TELEMEDICINE-THE EMERGING SCIENCE OF TODAY

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Summary

Telemedicine is a emerging growing and most challenging science. Cardiovascular diseases, Pshycological disorders, CNS depression and many more complications are very wisely treated by this telemedicine therapy. Counselling, Soothing words, Emotional security and confidence building in patients has become challenge to a medical science. In the present review we have discussed concept of telemedicine/ how it works/ Type and need in todays world. Proper scientific, Systemic exploration of this technique will certainly help many respondents in future.

Key-words: Diseases , Medicine, Surgery ,Telemedicine.

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Introduction

Care at a distance (also called *in absentia* care), is an old practice which was often conducted via post; there has been a long and successful history of in absentia health care, thanks to modern communication technology which has evolved into what we know as modern telemedicine. Telemedicine is the delivery of medicine using the telecommunication devices. The term telemedicine is composed of the Greek word tele meaning 'far', and medicine. It is a rapidly developing application of clinical medicine where medical information is transferred through the phone or the Internet and sometimes other networks for the purpose of consulting, and sometimes remote medical procedures or examinations. It generally refers to the use of communications and information technologies for the delivery of clinical care. It is as simple as two health professionals discussing a case over the telephone, or as complex as using satellite technology and video-conferencing equipment to conduct a real-time consultation between medical specialists in two different countries.

NEED FOR TELEMEDICINE:

1. The population is predominantly rural and distributed in distant geographical locations apart from the high-density urban areas. To provide the basic minimum health care has been one of the priorities of the Health administration all along.
2. High cost of health care and lack of investment for health care in rural areas.
3. Inadequate medical facilities in rural & inaccessible areas.
4. Problem of retaining doctors in rural areas where they are required to serve & propagate widespread health awareness.
5. Specialist doctors cannot be retained at rural areas as they will be professionally isolated and become obsolete and even monetary incentives cannot prevent it.

TYPES OF TELEMEDICINE:[1]

1.Real time telemedicine (synchronous) :

a. It requires the presence of both parties at the same time and a communications link between them that allows a real-time interaction to take place.

E.g. Video-conferencing equipment.

b. Medical specialties conducive to this kind of consultation include psychiatry, family practice, internal medicine, rehabilitation, cardiology, pediatrics, obstetrics, gynecology, neurology, speech-language pathology and pharmacy.

2.Store-and-forward telemedicine (asynchronous):

a. 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.

E.g. Dermatology (teledermatology), radiology, and pathology are common specialties that are conducive to asynchronous telemedicine. A properly structured Medical Record preferably in electronic form used for this transfer.

3.Home Health Telemedicine :

a. Allows the remote observation and care of a patient. Home health equipment consists of vital signs capture, video conferencing capabilities, and patient stats can be reviewed and alarms can be set from the hospital nurse's station.

E.g. Disease management, post-hospital care, assisted living, etc.

HOW IT WORKS: [2]

1. When the patient-end doctor feels the need for a second opinion, he/she uses a telecommunication means, to consolidate relevant clinical information of that patient into an Electronic Patient Record (EPR) and then seeks an opinion of the specialist using teleconsultation.
2. After the connection to the specialist-end is established, the electronic patient record is uploaded. The specialist also has this software installed. Using the software, the specialist then examines the clinical information, and suggests a course of action.
3. If need arises, the doctors on both the ends arrange for a video conferencing to arrive at the diagnosis in a collaborative manner and decide upon the course of treatment in a participative manner. This advice is then formalized after the specialist sends back his opinion to the patient-end doctor.

4. As a user of the integrated telemedicine software (Sanjeevani), the two doctors engaged in teleconsultation are able to get all the services such as patient demographics, general information, patient's medical-history, other information or data including clinical data like ECG, radiographs, pathological reports, clinical images, appending queries and advice, conducting a video conferencing etc.
5. It also enables clinicians to create, edit and view electronic patient record, generate prescriptions, work out interpretations for radiographs and pathological reports besides annotating digitized images, acquire and display ECGs and conduct video conferencing.

