Telemedicine: A Medical Virtualization Technology

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***Abstract*— Many patients with illnesses difficult to diagnose and treat come to infirmaries for medical assistance, and the value of traveling and accommodation is high for them, especially for those from the lower or remote border areas. As networks become more excellent and increase in speed, various energetic activities have begun to emerge. The novel systems will cause a significant change in society, and one area, which is required to be an efficient application of the internet, is telemedicine. Telemedicine can get specified as the distribution of health care and sharing of medical knowledge over a certain distance using telecommunication medium. Telemedicine provides medical information transfer at a distance, to support medical procedure, with the final goal of developing community health care. In these experiments, combined functions such as the transmission of medical images, collaboration, and video conferencing and contributed great personal interfaces for telemedicine. As high-speed broadband networks spread, telemedicine assistance functions and areas where telemedicine services are available will rise. In the medical field, the evolution of a new format for medicine is expected, to include an equalization of chances to receive advanced care, and providing critical medical care by linking hospitals and clinics. This article focuses on studying about this new medical virtualization technology called as Telemedicine.**

***Keywords*----** Medicine, Medical, Virtualization, Technology, Trend, Technique, Telemedicine**.**

I. INTRODUCTION

Telemedicine is the application of telecommunication and information technology to present clinical health care at a range. It helps reduce distance limitations and can develop access to medical assistance that would consistently not be available in remote village areas. It is also employed to preserve lives in urgent care and crisis situations. Although there were distant precursors to telemedicine, it is primarily a product of 20th-century telecommunication and information technologies. These technologies authorize conversations between patient and medical staff with both convenience and care, as well as the frequency of medical, imaging and health informatics data from one site to another. Early forms of telemedicine gained with telephone and radio have got supplied with video telephony, superior diagnostic schemes supported by shared client/server applications, and additionally with telemedical tools to encourage in-home care.

Telemedicine system is one of the principal forces shaping the destiny of healthcare. People who exaggerate to telemedicine's early problems or underestimate its scope will be surprised by its real power. Telemedicine will eventually revolutionize healthcare – refactor virtually every relationship and activity that define late-twentieth-century medicine. In some nations telemedicine is already applied in actual medical practice, the scope is still limited though. The telemedicine technique demands healthcare networks allowing doctors from more than one place to join a video conference at a time, and these networks should have a capacity to transfer high-quality images immediately. Information technology is now growing to be the most successful technology every field should consider [1]. To make telemedicine and active medical practice it is essential to have extensive telemedicine system. That means it should be applied with ease in any department and should be connected to hospital information system with ease as well. Until now most telemedicine systems are modeled only for some fields. There are two types of the telemedicine systems. One can get applied between large range hospitals, and the other is a home care designed system through which patients at home can view physicians.

One of the essential purposes of telemedicine can get denoted by the saying: "Move the information, not the patient." When a subject needs to consult professional, information about the subject could be obtained locally and transferred through a network to a professional. In many circumstances, this can replace transporting the patient or the professional [2] to a given location. This sharing of information for medical diagnosing and treatment is a basic concept of telemedicine using the technology like image processing and video processing. The investigation, monitoring, and management of patients and the training of subjects and staff using systems which provide ready access to expert advice and patient knowledge no matter where the subject or relevant information gets found. Telemedicine may, therefore, get viewed as all locations where information is switched electronically between health care people that collaborate in treating victims.

II. FEATURES OF TELEMEDICINE

The major characteristics of the telemedicine technology get illustrated as follows:

- Provides the powerful and available techniques for patients and doctors to interact with each other and permits patients to send their medical data such as images through the Internet.
- It presents an event for subject diagnosis and subject consultation on the remote spot.
- It builds processor-based subject records and other electronic information systems that provide relatively easy and fast way to large databases and that permit [3] the application of robust statistical methods for analyzing and displaying those data.
- It expresses approaches for authenticating knowledge to patients, clinicians, and others in ways that promote informed decisions and excite desired changes in behaviors and outcomes;
- It potentially allows easier access to more features about a subject than the user both requests or needs.
- It automatically generates a payment including types of telemedicine services and would be divided into professional and facility components.
- It provides a secure web payment system and authentication procedures to ensure that messages are received from the stated source exactly as they get sent.

