

Telemedicine-Applications in Cardiology

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Introduction

A country like India, owing to its vast geographical spread and the enormous population, requires tremendous resources and well trained medical personnel so as to be able to deliver emergency medical care within a life-saving time frame in every nook and corner of the country. This may not always be possible given the fact that majority of the specialists are concentrated in urban areas with a significant paucity of trained specialists amongst the rural population. In a patient with a cardiac illness, the timing of medical intervention is crucial and dictates the outcome of treatment often proving to be the difference between life and death. A typical example being the initiation of treatment early in a patient suffering a heart attack (golden hour), which can save life and have an important bearing on the quality of life post event¹. Considering the fact that a significant proportion of the *Infant Mortality Rate* of 63.19 per 1000 births² in our country could be attributed to the mortality associated with congenital heart defects, the burden posed by heart disease in the paediatric age group assumes enormous

significance. An estimated 48,000 to 1,28,000 babies are born every year with heart defects in India. This is based on the statistics that there are 16 million live births in India in a year and the incidence of heart disease in newborns is 8-12 per 1000 live births. Only a bare 5% of these obtain medical attention and surgical care. Nearly 65% will die below 1 year of age and only 15% will survive beyond the age of 5 years. With at least 50,000 new cases of *Rheumatic fever* every year, it is estimated that there are currently more than one million patients with rheumatic heart disease in the country, which only adds to the disease burden. To compound these problems, there are less than 15 trained pediatric cardiologists in the country and less than 10 institutions in the country with the requisite infrastructure and manpower to offer surgical correction for neonates and infants with heart defects. There are, also, not more than 10 dedicated pediatric cardiothoracic surgeons.

The mismatch between the medical need and the availability of specialist care in our country is thus clearly evident. As mentioned earlier, this is because there is an estimated

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620 million population living in the villages and the availability of specialist doctors there is inadequate. For this reason, the rural population is known to be at twice the risk of death when compared to the urban population, for the same illness. Telemedicine can play a tremendous role in bridging the great divide between the patient and the medical specialist, especially in a country like India. By bringing together the patient and the specialist face to face and by its ability to allow the specialist to conduct an examination and view investigations both in report format and in real time, Telemedicine allows a comprehensive medical consultation in the initial stages of the disease presentation without requiring the patient to travel long distances.

Tele-cardiology in india

The basic requirements for tele-cardiac consultation is for a computer with a web camera, a modem and a standard telephone connection at the remote site with ISDN (Integrated Services Digital Network) or broadband capacity.

All aspects of a comprehensive cardiac consultation, such as the following can be done to the satisfaction of the clinician and the patient through teleconferencing.

- A detailed history of the illness from the patient or the patient's attenders
- Visual general assessment of the patient's clinical status
- Auscultation of the patient's heart and lungs

- Reading the patient's ECG, chest X-ray and echocardiography, and
- Advicing appropriate management, including initiation of emergency life-saving treatment



Fig -1 Electronic stethoscope

Auscultatory findings play a crucial part in diagnosing cardiac ailments, especially in those with congenital heart disease. Recent technological aids such as electronic stethoscope makes it possible for the clinician to hear the patients' heart sounds for himself across many miles and come to an accurate clinical diagnosis. This eliminates the risk of error associated with having to rely on the attending persons clinical auscultation. Even a narrow bandwidth (analog) telephonic stethoscope has been proven to be effective in distinguishing accurately between an innocent and a pathological murmur.³

The clinical diagnosis, thus arrived at, can then be confirmed by reviewing investigations such as electrocardiogram

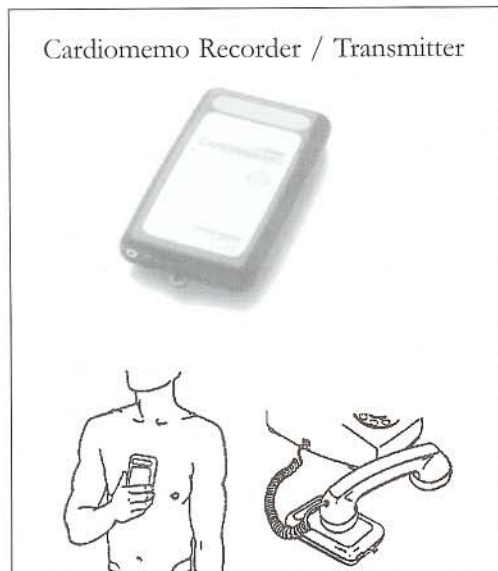


Fig-2: ECG recorder and mode of transmission to the specialist

(ECG), Chest X-ray, Echocardiogram, Treadmill test, Angiocardiology, cardiac CT scan, cardiac MRI scan, ambulatory ECG monitoring, pacemaker evaluation, and relevant blood tests. Most of these test results are reviewed using a *store and forward* technique from the remote site, where the tests are initially performed, captured and stored in the computer which is then forwarded as still frames to the specialist for review.

