PANIMALAR INSTITUTE OF TECHNOLOGY

(JAISAKTHI EDUCATIONAL TRUST)

CHENNAI 6000 123

DEPARTMENT OF CSE

(Accredited to National Board of Accreditation)

OMD 553 - TELEHEALTH TECHNOLOGY

III YEAR – V SEMESTER

LECTURE NOTES – UNIT – 1

Prepared By	Verified By	Approved By
Mrs. K. HemaPriya	Dr. V. Subedha	Principal
Asst. Professor	HOD/CSE	

UNIT I TELEMEDICINE AND HEALTH 9

History and Evolution of telemedicine, Organs of telemedicine, Global and Indian scenario, Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Advances in Telemedicine.

- "***tele"*** – derived from Greek . Meaning => 'far' /'at a distance'/ 'remote'.

BASIC DEFINITIONS

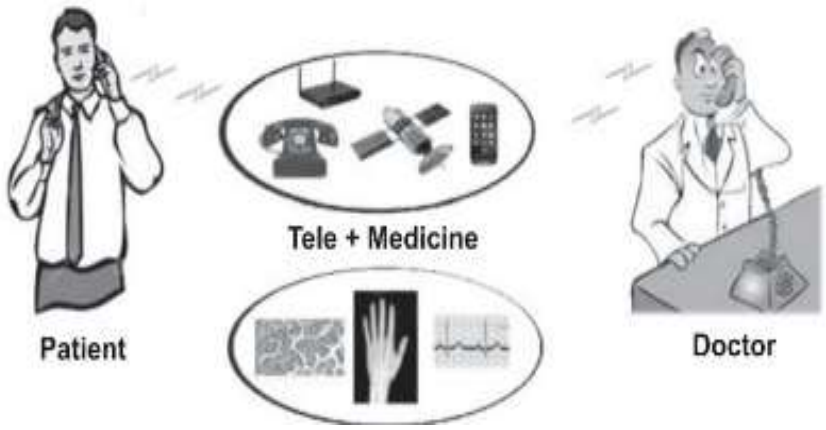
Telemedicine - Definition

Telemedicine is the Use of information and communication technologies:

i) **To provide specialized health care consultation to patients in remote locations,**

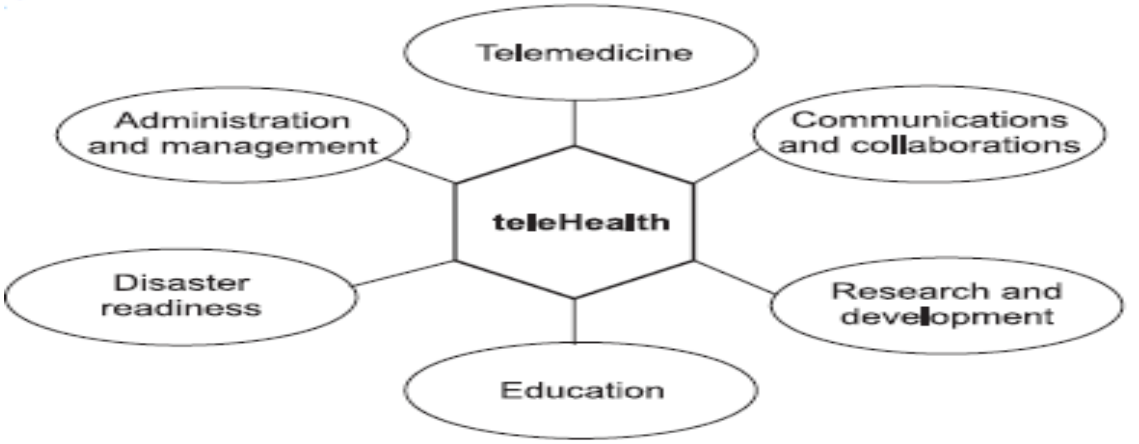
ii) To facilitate video-conferencing among health care experts for better treatment & care,

iii) To provide opportunities for continuing education of health care personnel.



A patient seeking advice from a medical expert via telecommunication network

- Telemedicine is the use of information and communication technologies to transfer medical information for the delivery of clinical and educational services.
- Telehealth is the use of information and communication technologies to transfer healthcare information for the delivery of clinical, administrative and educational services.
- Telecare is the use of information and communication technologies to transfer medical information for the delivery of clinical services to patients in their place of domicile.



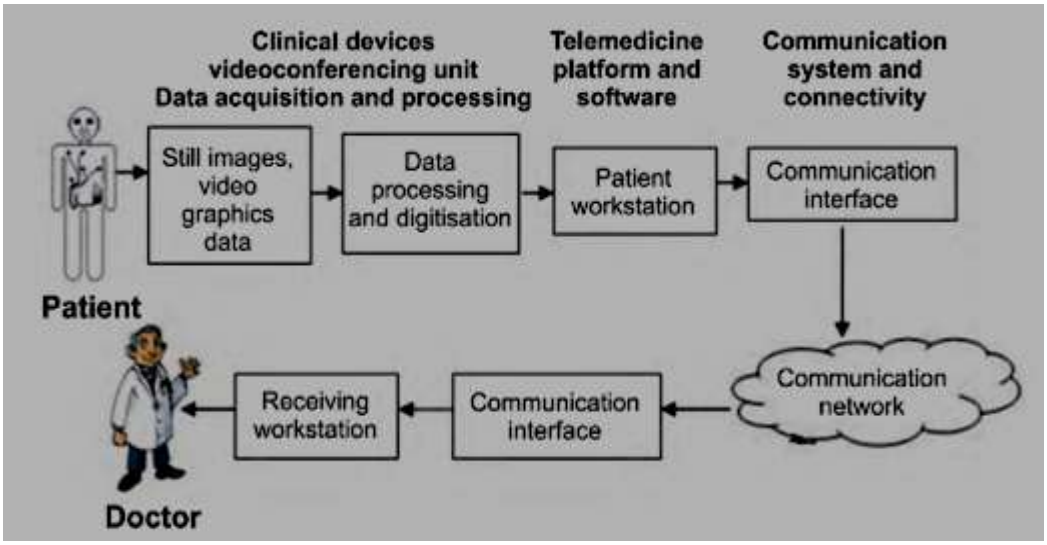
TeleHealth concept indicating that the telemedicine is a subset of teleHealth.

TELEMEDICINE INFRASTRUCTURE
(Or)

COMPONENTS OF TELEMEDICINE SYSTEM

The technology required for a telemedicine system is comparatively a simpleaffair. It is possible that many items required for the purposemay be available in the health facility for other applications.

Figure 2.2 is a block diagram of a typical hospital based telemedicine system. The system consists of a two-way communication link between a medical centre by one or more specialists and one or more our satellite stations staffed by nurses, paramedical staff or even a physician. This arrangement provides an opportunity for the patient to be seen by a staff member in the satellite station, while the patient has full access to a specialist at the tertiary level medical centre. Telemedicine may involve two-way interactive video consultation along with transmission of digital images such as x-rays, CT, MRI images, etc. to the specialist centre. Thus, telemedicine systems can range from consultation on telephone networks to sophisticated audio-video systems.



Block diagram of a typical hospital-based telemedicine system

A successful telemedicine programme requires integration of a number of different devices and technologies. Major areas of devices and technology integration are:

Telemedicine platform (IT infrastructure): Computer/Laptop/Tablet/Smartphone with suitable processor/minimum speed, memory requirements interfaces and associated peripherals (Chapter 4).

Clinical/Medical devices: Include devices for measuring diagnostic parameters and imaging devices.

Videoconferencing unit: Includes cameras, display monitors, audio system (Chapter 12).

Software: An operating system, telemedicine software and backend database.

Communication system and connectivity hardware: Options for POTS, ISDN, VSAT, leased line, satellite, Internet, etc. ([redacted]). Various hardware items used for interfacing the telemedicine system with communication network. Wireless networks ([redacted]), computer networks LAN/WAN ([redacted]).

1. Telemedicine Platform(Information Technology Infrastructure)

Computers have been used in hospital, most often for billing and accounting. However, during the last two decades, there has been a shift towards using computers in all areas of medicine and healthcare, including telemedicine.

The heart of telemedicine system is the network computing. This includes the computing devices which facilitate the acquisition of desired data from the medical device, permits its storage at local or on a central server, and forwards it to the communication platform for distribution to the concerned professionals. In this process, the following issues are involved:

1. Computing hardware: requires video cards, audio cards and the method of interfacing devices to the computing platform
2. Networking requirements: local area network or wide area network
3. Data storage requirements for the network: PC or server based
4. Compatibility with the medical devices to assure appropriate data capture, transmission and storage.