III. METHODOLOGY

A. The System Methodology

The developed system operation mostly relies on existing public communication infrastructure, i.e. fixed the unrestricted telephone. The obstacles with a non-mobile telemedicine system are:

1. It is not easy to be improved and less flexible, particularly in fields where the information and transferring infrastructure has not been available yet.

2. Deployment of the system could be very problematic especially in the case of emergency cases and natural disasters such as tsunami, earthquake, and flooding [4].

3. India has more than 100 crores population, spread out all over the country. Since the demography condition of India, a mobile and movable system will be demanding because a fixed system 's hard to be reached by patient living in remote urban or village area, so he or she cannot be given proper health services.

For the moderation of these obstacles and support the different growing application of telemedicine, this article suggests the Evolution of ICT-Based Mobile Telemedicine Systems with Multi Communication Link. One of the significant enigmas to deliver health services in India is the particular demography and the availability of needed infrastructure. The Telemedicine technology will exploit the advantage of wireless technology and combine it with other communication technologies such as wideband radio packet to complete different locals and demographic requirements.

The system can get operated in both on-line mode and the extended mode (data is stored and forwarded later on). The data can get transmitted in a different way of communication links, and the system will be bandwidth independent. As a result, the telemedicine technology should be able to be employed also if only the little bandwidth is present in the local location. Telemedicine will get provided with options of various communication links from ordinary telephone lines, mobile phone both GSM or CDMA [5] and also packet radio. Depending on the geographic location, a user can determine the mode of communication that suits the requirement.

B. The System Design

Mobile telemedicine directs a mobility aspect of the subject, therapeutic data, health assistance, and emergency team movement. Telemedicine is meant to be on the deployment of a mobile unit provided with a processor, and diagnostic tools and processes. The unit is called Telemedicine unit also known as a mobile or movable unit and supported by specially designed hardware and software. Just like the Mobile Unit, the article will also develop a Hospital unit that gets located in the Medical Center or any reference hospital.

According to the most requirements of health services in India, the design system will get focused on application telemedicine for:

- Tele diagnostics
- Teleconsultation
- Recording and reporting
- Distance education
- Other service applications.

The Mobile Unit is shown in Figure 1, while Figure 2 depicts a Hospital unit.

1. The Mobile Unit

The Mobile Telemedicine Unit consists of three blocks i.e. the medical devices that performance analysis and retrieval of medical data including a set of video camera devices; the interface block [6], and a processing data unit.

