Update Article

Embracing a Revolution – Telemedicine

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Abstract

The recent advances in information and communication technologies offer real and practical opportunities to health professionals to share expertise and resources in health care over distances. For a country like India with pockets of medical excellence surrounded by a vast number of badly equipped hospitals with limited specialists, telemedicine could revolutionize health care. The potential of telemedicine seem to be vital in avoiding the frame of travel, in timely getting specialist advise to remote areas, minimizing the cost and of course an opportunity to learn from each other. In developed countries the technological advancement and research aims primarily to satiate the needs of their armed forces and to ensure tactical and technical supremacy. The medical community in the Indian Armed Forces should harness the technologies and embrace this revolution of the information age to provide world class combat casualty care.

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Introduction

Information technology is becoming a major sector in health care delivery system and is attracting health care professionals all over the world. Telemedicine allows a specialist or a super-specialist at major cities to give advice to a doctor in a remote rural area for an in situ medical care, or even guide that doctor during surgery. A medical student can watch a rare procedure that would otherwise be unavailable, and researchers can readily exchange information with the audio-video link.

The biggest beneficiaries of this would be the rural population or those in isolated places who have hardly any access to specialist medical facilities. Patients have to face the agony of travel and spend exorbitant sums of money to benefit from expert medical treatment.

In India, certain corporate hospitals are already providing specialist cover to the peripheral hospitals, and it is becoming increasingly evident that satellite links connecting urban hospitals with remote clinics can revolutionize health care. Apollo hospital groups project at Aragonda, a small village in Chittoor District of Andhra Pradesh serves 24 villages covering 48000 people in the vicinity and provides access to super-specialists at the Apollo hospitals in Chennai and Hyderabad. The project will soon extend across five states, covering 10 districts and 20 village groups in each state. In the next phase of the project 125 primary, 25 secondary and 3 tertiary centers in the five states of Maharashtra, Gujarat, Madhya Pradesh, Tamil Nadu and Andhra Pradesh will be covered. Phase three will connect 500 primary, 500 secondary and 100 tertiary centers all over the country. Similarly many projects are underway in other states as well to extend telemedicine to the vast rural populace that has virtually no access to proper medical care [1].

The ambitious plans of ISRO (Indian Space Research Organization) envisage connecting almost all the major hospitals in the country and in the next three years having even a dedicated health satellite. The launch of INSAT-3C on the July 3rd last year has ushered another social dimension to space applications. A telemedicine project which links the GB Pant Hospital (Port Blair) with the superspeciality Sri Ramachandra Medical College and Research Institute (Chennai) through satellite has placed top medical expertise at the service of patients in far-off Andaman and Nicobar islands.

The Indian army has troops deployed throughout the length and breadth of the country and often those requiring specialist / superspecialist medical care have to face the tortuous travel from forward areas, even for routine reviews by specialists, thereby leading to the agony of travel, wasted man-hours and depletion of the crucial manpower.

Most of the available telemedicine systems are distinctly "low tech" and slow. Satellite-based telephony, which is now available from companies such as Iridium and Global star (USA), or satellite-based radio

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communication, such as the Inmarsat system (UK), are potential solutions to this common problem [2]. Additionally, recent proposals to use low earth orbit satellites for 64-kilobyte (kb) Internet access could facilitate data and telemetry transmission for patients in rural hospitals or faraway location [3]. These readily available, "off the shelf" solutions to the communication dilemma of rural or isolated health care providers may be the most cost-effective method of correcting the deficiencies of the current system.

The 1970s saw the introduction of the first digital modality in imaging viz. CT. Later came other modalities like USG, MR, Echo and even conventional radiography (CR) became digitalized. In both versions, data transfer was defined for point-to-point connections, i.e. a networked environment was not considered. To address the above shortcomings, the DICOM standard (Digital Imaging and Communications in Medicine) was developed.