Transtelephonic ECG provides the means of transmitting an electrocardiogram recorded in a patient with rhythm disorders or a myocardial infarction, enabling immediate initiation of treatment.

Having connectivity between an ultrasound

(echocardiography) equipment and the computer, enables the transmission of



Fig 3: Fetal echocardiography image showing normal 4 chamber view

streaming video pictures of the heart scan in real time to the specialist. This is particularly useful in situations where a child is brought in with a complex cardiac lesion. The primary doctor or technician may not be skilled to perform a detailed scan of the heart of the child and interpret them accurately, and in such cases the specialist is required to view the test live to be able to make an accurate diagnosis. Telemedicine can be effectively used to transmit fetal echocardiography images as identifying fetal cardiac anomalies early on in gestation prepares the parents and the attending doctor towards care immediate post-partum thus greatly enhancing the outcome of management for that baby. As not many are trained to identify cardiac anomalies in early pregnancy, a technician could be directed by the clinical specialist at the referral center to

show the required views to enable a diagnosis of fetal cardiac problem.

Study on application in Radiology:

A total of 102 children were evaluated between July 2000 and December 2003 by this author, using videoconferencing as an application for diagnosing and managing cardiac and related problems. 52 children (50.9%) were diagnosed with cardiac problems of which 30(57%) had a cardiac condition requiring surgery. 4 underwent surgery following the teliagnosis and subsequent confirmation of diagnosis at the referral centre, while 18 were awaiting surgery and 8 died while waiting for surgery. A significant proportion had a cardiac aetiology for their presenting symptoms ruled out and underwent appropriate management with subsequent good recovery.

The remote centre was situated in the Apollo

Rural Hospital in Aragonda, a village in Chittoor district of Andhra Pradesh and the paediatric cardiologist was based at Apollo Hospital, Chennai. The remote centre was equipped with the following hardware to facilitate videoconferencing including viewing of echocardiography in real time.

- Satellite dish antenna,
- DAMA (Demand Assignment Multiple Access) equipment to receive signals from the satellite and route it to the videoconferencing equipment,
- Videoconferencing equipment with high resolution camera (Polycom) and capability of handling image transfer at a bandwidth of 512 kilobytes/sec (kbps)
- Echocardiography equipment with connectivity to the videoconferencing equipment through S-Video cable,
- Computer with a web camera and 17" monitor and connectivity to the videoconferencing equipment, Frame

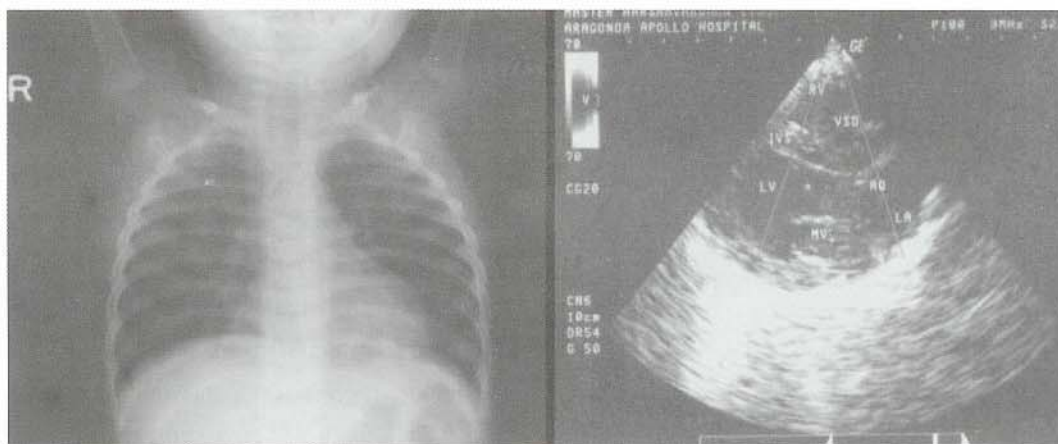


Fig 4: Chest X-ray and Echocardiography as transmitted by internet.

Grabber/ Ethernet card, Terminal adapter,

- Laser printer, and
- Scanner.