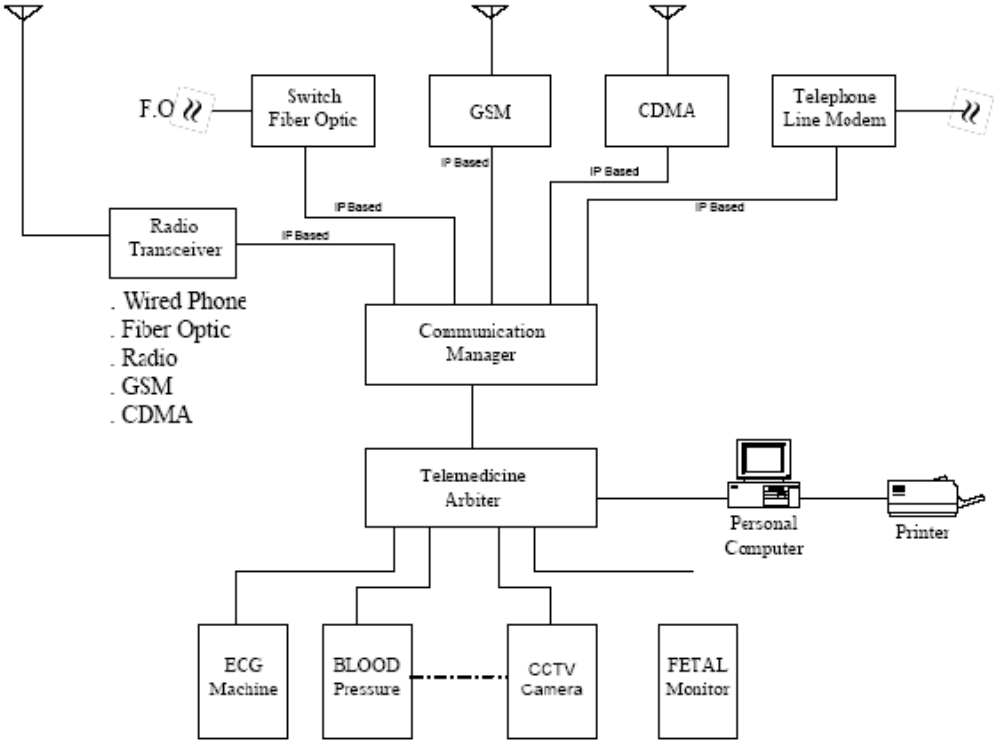

Figure 1: Mobile Unit

2. Medical devices block

Medical devices which get equipped with the unit may vary, according to the urgent health care assistance that is mostly demanded by the inhabitants within the area of business. Each of therapeutic tools gets connected to a Telemedicine Arbiter that works as an interface between the equipment [7] and the local machine. Moreover, the telemedicine arbiter is also employed as a control unit for communication transaction to the local machine and the communication manager.

3. Communication block

It consists of two main parts, namely:

• Telemedicine Arbiter

• Communication director.

The arbiter is capable of data acquisition or polling of medical record from various medical tools. Data will get stored in a Medical Data Base. One of the most significant factors has to get taken [8] into account is the possibility of serving a broad range of data format. A special purpose software must get modeled as a protocol for data exchange, and biosignals retrieval modules to support the necessary system has to be developed as well.

Communication between the Mobile Telemedicine Unit and the Hospital Unit gets implemented by using different communication mode. For carrying this job, a communication module called Communication Manager will get modeled. This module provides an option for data transmitting according to the available communication link infrastructure and consists of the multi-modem [9] (radio, GSM, CDMA, Fibre optic). The performance of the module gets manipulated by predefined software communication protocol to handle data transaction such as data flow in – data flow out that matches to format data based on the available communication link, learn a kind of communication link, and maintain the relationship between the units.

4. Processing Data Unit

A personal processor gets employed as a processing data unit. The selection of the computer depends on the application of the Telemedicine Unit that is a link parameter to a high-speed network that translates different data format such as subject record, image, multimedia, effective storage of data, and efficient handling of growing number of system users [10].

5. The Hospital Unit

As seen in Figure 2, the Hospital Unit consists of a dedicated processor and a Communication Manager. The machine gets used for monitoring signals and data coming from the Telemedicine Unit. Incoming signals are biosignals estimated by medical devices within the Telemedicine Unit. The information may be in a different format, and the Communication Manager controls the data transaction [11].