DICOM Network Services

The DICOM network services are based on the client / server concept. Before two DICOM applications can exchange information, they must establish a connection and agree on the following parameters: (a) Who is client and who is server? (b) Which DICOM services are to be used? (c) Which format is to be used for data transmission (i.e. compressed or uncompressed)?

eFilm

Organizations are often faced with equipment that does not support the DICOM standard or provide the means of outputting digital images. eFilm Video is a system that captures still images and video streams from analog medical image acquisition devices (with analog outputs) and converts them to the industry standard DICOM 3.0 format. Promoting integrated digital medical imaging, eFilm Video images and video loops can be sent to DICOM compliant devices for display and processing. Unlike many similar applications, video offers modality work-list capability, thereby eliminating redundant patient data entry.

Available Systems

A conventional telephone line and modem can provide data transmission at a maximum rate of 64 kb/sec. A T-1 line will provide maximum data transmission rates from 1.5 to 2.0 megabytes (Mb) per second and takes approximately 11 minutes to transmit a digital mammogram, which contains only 128 Mb of data. A fibreoptic OC3 line is capable of supporting rates of up to 155 Mb/sec under optimal circumstances and would require only 6.4 seconds, whereas a OC48 line would take only 0.4 seconds for the same data [4]. High-speed landlines, such as OC3 fibreoptic cables, are not widely available at this time. Current availability is limited primarily to large urban areas. Unfortunately, patients receiving care in rural hospitals who could benefit most from teleconferencing are not likely to be eligible for these services due to lack of fibreoptic infrastructure.

Satellite-based telemedicine could rapidly fill the gap now present in the area of high-speed data transmission. The Advanced Communications Technology Satellite (ACTS), which is capable of a 622-Mb/sec-transmission rate, was recently used in an experiment that linked physicians at Phoenix Children's Hospital in Phoenix, Ariz, with consultants at the Mayo Clinic in Rochester, Minn [5]. Using ACTS and high-speed fibreoptic land lines, essentially real-time consultative evaluations of 38 patients with congenital heart disease, including review of cine-angiograms, was done. These long distance consultations were believed to be equivalent to in-person, "hands on" consultation.

Armstrong and Haston [6] recently reported on their initial experience with a telemedicine system that linked a small rural facility in Peterhead, Scotland, with the emergency department of the Aberdeen Royal Infirmary by way of an integrated services digital network land line capable of 128 kb/sec and a satellite link capable of a data transmission rate of 64 kb/sec. In a 1-year period, teleconsultations were done for 120 patients enrolled in the telemedicine program. Teleradiology was used in 116 consultations, video-conferencing was used in 76 cases and telepresence was used for 4 patients. In this study, both emergency medicine consultants in the tertiary care facility and the rural practitioners believed that the use of telemedicine improved care. Use of this rudimentary low-tech telemedicine system obviated the need for transfer of 70 patients and produced estimated savings of £65,000 per year.

There are telecare products available that are ready to use: Telemed Mobile Van – The latest innovation in the field of telemedicine; Telemed-3000 – A DICOM 3.0 & HL7 International Standard compatible hospital based total telemedicine system with features of PAC system. Broadcasting & Tele Education: Disamed-2000 – A Disaster Telemedicine System etc. Some of the speciality specific products that are available are Teleuro 2000, Telepatho 3000, Telecardio 3000, Teleradio 3000 etc.

Advances in Telemedicine Technology

Perhaps one of the best examples of telemedicine that is available for current patient care is the LSTAT (Life Support for Trauma and Transport). The LSTAT is the result of a joint effort of Northrop Grumman Corp (Los Angeles, California) and the various military medical

services in the US. The LSTAT is a self-contained, stretcher-type platform that is designed to aid in field stabilization and transport of severely injured patients. The LSTAT incorporates a number of on-board devices for ongoing treatment, which include monitors for basic vital signs and blood chemistry; mechanical ventilation and oxygen supplementation for patients requiring endotracheal intubation; a self-contained, battery-powered infusion pump to deliver intravenous fluids and a self-contained, battery-powered suction pump. An automated external defibrillator is also built into each of the LSTAT units. All patient medical data that is monitored by the on-board devices of the LSTAT can be data-linked to the receiving medical facility while the patient is being transported by air or ground ambulance. This system provides real-time respiratory and hemodynamic data to receiving physicians. The LSTAT system is now being field tested by the military [7].

