Future of Tele-echocardiography

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Abstract. **Telemedicine is defined as the 'delivery of health care and sharing of medical knowledge over a distance using telecommunication systems'. Echocardiography is often used to diagnose and exclude important cardiac diagnoses in adults and children. Evolving telemedicine technology has boosted access to echocardiography and has created a network that offers many possibilities for clinical, research and teaching activities.The two primary modes of telemedicine practise are ' store and forward' and 'real time' videoconferencing. Using these technologies, relevant, up-to-date scientific information is instantly available for analysis and interaction. Studies have also shown these to be accurate, cost effective, improves patient care, enhances echocardiography quality and sonographer proficiency and promotes practice expansion.**

The growing use of technology such as smart phones, laptops and computer tablets as well as newer technologies like cloud computing, picture archiving computer systems(PACS) and the standardization of medical images(DICOM) has fuelled the now accelerating specific demands for tele-echocardiography.
However, all these are not without challenges and obstacles. Some of these include lack of standardization of telemedicine components, confusing medico-legal and licensure issues, privacy/confidentiality, poor reimbursement, training issues as well as attitude and acceptance.

These issues need to be addressed by all those involved in medical practice. Clinicians must work with sonographers, medical IT experts, hospital management and hospital physicists as well as manufacturers and insurance companies to ensure that the new system is integrated as an extra function within ultrasound consoles. National and international societies such as the European Society of Cardiology (ESC) and the American College of Cardiology (ACC) could play a role in bringing everyone together and define the necessary training programmes.
In conclusion, the revolution in digital technology is rapidly changing the world of telecommunications. Tele-echocardiography has a bright future to become an integrated part of our clinical available echocardiographic tool set – in a matter of time.

Keywords-component;echocardiography, telemedicine, computer

INTRODUCTION

Telemedicine, in essence, consists of information sharing between at least two physically and geographically disparate sites for educational or health purposes. It can involve a simple telephone call conversation or a complex scenario as a real time, applications based interaction via videoconferencing. Consultative and direct patient care with continuing medical education over a distance is accomplished using telemedicine.Telemedicine has the potential to enhance acess to health care, improve quality of care and provide care which was not previously available and also reduce the cost of healthcare. It has penetrated every field of medicine, including cardiology and echocardiography.
Echocardiography is a widely applied tool in telecardiology which affects cardiology intervention strategies[1]. It has the potential to bring real time diagnoses to remote fascilities without resident cardiologists. In addition to lowering the mortality rates of patients who suffered heart attack, telecardiology can reduce the costly transportation from home to hospital or unnecessary transfers between hospitals[2,3,4].Using these technologies, relevant, upto date scientific information is instantly available for analysis and interaction. Studies have also shown these to be accurate, cost effective, improves patient care, enhances echocardiography quality and sonographer proficiency and promotes practise expansion. Evolving telemedicine technology has boosted access to echocardiography and has created a network that offers many possibilities for clinical, research and teaching activities. These will definitely benefit clinicians,researchers and students.
In this paper, we review and discuss the development of tele-echocardiography with areas that indicate further improvement for future service practice in our global community.

EXPANSION OF TELE-ECHOCARDIOGRAPHY

The words 'tele' and 'remote' conjured up images of absolute distance or far flung, remote areas which took long travel times. With the advent of space travel came the international space station orbiting the earth which has echocardiography machines on board[5-8]. Such projects show the benefits of long distance consultation. Times have changed and the outmoded 'tele' paradigm has shifted. As such, we are geared towards contacting lots of remote areas via electronic means cutting travel time and costs and increasing time spent on expert consultation[9].

With the advent of modern technology, high speed internet plus the demand for faster diagnosis and cost reductions in treatment, the need for telemedicine has grown at an amazing pace. Telecardiology, specifically tele-echocardiography has not been spared this growth.

The two primary modes used in telemedicine practise are 'store and forward' and 'real time' videoconferencing.

Traditionally,physicians used store and forward teleconsultation with video being digitalized, compressed and sent to remote cardiologists as real time teleconsultation[10,11]. Modern echocardiography modalities generate a sequence of digital imaging and communications in medicine (DICOM) based images and export the digital video files for store and forward interpretation or real time examination. Cardiologists benefit greatly from DICOM based images as the advantages include rapid data retrieval via picture archiving and communication system (PACS), convenient comparion with previous examinations and shared access to the data among cardiologists[12].

The difficulties encountered in these systems included transmitting cardiac image data, wherein the heart being a dynamic organ, required a high quality image for an accurate diagnosis. Large amounts of data needed to be transmitted and compressing images caused deterioration in quality of images transmitted[13]. Then there were issues with time management and in general, there was delay before images could be viewed and discussed. Furthermore, there were in-house projects which could not be used on a larger scale. This was due to the connectivity factor - poor acess to high speed bandwidth internet connection which is so vital for telemedicine. This is especially so for rural hospitals and remote healthcare settings.

