

5 section five

Enhancing Patient Care through Telecare, Telemedicine, and Personalised Patient Education in Singapore Health Services



This article highlights the innovative low-cost in-house solutions developed by the Singapore Health Services (SingHealth) aimed at providing innovative services to engage and empower patients anytime, anywhere, as well as tools for clinicians to provide better patient care. The five tele-healthcare projects presented in this paper are: MyTelecare for chronic disease patients, MyEduCare for enhanced patient care, 3G Telemedicine for the transfer of critically ill patients, 3G Telemedicine for Obstetrics Care, and Virtual Podiatrist.

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1 Introduction

Leveraging on the ubiquitous ICT infrastructure and an increasing tech-savvy population in Singapore, the Singapore Health Services (SingHealth) has been conducting pilot projects in tele-healthcare since October 2005 with a view to enhance patient care. These are collaborative projects between the SingHealth Innovative Technology Application Group (iTAG) and SingHealth clinicians across various specialties and institutions. This article highlights the innovative low-cost in-house solutions developed by SingHealth aimed at providing innovative services to engage and empower patients anytime, anywhere, as well as tools for clinicians to provide better patient care. The five tele-healthcare projects presented in this paper are: MyTelecare for chronic disease patients, MyEduCare for enhanced patient care, 3G Telemedicine for the transfer of critically ill patients, 3G Telemedicine for Obstetrics Care, and Virtual Podiatrist. These projects are funded by the SingHealth iTAG fund, and is developed and supported by a two-man SingHealth project team. The projects presented have been reviewed by the respective hospital's ethics board.

2 MyTelecare for Chronic Disease Patients

Singapore is experiencing three specific trends: a rapidly ageing population, a greater prevalence of chronic diseases and a population who are increasingly well informed and perceptive about ICT and health matters. To address these

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needs, SingHealth has embarked on a Telecare project empowering outpatients to self-monitor their health with the assistance of their SingHealth clinicians through the MyTelecare portal (www.mytelecare.com.sg) and/or mobile text messaging (SMS).

Since the launch of SingHealth MyTelecare [1, 2, 3] in October 2005, the following eight outpatient groups are using the system on a pilot basis:

- Heart failure and post heart transplant patients;
- Women with pregnancy-induced hypertension;
- Pregnant diabetic patients [4, 5];
- Peritoneal dialysis patients with kidney failure [6, 7];
- Cardiac patients with diabetes;
- Polyclinic patients with well-controlled hypertension [8];
- Occupational asthma patients; and
- Congenital heart patients with cyanotic heart disease.

The SingHealth institutions and clinical departments involved in this project are:

- The National Heart Centre (www.nhc.com.sg)
- The Department of Obstetrics & Gynaecology, Singapore General Hospital (www.sgh.com.sg)
- The Department of Renal Medicine, Singapore General Hospital (SGH)
- The Department of Respiratory & Critical Care Medicine, SGH
- The SingHealth Polyclinics (polyclinic.singhealth.com.sg).

The MyTelecare system allows the development of a personalised monitoring plan for each patient as clinicians are able to customise the vital signs to be measured, set individual parameter thresholds and tailor the health symptom questionnaire to the needs of each person. A patient's health history can be monitored by the patient concerned, as well as by the clinicians, through interactive informative charts. Besides vital signs and symptoms, the Telecare system also provides a Secure Messaging module for the patient and clinician to personally communicate with each other, so that patients can rapidly and confidently manage their condition on their own. Through MyTelecare, when a patient's health is beyond their clinician's recommended norms, clinicians have the option to be immediately alerted via SMS, so that they can provide timely intervention to reduce complications and emergencies. Patients are also informed, and may receive a self-help message (customised by their clinician) through the system.

With the help of MyTelecare, clinicians are also able to rapidly fine-tune the medication of their outpatients and adapt it to the patient's current health status and lifestyle, rather than wait until the individual shows up for a regular clinical review, which may vary from weeks to months. MyTelecare also assists clinicians in extending their reach and care to overseas and travelling patients.

