International Journal of Clinical & Medical Informatics

ISSN: 2582-2268 **Review Article** | Vol 2 Iss 2

Telemedicine, Obstetrics and Gynecology

Marion Ben-Jacob

Department of Mathematics & Computer Sciences, Mercy College, Dobbs Ferry, New York, USA

Corresponding author: Marion Ben-Jacob, Mercy College, 555 Broadway, Dobbs Ferry, New York-10522, USA, Tel: 9146747524; E-mail: MBenJacob@mercy.edu

Abstract

This paper prevents an overview of the field of telemedicine from the perspectives of healthcare and technology. It focuses in on the subspecialty of telemedicine for women's healthcare, particularly for obstetrics and gynecology, and addresses infertility.

Keywords: Telemedicine; Obstetrics; Gynecology

Received Date: November 19, 2019; **Accepted Date:** November 27, 2019; **Published Date:** December 04, 2019

Introduction

Telemedicine is medical care via the use of technology. The expressions telemedicine, telehealth, and e-health are often used in the same context, but there is a distinction. Telemedicine is an integral component of the field of telehealth or e-health. Telehealth or e-health is a mechanism for providing health services using technology. This can include educating someone via video or having a support group online as well as delivering a diagnosis. Telemedicine is concerned with a healthcare professional providing care to a patient, including remote video visits, and sharing medical information or consultations with another professional. It is generally used in situations where the patients are geographically remote form the health care provider. It is also used for recording and storing patient history and the transmission of scans such as x-rays and MRIs. Consultations between health care providers and diagnosis between experts are facilitated with this venue. There are two major components for the success of telemedicine. The first one is obviously the healthcare and the second one is the technology [1,2]. This paper will provide an overview of the technology needed for a successful telemedicine program and then segue way to a discussion of how telemedicine has been implemented in the field of obstetrics and gynecology including the treatment of infertility.

Telemedicine Education

There are onsite and online courses in telemedicine (HFMA seminars 2017, Arizona Telemedicine, 2017). They are apt to be relatively short in length as the supposition is that people enrolled are knowledgeable medical professionals. Given the critical nature of the use of telemedicine when involved directly in the healthcare of individuals these courses should be longer and cover more information. More practice and more case studies need to be integrated. These courses should encourage group work rather than just familiarizing the participants familiar with the technology. Teleconferencing for consultation may be necessary in certain circumstances. Advance practice with the technology and the art of consultation in tandem can be very important [2].

Citation: Marion Ben-Jacob, Telemedicine, Obstetrics and Gynecology. Int J Clin Med Info 2019: 2(2) 82-89.

Telemedicine is a different venue from face-to-face medicine. The goal is to provide healthcare in both milieus, just in different modes [2]. As we will discuss, different aspects of telemedicine are necessary for the education and treatment of pregnant women and those who have recently given birth. Many of these women are from poor areas and would otherwise not have the necessary healthcare they need.

Brief History

Telemedicine, which is rapidly gaining in popularity, has been in existence for many years. A brief overview of its early history begins in 1964 with the Nebraska Psychiatric Institute using a closed circuit television system for teleconsultations. In 1967, Massachusetts General Hospital provided occupational health services on a remote basis to travelers and employees at the airport. NASA delivered basic medical care to Papago Native Americans in 1972. Here, the underlying structure consisted of a van with healthcare providers and a micro connection to specialists [3]. Tremendous progress has been made over the years.

Familiarity on the part of the general population of the western world with aspects of telemedicine include on-site kiosks situated at jobsites and in local pharmacies that consist of a computer interface and some type or types of medical devices to measure vital signs, e.g. blood pressure. Mobile apps that can be accessed from a smart phone or mobile device are used to track weight, and sleep patterns. A physician can be contacted via 2-way videos on some of these apps as well. Secure email provides a way of receiving reminders about preventive care and appointments. The Internet has websites providing information about symptoms and diseases and medical treatment. The telephone, a tool that has been use for quite some time, is a component of telemedicine. It is a communication device between patient, physicians and pharmacists [1].

Technology

In general, essential components of a telemedicine system are an interface for patients, an interface for professional caregivers, and a network for connection. At the beginning of any treatment or healthcare interaction, authentication of the user is required. 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 [4]. Different devices require different data rates to be suitable. 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 for an ENT scope requires a rate of 384 p to 1.544 Mb/s [5].