Data Transfer-

- It uses socket programming for transferring the data from one PC to another PC provided they are connected by some means to either LAN or WAN.
- For ensuring proper transmission and reception, a log is maintained till data gets transferred.
- It also provides real time communications with the help of the feature of video conferencing.

Need for Telemedicine standards: [3]

- The full potential of telemedicine cannot be reached without clinical and technical standards and guidelines.
- Without these, interoperability and interconnection is not possible and the great potential of telemedicine will be difficult to achieve.
- Older equipment often does not connect with newer versions of the same machine.
- Different brands do not operate with one another, making networking across projects and sometimes within a project expensive and frustrating. Hence there is the need for technical standards for Telemedicine**.**
- In addition to technical standards, clinical protocols and guidelines are needed. Clinical protocols for telemedicine practice include preliminary scheduling procedures, actual consult procedures and telemedicine equipment operation procedures (such as telecommunications transmission specifications). The clinical technical standard for image quality in a video transmission would specify the technical standards needed by a specialist such as a dermatologist to achieve the high levels of image clarity and color required to correctly diagnose a patient.

TELEMEDICINE UNIT [1]

The Telemedicine unit mainly consists of four modules, the bio signal acquisition module, which is responsible for bio signals acquisition, a digital camera responsible for image capturing, a processing unit, which is basically a Personal Computer, and a communication module (GSM, Satellite or POTS modem).

The bio signals collected by the patient (and then transmitted to the Base Unit) are:

- ECG
- Oxygen Saturation (Sp02).
- Heart Rate (HR).
- Non-Invasive Blood Pressure (NIBP).
- Invasive blood Pressure (IP).
- Temperature (Temp)
- Respiration (Resp)

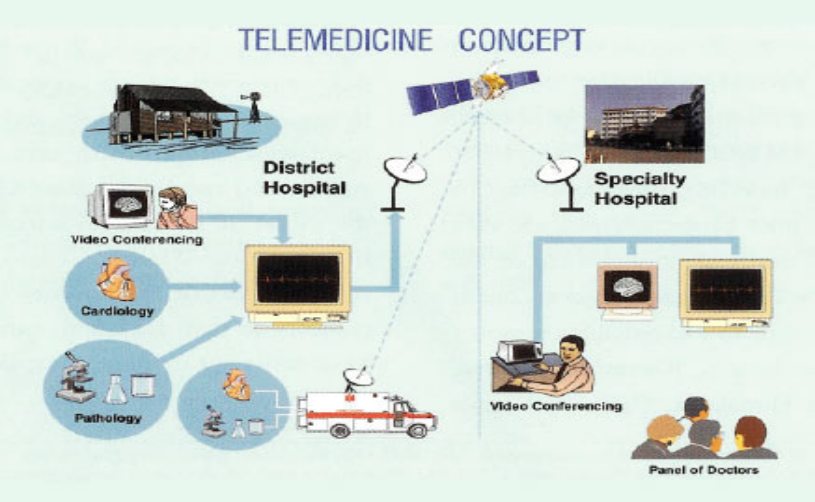

Fig: 1: Telemedicine concept Infrastructure: [3]

This will include minimum standards for all the hardware and software used in a telemedicine system. Hardware includes standards and guidelines for basic telemedicine platform, servers, clinical devices, videoconferencing system, communication hardware and power support. The software standards address operating system, telemedicine software, and server software.

1) **Hardware**:

Telemedicine platform: This will include minimum standards for type of platform to be used, processor/minimum speed, memory requirements, interfaces, and peripherals.

Clinical devices: It includes minimum standards for all the clinical devices to be interfaced or integrated with the telemedicine system, including performance specifications for devices measuring diagnostic parameters, imaging devices, compression, and their safety requirements.

Video conferencing units: This will include minimum standards for video conferencing system, including data rate, picture resolution, frame rate, type of camera, audio quality etc.

Communication hardware: It includes the minimum standards for various hardware used for interfacing the telemedicine system with the communication network, including all types of terrestrial and satellite based networks.