The project is currently in its pilot stage involving local and overseas patients aged between 19 and 96. For patients who are not tech-savvy, monitoring is done with the assistance of their loved ones or care givers. The system has been developed in-house and supported by a two-man SingHealth project team in close collaboration with SingHealth clinicians. As a public healthcare provider, the project team has consciously endeavoured to provide low-cost telemedical care to the patients by using affordable communication devices/services and personal healthcare

monitors. Prototype versions of other user input options such as touch-tone phone input and direct vital sign monitor interfaces have also been developed by the project team.

MyTelecare was developed using object-oriented methodology on the Microsoft .NET platform. The system is web service enabled, and can be interfaced to other systems through interface standards such as Health Level 7 (HL7).

In addition to chronic disease management, MyTelecare is also innovatively used to:

- Replace one of the regular clinic reviews for Polyclinic patients who have well-controlled hypertension. These patients only need to see a doctor every six months, instead of the current three-monthly appointments. This saves the patient time and money and frees the clinician to focus on more acute patients, without compromising the care of patients whose condition is well controlled.
- Facilitate the diagnosis of Occupational Asthma patients through real-time monitoring of the peak flows and troubleshooting.
- Facilitate the recommendation of appropriate therapeutic planning for congenital heart patients with cyanotic heart disease when performing daily activities.

The response from clinicians and patients involved in this pilot project has been favourable and encouraging. Patients have benefited from the interventions made by clinicians when they have problems. "Telecare will revolutionise the way we practise medicine and manage chronic disease towards a more cost-effective healthcare. The system empowers patients to manage their illness confidently. Travelling abroad is no longer a worry as the physician is just a few 'clicks away'," says Dr Marjorie Foo, Senior Consultant at SGH's Department of Renal Medicine. "In my case, I get a phone call from the doctors when either my weight or blood pressure increases too much. This really helps me to ensure that potential serious problems are prevented," explains a 33-year-old male peritoneal dialysis patient.

Telecare is a possible long-term solution to provide care for a rapidly ageing population with increased susceptibility to chronic degenerative diseases. The Telecare project was a finalist in The Stockholm Challenge 2006, Asia Pacific ICT Award 2006 (APICTA), and one of the winners at TEC Public Service Innovation Award 2006 (Merit).