As technology continues to improve, substantial efforts have been directed towards development of Telepresence as an adjunct to having physicians on site, or in some instances, as replacement for on-site physician expertise. Telepresence may be described as the ability to perform a "virtual examination or intervention" for a patient over a distance, made possible by telecommunication technology. Satava and Green [8] first described a telepresence operating system for laparoscopic procedures in 1992. This system was later manufactured and has been used experimentally. In 1997, Himpens et al [9] in Belgium did the first telepresence laparoscopic cholecystectomy in a human patient. One year later, Carpentier et al [10] reported the use of a telepresence operating system for more than 150 operations on beating hearts. Schlag et al [11] in Berlin have used a telemedicine system that utilizes a satellite link and fiberoptic land lines with data transmission rates of 2 X 17 Mb/sec and 2 X 34 Mb/sec, respectively to demonstrate stereoscopic telepresence operations between Paris and Berlin and between Chicago and Berlin, as well as to carry out real-time, high-resolution consultations.

One of the problems encountered in teleoperations over great distances is that of latency or delay factor. A surgeon using a telemedicine system that uses a satellite in geosynchronous orbit would observe a period of latency of 1.5 seconds before his tactile inputs would be carried out in his distant patient. Despite these technical problems, the possibilities associated with telepresence operations are exciting.

Military medicine has been extremely interested in the potential of telemedicine because of the obvious logistic problems associated with fulfilling the medical mission of the Armed Services [12]. In USA extensive research has been conducted by the Military in conjunction with industry for the development of practical telemedicine systems, including development of a Personal Status Monitor for personnel located in combat areas. This is a wrist-watch sized device that transmits vital signs to a central monitoring facility and could greatly enhance the ability of medical officers to carry out battlefield triage and initial treatment.

The health care in the Indian Army has been extended to the troops by Regimental Medical Officers (RMO), Nursing Assistants, Battle Field Nursing Assistants (BFNA), shoulder to shoulder at the Forward Defended Locality (FDL). The chain of evacuation of casualties is planned to suit the terrain, climate and the operational requirements, but specialist care is lacking. The Forward Surgical Centres (FSC) provides only specialist surgical care as and when made available to the formation. Nonetheless, telemedicine is being practiced in a primitive way through telephonic consultations between RMO at the Battalion Headquarters and the paramedics at the forward posts, where evacuation of casualties is a nightmare even to the nearest helipad. The problems that telemedicine is envisaged to solve are

(a) Problems of the patients – The agony of travel to referral centers
  (i) For specialist advise and treatment
  (ii) For specialist opinion for re-categorisation medical boards
  (iii) For specialist reviews
(b) Problems of health professionals
  (i) Advice of a senior colleague is not forthcoming in tackling certain ailments and emergencies
  (ii) Referring patients for reviews / opinions only
  (iii) Monotony and lack of opportunities for continuing medical education
(c) Problems of Commanding Officers / Commanders
  (i) Loss of crucial man-hours
  (ii) Depletion of force from critical areas

Today, the Army exists in a global environment in which communication and digitalization play an important role in attaining the desired level of modernization. A separate server for the Indian Army will surely transform the practice of medicine at a distance over a network. V-SAT based communication network is already in place at certain areas providing Internet access and can be integrated for practice of telemedicine. A lot can be achieved through 'Chat' where a medical officer located in a remote locality can take advise from the senior specialist / super-specialist at referral centers. The opinions / recategorization of patients can be obtained by forwarding the case histories, clinical data and lab

results to the concerned specialist by e-mail.