Software:

- An operating system
- Licensed telemedicine S/W (with PIR with the mandatory fields) with appropriate User Interface(UI)
- Back-end Data Base with the mandatory tables/ fields (if applicable)

Connectivity: The options for telemedicine services are:

VSAT (Very Small Aperture Terminal).
PSTN (Public Switched Telephone Network)
ISDN (Integrated Services Digital Network)
Wireless LAN /WAN

Data interchange/exchange Standards and Minimum data sets (MDS):

1) **Identifiers** :

Patient

Telemedicine Centre

The identifiers are frequently not standardized within a single health plan or across plans. This lack of uniformity results in a single health care provider having different numbers for each program and often multiple billing numbers issued within the same program, significantly complicating providers' claims submission processes. In addition, nonstandard enumeration contributes to the unintentional issuance of the same identification number to different health care providers.

Unique Provider Identifiers:

Unique Provider Identifiers in addition to overcoming communication and coordination difficulties, identifier would enhance the ability to eliminate fraud and abuse in health care programs. Payments for excessive or fraudulent claims can be reduced by standardizing enumeration, which would facilitate sharing information across programs or across different parts of the same program.

- **Unique Patient Identifier:**

Each and every patient is identified by a unique and universal Patient Identifier. This Universal Patient Identifier will enable the following benefits:

- Same patient can move across multiple providers without loss of data
- One centralized PIR can be assimilated.
- Medical records database can be built and queried across time
- Captures one-time patient demographics for later analysis.

Telemedicine Centre Identifier:

Each Telemedicine service center acting as either Telemedicine Consulting Centre (TCC) or Telemedicine Specialist Centre (TSC) or both is identified by a unique and universal identifier code.

- **Benefits of Telemedicine Centre Identifier :**
    a) Allows for easy identification of provider for Telemedicine purpose.
    b) Only genuine hospitals can get onto Telemedicine network having proper infrastructure.
    c) Allows for common billing format across providers.
    d) Registration number of providers can be used as identifier.

Key Objectives in defining the standards:

- To promote the growth of Telemedicine.
- To Increase availability of quality medical service to those in need.
- To Improve quality of medical services, as it facilitates access to expert opinion leading to better diagnosis, treatment and prognosis.
- To define usage of Telemedicine technology that is appropriate to the Indian environment.
- To identify the mechanisms for protecting the privacy & confidentiality of individuals' health data.
- To define processes for scientific practice of Telemedicine.
- To contribute to broad international cooperation in the scientific, legal and ethical aspects of the use of Telemedicine.

- To encourage continued support for the advancement of Telemedicine and its applications globally to keep the standards contemporary.
- To provide a framework for interoperability and scalability across Telemedicine services within the country and outside.

Security

Security strategies, designed to protect the privacy, authenticate, authorize, and maintain integrity. These are necessary to protect against the threats of eavesdropping, manipulation, impersonation and unauthorized access to health care information of individuals.

- Who can have access to individuals' health information?
- What kind of security technology is used for the above authentication, such as password, fingerprint and smart card?
- What kind of encryption is used for storing medical data?
- What kind of encryption is used for transmitting medical information?

These should be clearly mentioned in the specifications of the System and be made available.

User Authentication, Entity Authentication:

It is necessary to authenticate the users of the system. This is to be done by the Telemedicine System. This should be done by using mechanisms such as Passwords, Smart card authentication, any Biometric devices such as Thumb scanners, Iris Scanners, etc. Further the Telemedicine System itself has to be authenticated. This can be done using Digital Certificates

Telemedicine Process Guidelines : [2]

Patient Criteria: Indicative guidelines

• Informed written consent must be obtained from the patient before beginning the use of video visits

• Patients cannot be viewed through the video without their knowledge or prior written consent. If other agency personnel or visitors come into the viewing site, the patient must be made aware of their presence, and the patient's approval must be obtained for such personnel to participate in the video visit.

• On initializing the video conferencing the patient should verbally identify himself or herself to the specialists at the TSC. Similarly, the specialist at the TSC identifies himself or herself to the patient.