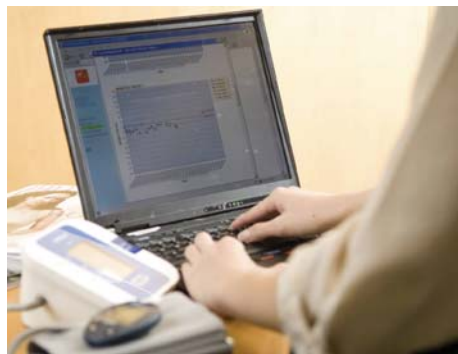


Figure 1: SingHealth – www.myTelecare.com.sg

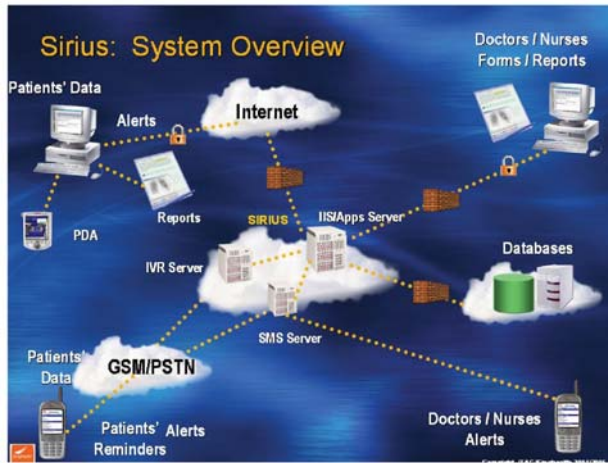


Figure 2: System Overview of SingHealth Telecare system

3 MyEduCare for Enhanced Patient Care

To help our outpatients better manage their disease on their own, effective and engaging patient education is key. In 2007, SingHealth launched the MyEduCare portal [9], where patients can download engaging personalised patient education content for review anytime, anywhere. For each patient, these multi-lingual, multimedia patient education content are personally assigned by their clinicians, and are available in formats for multiple devices (such as mobile phones, PDAs, smartphones, PCs, Macs, iPods). MyEduCare is built upon the MyTelecare engine.

At the SGH Department of Respiratory and Critical Care Medicine (DRCCM), asthma patients are given an asthma action plan after each consultation. This written plan explains to patients how and when to administer medication for asthma relief. The action plan also advises patients to seek urgent hospital treatment in cases of severe attack or failure in self-management. Patients are also taught the proper inhaler technique to administer asthma medication. Patients are advised to carry their action plan around with them.

Riding on the pervasive usage of mobile phones in Singapore, through MyEduCare, asthma patients may receive their personal action plan in SMS format into their mobile phones. This ensures that patients have their plans with them all the time. Through the MyEduCare portal, patients may also download their personal asthma action plan in MP3 and Acrobat text formats. Besides the asthma action plan, patients may also download a personalised video clip (wmv, 3GP, MP4 formats) demonstrating the correct inhaler technique for the specific inhaler they are using.

For asthma patients with low literacy [10], an MP3 player loaded with their personal action plan is loaned to the patient, who can listen to it in their preferred language. The low-cost MP3 player helps the patient bridge the literacy barrier and improves self-management skills. The MP3 players were loaned by Creative Technology.

Dr Tan Keng Leong, Senior Consultant, DRCCM, explained, "most asthmatics do not carry their written asthma action plan with them, while some tend to misplace their asthma action plan or are unable to read the written instructions due to low literacy. The written asthma action plan has been shown in studies to lead to the reduction in hospital admissions, emergency rooms attendances, unscheduled visits to the doctor for asthma, days off work, night time awakening and a reduction in the risk of asthma death and is a recommended guideline on the management of asthma. MyEduCare helps to overcome some of the barriers to good asthma care in the real world".

MyEduCare complements the MyTelecare system by providing patients with personalised self-care management information from their trusted clinicians so that patients can rapidly and confidently manage their disease on their own. Other MyEduCare content are for gestational diabetes patients [11], congenital heart patients with cyanotic heart disease, cardiac surgery patients, occupational therapy patients and more will be added in the coming months.



Figure 3: MyEduCare personalised patient education video content so that patients can review them anytime, anywhere (The videos in the photograph are for asthma and gestational diabetes patients)

4 3G Telemedicine for the Transfer of Critically Ill Patients

In a joint iTAG trial between SingHealth and SingTel (www.singtel.com), the mobile paediatric ICU team of KK Women's and Children's Hospital (KKH, www.kkh.com.sg) has been using 3G mobile phones to enhance communication when they transfer critically ill children from other hospitals to KKH [12]. The team consists of a critical care doctor and an ICU nurse.

For such transfers, the mobile ICU team works closely with the hospital-based intensive care physician to stabilise the patient during the transfer. Prior to this project, the team made a voice call to update the consultant in KKH on the child's condition. Through adding a 3G video call into their process, more information is provided to the doctor.

Dr Janil Puthuchery, Director of the Children's Hospital Emergency Transport Service, explained, "When communication is done by voice, we have to rely on the other person's interpretation of the situation, but when we see a picture or video, the reality might be very different. We can now also offer our own interpretation".

The 3G mobile calls enables the mobile ICU team to make a video-call to the ICU, relaying live video images of the patient, patient monitors and life-support equipment, as well as X-rays and charts. The added dimension of video enhances patient safety, as the senior doctors at the hospital can monitor how the mobile ICU team is managing the patient and advise accordingly.