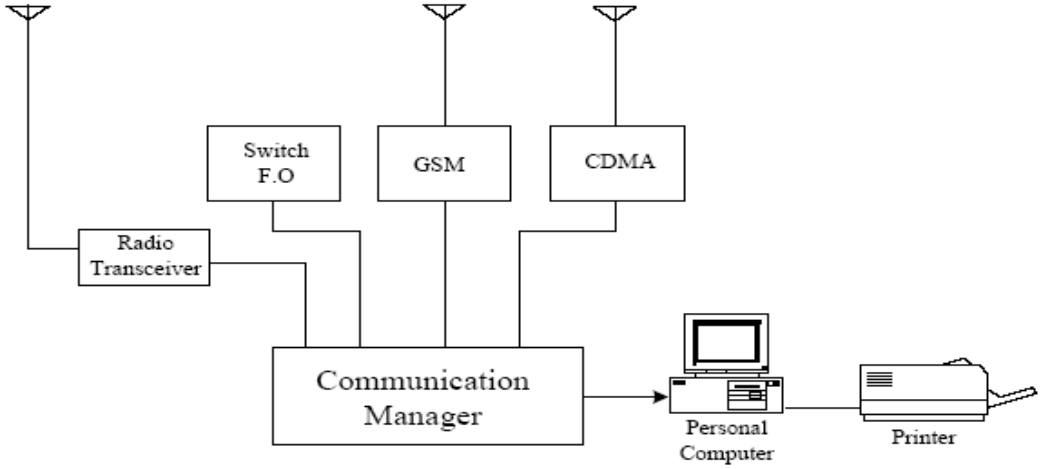

Figure 2: Hospital Unit

IV. IMPLEMENTATION OF TELEMEDICINE

A. The Mobile Telemedicine Platform

Mobile Unit is created to be expandable and flexible according to the user specifications. Hence, the unit gets devised in modular form; the mobile telemedicine unit gets provided with both hardware and software. The minimum tool contains a processor or laptop, a digital camera, power source, and medical devices. Based on the most demands, the medical devices included are:

1. Blood Pressure
2. ECG machine
3. Doppler Fetal monitor.

It is acceptable to use the only digital instrument and medical tools, although the analog device may also get employed if required. The main problem which must get taken into account is the accuracy level of biosignal and data requested by a doctor for diagnosis, portability, and robustness means the tools can perform in almost any conditions area. Also, the mobile unit will also get provided with image processing software and a scanner for digitizing resulted image.

The telemedicine also contains Patient Information Record (PIR) that gets required for providing health care using telemedicine. The medical knowledge consists of clinical as well as nonclinical data. Clinical information is health information of a patient, which is:

- the disease he or she is suffering for
- the doctor's perception of the subject's sickness
- the diagnostic examination to be conducted out to determine the victim's ailment
- the result of the diagnostic examination
- the kind of treatment to be given
- the method of therapy should get refunded to them

Moreover, hence the non-clinical data is about the subject's surrounding, such as address, occupation, spouse, and age [11].

The telemedicine technology gets modeled to get utilized in a hospital. Depending on the application and space limitation, the platform of Hardware and Software for telemedicine technology may vary.

V. TYPES OF TELEMEDICINE

Telemedicine can get broken into three broad categories: store-and-forward, remote patient monitoring, and real-time interactive services.

A. Store and forward telemedicine

Store-and-forward telemedicine comprises procuring medical data such as medical images, biosignals and then forwarding this data to a doctor at a favorable time for assessment offline. It does not require the presence of both parties at the same time. Dermatology (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 fundamental distinction between regular in-person case encounters and telemedicine encounters is the elimination of an actual physical test and history. The store-and-forward process requires the professional to depend on history report and audio or video information instead of a physical examination [12].

B. Remote monitoring telemedicine

Remote control authorizes physicians to monitor a patient remotely using various technological devices. This technique gets primarily utilized for managing lifelong illnesses such as heart disease, diabetes mellitus, or asthma. These aids can provide comparable health outcomes to traditional in-person patient encounters, supply greater satisfaction to patients, and may be cost-effective. Examples include home-based nocturnal dialysis and improved joint management [13].

C. Real-time interactive telemedicine

Electronic consultations are possible through interactive telemedicine services which provide real-time interactions between patient and provider. Many ventures such as history review, physical examination, psychiatric evaluations and ophthalmology assessments get conveyed comparable to those done in traditional face-to-face visits. Also, doctor-interactive telemedicine aids may be less costly than in-person clinical visit [14].