All that has changed now. Revolutionary progress in telecardiology has been made with information technology by leaps and bounds, changing the winds of tele-echocardiography to a dynamic and versatile platform.

NEW FRAMEWORKS OF TELE-ECHOCARDIOGRAPHY

Mobile devices such as smart phones have driven the demand for tele-echocardiography more strongly in the short term to become commercially available[14,15]. These devices can connect to both wireless computer networks as well as to wireless telephone networks, enabling independent access to patient data wherever one is. Smart phone devices such as GE V scan and Mobi Sante MobiUS, which enable sonographers to conduct ultrasound examinations with real time image transmission via Wi-Fi or 3G mobile phones, while the images are stored in a PACS. These images are of an acceptable quality[16,17]. Mobile phone based tele-echocardiography can further expand the application of services to pre-hospital care as well as to home care. Another example of mobile devices are the tablet computers such as the Ipad™ from Apple, which has screens that outperform most of the standard outpatient clinic computer monitors.

In this current 21st century, there is a great demand for a common telecardiology platform with shared access nationwide or even worldwide. This would enable sharing of data and patient clinical records across a wide spectrum of networking healthcare workers

With the development of all these, a serious issue would be the storage of rapidly increasing medical data. Hospitals will need to adopt an outsourcing strategy of storing and this is when the concept of storage as a service comes into play, that is cloud computing. This strategy not only resolves the storage problems, but also fascilitates big data analysis[18,19,20].

Mobile computing based telecardiology services including imaging tele-echocardiography services have been developed by Hsieh's lab since 2009[21]. The following information below has been obtained as in [21].

i)Cloud computing and its effects on large scale medical data

Cloud computing is a relatively new model of delivering computing resources such as processing,memory, storage and network. These are accessed by users with Web via the internet[22-25]. In cloud computing, applications run on a virtual machine, which functions as a real computer. These functions can be adjusted based on users demand with high scalability. Cloud computing providers have fascilities to back up data and filter out break in activities with firewall protection. For hospital managers, these are definitely superior to the traditional

methods of clinical data management and storage. For research scientists and clinicians on a global platform, these can perform computing intensive data analysis and share big data in the cloud. Big data computing in turn will require large scale data capacity.

ii)*A Cloud PACS extended from local to global*

Cloud–PACS, which implements PACS, is a critical technology for the revolution in telecardiology[19]. With PACS, clinicians can index the echocardiography images and share the image files across the hospitals.Cloud-PACS can easily fascilitate the interoperability of echocardiography images in a unified data form, DICOM, and allow medical centres to use the service on the basis of pay as you go. This is rather attractive to the end user as it enables hospitals to store a large amount of images at a low cost. Moreover, this technology can serve for both research and education purposes if image interpretation is confirmed by cardiologists with a report. Also, this service can be extended from a local to a global level where medical centres and fascilities can share echocardiography file images around the world for further collaboration of pre-hospital,in hospital and post hospital diagnosis and consultation.

The development and deployment of cloud computing and big data has inexpressively fascilitated the application of tele-echocardiography across hospitals and expand series within countries, regionally and on a global scale. As such, persons living in rural or remote areas as well as those in towns and cities where health care is easily accessible, have equal opportunities of being evaluated by qualified physicians and cardiologists alike via telecardiology. Most importantly, these services will increase global collaboration to allow cardiologists to better communicate with non-specialists within their regions,or from various regions and nations, and also to fascilitate the work of charitable organizations , like Swinfen, to provide expertise to developing countries[26].

In this way, the clinical practise and scientific research in cardiology will rapidly advance worldwide.

CHALLENGES FACED BY TELE-ECHOCARDIOGRAPHY

The current challenges faced in the tele-echocardography industry are various and of a multi modality nature. Some of these include lack of standardization of telemedicine components, confusing medicolegal, licensure and legislation issues, privacy/confidentiality debate, poor reimbursement, training issues as well as attitude and acceptance[27]. Most telemedicine delivery is offered within a hospital,between a clinic and a specific hospital or between under-resourced clinics and a metropolitan hospital[21]. These organizations face a tremendous expansion in technology, leading to more innovation and new ideas. As such, these challenges need to be confronted by all those involved in telemedicine in these organizations.

For a start, the issue of lack of standardization of telemedicine components can arise from the fact that compatibility issues between software and equipment produced by different manufacturers in different hospitals can cause interfacing hurdles especially when dealing with echocardiography and technical images. Therefore, we need to have standardized equipment and interfacing infrastructure that are compatible between the telemedicine centres and which can be upgraded as technology advances to enable integration and become an extra function within ultrasound consoles.

Secondly, medicolegal licensure issues can prove to be daunting for tele-echocardiography services. Regulatory challenges such as liability, cross hospital credentialing and cross-state credentialing of health care workers need to be taken into consideration. These are already in place in developed countries such as the United States and Europe. India and Russia are rapidly progressing too.