Telemedicine network typically comprises specific equipment arranged in the form of *workstations* at the two sites:

1. ***Referral or originating station:*** This site sends the patient's information and request a consultation or medical advice. At the *referring station*, basic set up should have a single multimedia computer system, which should be capable of creating and maintaining Electronic Medical Record (EMR) of the patient along with the expert opinion. This should support offline, online, and interactive telemedicine creating complete technological base of all types of services/modalities.

2. ***Consulting or referral station:*** This site receives remote patient's data and provide medical consultation, advice and treatment. At *referral centres*, with multiple lower level units connecting, transmitting data, and requiring expert opinion/intervention,

it is necessary to provide multiple telemedicine stations at these locations. These units will have multi-point videoconferencing system so that it can cater to various locations at a time.

2. Clinical / Medical Devices

Clinical devices are used to collect information of interest from the patient. It could be in the form of electrical signal (ECG), sound (phonocardiography), images (x-ray) or data (biochemistry reports). The choice and selection of medical devices are driven by the intended medical applications and the associated operational and technological considerations. As the medical devices usually provide an interface between the patient and the PC, several technical considerations need to be taken into account in their selection. Most of the clinical devices today have USB port, except for some of the older versions which may have RS 232 connectivity. These devices work well with standard PC configuration, tower or desktop, laptop or tablet.

Personal wearable and portable communicable systems for remote monitoring patients' health data and supporting clinical management at a distance are other medical devices which will become popular in the near future.

The medical devices also include specialised diagnostic equipment for capturing patients' diagnostic information in digital format. Example of these are a microscope with a digital camera for telepathology and x-ray digitiser for x-ray films for teleradiology.

In general, the referring centre should have all the medical equipment and devices that are considered necessary for making a diagnosis by acquiring the data from the patient. The selection of the equipment for each centre would depend upon their utility which they would bring into the functioning of the centre (Manamel and Sarkar, 2009). Thus, a careful analysis about the requirements of a centre must be done in advance. The list could contain numerous equipment but the commonly used medical equipment are covered under this section.

3. Videoconferencing Equipment

Videoconferencing equipmentincludes high definition**video cameras, camcorder**.

1. Video cameras:

The standard video cameras included with videoconferencing systems are adequate to meet the requirements of physical examination.

They have standard motorized pan/ tilt/ zoom capabilities that facilitate full body imaging while the patient is being interviewed.

2.Camcorder:

It is required for seeing the **specific area** of the body for detailed examination.
With high capacity zoom lenses, they work well under **varying light conditions**.

4. Software Requirements

- Diagnostic information and performance is dependent largely on hardware and software which are used for medical information acquisition, transmission and display.

- Software must be designed with features that assist the user to enhance, organize and store data in a convenient and better way.

- For example, most imaging software allows the image to be zoomed, rearranged or color and contrast enhanced on the display screen.

- Telemedicine programme applications must be easily interfaced with the existing database systems of the organization.

- These software include financial reporting, billing, physician scheduling etc.

5. Connectivity and communication Systems

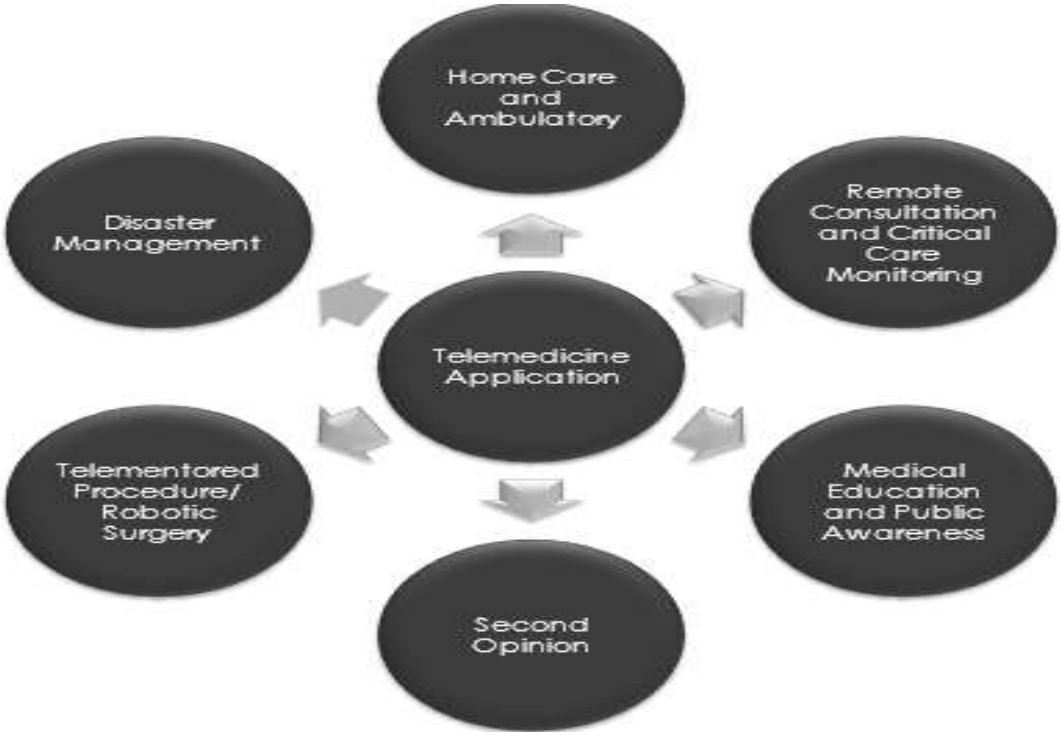
- Telemedicine demands a continuous and reliable communication link for exchange of information.

- There are various digital communication services available today for the telemedicine purpose.

- Types of telecommunication technologies used:
    - PSTN / POTS
    - ISDN
    - LAN
    - ATM
    - Internet
    - Email
    - Satellite connectivity
    - VSAT
    - Wireless LAN
    - CDMA
    - GSM/GPRS/3G/4G network

▶ **Telemedicine Tools**

TELEMEDICINE APPLICATIONS ARE



Benefits of Telemedcine to Patients

- Access to specialized health care services to under-served rural, semi-urban and remote areas
- Early diagnosis and treatment

- Access to expertise of Medical Specialists
- Reduced physician's fees and cost of medicine
- Reduced visits to specialty hospitals
- Reduced travel expenses
- Early detection of disease

HISTORY AND EVOLUTION OF TELEMEDICINE

The exact date when telecommunications first were used in health care is unknown. The concept may have originated centuries ago.

Four phases of teleMedicine development, based on the exploitation of telecommunication and information technologies

Development phase	Approximate timescale
Telegraphy and telephony	1840s–1920s
Radio	1920s onwards (main technology until 1950s)
Television/space technologies	1950s onwards (main technology until 1980s)
Digital technologies	1990s onwards

First Phase - Telegraphy and telephony Phase

- **Telegraphy** was used during American Civil War to send casualty lists and order supplies.
- Dr. Alexander Graham Bell's **telephonically** calling his associate from another room "come here, Watson, I need you" was considered as the first application of modern telemedicine technology.

Second Phase - Radio Phase

- It is replaced by long distance communication following Marconi's invention of the radio-telegraph in 1897.
- During World War I, radio communication was already established and by 1930, it was used in remote areas such as Alaska and Australia to transfer medical information
- In one form or another, these services continue in operation to the present day.
- The most celebrated example is the Italian International Radio Medicine Centre, which began in 1935 and had assisted over 42,000 patients.
- In 1925 Gernsback wrote an article in an issue of *Science and Invention* about a device called "**teledactyl",** (Tele, far; Dactyl, finger — from the Greek)
  - ✓ a future instrument by which it will be possible for us to "feel at a distance."

- ✓ allow doctors to see their patients through a view screen, but also touch them from miles away with spindly robot arms.
- ✓ He effectively predicted telemedicine, though with a weirder twist than we see implemented in 2012.
- ➢

The image on the *Radio News* cover depicts a young boy sitting on the edge of his bed, with his tongue sticking out, as he stares into the monitor of a sophisticated device: a radio equipped with interactive video transmission and several medical instruments. At the other end of the connection, as represented in the monitor, a physician peers into the patient's throat, while simultaneously listening to his heartbeat through a stethoscope applied to the boy's chest.

Phase three - Television./Space Technologies

- ➢ The next phase starts by using of black-and-white television in the 1950s.
- ➢ visualising a patient's condition rather than rely on an audio description enhances diagnosis and the confidence of those engaged in treatment.
- ➢ In 1955, the Nebraska Psychiatric Institute developed a two-way link with Norfolk State Hospital, 112 miles away, in 1964 with further extensions in 1971 that was used for education and consultations between consultants . This project is one of the first example of tele psychiatry.
- ➢ At late 1950s 20-year collaboration was made between Lock-heed, the US Public Health Service and the National Aeronautics and Space Administration (NASA).