VI. APPLICATIONS OF TELEMEDICINE

A. Telenursing

It refers to the application of telecommunications and information technology to provide nursing services in health care whenever a significant physical distance exists between patient and nurse, or between any numbers of nurses. As a profession, it is a member of telehealth and has numerous points of connections with other medical and non-medical treatments, such as telediagnosis, teleconsultation, and telemonitoring [15].

Telenursing is achieving substantial growth rates in many countries due to several factors: the preoccupation in reducing the costs of health care, an improvement of aging and chronically sick population, and the improvement in coverage of health care to remote, rustic, tiny or sparsely populated areas. Among its profits, telenursing may help solve increasing shortages of nurses; to overcome distances and save travel time, and to retain patients out of the hospital. A prominent degree of job satisfaction has got recorded among telenurses.

B. Telepharmacy

It is the delivery of pharmaceutical care through telecommunications to victims in locations where they may not have a direct connection with a druggist. It is an instance of the wider aspect of telemedicine, as implemented in the field of pharmacy. Telepharmacy assistance includes drug therapy monitoring, patient counseling, prior permission and refill support for prescription drugs, and monitoring of formulary agreement with the aid of teleconferencing or videoconferencing. Remote administering of medications by electronic packaging and labeling systems can also get thought of as an instance of tell pharmacy. Telepharmacy assistance can be passed at retail store sites or through hospitals, nursing homes, or other medical care offices.

The term can also apply to the usage of video conferencing in pharmacy for other goals, such as implementing education, training, and management assistance to pharmacists and pharmacy workers remotely [16].

C. Telerehabilitation

Telerehabilitation is the transmission of recovery assistance over telecommunication networks and the Internet. Most types of support fall into two categories: clinical evaluation which means the patient's functional abilities in the surrounding, and clinical treatment. Some areas of recovery study that have examined telerehabilitation are neuropsychology, speech-language pathology, audiology, occupational therapy, and physical therapy. Telerehabilitation can give treatment to people who cannot travel to a dispensary because the subject has a weakness or because of travel time. Telerehabilitation also provides experts in rehabilitation to join in a clinical discussion at a range.

Most telerehabilitation is profoundly visual. Until the year 2014, the most commonly used means do webcams, videoconferencing, phone lines, videophones and web pages comprise rich Internet applications. The visual

nature of telerehabilitation technology restricts the types of rehabilitation services that can get produced. It is significantly widely applied for neuropsychological recovery and fixture of repair tools such as wheelchairs, braces or artificial limbs and in speech-language diagnostics. Rich Internet uses for neuropsychological rehabilitation of cognitive impairment were first introduced in the year 2001. This attempt has grown as a teletherapy treatment for cognitive skills improvement programs for school children. Tele-audiology is a growing employment. Telerehabilitation is the practice of professional treatment, and physical therapy is limited [17].

A couple of critical areas of telerehabilitation research are (1) demonstrating equivalence of assessment and therapy to in-person evaluation and therapy, and (2) building new data collection systems to digitize information that a therapist can use in practice. Ground-breaking research in Telehaptics which is the sense of touch and virtual reality may broaden the scope of telerehabilitation practice, in the future.

D. Teletrauma care

Telemedicine gets utilized to develop the efficiency and effectiveness of the transfer of attention in a shock environment. Instances include:

Telemedicine for Trauma triage: using telemedicine, trauma experts can communicate with personnel on the scene of a mass casualty or disaster situation, through the network using mobile applications, to define the strictness of injuries. They can provide clinical evaluations and decide if those injured should get evacuated for urgent attention. Remote trauma experts can provide the same quality of clinical assessment and plan of care as an injury expert located physically with the patient.

Telemedicine for intensive care unit rounds: Telemedicine is also being employed in some trauma ICUs to decrease the spread of epidemics. Shots are usually conveyed at hospitals across the nation by a team of almost 10 or more people to involve revisiting physicians, fellows, residents and other doctors. This society usually moves from bed to bed in a unit examining each patient. This aids in the transformation of concern for patients from the night shift to the morning shift, but also assists as an educational practice for new residents to the organization. A novel strategy features the team carrying rounds from a conference room using a video-conferencing system. The shock attending residents, fellows, nurses, nurse practitioners, and druggists can view a live video stream from the patient's bedside. They can see the constant warnings on the monitor, see the settings on the respiratory ventilator, and see the patient's injuries. Video-conferencing allows the distant observers two-way communication with doctors at the bedside [8].

