

## EMR-based TeleGeriatric System

P.M.D.S. Pallawala<sup>a</sup> and K.C. Lun<sup>b</sup>

<sup>a</sup>School of Computing, National University of Singapore, Singapore

<sup>b</sup>Medical Informatics Programme, National University of Singapore, Singapore

### Abstract

*Introduction: As medical services improve due to new technologies and breakthroughs, it has lead to an increasingly aging population. There has been much discussion and debate on how to solve various aspects such as psychological, socio-economic and medical problems related to aging.*

*Our effort is to implement a feasible telegeriatric medical service with the use of the state of the art technology to deliver medical services efficiently to remote sites where elderly homes are based.*

*The TeleGeriatric system will lead to rapid decision-making in the presence of acute or subacute emergencies. This triage will also lead to a reduction of unnecessary admission. It will enable the doctors who visit these elderly homes once a week basis to improve their geriatric management skills by communication with geriatric specialist. Nursing skills in the geriatric care will also benefit from this system. Integrated electronic medical record (EMR) system will be indispensable in the face of emergency admissions to hospitals. Evolution of EMR database would lead to future research in telegeriatrics and will help to identify the areas where telegeriatrics can be optimally used.*

*Methodology: This system is based on current web browsing technology and broadband communication. The TeleGeriatric web based server is developed using Java Technology. The TeleGeriatric database server was developed using Microsoft SQL server. Both are based at the Medical Informatics Programme, National University of Singapore.*

*Two elderly homes situated in the periphery of Singapore and a leading government hospital in geriatric care have been chosen for the project. These 3 institutions and National University of Singapore are connected via ADSL protocol. ADSL connection supports high bandwidth, which is necessary for high quality videoconferencing.*

*Each time a patient needs a teleconsultation a nurse or a doctor in the remote site sends the patient's record to the TeleGeriatric server. The TeleGeriatric server forwards the request to the Alexandra Hospital for consultation.*

*Geriatrics specialists at the Alexandra Hospital carry out teleward rounds twice weekly and on demand basis.*

*Summary of Results: Following the implementation of the system, a trial run has been done. Total results have demonstrated a high degree of coordination and cooperation between remote site and the Alexandra Hospital. Also the patient compliance is very high and they prefer teleconsultation.*

*Conclusion: Initial results show that the TeleGeriatric system has definite advantages in managing geriatric patients at a remote site. As the system evolves, further research will show the areas where telegeriatrics can be used optimally.*

### Keywords:

Medical Informatics; Telemedicine; Aged; Telegeriatrics; Remote Consultation; Computerized Medical Records; Electronic Medical Records; Geriatrics; Ethics; Legal Status; Asymmetrical Digital Subscription Line;

### Introduction

Twentieth century inventions and discoveries in medical and related areas have paved the way to increased life expectancy. This has given rise to fast aging population and related medical problems. The Singapore population is also rapidly aging. It is estimated that by the year of 2030, one fifth of the total population would be above 65 years. In this context one would need to develop more efficient methods of delivering healthcare services to the elderly in their homes or institutions.

The Medical Informatics Programme (MIP) of the National University of Singapore and the A&E and Geriatrics Departments of Alexandra Hospital have collaborated in implementing a feasible telegeriatric medical service with the use of state of the art technology to deliver medical services efficiently to remote sites where elderly homes are based. [1]

The TeleGeriatric system enables the residents of elderly homes to reach specialists through teleconsultations. Images of them can be transmitted from these homes to Alexandra Hospital. This reduces the hassle and stress for

relatives and institutional staff in bringing the elderly to the hospital.

Remote therapy can be undertaken via telemonitoring, thereby reducing the length of hospital stay and avoiding unnecessary admissions.

This service also greatly reduces commuting time, as treatment is no longer constrained by distance. It is extremely difficult to transport the elderly to the hospital for treatment or consultation sessions, as can be testified by relatives or institutional staff. Often, the doctor has to drive to the elderly homes, some of which are located in the outskirts of Singapore. To solve logistical problems, some of the elderly are transported to the hospitals via ambulances.

There may be instances of false alarms, which could have been avoided if doctors could communicate with nurses in the elderly homes to conduct basic examinations. False alarms constitute a waste of ambulance and personnel resources, which could be more effectively deployed.

With proper instructions from doctors, nurses at these elderly homes can administer simple treatment and avoid transfer to hospital for same treatment.

This system will enable the support staff in the elderly homes to make rapid decisions in the face of an emergency by communicating with the Alexandra Hospital via teleconsultation.

Another advantage of this system is in improving geriatric nursing skills. This will improve geriatric care at elderly homes.

Hospitals can also use telegeriatrics to cut down on hospital occupancy for rehabilitation. Patients can be monitored from their homes or institutions, with not just videoconferencing equipment, but equipment that allows for data transfer of readings (such as pulse rates and blood pressures) back to the hospital.