- Space Technology Applied to Rural Papago Advanced Health Care (STARPAHC) implemented by NASA, provide medical care to rural communities of Papago Indians in Arizona via the transmission of electrocardiographs and X-rays to centers staffed by specialists.

- For transmission van was employed and equipped with variety of medical instruments. Van is linked by a microwave transmission system to the public health service hospital for tele-consultation.
- In 1967 Massachusetts General Hospital established a microware link between the hospital and Boston's Logan Inter-national Airport to provides health services to airport employees and to deliver emergency care and medical attention to air passengers using two-way interactive television (IATV).
- Two programmes from the 1980s illustrate the increasing sophistication of visioning facilities, including the use of colour, and the extension of satellite links to emergency

1. North-West Telemedicine Project

- set up in Queensland, Australia, the only major telemedicine project outside North America until 1990.
- serve rural communities, Aborigine populations

2. NASA SpaceBridge

- US/USSR project developed to do tele-consultation during disaster situation.
- Connects several Armenian regional hospitals with 4 US Medical centers.
- Facility => two-way audio and one-way full motion video transmissions from Armenia to US.
- Consultation => neurology, orthopaedics, psychiatry, infectious diseases and general surgery.

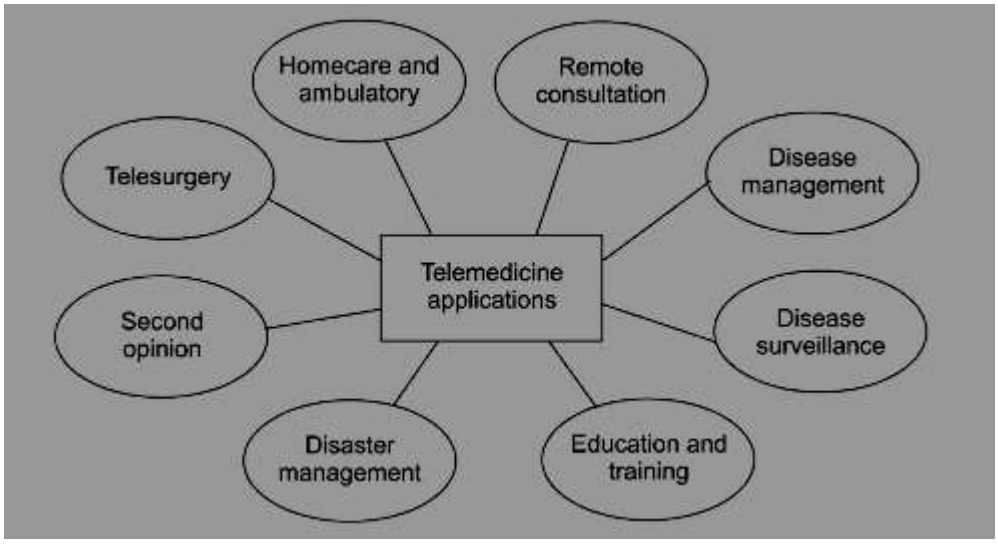
Phase four - Digital Technologies

- TeleMedicine remained stagnated throughout 1970 and early 1980 due to cost issue.
- Two major advances => digital imaging and the Internet has influenced teleMedicine developments
- The multiple advantages by the digital technology and availability of Internet make teleMedicine at an affordable practical level.

MAJOR AREAS OF TELEMEDICINE
(or)
ORGANS OF TELEMEDICINE
(or)
APPLICATIONS OF TELEMEDICINE

Teleconsultation (Remote consultation)	Consultation by the patient and the local doctor with the specialist regarding diagnosis and line of treatment, discussions on critical medical cases through teleconferencing
Telediagnosis (Second opinion)	
Teletreatment (Disease management)	
Tele-education	For Continuing medical education, training for doctors and paramedics from a higher level hospital/institution
Teletraining	
Telemonitoring (Homecare and ambulatory)	Regular monitoring for emergency and intensive care
Telesupport (Disaster management)	Support during disaster management to handle medical emergencies

Telesurgery	Surgical care over a distance, with direct, real-time visualisation of the operative site, even allows the surgeon to manipulate robotic arms that exactly reproduce the surgeon's hand motions from the surgical workstation to the remote surgical unit.
Telesurveillance	Monitoring the spread of disease in order to establish patterns of progression. The main objective is to predict, observe, and minimise the harm caused by outbreak, epidemic, and pandemic situations, as well the practice of disease case reporting.



The above applications of telemedicine are under different stages of development (Dan and Luprano, 2003). The positioning of various telemedicine segments is shown in Figure 1.13 with respect to the level of maturity in their applications.

The maturity level is determined by several factors. They include quantity and quality of research relating to the application, the degree to which the application has been accepted by the medical professionals, and the development of standards or protocols for its use and applications (Misra and Kalita, 2009). The attributes such as technical feasibility, diagnostic accuracy, sensitivity, specificity, clinical outcome and cost-effectiveness form the basis of evidence of a particular telemedicine application.

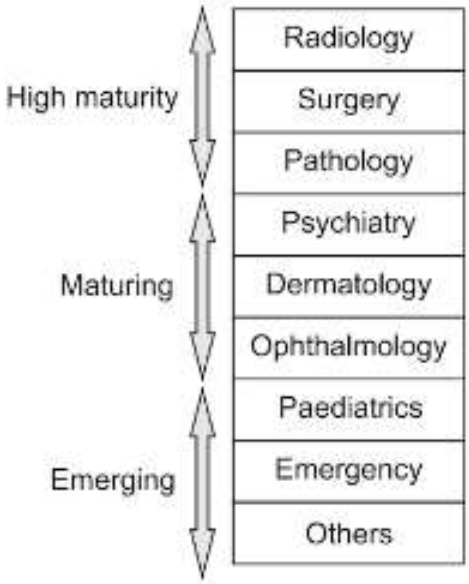


Figure 1.13 Maturity levels of various telemedicine specialities (adapted from Misra and Kalita, 2009).

DELIVERY MODES IN TELEMEDICINE
(or)
TYPES OF TELEMEDICINE

Telemedicine refers to the delivery of clinical services at a distance. The practice of telemedicine largely breaks down into three types of solutions,

- **Store-and-forward Telemedicine**
- **Real-time Telemedicine.**
- **Hybrid Systems (Real time + Store-and- forward)**
- **Remote patient monitoring**

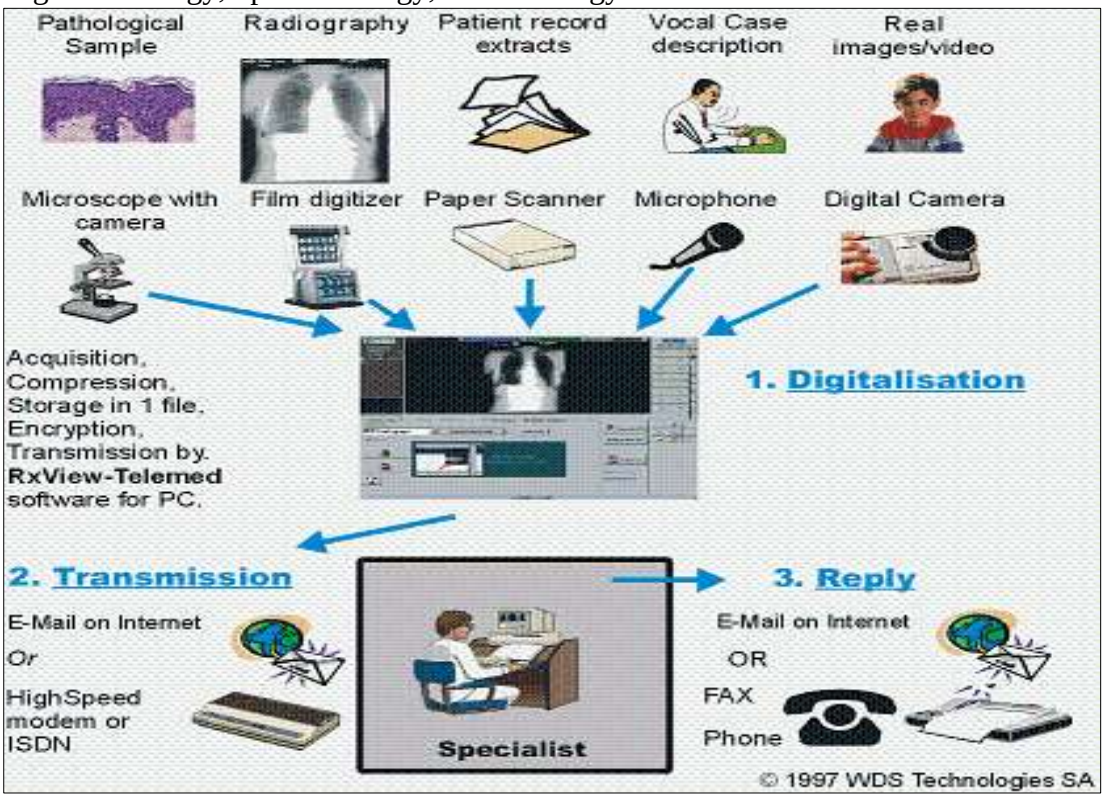
Store-and-Forward Telemedicine

Store-and-forward telemedicine is also called "asynchronous telemedicine." It is a method by which healthcare providers share patient medical information like

- lab reports,
- Databases(Electronic patient recod,e-pharmacy)
- Radiology images(x-ray, CT,MRI images)
- Still image applications(pathology, dermatology, etc.)