Telemedicine for Trauma education: some trauma stations are delivering trauma training lectures to hospitals and health care providers worldwide utilizing video conferencing technology. Each speech provides fundamental principles, firsthand knowledge and evidenced-based techniques for critical analysis of established clinical practice standards, and associations to newer big dilemmas. The various sites collaborate and share their perspective based on location, available staff, and available support.

Telemedicine in the trauma operating room: trauma specialists can observe and consult on subjects from a remote position using video conferencing. This inclination permits the attending to inspect the residents in real time. The remote surgeon can control the camera to get the best angle of the method while at the same time contributing expertise to provide the best possible care to the victim.

E. Telepsychiatry

Telepsychiatry, another perspective of telemedicine, also employs video conferencing for subjects living in underserved areas to access psychiatric services. It offers a broad range of assistance to the patients and providers, such as the meeting between the psychiatrists, educational, clinical programs, investigation and evaluation, medication treatment administration, and regular follow-up gatherings. Most telepsychiatry gets initiated in real time (synchronous) despite in recent years study at UC Davis has improved and approved the method of asynchronous telepsychiatry. Recent surveys of the literature in 2015 fortified that telepsychiatry is as productive as in-person psychiatric meetings for personal evaluation, is at least as useful for the treatment of dysfunctions such as grief and post-traumatic stress disorder [8].

F. Teleradiology

Teleradiology is the capacity to send radiographic images from one position to another. For this process to get executed, three essential elements get expected, an image sending station, a transmission interface, and a receiving image review site. The most typical implementation is two machines connected through the network. The processor at the end of receipt will need to have a high-quality display screen that has been examined and discharged for clinical goals. Sometimes the computer of receipt will have a printer so that images can get printed for convenience [4].

The teleradiology process begins at the picture sending location. The radiographic image and a modem or other associations are expected for this first step. The picture gets scanned and then sent through the network connection to the receiving computer.

Today's high-speed broadband based Internet enables the use of new technologies for teleradiology: the image reviewer can now have access to remote servers to view an exam. Therefore, they do not need particular workstations to see the pictures; a standard processor and the digital subscriber line (DSL) connection are enough to reach keys central server. No special software is necessary on the machine, and the images can get made from wherever in the universe [2].

Teleradiology is the most common use for telemedicine and estimates for at least 50% of all telemedicine practice.

G. Telepathology

Telepathology is the study of pathology at a range. It utilizes telecommunications technology to promote the transfer of image-rich pathology data between distant locations for diagnosis, education, and research. The performance of telepathology wants that the pathologist selects the video images for review and the rendering examinations. The application of television microscopy, the pioneer of telepathology, did not require that a pathologist has physical or virtual involvement is the selection of microscopic fields-of-view for analysis and investigation [10].

H. Teledermatology

Teledermatology provides dermatology discussions over a range using audio, visual and data communication and has been found to improve efficiency. Applications encompass health care administration such as diagnoses, consultation, and treatment as well as continuing medical study [15].

I. Teledentistry

Teledentistry is the application of information technology and telecommunications for dental concern, discussion, education, and public recognition in the same way as telehealth and telemedicine.

J. Teleophthalmology

Teleophthalmology is a branch of telemedicine that gives eye care through digital medical tools and telecommunications technology. Today, utilization of teleophthalmology encompass path to eye specialists for patients in outside areas, ophthalmic disease screening, examination, and monitoring; as well as distant learning. Teleophthalmology may help decrease variations by providing remote, low-cost screening studies such as diabetic retinopathy screening to low-income and uninsured victims [8].