The communication channel was through ISDN (Integrated Services Digital Network) initially between July 2000 until Feb 2001 and subsequently through Satellite VSAT (Very Small Aperture Terminal) provided by the Indian Space Research Organisation. The history, clinical findings and investigations such as blood tests, electrocardiogram (ECG) and chest X-Ray were sent from the remote centre in a store and forward mode. This involved scanning the Chest X-Ray and ECG, which were then captured in the PC and then forwarded as image files to the specialist through net meeting using ISDN dial up service.

S-Video connectivity between the echocardiography equipment and the videoconferencing equipment at the remote



Fig-5: Specialist viewing transmitted live echocardiography from a remote centre

centre enabled the paediatric cardiologist at the referral centre to view the pictures in real time and advice the echocardiography technician on adjustments to enable accurate views of the cardiac anatomy. The specialist centre was equipped with a satellite dish antenna, DAMA equipment, videoconferencing equipment and a 28" television screen to view the images.

The practice of diagnosing complex congenital heart defects by transmission over an ISDN line is well established.⁴ However, in our experience, it was found that broadband or VSAT connectivity was superior to ISDN connectivity in that it enhanced the quality of the transmitted images as well as ensured an uninterrupted transmission, especially when transmitting streaming images such as online echocardiography. This is crucial for ensuring accuracy of the diagnosis, particularly in the case of a complex congenital cardiac anomaly. There are previous studies corroborating the accuracy of a diagnosis by Telemedicine as compared to one by personal clinical examination.⁵

In acute cardiac events, telecardiology provides the means by which the specialist is able to guide the primary doctor or the paramedical personnel at the scene to undertake measures which would help save the life of the cardiac patient based on the history provided, and the investigation

findings. An extremely important aspect of telecardiology is that it achieves shared care of the patient by the primary physician and the specialist and also in the process entrains the primary physician in the ways of specialist management for the specific condition. Telemedicine can also be effectively utilized to propagate the knowledge of the specialist to primary care physicians and the public through teleconferencing continuing medical education (CME) programs.

Important aspects of diagnosis in Cardiology

Cardiac problems differ in the population according to the age group. The predominant cardiac ailments in the adult population is related to myocardial infarction, valve pathologies, cardiomyopathies etc. The spectrum of heart disease in the paediatric population differs entirely from those seen in the adults, mainly because they are congenital defects which again may be acyanotic heart disease such as ASD, VSD, PDA, Coarctation of Aorta, Rheumatic heart disease such as Tetralogy of Fallot, Hypoplastic left heart, Total anomalous pulmonary venous drainage, pulmonary atresia etc.

While the preliminary investigations required to make a basic diagnosis of a cardiac problem in the adult population are ECG, Chest X-ray, Echocardiography and occasionally blood tests such as Troponin T,

CPK-MB, lipid profile etc. echocardiography plays a vital role in diagnosing cardiac problems in the paediatric age group. This is so because the complexities of congenital cardiac problems can be evaluated in detail only by echocardiography and a detailed anatomical diagnosis is essential for the subsequent management of the child. With the provision of a good telelink providing streaming video transmission of good quality, all complex cardiac problems in children can be diagnosed. In the adult population, echocardiography could reveal evidence of myocardial infarction by way of ventricular wall motion abnormality, left ventricular function, valve pathologies such as stenosis, regurgitation etc.

ECG is useful in detecting evidence of myocardial infarction, rhythm disorders or evidence of cardiac chamber dilatation or hypertrophy.

Chest X-ray contributes by revealing the cardiac size and pulmonary vascularity both of which would indicate the severity and extent and chronicity of the disease.

Treadmill test, Nuclear perfusion scan, Angiocardiology and Holter ECGs are all supplementary tests used to further help in planning management of the cardiac patients and can be transmitted as part of teleconsultation either live or using a store and forward technique.

In short all investigations can be transmitted

effectively during teleconsultation and taking into consideration the fact that the clinical examination such as auscultation can also be carried out by the specialist clinician through Telemedicine, this modality provides us with a scenario where there are no such cardiac conditions which could not be diagnosed. The basis for this, however, is a good quality transmission at adequate speed and the basic provisions for performing the investigations and transmitting it from the remote centre.

Recommendation

Accessibility to Telemedicine centers can be enhanced if such models as the one in this study are developed on a larger scale networking the entire length and breadth of the country. This could be done with government and private sector partnership nurturing the way to establishment of a platform for dispensing uniform health care to one and all in the country despite the geographical restrictions.

Conclusion

The data from our study reveals that Telemedicine applications in paediatric cardiology allows definitive diagnosis of any heart disease in children, both acquired and congenital. By offering immediate management advice, it can be life saving and avoids potentially life-threatening travel while

the patient is acutely sick. Importantly, in those with a non-cardiac problem, by ruling out a cardiac pathology, it facilitates initiation of treatment for the appropriate system without undue delay.

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