The information of a telemedicine system needs to be private so there is no unauthorized access. As such, encryption algorithms, formulas used to change ordinary data, or plaintext, into a coded data known as ciphertext are used. When one compares encryption algorithms one does so from the point of view of speed, security level and implementation complexity, i.e., cost. The three most popular algorithms are single churning, triple churning, and the Galois Counter Mode or Advanced Encryption. The Galois Counter Mode is the fastest and has the highest level of security but is the most expensive of the three [6].

For effective healthcare at a distance, image quality and moving images must be of high quality [7]. There are a number of telecommunication systems presently in use for telemedicine. They include Digital Video Transport Systems (DVTS) and Multipoint Control Units for DVTS, H.323 Video Conferencing Solutions, and Vidyo. Of these, the most popular one is DVTS.

DVTS is relatively inexpensive and it sends and received digital video using broadband Internet. The quality of its transmission is high, as it does not use a compression process. It requires a minimum of 30 Mbps of bandwidth and a public IP address. It is

the least expensive of all the telemedicine systems, but it does require the appropriate Internet capability. There are two Multiple Control Units (MCUs) for DVTS systems used at present, which afford 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, 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. For those having the PAL system they need to purchase either an NTSD system or a converter. DVTS is competitive with 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 only compatible with only NTSC but research is being done for a PAL version [7].

Another system is the H.323 Video Conferencing System. All the requisite video and audio equipment is built into hardware that regulates compressions of audio and video streams in real time. It supports a maximum of six sites and is relatively easy to use. The only caveat is that the quality of video streaming that is supports leaves something to be desired. There is a software version of the H.323 video conferencing system that requires only a standard PC and webcam. This system is not adequate for a large healthcare system [7].

A company called Vidyo has developed a videoconferencing system based on an effective compression technology. Support for this system is through the Vidyo Company, only, and cannot be obtained at independent healthcare centers. 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 Video Gateway. This system supports low latency and high quality video conferencing over the Internet [7].

In order to be successful, every telemedicine system needs to support the transmission of patient records, including images when relevant. It should also support the transmission of prescriptions and the ability to schedule appointments with the remote healthcare provider. One caveat is that when a prescription is sent remotely, it needs to be honored in the remote location, independent of where the healthcare provider is located. Sometimes, this can present a glitch in the care.

Obstetrics and Gynecology

Telemedicine is used in different areas of medicine. We will focus on its use in the field of obstetrics and gynecology. There are many ways telemedicine has been used in this specialty and we will examine several of the most critical and popular ones. One of the most publicized instances of the use of telemedicine is in the diagnosis of breast cancer and the beginning of chemotherapy treatment of a woman when she was in Antarctica until she was able to be transferred elsewhere [3].

The Center for Disease Control and Prevention provided the following statistics for 2007: 12.7% of live births were preterm and 70.5% of pregnant women had access to adequate prenatal care. The latter statistic has significant health consequences for both mother child. This obviates the need for some type of intervention and obstetrical telemedicine will help with the issues of pre- and post-natal care, labor and delivery of babies [8].

Tele colposcopy, or the integration of technology and colposcopy, is being used in the diagnosis of abnormal cervical cytology or cells. Telepsychiatry is used specifically in women's health care to help women who need counseling and support, for sundry reasons and situations. Fetal care in remote areas relies on telemedicine as well [9].

An impressive example of the use of telemedicine is in fetal care. A telesurgical and ultrasound consultation from the United States was used to assist in performing an operative fetoscopy, a procedure during pregnancy that gives access to the fetus, the amniotic cavity, the umbilical cord, and the fetal side of the placenta, for the correction of birth defects in a pregnancy involving an acardiac twin. Acardiac twins is a situation where the blood systems of the twins are connected rather than independent. As the images of remote radiology are transmitted faster and clearer, fetal ultrasound capabilities such as a virtual cardiological examination via telemedicine are being integrated into women's healthcare on a wider basis [9].

Telemedicine is used in the distant monitoring of blood glucose in diabetic pregnancies. The monitoring of blood glucose in non-pregnant patients has become widespread in medical practices all over the world, and now the technology has been applied to the monitoring of diabetic pregnancies. This practice has resulted in the improved glycemic control in pregnant diabetic patients implying the betterment of fetal and maternal outcomes [9].