Store-and-forward telemedicine is an efficient way for patients, primary care providers, and specialists to collaborate because they can all review the information when it is convenient for them.

Store-and-forward is particularly popular for diagnoses and treatment with certain specialties including dermatology, ophthalmology, and radiology.



Real-time telemedicine

When you think of telemedicine, it is likely **real-time video** visits that comes to mind. During a real-time telemedicine, patients and providers use video conferencing software to hear and see each other.

While the other types of telemedicine are used to enhance traditional in-person visits, real-time telemedicine can be used instead of a trip to the doctor's office in certain situations. It is popular for **primary care, urgent care, follow-up visits**, and the management of medications and chronic illness.

Hybrid Systems

The capabilities of store-and-forward and real-time modes of telemedicine can be combined to give hybrid systems. Combining stored still or motion video with real-time videoconferencing is an illustration of a hybrid telemedicine systems.

For example, video clips of patient examinations stored and forwarded to a specialist along with real-time interaction can be helpful for telediagnosis and consultation.

The specialist doctor can play, pause, or sequentially step through digitized video movies while interacting with the patient in real-time.

Remote Patient Monitoring

Remote patient monitoring, or "self-monitoring" or "telemonitoring" is a method that allows healthcare professionals to track a patient's vital signs and activities at a distance. This type of monitoring is often used for the management of **high-risk patients**, like those with heart conditions and people who have recently been released from the hospital.

Remote monitoring is also extremely useful for the treatment of a number of **chronic conditions**. It can be used by diabetics, for example, to track their glucose levels and send the data to their doctor. **Elderly patients** at home or in assisted living facilities can be conveniently and inexpensively monitored.

Purpose and Methodology of Store-and-forward and Real-time telemedicine

Purpose and methodology of store-and-forward and real-time telemedicine

Purpose	*Store-and-forward*	*Real-time*
Clinical	Patient data and digital images sent via email direct to the specialist for diagnosis and management advice	Videoconferencing used for clinical consultations involving the patient, primary care provider and the specialist
Educational	Educational and training material sent by email in the form of tutorial notes, audio or video resources	Lectures transmitted via video-conferencing to multiple sites simultaneously
Administrative	Administrative information regarding meetings and other associated require-ments may be mailed or sent by fax	Audio/video conferencing may be used for interactive discussions between participants

- **Choice of choosing the delivery modes**
  - ✓ information needs to be transmitted
  - ✓ Availability of the appropriate telecommunication resources
  - ✓ Urgency of getting the response from the experts

TYPES OF TELEMEDICINE SERVICES

Direct patient care: It includes sharing audio, video and medical data between a patient and a health professional for use in rendering a diagnosis, treatment plan, prescription or advice. This might involve patients located at a remote clinic, a physician's office or home.

Specialist referral services: Such services typically involve a general practitioner seeking the assistance of a specialist in reaching a proper diagnosis. This could be in the form of an interactive live session wherein the patient is "seeing" a specialist over videoconferencing set up. Alternatively, diagnostic images and/or video along with patient data could be transmitted to a specialist for later viewing and advice.

Remote patient monitoring: These services known as "telehome care" involve the use of devices to remotely collect and transmit data to a monitoring station for interpretation, diagnosis and records. Such services make use of telemetry devices to capture vital signs data, such as blood pressure, glucose, ECG or weight as per the instructions of the monitoring centre. These services could be used to supplement the work of visiting nurses.

Medical education and mentoring: They include a wide range of services such as continuing medical education, seminars for special groups, expert advice through interactive videoconferencing and demonstration of medical procedures.

Consumer medical and health information: These services relate to the use of Internet by consumers, especially the patients to get specific health related information and to join online discussion groups of interest.

GLOBAL AND INDIAN SCENARIO

Global Scenario in Telemedicine

Every developed nation throughout the world, whatever the political persuasion of its government, is facing serious difficulties with the delivery of healthcare to its citizens. This is the case whether government is federal or national, whether the main source of funding is taxation or insurance (social or private), or whether provision is mainly in the hands of the public or private sector.

The USA and the countries of Europe exhibit the full diversity of these different systems but they face the same daunting problems, particularly:

- the increasing age of the population;
- the increasing cost of medical technology;
- patient expectations;
- economic and social change.

These and other factors drive up the cost of healthcare and reduce equity of access. Governments have three main ways to address these problems: increase taxation (particularly in welfare systems), ration the provision of healthcare or make healthcare more cost effective. The first two options are politically sensitive and in several countries have currently been pressed to their practical limits. Increasingly, therefore, administrations are turning to the third alternative and seeking to control the cost of healthcare while improving its effectiveness and 'adding value' to meet patient expectations.

As we have seen, this goal of cost reduction is a major driver of interest in telemedicine, which offers the prospect of lower costs for providers, especially staffing and overheads, as well as reduced travel costs for patients. As we have also noted, the cost effectiveness of many projects has yet to be established beyond doubt.

At the same time, telemedicine is perceived to be more convenient for the patient, to extend access to communities, and to improve the quality of treatment by expanding specialist advice. These advantages are difficult to factor into the cost–benefit equation but they are attractive to countries such as Australia, Canada, Sweden, Norway and Finland where distance and/or climate prevent rural communities from experiencing the same provision of services as their urban counterparts.

Potential of Telemedicine inIndian Scenario

There are more than 100 telemedicine initiatives today in the country by various public and private agencies. Considering that there are over 20,000 primary health centres in rural areas and more than 500 district level hospitals, there is an increasing awareness about the potential of telemedicine among the decision makers in the health sector. In addition, fibre optic network across the country has been laid down by the both public sector and private telecommunication service providers paving the way for availability of high bandwidth terrestrial connectivity to build country wide network for telemedicine. Therefore, the number of telemedicine centres are only going to increase as the technology costs come down. This will enable the provision of specialised medical care, services and treatment to the patients in the far-flung, remote and inaccessible areas from the specialty hospitals where it is not possible for them to reach there in time.

Historically, developments in telemedicine was from the beginning driven by the space research, military, sea fare and aviation industry. The effort was mostly concentrated in alarm situations where the geographical distances made it impossible to transfer injured/ sick persons to hospitals or where qualified personnel were not available. However, recent efforts are getting increasingly focused on problems to provide healthcare across geographical distances to avoid inconvenience of travelling and reducing the number of in-house patients in the hospitals.

ETHICAL AND LEGAL ASPECTS OF TELEMEDICINE

4.1. Ethical Issues

Defn: A problem or situation that requires a person or organization to choose between alternatives that must be evaluated as right (ethical) or wrong (unethical)

- ethical issues in telemedicine can be investigated from several aspects like **technology, doctor-patient relationship, data confidentiality and security, informed consent, patient's and family's satisfaction with telemedicine services**

4.1.1 Confidentiality

Defn: the information is not made available to who are not authorized.