This project serves to introduce a new mode of healthcare delivery. If successful, other telemedicine initiatives could follow e.g. Teleradiology, Telepsychiatry, etc. This would enhance the speed and quality of the delivery of healthcare, as patients are able to obtain treatment in the shortest time possible, as well as seek a second or even third opinion easily.

This project provides a low cost solution to healthcare. With only 2 PCs, 2 modems, 2 Web cams and a SingTel Magix connectivity (512kbps ADSL), the patient and doctor are able to carry out a live conversation. This paradigm shift paves the way for cheaper alternatives to more efficient healthcare delivery.

Lastly, this project centers on organizational behavior. Its intrinsic value lies in the study of how human beings cope with new technology and how they make sense of it.

Ultimately, the benefits ought to reach the patient in both tangible and intangible ways, and that is the main objective of this project.

## Materials and methods

For the implementation of this system we have used low cost solutions. Each remote site and the Alexandra Hospital has a Pentium III Computer and a 3Com web camera. Specifications of the 3Com web camera are 300\*230 pixels and 30 frames per second. These specifications are adequate for quality videoconferencing.

The TeleGeriatrics application server is developed using Java Web Technology. Hence the TeleGeriatric system is platform independent and can be browsed from any site, using an Internet browser. The TeleGeriatrics database server is developed on Microsoft SQL server. This database server enables high security and flexibility.

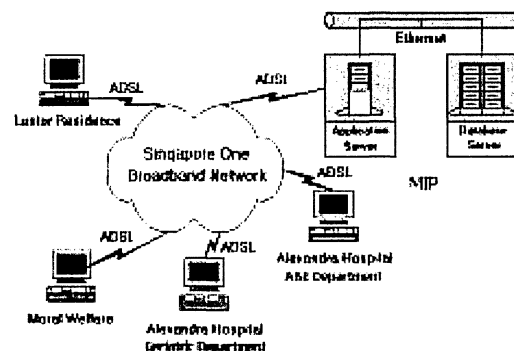


Figure 1- System Connectivity

Asymmetrical digital subscription line (ADSL) technology is used to facilitate high quality videoconferencing between two sites. The SingTel Magix ADSL connects at 512kbps through Singapore One broadband network (Figure 1). For videoconferencing, the TeleGeriatrics system is integrated to Microsoft NetMeeting software.

Prior to the implementation of the system, trainings in the use of the system were given to specialists from the Alexandra Hospital, the nursing staff at the two elderly homes and the administrative staff. Special emphasis was given to the security features of the system [2].

Doctors from the Alexandra Hospital visited the two elderly homes and informed written consent was obtained from the patients. Later thorough initial assessment of all the patients was done. All the findings were recorded in the EMR. Doctors also trained nurses in the elderly homes regarding basic examination techniques and how to use the EMR [4].



*Figure 2- Teleconsultation*

EMR contains bio data, clinical findings and management details of patients. Clinical data includes presenting complain, history, past medical/surgical history, any allergies, examination findings, body temperature, pulse rate, blood pressure, respiratory rate, blood sugar test results, results of any other basic investigations and comments. Management details includes general condition and observations, investigations to be done, possible diagnosis, treatment details, follow-up details.

When a patient needs a teleconsultation, nursing staff on the remote site creates a new consultation request by logging into the Telegeriatrics system and entering the patient's bio data and clinical findings. Following that, the TeleGeriatrics application server forwards the request to the Alexandra Hospital for consultation. The system displays the patient's name and remote site on the Alexandra Hospital monitor. By selecting a particular patient's name, consultant can obtain the clinical data of the patient. During the consultation videoconferencing (Figure 2) is used to communicate with the patient and the remote site staff. Following the teleconsultation, the specialist enters the plan of management, which is sent to the remote site via the TeleGeriatric application server.

## Results

Both the elderly home nursing staff and the Alexandra Hospital staff have shown great interests in the system. Two geriatric specialists from the Alexandra Hospital and five nursing staff from the elderly home are involved in Teleconsultations twice weekly. They have shown a high coordination in carrying out the teleconsultations. Currently EMR contains 72 patients.

The nursing staff feels that the system has reduced the transfers. Nurses were enthusiastic about the prospect of practicing in this way. They also feel that their management skills have improved significantly and are confident in an event of emergency.

Doctors have also confirmed that the number of admissions from particular nursing homes is reduced. Possible research in this new area has stimulated many doctors to take part in the system.

Elderly patients also prefer the teleconsultations as transfers may lead to many physical problems and ailments. They were also confident about the teleconsultations. On the whole, patients perceived the system as a valuable resource that offered great potential.

## Discussion

Although telemedicine [6] is not a new concept, teleriatrics has not been developed into the same extent as teleradiology [18] and telepathology [19]. One reason could be due to the challenges in teleriatrics [7]. Existing teleriatric systems [8], [5] only use simple videoconferencing facilities to manage the patients. Our aim is to integrate both videoconferencing capabilities and electronic medical records [9] into one system, which can be used more effectively in geriatric care.