Telemedicine is used in fetal monitoring throughout the world. In China, pregnant women are able to send their pregnancy non-stress tests over standard phone lines for remote fetal evolution. Preterm labor for high-risk patients has been ongoing for a number of years. As long ago as, 1979 fetal monitoring was ongoing by means of a Xerox telecopies to tertiary healthcare environments. In countries like Asia, Europe and America, home monitoring is customary [9].

An integral part of women's healthcare is that of an annual mammogram. Teleradiology is the rubric for telemammography. Tremendous progress and implementation in this area is ongoing. Presently research is looking at the real-time evaluation of mammogram images. This allows Navaho women in the western United States to obtain results before they travel back into the remote areas of their nation, most of which have limited in any means of communication capabilities. Telemammography for women is rapidly becoming a standard in today's world [3].

Critical use of telemedicine in this field involves the direct health of the baby or mother. In rural America, pregnancy-related complications have risen over the past few years. Specialists, unfortunately, do not usually practice in small towns and so the use of telemedicine consultations are often lifesaving. A prime example of this takes place in rural Georgia. Dr. Joy Baker, a local ob-gyn in rural Georgia, arranges for her patients to have appointments with specialists affiliated with Women's Telehealth in Atlanta. One of her patients started having special ultrasounds administered by local technicians who were trained by Women's Telehealth. Then, video consultations took place with Dr. Patterson, a specialist in Atlanta. In spite of the fact that the vital signs of the fetus were normal, the blood was not flowing properly through the umbilical cord, i.e. the baby was not receiving adequate oxygen or nutrients. The outcome was that Dr. Baker delivered the baby via emergency caesarean section, and both mother and child were fine [10].

The statistics are alarming. About 70% of Dr. Baker's patients are high risk for issues based on their diabetes, or obesity or other risk factors. Dr. Baker is one of two obstetric-gynecologist serving eight different counties. Before the installation of the videoconferencing equipment, Dr. Baker's patients who need to consult with specialists had to travel an hour or more to meet with a specialist. Unfortunately, many of them did not have access to the necessary transportation, could not afford the gas, or could not take time off from work to keep such an appointment [10].

In Arkansas, there is a statewide telemedicine program for high-risk obstetrics, Antenatal and Neonatal Guidelines, Education and Learning Systems (ANGELS). Dr. Curtis Lowery is the director of the University of Arkansas for Medical Services for

Distance Health, which is in charge of this program. Federal funding has supported the building of T1 Internet lines that allows the center to connect to more than 400 hospitals, clinics, and other medical facilities across the state. Realizing how critical this type of medical service is, the University of Arkansas is expanding its technological capabilities to reach patients at home and providers for whom the more expensive equipment is too great a financial reach [10]. Over 1500 patients have received genetic counseling through the ANGELS network. Approximately 2500 ultrasounds were performed via telemedicine in the ANGELS network over a two year period [8].

Dr. Adair of Regional Obstetrical Consultants, a maternal-fetal medical practice in Chattanooga Tennessee, acknowledges the need for telemedicine practices as well. He started the telemedicine program, Solutions to Obstetrics in Rural Counties (STORC) in 2009. The statistics show that two thirds of Tennessee counties have no private provider of prenatal care. Video conferences now take place via video. STORC expects to supply telemedicine equipment to hospitals as well [10]. Under this program 24-hour access to a maternal fetal medicine specialist is available. A practical nurse and sonographer make weekly visits to the hospitals involved in this program [8].

Avera eCare in Sioux Falls, South Dakota is going to add ob-gyn telemedicine consultations to its list of services. It, too, has recognized the need for consultations in rural areas [10].

An interesting and effective program that helps women is the text4baby program that is sponsored by the National Healthy Mothers Health Babies Coalition that has been in existence since 2010. If a woman signs up for this program, she receives 3 informative text messages weekly for the duration of her pregnancy and throughout the first year of her child's life. The underlying goal of this program was to reach out to women in the early stages of their pregnancies, especially those in low-income or poverty areas. The more involved the women were in this program, the more they kept to their scheduled appointments with their doctors [8].

Telemedicine is particularly critical for areas where mortality rates are high for both infants and mothers. These areas are usually remote and poor. The Mobile Alliance for Maternal Action supports health information for pregnant mothers and those with infants. In Bangladesh, India and South Africa. Inexpensive cell phones are given to the women and information about healthcare is transmitted via voicemail and text messages. There are also messaging services to transmit information for the preventions of mother-to-child transmission of HIV. Cell phones usage was implemented in rural Africa to report postpartum hemorrhaging [8].