- Confidentiality is commonly applied **to conversations between doctors and patients**.
- In telemedicine, interaction takes place between doctors and patients over large distances ,use of computers, telephones, fiber optic cable and other means of data transmission=> issue of **confidentiality is genuine and requires to be addressed**
- confidential => its release has the potential **to injure a person either emotionally or materially(meaning in some way).**

- International Code of Medical Ethics => **doctor must preserve "absolute confidentiality in all he knows about his patient" even after the patient's death**

- The **privacy of medical data** is subject to threats from the following types of disclosures
  - Unintentional disclosure => information is displayed on a computer screen without the presence of any person working there
  - "routine " information is circulated without the knowledge of the patient
  - Providing information to third parties(e.g., insurance company/with an employer)
- Irrespective of their legal systems, democratic countries follow guidelines to have patient confidentiality on the following three guidelines (**applied to all form of information)**
  - There exists a basic right of patients to privacy of their medical information and records.
  - Patients' privacy should be observed unless waive in a meaningful way(i.e. informed, non-coercive(not forcing)) or in rare instances where it counters public interest
  - Information disclosed should be limited to that information or portion of the medical record needed to fulfil the immediate and specific purpose.
- The legal force of these and additional guidelines may differ not only from country to country, but in federal nations such as the USA, from state to state
- telemedicine creates special problems => non clinical personnel in teleconsultations and the **vulnerability of transmission lines to security breaches**(meaning break).
- **privacy and confidentiality of health information** is clearly an international concern in the global information society
- **List of confidentiality issues** raised by telemedicine are:

  - **Confidentiality and the Law**
  - **The Patient-Doctor Relationship**
  - **Patient Consent to Disclosure of Information**
  - **Access to Medical Records**
  - **Consent to Treatment**
  - **Data protection and security**
    - The UK Data Protection Act (1984)
    - The UK Computer Misuse Act (1990)
    - The UK Data Protection Act (1998)
  - **Secure Network Access**
  - **Secure Data Transmission**

Confidentiality and the Law

The principle of confidentiality in medical ethics states that a doctor must preserve 'absolute confidentiality in all he knows about his patient' even after the patient's death.

Irrespective of their legal systems, most democratic countries now base their modern practice of patient confidentiality on the following three guidelines [2]:

- There exists a basic right of patients to privacy of their medical information and records.
- Patients' privacy should be observed unless waived in a meaningful way (i.e. informed, non-coercive) or in rare instances where it counters public interest.
- Information disclosed should be limited to that information or portion of the medical record needed to fulfill the immediate and specific purpose.

Telemedicine creates special problems due to the involvement of non-clinical personnel in teleconsultations, and the vulnerability of transmission lines to security breaches.

The Patient-Doctor Relationship

Patients who reveal personal information to their doctors must be able to trust them not to divulge the same information to others incidental to the care process. The UK General Medical Council's (GMC) [3] guidelines on the duties of a doctor summarize international opinion by stating that:

Patients have a right to expect that you will not disclose any personal information which you learn during the course of your professional duties unless they give permission. Without assurances about confidentiality patients may be reluctant to give doctors the information they need in order to provide good care.

Patient Consent to Disclosure of Information

Most patients understand that the principal physician in charge of their case will need to ensure that all members of the team have the information necessary to discharge fully their professional roles in the care process.

Once again, the **GMC guidelines to doctors** make the points clearly.

- When patients give consent to disclosure of information about them, you must make sure that they understand what will be disclosed, the reasons for disclosure

- You must make sure that patients are informed whenever information about them is likely to be disclosed

- You must respect requests by patients that information should not be disclosed to third parties

• If you disclose information you should release only as much information as is necessary for the purpose

• You must make sure that health workers to whom you disclose information understand that it is given to them in confidence which they must respect;

• If you decide to disclose confidential information, you must be prepared to explain and justify your decision.

Access to Medical Records

If a patient consents to disclosure of personal health information then he or she has an obvious interest in knowing what information is recorded in their medical record.

The development of this position can be observed from two pieces of legislation introduced between 1988 and 1990.

The first piece, **the Access to Medical Reports Act (1988),** gives patients limited rights to control reports created for employment or insurance purposes. The conditions of this Act are relevant to the potential use of telemedicine to provide occupational health services. A teleconsulting doctor is obliged to draw a company's attention to conditions that may adversely affect the health of his patients.

The second piece of legislation is the **Access to Health Records Act (1990).** This Act gives patients access to health records made after 1 November 1991. The main grounds for exercising discretion, and possibly denying access, are when the doctor believes that the information is deleterious to the patient's health or when release of the information could jeopardize the confidentiality of other persons. Both circumstances are conceivable in telemedicine.

Consent to Treatment

Every competent adult has a right to refuse or consent to available medical treatment or healthcare and the clinicians in charge of this care must obtain a patient's consent before proceeding with the treatment. Any clinician who proceeds without this consent runs the risk of prosecution for tort of battery or negligence. Courts will only accept consent as a valid declaration if patients are made fully aware of the options available to them. Consent may be implicit (e.g. offering an arm for a blood pressure measurement) or explicit (e.g. signing a form of consent before a surgical operation). **The GMC guidelines on the duties of a doctor** state the position clearly by requiring doctors to

> *Give patients the information they ask for or need about their condition, its treatment and prognosis; give information to patients in a way they can understand; [and] respect the rights of patients to be fully involved in discussions about care.*

As we have noted already, the ethical aspects of telemedicine are similar in many respects to conventional medicine but telemedical practice sometimes leads to **more testing situations.**

A second difficulty, highly relevant to telemedicine, is the point at which a **patient should be asked to give consent.** A company might provide telemedical cover for their employees who have to travel to remote areas on company business. Neither the company nor its employees can foresee all of the circumstances in which consent would be required and it is always possible that an employee might want to change their decision.

A third and final problem noted here arises when a patient **refuses treatment.** For example, a patient may be willing to receive treatment but only by conventional means and not by telemedicine. Alternatively, and reflecting the global nature of modern medicine, telemedical treatment may be acceptable but not by certain practitioners, e.g. an Albanian patient might not wish to be treated by a Serbian doctor. Yet again, a patient may **refuse treatment on moral or religious grounds.** In these situations, patients with the capacity to do so are required to sign a written record stating the fact of their refusal and accepting its medical consequences.

Data protection and security

We pointed out that the legal perspective of confidentiality focuses on the relationships between the persons involved rather than the systems by which they communicate. In the UK, there are three primary pieces of legislation relevant to our discussion:

- **The UK Data Protection Act (1984)**
- **The UK Computer Misuse Act (1990)**
- **The UK Data Protection Act (1998)**

The UK Data Protection Act (1984):

For over 15 years the UK Data Protection Act (1984) has regulated the use of automatically processed information relating to individuals, and the conduct of services in receipt of such information. **The Act lays out the eight data protection principles:**

1. The information to be contained in personal data shall be obtained, and personal data shall he processed, fairly and lawfully
2. Personal data shall be held only for one or more specified and lawful purposes
3. Personal data held for any purpose or purposes shall not be used or disclosed in any manner incompatible with that purpose or those purposes
4. Personal data held for any purpose or purposes shall be adequate, relevant and not excessive in relation to that purpose or those purposes
5. Personal data shall be accurate and where necessary kept up to date
6. Personal data held for any purpose or purposes shall not he kept ,for longer than is necessary for that purpose or those purposes
7. An individual shall he entitled:
    a. At reasonable intervals and without undue delay or expense:
        i. To be informed by any data user whether he holds personal data of which that individual is U subject; and
        ii. Access to any such data held by the data user; and
    b. Where appropriate, to have such data corrected or erased
8. Appropriate security measures shall he taken against unauthorized access to, or alteration, disclosure or destruction of personal data and against accidental loss or destruction of personal data

The UK Computer Misuse Act (1990):

The Computer Misuse Act (1990) was introduced to provide protection against the misuse of data held on stand-alone or networked computers. Three new offences were created under the Act :

1. Unauthorized access to computer material;
2. Unauthorized access with intent to facilitate commission of further offences;
3. Unauthorized modification of computer material.

A person is guilty of an offence if:

- he causes a computer to perform any function with intent to secure access to any program or data held in any computer;
- the access or intended access is unauthorized;
- he knows at the time when he causes the computer to perform that function that this is the case.

The new law was designed to avoid tangible evidence difficulties that had arisen in the 1980s. The Act does not provide a complete answer to problems of unauthorized access to computers and few cases have been brought to the courts. Perceived problems include:

- organizations are often reluctant to bring cases of hacking and virus penetration to court because of bad publicity;
- the police have difficulty collecting evidence:
- telecommunications companies are not obliged to reveal information;
- mainframe computers cannot be retained as evidence-the police have to rely on local expertise and advice as to what material can be collected as evidence;
- files can be erased without trace;
- juries appear to view hackers (and perhaps virus spreaders) as maverick 'Robin Hood' characters pitting their wits against the 'system';
- sentences are perceived as being too light in comparison with the seriousness of the offences;
- judges and barristers/advocates lack the specialist knowledge of computers to apply the law as it was intended-they tend to make inappropriate interpretations.