Following the analysis of the domain we have selected the Alexandra Hospital as the specialist center for the project. Alexandra Hospital is the one of the leading government hospitals in Singapore, which caters for the geriatric population. The hospital has a fully functional geriatrics department and a team of geriatric specialists.

As for the remote institutions, we have selected two elderly nursing homes. The reasons for selection were due to the fact that all the transfers from these nursing homes were directed to the Alexandra Hospital. In some cases, Alexandra Hospital doctors often have to visit these elderly homes. So this selection has led to much coordination between the hospital and the nursing homes.

As this system heavily depends on videoconferencing, we considered choosing ADSL (Asymmetrical Digital Subscription Line) communication protocol for this project, which offers a digital channel capable of delivering compressed video signals over the existing copper wire. The ADSL system in effect comprises a pair of specialized modem devices attached to the either end of a copper wire pair. These ADSL modems 'condition' the line to expand the useable bandwidth to provide voice, data and video at 512kbps. The problem with the ADSL system is that the send-out rate is far less than the receive-up rate. However 512kbps is about twice the speed of ISDN. This enables high quality videoconferencing. National University of Singapore, Alexandra Hospital and the remote sites are connected via ADSL to Singapore One (Figure 1). Singapore One is the nation wide broadband backbone implemented by the Singapore government for high-end multimedia and videoconferencing applications.

The Telegeriatrics application server is developed using Java web-server technology, which is platform independent. The advantage of being a web-based system is

that it can be accessed from any site, given that it has an Internet access and an appropriate authorization. The remote site should also be equipped with videoconferencing abilities and ADSL connection for high quality videoconferencing. The TeleGeriatrics database server is developed using the Microsoft SQL server. Built-in security features of the MS-SQL enable developers to achieve high degree of security.

Overall cost of the above system also included the development cost and the maintenance cost. Development duration was about 8 months and two full time staff was involved with the software development. Maintenance cost includes full time system administrator and monthly ADSL subscription.

We conducted several meetings with the Alexandra Hospital staff and the Elderly homes staff. Our aim was to familiarize the system among the staff. Several demonstrations were carried out to educate the staff regarding how to log on to the system, how to create a consultation request, how to view the EMR and how to carry out the videoconferencing between two sites. As most of the staff had experience with an Internet browser, they quickly grasped the concepts and managed to make a request. For the staff that had a poor knowledge of computers and Internet access, training classes were organized.

Special emphasis was given to the ethical issues [10], [11] and the patient's rights [14] related to the system. Every patient was explained about the system thoroughly and its advantages and possible disadvantages by a doctor. Later written consent [3] was obtained from them to participate in the study.

The patients agreed to participate as the service allowed them to consult a specialist before transfers and to be followed up at remote site without routine clinic visits. All the patients were thoroughly examined by the Alexandra Hospital doctors and initial EMR was created.

A group of doctors from the Alexandra Hospital has trained the nurses in basic examination techniques. Nurses were willing to learn as they can improve their examination skills and medical knowledge.

There are several legal issues [12], [13] which are related to the TeleGeriatric system. As the system transfers sensitive medical data over the Internet, security and confidentiality [15] of data was a major issue. Although we have implemented a strict password system, it was felt that it is not adequate. And it was decided to implement the secure socket layer (SSL) technology in the next version. This technology allows transfer of sensitive data over the Internet.

Another medico-legal [16] issue raised was related to the teleconsultations and remote management of patients. It was shown that for a doctor to prescribe a drug or to treat a patient, both patient and the doctor should be in the same

location unless the remote location is physically inaccessible. The Singapore government is taking necessary steps to introduce new legislation to promote the practice of telemedicine in Singapore. This will enable widespread use of telemedicine applications throughout Singapore.

From medical point of view, the TeleGeriatric system was limited to taking the history from the patient and remote inspection of the patient. To overcome this problem, nurses were specially trained in basic examination methods. In the next version we are planning to introduce digital stethoscopes, digital ECG monitors and pulse-oxymeters. Studies [17] have shown that these are valuable features in telemedicine applications. Their uses would enable doctors to be more confident in their telegeriatric management.

## Conclusion

Initial results show that the TeleGeriatric system has definite advantages in managing geriatric patients at a remote site. As the system evolves further, research will show the areas where the telegeriatrics can be used optimally.

Future enhancements such as integration of digital equipments into the system and change in legislature will lead to rapid growth of telegeriatrics.

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#### Address for correspondence

Pallawala PMDS  
 School of Computing  
 National University of Singapore  
 10 Kent Ridge Crescent  
 Singapore 119260  
[pererapa@comp.nus.edu.sg](mailto:pererapa@comp.nus.edu.sg)