3D imaging is directly related to telemedicine practice; it allows the storage of large datasets without loss of information and so can be analyzed off-line and referred to in a future consultation. 3D ultrasound has been used to diagnose uterine anomalies, assess tubal patency and to exclude intrauterine and ovarian pathology. 3D sonography has the capability of showing the endometrial cavity and the myometrium simultaneously in the coronal plane. Congenital uterine irregularities are linked to a greater risk of first and second trimester miscarriages and preterm delivery. With the use of 3D sonography, healthcare providers can identify those patients at risk and surgical intervention can be performed. The technology affords the showing of the endometrial cavity and the myometrium simultaneous in the coronal plane. Intervention is critical as women with a subseptate uterus have a larger proportion losing a pregnancy than those with an arcuate uterus have a larger proportion of losing a pregnancy in the second trimester and preterm labor than those with a normal uterus. Research with this technology has also showed that

women who have experienced several miscarriages and have arcuate and subseptate uteri have the remaining length of the uterus shorter than those with a normal uterus [11].

3D sonography has also been successfully used in revealing endometrial polyps in sub fertile patients. Significant improvements in diagnosis over standard imaging with and without saline contrast has been shown [11].

With contrast media, 3Dsonography has been used in the assessment of tubal patency. It has also been used in to validate the increase in vascularity and volume of the ovaries in polycystic ovarian syndrome. 3D sonographic studies as a predictor of antral follicle counts, ovarian volume and ovarian blood flow [11].

The thought of the major benefits of 3D is its ability to illustrate the 3 orthogonal planes of the coronal vie of the uterus. This allows for the diagnosis of uterine anomalies, including the locations of fibroids and polyps. The fact that images obtained by 3D ultrasound can be stored and reviewed at a later time allows the healthcare provider to give further thought to the diagnosis without the patient having to be on site [11]. For women who are having difficulty conceiving or bringing a pregnancy to term successfully, 3D ultrasonography is a boon.

Technology is ever progressing and now there is 4D dimensional ultrasonography (4DUS) with spatiotemporal image correlation (STIC). It is used for fetal echocardiography. Congenital heart defects in the Unites States are the most common birth defects. They are also a leading cause of infant mortality and morbidity. Diagnosis before birth allows for counseling and management. Examining the four chambers of the fetal heart and the outflow tract are considered standard during the second trimester [8].

Telemedicine is being used to set up forums for questions of pregnant women. These questions range from needing moral support in general to questioning the medical opinion of their own ob-gyn doctors. The former type of question reflects the fact that the primary healthcare providers did not meet the emotional support [12].

One such forum had patients communicating with an expert on involuntary childlessness. Those who frequented the website generated the questions in an open format. A software program called Atlas-ti determined the results of the survey, which follows. The majority of respondents (65.5%) expected general information about involuntary childlessness, conception, or an evaluation of drugs. Others were concerned about their actual treatment (40.6%) and therapeutic options (28.8%). Some questions just expressed curiosity on the act of reproduction [12].

The benefits of telemedicine in the field of obstetrics and gynecology cannot be denied. The technology coupled with trained healthcare providers is used to read ultrasounds, interpret non-stress tests, counsel patients, manage diabetes, ameliorate postpartum depression, and provide support for parents remotely. Reductions in time lost from work, transportation costs, and more efficiency for the health care providers, and reducing medical costs all have been suggested as benefits of telemedicine. The future of technology and medicine hold great promise for women's health. At present, research is being done if using a robot instead of a sonographer at distant sites will be comparable [8]. Technology research will produce faster, safer and clearer transmissions of video. A company called Cambridge Temperature Concepts, started by a chemist, Shamus Hasheer, has invented a fertility monitor, and called DuoFertility. Their claim based on data that was published in a peer-reviewed journal is that it is as effective as conventional IVF and very much cheaper [13]. Medical research has already succeeded in the first birth of a baby resulting from a womb transplant in the United States. A woman who was born without a uterus give birth to a baby at Baylor

University Medical Center in Texas [14]. Only the future will tell how telesurgery and telemedicine will be involved in this aspect of women's healthcare.

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