• If a third remote site is participating in the video visit, the patient must again be aware and approve of such participation.

• Patient satisfaction regarding video visits should be a part of the protocol.

Ensuring quality of Consultation:

Separate consultation forms need to be evolved for each specialty eg. The data needed from patient for cardiology case is very different from a neurosurgery one

Confidentiality of Records:

- Information regarding a person's physical condition, psychological condition, healthcare and treatment shall not be released without the patient's consent.
- Guidelines should ensure that transmission of medical information, including, but not limited to electronic transmissions of telemedical records to and from telemedical facilities, is done in a secure manner.
- Strict verification of identity of each person logging into the telemedicine system should be ensured.

Telemedicine Consultation Centre (TCC): Indicative guidelines:

- The staff should demonstrate the ability to correctly use the technology and troubleshoot common problems and should have written troubleshooting guidelines to follow and a method for follow-up if problems are not quickly resolved.
- Patients must be given clear written instructions as to who to call in case problems arise.

Telemedicine and Pharmacy:

a) The first documented use of telemedicine was done at The University of Nebraska College of Medicine in 1959.

b) Telemedicine technology developed at Mohali has been centered on an integrated telemedicine solution application software) which offers a spectrum of tools, applications and services for telemedicine linkages.

c) In 1999 - Department of Information Technology at the Ministry of Communications and Information Technology (Government of India) launched a pilot project entitled 'Development of Telemedicine Technology' with an objective of reinforcing the national healthcare delivery system implementing telemedicine technology at three premier tertiary level hospitals in the northern parts of India, namely, The All India Institute of Medical Sciences (AIIMS), New Delhi; The Post Graduate Institute of Medical Education and Research (PGIMER) at Chandigarh and The Sanjay Gandhi Post Graduate Institute of Medical Sciences (SGPGIMS) at Lucknow (Uttar Pradesh).

d) The first interactive Telemedicine system, operating over standard telephone lines, for remotely diagnosing and treating patients requiring cardiac resuscitation (defibrillation) was developed and marketed by MedPhone Corporation in 1989.

Telediagnostics: Telediagnostics is the use of information and communications technologies to enable the diagnosis of a patient between geographically separated individuals. Telediagnostics is usually a real time and live dialogue between the specialist and the doctor at the remote site with regard to the diagnosis of the patient's illness [2]

Real time transmission: It is the method of transmission of medical images and wave-forms (images from CT scan, Cath Lab, Color Doppler, Ultrasound, X-ray, PFT, ECG etc.) from TCC to the TSC as it is being acquired. In this method the Teleconsultation is carried out along with the medical data while being acquired at the TCC and rendered at the TSC.

Still Medical Images: These include still images of diseases, pathological slides, X-rays, CT, MRI, etc. Each image represents a single projection. Series of images represent volumetric data. Diagnostic Imaging and Communication in Medicine (DICOM 3) is the accepted standard for these image data storage and transmission. ACR (American College of Radiology) and NEMA (National Electronic Manufacturer Assoc.) are forming relationships with pathology and cardiology groups to extent the standard for additional types of images and photographs, including pathology slides, medical photographs, microscopy, Angiography, Endoscopy, Laproscopy, full motion heart and blood vessel images and ultrasound images. As standards become available they should be incorporated.

Some of the standards formats for storing of several still images, which are applicable in Telemedicine:

1. JPEG (Joint Photographic Experts Group):
JPEG, which is developed by the joint organization of ISO and ITU-TS, is a compression and decompression standard for still image. JPEG is designed for digitization of full-color image and gray-scale image but not for moving image. Currently, JPEG is also used for still image transmission on the WWW (World Wide Web). For the purpose if this exercise JPEG can be accepted but it must be at least version JPEG2.

2. GIF (Graphics Interchange Format)
GIF is the format for color raster image. GIF87 was released in 1987, GIF89 in 1989. It is a standard format for WWW (World Wide Web). Most PC and UNIX workstations support GIF format. However, the color is limited to 24 bits.