These criticisms support the thesis that computer crime is a fast-developing field and that legislation needs updating to reflect the opportunities available to both criminals and officers of the law.

The UK Data Protection Act (1998):

The European Directive on Data Protection was agreed in 1995 and became law in October 1998. Its provisions were incorporated in UK law on 1 March 2000 in the following significant respects :

- it defines key concepts differently;
- it extends data protection controls to certain manual records;
- it sets more stringent conditions for processing personal data;
- it affords certain exemptions for the media:
- it strengthens the rights of individuals;
- it strengthens the powers of the supervisory authority;

- it sets new rules for the transfer of data outside the European Union;
- it allows the existing registration scheme to be simplified.

Secure Network Access

Telemedicine relies heavily on the transmission of data, video and audio across telecommunication networks, and secure network access and data transmission are critical to the confidentiality and privacy of personal medical data.

The basic provisions include :

- access is protected by at least one authentication control (password);
- controls are in place to ensure non-NHS access is available only to authorized users;
- one named individual is made responsible for the security of a connected system;
- all relevant staff are made aware of their responsibilities;
- physical access to NHS-wide termination equipment is controlled:
- all incidents which constitute a threat of security are reported appropriately.

The most obvious way of reducing the risk of unauthorized access to computer data across the Internet is to control the traffic across the interface between the local area network and the external Internet. This is the function of a firewall. It is important to know they cannot protect against traffic that does not go through them.

Conceptually, there are **two types of firewall**.

- **The network-level firewall** uses a router to make decisions on what to pass or block based on network protocols, typically Internet protocol (IP) addresses.
- **An application-level firewall** is more sophisticated and is based on a system comprising a PC with two ports, one for incoming, and the other for outgoing, traffic.

Secure Data Transmission

A firewall is a means of ensuring that only the right traffic gets through. It does not guarantee that the traffic is itself 'right'. **Cryptography** is therefore a powerful aid to secure telemedicine transactions. There are **two types of encryption algorithm**.

With **symmetric encryption (secret key encryption)** the sender and the receiver both use the same key to lock and unlock the message.

In contrast, with **asymmetric encryption (public key encryption)** each user has two unique keys, a public key and a private one. You distribute your public key to correspondents and they use this key to encrypt messages they send to you. Messages encrypted with your public key can only be decrypted with your private key. Your private key can also be used to encrypt any message you send as a digital signature. The recipient can decrypt the signature with your public key to verify your identity and the authenticity of the message. The power of digital signatures is that they detect even very slight changes to a message.

SSL is a protocol layer between the standard Internet transmission control protocol (TCP/IP) and the application layer protocol, Hypertext Transmission Protocol (HTTP).

SSL (**Secure Sockets Layer**)is the standard security technology for establishing an encrypted link between a web server and a browser. This link ensures that all data passed between the web server and browsers remain private and integral**.**

SSL is an industry standard and is used by millions of websites in the protection of their online transactions with their customers.It guarantees secure data communication from an SSL-enabled server to an SSL-enabled browser.

4.2. Legal: relating to the law

Legal Issues: Telemedicine raises a number of legal concerns

1. **Doctor-Patient Relationship**

- If **malpractice has been committed in a telemedicine session** it is important to understand legal position regarding Doctor-Patient Relationship
- Following questions determine for the relationship existence
    - Personal meeting between the doctor and patient ?
    - Examination of the patient by the doctor ?
    - Review of the patients records by the doctor ?
    - Payment to the doctor for services by the patient ?
- A patient talks to the regular physician=> not a telemedicine service
- A doctor evaluates the patient condition, recommended treatment over the phone=>doctor-patient relationship exist in telemedcine
- If the pathologists examines the patients slide=>doctor-patient relationship

2. **Jurisdiction**

- The physician must be licensed under the jurisdiction of the state where the patient is located, if any malpractice occurs during telemedicine session, law suit can be filed by the patient.
- Doctors practicing telemedicine should be aware of laws and regulations of each state and other countries

3. **Licensing**

- Physician to physician communication => does not need licensing
- Doctors wishes to practice telemedicine in a geographcial area spread more than one state, physician should fulfill the licensing requirements of all the states

4. **Informed Consent**

- Physician should disclose to their patients **available treatment, choices along with the risk and benefits of each choice**

- Patient's attending **doctor should obtain consent to solicit** (meaning ask for) telemedical consultation.

5. Continuity of Care

- To ensure continuity of care the patient should be able to get **follow-up and proper documentation** must be maintained by the physician to provide care-services using telemedicine else patient-doctor relationship does not exist.

6. Medical Records

- Past care, prescription, Laboratory and test results, evaluation and consultation, Patient-Physician Electronic communication, copies of informed consent must be properly documented and made accessible to both physician and the patient

7. Prescribing

- Medication formulations should be limited to ones that are deemed safe while using telemedicine.

4.3. Safety (Security) Issues

- Online **privacy and security issues of the internet are major concern**
- Security points at which data could be at risk

1. Data capture stage

- ✓ Wrongly identified participants(doctor, patients)
- ✓ Lack of control to data access (authentication, access control)

2. Communication stage

- ✓ Cross talk on point to point to links(e.g., dedicated, dial-up)
- ✓ Involvement of intermediaries(e.g., browsers)
- ✓ Problems in data management in store and forward (e.g., email)

3. Data review and storage stage

- ✓ Long-term electronic and physical files(tape, disc)
- ✓ Incidental information(cache memory, printouts)

- **Security risks when working with Internet**

1. Hacking

- ✓ refers to all activities that exploit weaknesses in software and computer systems
- ✓ Exploiters attempt to **hack related information due <u>to curiosity or criminal inklings</u> of stealing or altering data**

2. Malware/Malicious code

- ✓ Software developed with the specific intention of attacking a computer.(viruses, worms, Trojans).

3. **Phisher**
   - ✓ Attempt to play fraud on email to gain unauthorized access.
   - ✓ Done to target a specific group of people or an organization
4. **Spam**
   - ✓ Unsolicited **advertising materials that are put on the internet**
   - ✓ Result in wasting network resources (bandwidth, storage space in mailbox)
   - ✓ Usually sent with malware

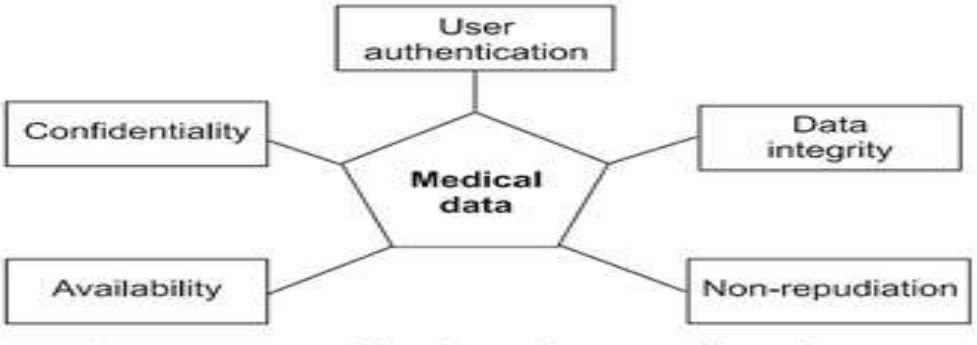
- Security is the **fundamental requirement for telemedicine application.**
- Security measure that Telemedicine systems must implement:
  - Access control
  - Audit trails
  - Physical protection
  - Maintaining the confidentiality
  - Integrity of data

- Measures are needed to **protect against the threats of <u>manipulation and unauthorized access to health related information</u>**
- Security elements are **storage , network and data encryption**
- Proper mechanism has to be **set to identify users and their rights to access data**
- Each telemedicine center must ensure
  - ✓ Secure environment for communicating with other telemedicine center
  - ✓ Maintaining the confidentiality and integrity of data under the control

- **Components that affects the secure healthcare systems**

1. **Confidentiality**
   - ✓ Information is not made available to who are not authorized.
   - ✓ Applied to **transmitted data and secretive data**(stored data)
2. **Authentication**
   - ✓ Medical professional must be validated before allowing access to patient data (passwords, digital certificates)
3. **Integrity**
   - ✓ Relates to **accuracy of the transmitted and received data**.
   - ✓ During reception , using algorithms determine the content received is intact or altered.(e.g., MD5-Message-Digest algorithm 5)
   - ✓ Digital signature may be used to have a stronger test for integrity

4. **Non-repudiation**
   - ✓ a party to a transaction **must not claim later that they did not participate in a particular transaction**
5. **Availability**
   - ✓ Ensures that the **system continues to perform its intended function** without getting disrupted by various technical reasons



Components affecting the security of healthcare systems.

