of technology will become more critical. As the Internet gets busier as we go forward in life, we need to promote greater speed and security for our computer systems.

The fusion of technology and medicine is part of this millennium. There is no way to undermine the role of technology. Technology is used for delivery, for training and for future academics. As this millennium progresses, computer systems will become faster, more secure and more reliable. This is a necessity for telemedicine to be integrated on a wide scale from all the aforementioned perspectives.

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