Dr Puthuchery also shared that the parents of the critically ill children liked the fact that the senior doctors have direct visual contact during the whole transfer process.

After completing a successful six-month pilot project, the use of 3G-based telephone communication is now part of KKH's standard transfer process.

Thus far, the hospital has only used the 3G technology for local transfers. However, as KKH also transports critically ill patients from overseas, it sees potential for monitoring international transfers, as 3G coverage and services become more widespread in Asia.

5 3G Telemedicine for Obstetrics Care

In another joint iTAG trial between SingHealth and SingTel, the Department of Obstetrics and Gynaecology, Singapore General Hospital (SGH) has been evaluating the use of 3G phones to monitor fetal heart traces [11, 13]. During labour and delivery, a device called a cardiotocograph (CTG) is used to ensure that the baby is healthy and coping well with the process of childbirth. By studying the fetal heart rate patterns on the CTG which are displayed on a computer monitor, obstetricians are able to tell if the baby is in distress. In such a situation, it may be necessary to carry out a delivery by caesarean section.



Figure 4: Transmitting cardiotocograph (CTG) by 3G video call at SGH Labour Ward

Interpretation of these fetal heart rate patterns are sometimes difficult and experience in the use of the CTG is essential. Doctors at SGH realised that important decisions based on the fetal heart patterns on the CTG especially outside regular working hours have to be made by doctors on duty without the benefit of input from other colleagues. During office hours, these important decisions are made after several specialists have studied the CTG. Dr Elisa Koh, the specialist who is conducting the study said, "We felt that if the doctors on duty at SGH could transmit images of the CTG to colleagues at home for a second opinion, women and their unborn babies would receive better care". In the pilot study, live images of the fetal heart rate patterns as recorded on the CTG at SGH were transmitted to doctors at remote locations using 3G phones via 3G video calls. It was found that these images were sufficiently clear to allow accurate identification of the fetal heart rate patterns. Dr Devendra, consultant obstetrician at SGH, said, "We wanted to ensure that senior doctors could accurately identify the characteristics of the fetal heart trace using the 3G phones before using the technology in the care of patients. The pilot study has proven this and our next step would be to introduce it into clinical practice".

6 Virtual Podiatrist

This iTAG pilot project involves the remote examination of diabetic in-patients with foot wound problems at Occupational Therapy Department, SGH. The resident podiatrist is able to remotely examine, review and give appropriate advice or consultation to such patients from his clinic. The patient on the ward is assisted by a podiatrist assistant who carries out the appropriate treatment under the supervision of the "virtual podiatrist".

It is hoped that this low-cost, portable system will help allow the podiatrist to see more patients. Patients also benefit from this solution as they no longer need to travel to visit the podiatrist at the clinic, and this prevents potential movement-induced aggravation to the foot wound.

Working with Principal Podiatrist Jasper Tong of SGH's Occupational Therapy Department, the iTAG project team developed an innovative in-house solution for use on the wards. Summing up his experience, Jasper said, "The system helps me to carry out an effective remote examination by providing me with full control of the camera to view the patient's foot from various angles, obtain good close-ups and assess the size of the wound. I am also able to zoom the camera to examine large and very small wounds (less than 2 cm in size), and clearly resolve skin ridges and prints with correct wound and skin colour. When required, I can also capture an image of the wound and record the examination. During the remote consultation from my clinic, the virtual system also gives me the possibility to chat with the patient or Podiatrist Assistant on the ward".

No special lighting is required when using the Virtual Podiatrist system. It is encrypted for security and provides good real-time video coverage. With the successful pilot project, a technology transfer of this system was also made to another government agency for telemedicine and tele-maintenance purposes for staff at remote locations.