- Telemedicine application System must follow the security measures
  - List of persons including doctors, paramedical staff and others who are authorized to have access to patient's health related information
  - Type of security technology used.(e.g., password, fingerprint , smart card)
  - Type of encryption used for storing medical data
  - Type of encryption used for transmitting medical information
- The security and privacy of data can be ensured by the following measures

i) **Physical security measures**: includes access controls, private networks, firewalls, authentication, encryption and time-stamping

ii) **Specific measures**: for securing email and web servers

4.4 Role of Regulatory Authorities in Standardization

- Subsystem used in telemedicine must conform to the appropriate regulations governing the use of medical devices
- In USA, the food and drug administration(FDA)
  - ✓ is a federal authority to regulate medical devices intended for human use
  - ✓ Categorizes all medical devices into several regulatory classes based on the level of control necessary to assure safety, efficacy and effectiveness of the device

- ✓ It considers the equipment and software that is used for diagnosis and treatment of a disease to be a medical device
- ➢ Software used in teleHealth systems is also regulated by FDA

SAFETY AND REGULATORY ISSUES OF TELEMEDICINE

Some of the significant legal and regulatory issues implicated by telehealthincludes:

- Provider licensure;
- Online prescribing;
- Medical malpractice;
- Coverage and reimbursement;
- Privacy and security; and
- Fraud and abuse.

BENEFITS OF TELEMEDICINE

BENEFITS

- better access to healthcare;
- access to better healthcare;
- improved communication between carers;
- easier and better continuing education;
- better access to information;
- better resource utilisation;
- reduced costs.

These benefits are clearly interrelated but we can deal with them in turn, building on comments made in previous sections.

Better Access to Healthcare

Extending healthcare access to rural communities and disadvantaged populations, poorly served or without these facilities, is still one of the major

drivers of telemedicine (Section 1.4.2). This socio-economic impetus has provided a strategic aspect to telemedicine programmes in several countries [81, 82].

Greater convenience to patients by reducing travel and disruption is also a benefit sought for and claimed by the majority of projects. Time savings for both patient and carer and faster access to care are similarly easy to demonstrate where they occur. Telecare offers many examples of these benefits.

Access to Better Healthcare

Any healthcare is obviously better where none existed before (see above) but under this heading we are looking for improvements in the quality of care. A clear benefit of telemedicine is the remote access that a patient and his or her physician have to specialist advice when it is not available locally.

Early intervention, more seamless care (including care protocols) and better monitoring of progress [83] are additional advantages of telemedicine links involving a primary care doctor [73], a hospital specialist and a community care nurse. As we have seen, the monitoring process may also entail telemonitoring (Section 2.2.3).

Improved Communication between Carers

The shift to digital information offers numerous benefits for carers and their patients. Digitised data such as a patient's previous history, X-rays, test results and notes for the current episode are readily transmitted electronically using standard protocols and technologies such as email [73]. Discharge letters are similarly available without delay.

Digital communication provides healthcare information that is more accurate, more complete and more timely—attributes of quality that lead to better access and better healthcare.

Easier and Better Continuing Education

The discussion on tele-education (Section 2.2.2) dealt with this issue at length and we need add little here. One scenario not mentioned in the literature is worth a passing thought, namely the provision of healthcare courses, perhaps with awards, for the general public.

Several countries are promoting a subsidised scheme for low-income families to help them gain home access to the Internet. Low-income groups are often those identified as being at greatest risk from disease due to socio-economic conditions and lifestyle. The Internet could be used for health promotion with web sites targeting both children and parents. It could also be used to advertise health programmes such as cervical smear campaigns and facilities such as local fitness centres. Incentives could be provided to encourage take-up. The opportunities are endless.

Better Access to Information

The continuing education benefit referred to under the last heading is an example of the 'push' technology outlined in Section 2.2.2. Better access to information is concerned more with the individual endeavouring to 'pull' information from the Internet and/or other sources to answer specific questions.

The individual mentioned here may be a doctor accessing 'case-oriented' information in an electronic library [73], accessing the literature with an electronic search engine, or visiting a web site to find out about events of interest or the latest medical equipment [84]. Alternatively, he or she may be a patient wanting information on a medical condition, times of surgery hours, or advice on how to stop smoking. It's all out there somewhere!

Better Resource Utilisation

Better access to healthcare and access to better healthcare are one side of the access coin. Better resource utilisation is the other side. It is uneconomic to replicate resources in several centres when these resources have infrequent use. A preferred approach is therefore to set up a smaller number of resource sites and make these available to potential users via telemedical links.

The arrangement can apply to the disposition of both specialist and expensive equipment such as MRI machines as well as to 'walk-in' centres for patients with minor complaints [85]. Any spare capacity in the telemedicine network can be used for a range of tele-education purposes.

Reduced Costs

This is the most contentious benefit since few protagonists of telemedicine have been able to show cost savings in an unequivocal way. One of the reasons is that telemedicine trials often involve few presenting patients and it is not clear how costs and benefits scale.

Clear cost savings have been demonstrated in teleradiology, which has been around long enough for practitioners to create a marketable service and optimise its operation [35]. There is also evidence for economic benefits from telemedicine in home healthcare [86] and the care of prison inmates [87]. We give the cost–benefit issue fuller study in Chapter 5.

Challenges/ limitations/ barriers/ drawbacks in implementing Telemedicine

The governments in various countries have recognised that telemedicine has the potential to provide better and less expensive care, while promoting self-care and patient's independence. However, it has been observed that there are several challenges in the implementation of these services. Joseph, et al. (2011) carried out literature review to identify the key challenges. This subsequently followed by the survey of organisations in England involved in teleHealth projects in order to understand the challenges they faced. The analysis reveal seven key challenges facing implementers of teleHealth technology. These relate to lack of trained staff, lack of dedicated project manager, support of the patient, technology, partnership working between collaborating medical facilities, funding and lack of strategic plan for long term operation of the project. Sood and Khandpur (2002, b) list out the challenges in development of an integrated telemedicine system in a developing country.

A survey conducted by Health Intelligence Network, USA in 2013 shows that the cost of setting up a telemedicine system and its running cost is the major constraint. The factors which act as barriers in implementing telemedicine projects are shown in Figure 1.14. The major challenges in implementing telemedicine technology can be summarised as follows:

1.8.1 Medical Constraints and Challenges

The field of telemedicine is still facing several constraints from the medical field which presumes acceptance of the following:

(i) Need for cooperation between medical facilities at various levels
(ii) Recognising the complementary role and function of involved institutions/ organisation
(iii) Realising the increasing role of technology and change of working environment accordingly
(iv) Integration of telemedicine systems with the traditional working environment
(v) Availability of time and commitment of specialists in tertiary level institutes
(vi) Patient trust in the telemedicine due to concerns about maintaining privacy and confidentiality

(vii) Lack of physician familiarity with high technology, which can equate to reluctance to invest in equipment
(viii) Lack of faith of patients in telemedicine which do not allow a face-to-face interaction
(ix) In some countries, each state requires separate medical licence for physicians practicing within their borders. This does not get well with the telemedicine mode of working across national and international boundaries
(x) The issue of reimbursement of medical expenses for telemedicine consultation or treatment to the patient or physicians is still unresolved in its various aspects
(xi) The needs of medical profession and patients, vis-a-vis developments in technology

1.8.2 Telecommunication Constraints

(i) Most telemedicine projects are hampered by the non-availability of appropriate telecommunication technology, particularly in rural areas, in developing countries which do not have cable wiring or other kinds of telecommunication facility to provide adequate bandwidth. It implies that those who need telemedicine facility, the most are not able to avail of the same.
(ii) For videoconferencing, 384 Kbps is the basic minimum bandwidth requirement, which is not available at many places in the developing countries.
(iii) For effective telemedicine, use of information technology in hospitals requires to be increased to improve computer literacy.

1.8.3 General Issues

(i) Telemedicine is by no means cost effective, since it involves good amount of hardware and software costs, coupled with regular expenses on telecommunication networks.
(ii) Insurance companies have yet to provide risk coverage associated with telemedicine consultation.
(iii) Telemedicine systems are predominantly of proprietary nature.
(iv) Hardware and software compatibility, interoperability and related standards are still at infancy level. These are necessary to have competitive bidding.
(v) The implementation of telemedicine involves systems management, organisation and maintenance. Retraining and restructuring of staff are required for which training places are not readily identifiable.
(vi) Many telemedicine projects do not go beyond a pilot study stage. It is a key concern. Perhaps, careful planning for ensuring sustainability of the project is not properly considered at the initial planning stage.
(vii) Telemedicine is meant to augment and not replace traditional practices in medicine. Legal liabilities issues, especially for trans-border communications are yet to be resolved.