Certain legislations applying specifically to images reporting standards, turn around time for reporting and quality control procedures must be given due attention if we are serious in making tele-echocardiography a success. Smart Telecardiology, an emergency provider of offsite online cardiac medical imaging modalities is a successful example of this. It is a division of Heidelberg Medical Consultancy, an online health solution provider based in India with operations in Germany and with strong links with the United States. Smart Telecardiology comprises of a global group of board certified cardiologists and physicians providing peer reviewed echocardiographic images interpretation with turn around time starting from 4 hours. It has state of the art technology with standard quality control programmes and internationally recognized reporting standards.

With the rapid advance in telemedicine and tele-echocardiography technology, we need to have our regulations and systems in place on informed, distance based care to avoid medico-legal issues cropping up in the near future. A subset of this is privacy or confidentiality which stands out as a buzz word in most of our ethics and legal documents. This is especially in dealings between our health care workers and patients.

With so much medical data 'whizzing' on the internet, telemedicine has become vulnerable to the privacy/confidentiality buzz word. We need to implement services and reassure our customers and clients that all data are held with the utmost privacy and confidentiality. We can mobilize systems in place to that effect which in turn will confer higher trust in our services and at the same time, enhance our reputation, increase our client base and improve our business track records.

Thirdly, we have to deal with reimbursement of telemedicine services and financial issues which come into the picture at an early stage. Studies have shown that financial barriers, along with infrastructure concerns were the main stumbling blocks that prevented instituitions from implementing telemedicine service[28,29]. This is where governments, private bodies and organizations can play a role by assisting in monetary aid through donations, fund raising campaigns and offering discounted/free services in selected areas both to providers as well as to clients. All this will greatly help in steering telemedicine and tele-echocardiography services off the beaten track and into the main stream arena.

Also, the constrains of adequate training of health care workers and those involved in telemedicine delivery have become a key issue in the telehealth framework. Better delivery of information about the state of the art research and development in telemedicine can be enforced via national programmes to educate and train healthcare professionals. Concurrently, proper training on telemedicine and tele-echocardiography with state of the art technology as well as increasing awareness via seminars, workshops, symposia and conferences can all help in the dissemination of knowledge and skills to the respective parties. This has been seen in Virginia,United States with the opening of a training academy, the Southside Telehealth Training Academy and Resource Centre (STAR) which is a grant supported training programme. National and international societies such as the European Society of Cardiology(ESC) and the American College of Cardiology (ACC) could also play a role in bringing everyone together and ultimately defining the necessary training programmes and standards[27].

Finally, other complex interpersonal and interprofessional relationships which border on attitude can prevail in this situation. These facts have been studied and cited as below[30]. Telemedicine forces allied health staff to take orders from physicians they may never have met, challenging traditional conceptions of teamwork and collaborations. On the other side, patients are challenged to accept medical advise and treatment without the benefit of an in-person encounter to build trust or rapport. Disruptive technology is just that- disruptive, ie no one really knows where all these is leading to. As such, we need to revise- and perhaps completely rethink-health care regulations, putting into place a more flexible system that can protect patients while fostering continued innovation. Our job is to minimize potential harm by ensuring implementation of telemedicine and tele-echocardiography is based on solid data. The fact that in 2012 nearly half of United States hospitals reported having active telemedicine programmes indicates that telemedicine is now fully within the mainstream[31]. What more need to be said?

It is inevitable for clinicians to work with sonographers, medical IT experts, hospital management and hospital physicists as well as manufacturers and insurance companies to ensure that the new system can lead to health care that is not just different and more modern but also safer and better.

CONCLUSION

To conclude, tele-echocardiography is rapidly changing the world of telecommunications. These services will in a matter of time, increase global collaboration in every avenue be it clinical, scientific or research orientated fields. In a nutshell, we should take up the challenges offered by tele-echocardiography and spearhead its development as an integrated part of our clinical available echocardiography tool set. Tele-echocardiography is an asset for our future and it is here to stay.

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Dr Manohari Balasingam is a Senior Consultant Physician in Non-Invasive Cardiology and Internal Medicine as well as HOD in Medicine, practising in a government hospital in Malaysia. She has completed fellowships in clinical non- invasive cardiology from the National Heart Institute in Malaysia and at Mayo Clinic in Rochester and the BIDMC, Harvard University at Boston, USA. Her contribution in the fields of academic medicine relating to critical care cardiology and cardiovascular medicine is vast. Dr Balasingam has travelled widely and presented in a number of international seminars, forums and conferences and has published papers in international journals. She has also been the receipient of international awards for clinical and academic medicine. Her future plans are to expand further in the fields of critical care cardiology and tele-cardiology, for the healthcare of the community at large.

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