There would however be an immediate requirement of establishing telemedicine centers at select areas, which must be equipped with investigation facilities and necessary gadgetry to make a beginning. Provisioning of a lab with trained staff to perform haematologic and bio-chemical tests, an X-ray unit, electro-cardiography, electro-encephalography and the drugs to manage patients on specialist / superspecialist advice, should be the bottom line to start with. These telemedicine centers can be made available at a scale of one per Brigade / Field Ambulance and the resources already available at a Division level can be redistributed to equip them with the wherewithal. There would be a limited equipment purchase burden, which would be worth the price for embracing e-health in the era of information technology.

In the Northern Command the provisioning for effective convergence of communication and computerization to cater for the smooth induction of Information Technology (IT) resources has already made a beginning. The project expenditure has been conceived and procurement is being coordinated in accordance with the IT road map and priority procurement plan. The establishment of IT training labs, Local Area Network (LAN) down to the Brigade headquarters and extending data connectivety and Army Intranet have been identified as the key result areas and the IT road map indicates optimum functioning by 2005-2006.

The LANs down to the Division Headquarter level are already in place and the access to Army Intranet has been extended to the Corps level. The band width managers are being catered for the management of the available wideband media. Routers at each formation will be used to interface the bandwidth being made available for the connectivity to the existing LAN. All the formations and units under them will be interfaced to switches / hubs to provide local connectivity to the clients. This will enable them to access the Army Intranet as they will then be part of the Corps Wide Area Network (WAN). The integration of Medical units/ subunits with the Army Intranet right upto the peripheral level should revolutionize the practice of medicine and enable telemedicine to reach troops deprived of instant specialist care.

The experience of Telemedicine practice between MH Bhuj and MH Ahmedabad has however not been encouraging as regards management of mass casualties during the calamity, where the available medical teams were involved in giving medical aid on site, triage and evacuation. Moreover, the available specialist compliment at the two hospitals were the same. Nevertheless, the primary users do acknowledge that the telemedicine center established by the government of Gujarat, helped in seeking consultation and timely transferring of patient data.

Telehealth has grown from a mere notion in 1960s and 1970s to being a significant player in healthcare in the 21st century. The American Telemedicine Association (ATA) continues to be a premier national and international showcase for clinical telemedicine, international telemedicine and e-health [13]. Association of Telehealth Service Providers (ATSP) of USA