Initially, the project was launched to help alleviate the shortage of podiatrists in the hospital. Since then, the number of podiatrists has increased significantly, and the system is used as a valuable back-up.



Figure 5: Virtual Podiatrist

7 Lessons Learnt

The following are some of the lessons learnt and success factors the iTAG team has gathered from the experience of inspiring the innovative use of technology in healthcare:

- Supportive management that promotes innovation in the organisation through resources and funding for technology pilot projects. Pilots are good test-beds to test and refine ideas in the real world.
- Passionate clinicians (user champions) and their teams with vision, energy and courage who see the potential of using technology to enhance patient care.
- Evangelise by providing stimulating live demonstrations of the system. Address safety, ethical and legal issues. Articulate possible clinical benefits/value. Articulate a vision for the project and a realistic strategy to get there.
- Focus on clinical outcomes and/or patient experience and quality of life, rather than technology trends. Technology is a tool and an enabler.
- Technology solutions should preferably be sustainable with current resources and abilities. For pilot projects, bear in mind about sustainability of the project by the available resources after the pilot.
- Good execution wins confidence. The implemented system should work seamlessly with the clinician's daily work with minimal disruptions. Systems should empower the clinicians to customise and personalise for each patient. Be ready to refine and innovate upon the system. Respond promptly to user feedback and suggestions. Keep solutions simple. Have a competent technical team with an eye for details. Anticipate users' needs and suggest practical solutions.
- Win-win communication. Positive team dynamics. Build partnerships and collaboration.
- Be user-centric. Observe the present work. Meet the patients. Understand the needs and challenges. For the patients (who are members of the public) the system should be intuitive, user friendly, low-cost and use what the patient already has and can do. If possible, allow multiple user input devices. Build a system not just for the privileged few but for everyone.

- Provide effective training to the users of the system.
- Keep projects costs reasonable, preferably low.
- Develop platforms that can rapidly and flexibly be adapted to other clinical disciplines. Well-thought software architecture, system design and security features from the start. Be aware of the technology trends, and build future-ready systems that can readily accommodate to emerging technologies or disruptive technologies or interfaces to other clinical systems. Where possible, for patient use, augment solutions to address the digital divide.
- Like all technology innovations, our experience is similar to the Technology Adoption Lifecycle outlined by Geoffrey Moore in his book *Crossing the Chasm* [14]; it will take time for the acceptance of new technology.
- Be resourceful, passionate, focussed, optimistic and encouraging with a view to help the patients get better and improve their quality of life. Be open to spin-offs in the journey.

"Restlessness and discontent are the necessities of progress." - Thomas A. Edison

"Opportunity is missed by most people because it is dressed in overalls and looks like work." - Thomas A. Edison

8 Conclusion

Looking ahead, in the area of telemedicine and telecare, besides the need for growing acceptance by both patients and clinicians, the legal framework as well as appropriate business models and funding mechanisms need to be developed. Furthermore, Singapore is a small country where good healthcare facilities are reachable in less than half an hour. Hence, we foresee that the adoption of ICT solutions to facilitate remote care will be successful for applications where the technology is appropriate, affordable, enhances patient care and facilitates clinical work.

At a regional level, telemedicine and telecare has the potential to enhance SingHealth's reach to overseas and travelling patients by providing value-added services, and also assist us in providing medical expertise to medical practitioners around the region.

The iTAG team will continue to collaborate actively with visionary clinicians to stretch the boundaries with innovative telemedical projects in various clinical disciplines in SingHealth to enhance patient care and quality of life.

9 About SingHealth

Singapore Health Services (SingHealth, www.singhealth.com.sg) is the largest public healthcare provider in Singapore. SingHealth consists of a cluster of three Hospitals, five National Specialty Centres and a network of primary healthcare clinics (Polyclinics) distributed around the east side of the country. Each year, SingHealth attends to three million patient visits.