K. Telesurgery

Telesurgery is the ability for a physician to conduct surgery on a subject even though they are not physically in the same location. It is a form of telepresence. Telesurgery blends elements of robotics, cutting edges communication technology such as high-speed internet, haptics, and components of management information systems. While the area of robotic surgery gets fairly well set, most of these robots are controlled by specialists at the location of the operation [3].

Telesurgery is essentially advanced telecommuting for doctors, where the natural range between the surgeon and the patient is irrelevant. It guarantees to allow the expertise of functional residents to be available to subjects worldwide, without the necessity for victims to travel beyond their local infirmary.

Telesurgery is the performance of surgical procedures where the doctor is not physically in the same location as the patient, using a robotic teleoperation system controlled by the resident. The remote operator may give substantial feedback to the user. Telesurgery links components of robotics and high-speed data connections. A significant limiting factor is the speed, latency, and reliability of the communication system between the surgeon and the patient, though transatlantic operations have got shown [17].

VII. BENEFITS AND LIMITATIONS OF TELEMEDICINE

Telemedicine can be helpful to patients in isolated areas and remote regions, who can receive care from doctors or professionals far away without the patient having to travel to visit them. Recent progress in mobile collaboration technology can allow medical experts in multiple locations to share information and discuss patient concerns as if they were in the same position. Remote case monitoring through mobile technology can overcome the need for outpatient appointments and enable remote prescription confirmation and drug management oversight, potentially significantly decreasing the overall cost of pharmaceutical care. Telemedicine can also facilitate medical training by allowing operators to observe authorities in their fields and share best practices more efficiently [2].

Telemedicine also can exclude the possible importation of infectious diseases or parasites between patients and medical staff. It is particularly an issue where MRSA is a concern. Additionally, some victims who feel uncomfortable in a doctor's office may do great remotely. For example, white coat syndrome may get avoided. Subjects who are home-bound and would otherwise require an ambulance to move them to a hospital are also a concern [1].

The downsides of telemedicine cover the cost of telecommunication and data management tools and of professional practice for medical workers who will operate it. Virtual care also entails potentially decreased human interaction between physicians and subjects, an increased risk of error when medical aids get liberated in the absence of a certified professional, and an increased risk that protected health knowledge may get negotiated through electronic storage and transmission. There is also a concern that telemedicine may reduce time efficiency due to the difficulties of evaluating and treating subjects through virtual interactions; for instance, it gets estimated that a teledermatology discussion can take up to 30 minutes, whereas 15 minutes is typical as a regular debate. Additionally, probably lower quality of transmitted records, such as images or patient progress reports and decreased access to appropriate clinical data are QA risks that can compromise the quality and continuum of victim care for the broadcasting doctor. Other barriers to the implementation of telemedicine include an unclear legal control for some telemedical systems and difficulty claiming compensation from insurers or government applications in some fields [11].

Another challenge of telemedicine is the failure to commence treatment immediately. For instance, a victim suffering from a bacterial infection might be given an antibiotic hypodermic injection in the hospital, and observed for any reaction, before that antibiotic gets prescribed in pill form.

CONCLUSION AND FUTURE SCOPE

It does not require too much of an extent of the intelligence to understand that telemedicine will soon just get added a way to see a health professional in the coming future. Telemedicine has the inherence to make every minute count by assembling clinical information from multiple subjects concurrently. However, data may get dissipated due to a software anomaly or hardware meltdown. Therefore, relying too heavily on a computer system to prevent errors in health care data may be questionable. There has to be a bright balance between total dependency on computer explications [13] and the application of human intelligence. Striking that perspective may make all the difference in saving someone's life. The potential of telemedicine, telehealth and e-health are still left to our imaginations. Time alone will tell that if Telemedicine is a forward step in a backward direction or to quote Neil Armstrong one small step for IT but one giant leap for the healthcare industry. Hence in the days to come it might bring a change in the today's world by revolutionizing the healthcare industry.

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