Fig. 1 : X-ray chest - Maulik Jajarnis, 17 yr male rescue operation, Ahmedabad

Fig. 2 : CT scan - Maulik Hajarnis, 17 yr male rescue operation, Ahmedabad

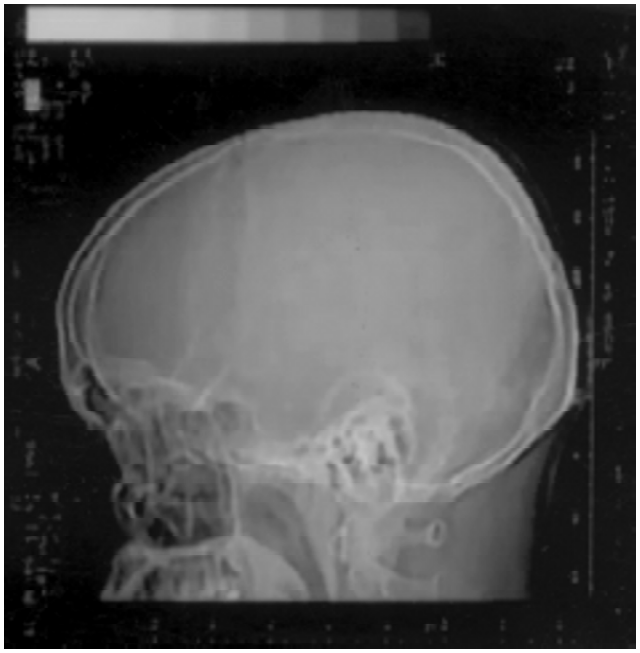

Fig. 3 : X-ray skull - Khudiram Jena, 35 yr male, earthquake, Gujarat

awarded winners prize to Online Telemedicine Research Institute of India (OTRI) for the year 2002. Telemedicine was used as a vital tool for re-engineering healthcare effectively during the recent Gujarat earthquake, which measured 8.1 on the Richter scale. Some 40,000 people died, including many health care workers. Many hospitals and other medical facilities were destroyed. Operating out of tents, the Online Telemedicine Research Institute was able to provide telehealthcare to thousands of people in the month that followed. Some of the images of the patients that were transmitted in these operations are shown in Figs. 1-4.

As with any new technology, implementation of telemedicine techniques would create new problems but at the same time it enhances patient care. Use of telemedicine techniques brings up several medicolegal issues and questions. For example, if a remote telemedicine consultation is done, who is actually the attending physician? Who would be subject to medicolegal litigation if it occurred? Another question regards state licensing for physicians providing telemedicine consultations across states or international borders. If a telemedicine consultation is provided for a patient in another state, must the consulting physician be licensed to practice medicine in both states?

Privacy and confidentiality are among the most important issues which also need to be addressed. Telehealth presents new specialized issues and security points at which the data might be at risk [14]

(a) Data Capture

(i) Participant identification – clinician, patient and others.

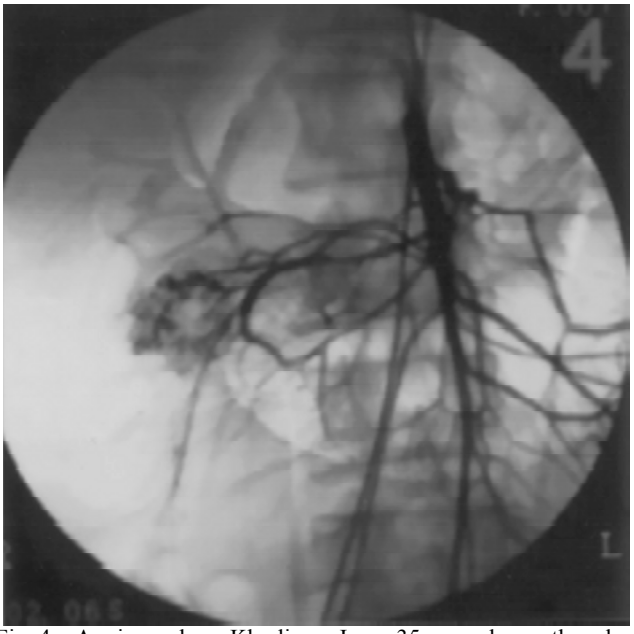

Fig. 4 : Angiography - Khudiram Jena, 35 yr male, earthquake, Gujarat

(ii) Data access – Authentication, access control and auditability.

(b) Communication

(i) Point to point, dedicated links and dial-ups

(ii) Involvement of intermediaries such as Internal browsers and video bridges

(iii) Storage-forward data management

(c) Data review and storage

(i) Long term – Electronic and Physician files (disc, tape and paper)

(ii) Incidental information – Cache memory and printouts

Conclusion

The future of Telemedicine in main stream medical care is full of potential. Physicians offices, examination rooms and even the traditional stethoscope might be replaced by private secure web sites and digital equipment that records vital signs and physical findings. Though this form of futuristic medicine will be less personable and erode the traditional physician-patient relationship but then it is believed to improve patient satisfaction, physician access and patient outcome. Embracing technological advancement is sure to make the practice of medicine more efficient, more economic, more effective and it is hoped more enjoyable.

To avoid such advancement might seriously limit our ability to provide superior care in the computerized world of medicine. The Indian Army is at the threshold of modernization and computerization and Information Technology is developing leaps and bounds to catch up with the latest. 'Telemedicine' should not be left lagging

behind in giving world class health care to the precious soldier located at remote localities.

When the doctor cannot meet the patient and the patient cannot meet the doctor the technology makes them meet

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