10 References

- [1] Lim FS, Tan YS, Devendra K, Foo M, Ong A, Telecare in Singapore Health Services, Med-e-Tel 2006, 5-7 April 2006, Luxembourg.
- [2] Lim FS, Foo M, Devendra K, Tan T E, Lim RMC, Bahadin J, Tan KL, Idris D, Ong A, Chee E, Telecare for Chronic Disease Patients - Anytime, Anywhere, HIMMS AsiaPac 07, 15-18 May 2007, Singapore.

- [3] Lim FS, Foo M, Devendra K, Lim RMC, Bahadin J, Tan KL, Tan TE, Tan R, Idris D, Ong A, Chee E, Enhancing Chronic Disease Management through Telecare – The Singapore Health Services (SingHealth) Experience, 7th International Conference on Successes and Failures in TeleHealth, 27-28 August 2007, Brisbane, Australia (Best Paper Awards), (proceedings to be published in Journal of Telemedicine and Telecare December 2007).
- [4] Devendra K, Lim FS, Lim SC, Tan LK and HK Tan, The Use of Internet and Mobile Phone Technology in the Remote Monitoring of Women with Diabetes in Pregnancy (TELECARE), 5th Singapore Obstetrics & Gynaecology Congress, 7-11 September 2005, Singapore (poster).
- [5] Jiang Y, Devendra K, Tan LK, Lim SC, Tham YL, Lim FS, Chee E, Tan HK, A Novel Strategy For The Joint Management of Diabetes In Pregnancy Using The Internet – A Pilot Study (TELECARE), 6th Singapore Obstetrics & Gynaecology Congress, 21-25 March 2007, Singapore (poster).
- [6] Foo M, Suhail SM, Lim FS, Yong KM, Chua HL, Wong KS, Pilot study on Telecare monitoring of Peritoneal Dialysis Patients in Singapore General Hospital, The 11th Congress of the International Society for Peritoneal Dialysis, 25-29 August 2006, Hong Kong (poster).
- [7] Tan R, K Thanalechumi, Lim FS, Chee E, Wong KS, Foo M, Chronic Peritoneal Dialysis using Telecare: The Singapore General Hospital Experience, First Asia Pacific Peritoneal Dialysis College, 21-22 March 2007, Incheon, Korea (Best Clinical Poster Award).
- [8] Bahadin J, Musrifah MS, Lim FS, Chee E, Chow MH, Lim RMC, TeleCARE@SHP: Our Initial Experience, 18th WONCA World Conference (World Organization of National Colleges, Academies and Academic Associations of General Practitioners/Family Physicians) 24-27 July 2007, Singapore (Merit Award).
- [9] http://www.singhealth.com.sg/Newsroom/NewsReports/2007/20070502_ForCare_ST.htm
- [10] Tan L, Kong MC, Lim TG, Lim FS, Chee MF, Tan KL, A pilot project of personalized asthma action plan in the MP3 format for asthmatics with low literacy, American College of Allergy, Asthma & Immunology (ACAAI) 2007 Annual Meeting, 8-14 November 2007, Dallas, USA (poster), (abstract to be published in Annals of Allergy, Asthma & Immunology).
- [11] Devendra K, Lim FS, Telemedicine, MyTelecare, MyEduCare – The SGH Obstetrics and Gynaecology Experience, 2nd Annual Healthcare IT 2007, 20-21 September 2007, Singapore.
- [12] 3G Mobile for a Mobile ICU, KeyLines, May-June 2006 (www.singtel.com/keylines).
- [13] Koh E, Devendra K, Tan HK, Lim FS, Chee E, The Use of 3G Handphones for the Transmission of Cardiotocography Traces in Labour – A Pilot Study, 31st British International Congress of Obstetrics & Gynaecology, London, UK, 4-6 July 2007 (Poster).
- [14] Geoffrey A. Moore, Crossing the Chasm: Marketing and Selling High-Tech Products to Mainstream Customer (1991, revised 1999) HarperBusiness.