3. TIFF (Tag Image File Format)
TIFF is another format for color raster image. Most PC and UNIX workstations support TIFF format. It was developed by Aldus, and currently owned by Microsoft.

4. Moving Medical Images
These include ultrasound, some nuclear medical images, etc. basically, ultrasound image is a series of images represented a temporal sequence. Medical images by various modalities must be able to create and transmit using the DICOM 3.0 protocol standards. For moving image, MPEG and MPEG2 can be used in non-medical applications are applicable in telemedicine.

5. MPEG2 (Moving Picture Experts Group 2): MPEG is the recognized standard for motion picture compression. It uses many techniques also used by JPEG, but adds inter-frame compression to exploit the similarities that usually exist between successive frames. Because of this, MPEG is able to compress a video sequence by about a factor of three more than "M-JPEG" methods for similar quality. The limitations of MPEG are: It requires far more computation to generate the compressed sequence (since detecting visual similarities is hard for a computer) It is difficult to edit an MPEG sequence on a frame-by-frame basis (since each frame is intimately tied to the ones around) MPEG video stream transmission requires high bandwidth, like TI or ATM or at least ISDN PRI in order to achieve a reasonable response time.

6. HTML (Hyper Text markup Language):
Hyper Text Markup Language (HTML) is a simple markup system used to create hypertext documents, which are portable from one platform to another. Essentially, HTML documents are SGML documents with generic semantics that are appropriate for representing information from a wide range of applications. HTML markup can represent:-

- Hypertext news, mail, documentation, and hypermedia:
- Menus of options
- Database query results
- Simple structured documents with in-line graphics
- Hypertext views of existing bodies of information.

The World Wide Web initiative (W3) links information throughout the world. To accomplish this, W3 uses the Internet Hypertext Transfer Protocol (HTTP), which allows transfer representations to be negotiated between client and server. Results are returned in a Multipurpose Internet Mail Extension (MIME) body part. HTML is one of the representations used by W3, and is proposed as a MIME content type. HTML is an application conforming to SGML.

Telemedicine diagnostic equipments are as follows:

Digital ECG

X-Ray Digitizer
Ultrasound (Sonography machine)
Glucometer
Pulmonary Function Test (PFT) machine
Fetal Heart Rate monitor

Diagnostic Interpretation of following is being practiced: [3]

Tele-Radiology - transferring digitized medical images like X-rays, MRIs and CT scans from one location to another for diagnostic reports.
Tele-Dermatology - exchanging digital images of skin for interpretation.
Tele-Pathology - sharing microscopic images with pathologists sitting in diverse locations for instant reports.
Tele-Cardiology - transferring data from modalities such as ECG, Echo Cardiogram for expert opinion.
Remote ICU Monitoring - an excellent solution for providing critical care to patients located in remote areas with basic healthcare facilities. Patients' vital parameters can be monitored from specialty care hospitals and timely alerts and appropriate treatment plans can be sent thus equipping the secondary care hospital with quality ICU/Critical care.
Ambulance Monitoring - a life saving solution in cases where patients need to be transferred over long distances to reach the nearest hospital. The vital signs of the patient can be monitored by a team of specialists and valuable as well as timely healthcare can be provided even before the patient reaches the hospital. Mobile Telemedicine Unit - a solution aimed at providing healthcare where hospitals are unavailable. Using a telemedicine van, videoconferencing and satellite communication, medical care is provided to people in remote areas. It also acts as a life saver providing timely health aid in times of large scale disaster or natural calamities. Electronic Health Record - a web based solution enabling healthcare professionals to access a patient's medical information anywhere and anytime.

Conclusion

Since telemedicine had only holistic approach but now it is studied scientifically. The present review explains the concept, development and future prospectus of telemedicine. Though Telesurgery is been thought in advanced countries like Canada and USA with Broadband telecom infrastructure facilities. Telesurgery conducted by electronic remote systems are been adopted in trial basis. Telemedicine will emerge as the most challenging field of medical sciences.

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