3. ADVANCES IN TELEMEDICINE

1. The first randomised controlled trial of home telenursing showed evidence of its cost effectiveness
2. Electronic referrals are a cheaper and more efficient way to handle outpatients
3. General practitioner teleconsulting may be cheaper than traditional consulting in some circumstances
4. Decision support over video links for nurse practitioners dealing with minor injuries is shown to be effective and safe
5. Call centres and online health meet a demand from the public, but are unlikely to be cheaper for the NHS

5.1. Telenursing

In the past decade there has been considerable interest in the possibility of using telemedicine as an aid in home nursing. Various feasibility studies into a range of different kinds of technology have been driven by the hope that care of chronically ill patients can either be provided more cheaply or be of a higher quality than traditional home visits.

The Kaiser Permanente organisation recently reported the first formal randomised controlled trial of home videophones. In this trial patients newly diagnosed with various chronic conditions (for example, congestive heart failure, chronic obstructive pulmonary disease, cerebral vascular accident, cancer, diabetes, anxiety, and need for wound care) were nursed at home. Patients in the intervention group were equipped with home videophones, an electronic stethoscope, and a digital blood pressure monitor.

Telenursing equipment used by patients in the Kaiser Permanente trial, comprising a low resolution videophone, an electronic stethoscope, and a digital blood pressure monitor. The stethoscope was placed by the patients themselves, or care givers, at sites as requested by the nurse, who could see where the stethoscope was being positioned and recommend adjustments if necessary. (Photo courtesy of Kaiser Permanente)

Many of the practical problems of implementing telemedicine in the patient's home are reduced in institutional settings, such as nursing homes, because the costs of expensive equipment can be spread across many patients, staff can be specially trained to operate it, and better telecommunications are possible. For this reason telenursing is likely to be easier in a community nursing home than in private homes, even though the economic gain to society may be less.

5.2. Electronic referrals

Electronic referrals to specialists and hospitals

For the past 10 years general practitioners in Finland have been able to make electronic referrals to the Peijas Hospital in Helsinki. Many of these referrals can be dealt with by the hospital staff without the patient needing to attend the outpatient clinic, either by electronic messages or by arranging a teleconsultation by video link. A 20 month study found that 52% of the referrals from general practitioners were dealt with electronically. This was a much cheaper method of referral than the traditional method, as used by two control groups of general practitioners with similar patients: the direct costs of a visit to an outpatient clinic in internal medicine were seven times greater per patient than those of an electronic consultation.[9]

In an extension of the principle of electronic referral, the Swinfen Trust, a medical charity, recently proved the efficacy of email in an ongoing project to support doctors in developing countries such as Bangladesh.[10] Advice to doctors is provided by a panel of volunteer consultants, mainly from industrialised countries, and early results indicate that the scheme is likely to be cost effective, at least for the referring doctor and the patient.

5. 3. General practitioner teleconsulting

Teleconsulting between general practitioners and specialists

In referring a patient to a hospital, the general practitioner hands over management to a third party, the hospital specialist. An alternative is for the general practitioner to retain the patient in primary care and manage the problem by teleconsulting the specialist. Telemedicine may be an attractive option when a conventional referral to a hospital involves much travel on the part of the patient or doctors concerned. A wide range of teleconsulting applications have been trialled in general practice in such areas as cardiology, psychiatry, orthopaedics, and ophthalmology, as well as techniques such as ultrasound examinations.[11–16] These experiments have shown technical feasibility, but obviously it is too early to know whether such applications will come into widespread use.

Dermatology is a specialty that lends itself well to telemedicine. Three trials—in the United Kingdom, Norway, and New Zealand have reported the circumstances in which teledermatology in primary care can be considered cost effective. The trials, which all used real time video links concluded that travel must be a considerable burden for patients before telemedicine is cheaper for society than the conventional alternative, sending the patient to hospital to be seen by a dermatologist. This sort of teledermatology is therefore not likely to be cheaper for the NHS in London, though it would almost certainly be more economical in rural regions such as the highlands and islands of Scotland.

A general practitioner in Taupo, New Zealand, consulting a dermatologist in Hamilton, about 160 km away. The computer allows real time videoconferencing. The doctor can use the digital camera to show close up pictures of skin lesions. (Photo courtesy of Waikato Health)

5. 4. Decision support over video links for nurse practitioners dealing with minor injuries is shown to be effective and safe

Minor injuries telemedicine

One of the most promising applications of real time telemedicine is the use of video links to aid decision making of nurse practitioners running minor injuries units (fig (fig3).3). Early work in Scotland showed that using telemedicine to avoid unnecessary transfers of patients from a community hospital resulted in major savings,[21] and telemedicine has now been adopted in about 20 minor injuries units around the United Kingdom.[22]Although we await a formal study of the cost effectiveness of telemedicine, a substantial follow up study from the Central Middlesex Hospital (one of the first hospitals to use the technique) has shown that it is both clinically effective and safe.

Teleconsultation between a nurse practitioner in a minor injuries unit and a doctor in the accident and emergency department of a main hospital. The immediate management of a fracture is being discussed. (Photo courtesy of the Ulster Community and Hospitals Trust)

5.5. Call centres and online health

The growth in telephone call centres that provide health information and advice shows that there is a demand from the public for these services. Many such call centres, such as NHS Direct, try to triage callers into those requiring emergency treatment, those who can be referred to primary care, and those who can be advised to treat themselves. Indeed, a study of 32 paediatric call centres in the United States.

HealthCare Applications, Website & Kiosk

Health systems and startup companies are using apps, websites and remote kiosk(centre) to provide physician appointments wherever and whenever patients need them. Here's a look at four services aimed at health care consumers.

At Home, at the Office, on the Go, at a Kiosk

1. **Board-certified physicians licensed in Virginia are available 24/7 via an app and website** to diagnose, recommend treatment and prescribe medication
2. **A video-conferencing kiosk with physician-controlled Bluetooth tools,** including a remote stethoscope, HealthSpot is providing hospitals and pharmacies with an on-site alternative to minute clinics. Physicians affiliated with Cleveland Clinic and other hospitals provide the service. HealthSpot accepts most insurance.
3. **Video consultation with a physician, psychologist or lactation consultant** is available via an app or on the Web through Doctor On Demand. Patients can get questions answered by board-certified physicians and, where state law allows, medical diagnoses and prescriptions via video.
4. **Free answers to medical questions or virtual medical appointments for a fee** are available through HealthTap, a 2015 Webby Award winner. The service comes via in-app messages, text chat and video consultation.

Smartphone Revolution

- The gadget currently sitting on your desk or in your pocket is one of the advances in technology that can be directly credited for telehealth's current success.

It's estimated that nearly 30 percent of the world's population currently carries a smartphone, and that statistic is projected to grow 7 percent by 2020. And, as of 2015, roughly 68 percent of American adults carry one of these devices.

That's a lot of people. Many are rural and homebound patients, who are among those most affected by the physician shortage and could benefit from access to telemedicine services. Cellular data service often reaches where landline data and wireless internet don't, which further increases the medium's portability and accessibility. Beyond smartphones' basic voice and video chat capabilities, which alone can be used to diagnose and treat a surprising number of conditions, the devices can also help patients manage other, specific medical activities through certified apps and add-ons.

Sensors, Sensors Everywhere

- Smartphones and internet-capable mobile devices may be the driving factor behind telehealth's success, but it's the gadgets and the growing popularity of the internet of things that is taking this market to new places.

You've likely already heard of, for example, ingestible "smart pills" and wearable heart and temperature monitoring devices. The snag? Internet of things technology isn't quite where it needs to be to meet healthcare's stringent security and privacy needs. Once these concerns are addressed, the sky's the limit. In the very near future, you could see people leaving pharmacies with bags of tiny, smartphone-connectable gadgets alongside their medications.

Wireless Data

The ability to send and receive data — the reason smartphones are smart — would be obsolete if it wasn't for the advances made in wireless networks and data connectivity. Healthcare facilities with access to broadband will tend to use landline connections, and patients with access to Wi-Fi will connect using that. But, for the 7 percent of rural facilities (and one percent of total facilities nationwide) that lack broadband access, and for patients without a reliable connection of their own, cellular data fills the gap left by a network infrastructure that has not expanded into their area.

In the near future, rural patients may see the benefits of initiatives such as Project Loon, a unique internet delivery system that uses balloons to provide data connectivity. Although Loon and similar technologies are still being tested, they will offer an opportunity for telehealth providers to reach new patients and underserved areas.