Report on Developments in ICT and Health Facility Design

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Centre for Health Assets Australasia

REPORT ON DEVELOPMENTS IN ICT AND HEALTH FACILITY DESIGN

PREPARED FOR

CAPITAL AND COAST DISTRICT HEALTH BOARD

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CAPITAL AND COAST DISTRICT HEALTH BOARD, NEW ZEALAND

REPORT ON DEVELOPMENTS IN ICT AND HEALTH FACILITY DESIGN

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1. INTRODUCTION

The Centre for Health Assets Australasia at the University of NSW was engaged by the Capital and Coast District Hospital Health Board, Wellington Hospital to conduct a worldwide review of health-related developments in Information Communication Technology (ICT) that could impact on future health facility design. To this end, the study reviewed recent literature, case studies, trade journals and noted exemplary use of ICT within health care facilities. The search was undertaken world wide using journals, various databases, contact with international health care architecture companies, embassies, international ICT research and support centres and interviews conducted with key healthcare ICT experts at the University of NSW, NSW, Australia.

The purpose of the study was to review a wide ICT healthcare research field unrestricted by cultural or traditional boundaries. In doing so the study has included Japan, South Korea, China, Singapore, and Saudi Arabia, in addition to the United States of America, United Kingdom and Europe within the scope of the research. As technology is not limited by boundaries, ICT and healthcare facility research should similarly not be constrained in this way.

2. METHODOLOGY

The following methods were used to gather information for the study:

- Interviews were conducted with academic experts – Professor Enrico Coeira, Director of the Centre for Health Informatics, UNSW and Professor Jeffrey Braithwaite, Director of the Centre for Clinical Governance Research, UNSW

- Relevant ICT information was scanned and retrieved from multiple search engines and professional data bases.

- Building on CHAA'S international network, contact was made via e-mail, relevant hospital development / procurement organizations in Europe, United Kingdom, United States and Canada, with information sought regarding trends in ICT.

- Similar bodies were contacted in Japan, South Korea, Singapore and China to identify innovative use of ICT in their health care facilities.

- A search was conducted for related trade journals and relevant articles retrieved and read.

- Written contact was made with the Embassies of China, Korea and Japan

- Contact was made with those architectural firms that had been reported for designing innovative, cutting edge hospitals. The purpose of contact was to obtain photographs or information regarding ICT within the new hospitals. To this end, written contact was made with:

    - Smithgroup Architects, USA.

    - Granary Associates, USA, (architects).

    - Ellerbe Becket (architects) USA.

- The report produced by Western Australia Ministerial Visit to the United States of

America, April 2007 was reviewed and this provided a more detailed list of new and innovative hospitals for further research and information gathering.

3. RESEARCH FINDINGS

3.1 Impact of Technology on Clinical Functions

3.1.1 Information management and sharing – EHR/EMR, PACS, EDIS, patient bedside terminals

Professor Jeffrey Braithwaite, Centre for Clinical Governance Research, UNSW

Telephone contact was made with Professor Jeffrey Braithwaite, Director of the Centre for Clinical Governance Research, UNSW on July 3, 2007. The Centre is internationally recognized for its original research and scholarly contributions to the health care sector. The Centre describes its core interest as being "to investigate issues of policy, governance and leadership in the health sector". Prof. Braithwaite was supportive of the topic under investigation, namely "what can you tell me about cutting edge, innovative use of Information Communication Technology within health care settings for a research project being conducted for New Zealand Health?" I was referred to various journals and to contact Enrico Coiera, Professor and Director of the Centre for Health Informatics, University of NSW.

Professor Enrico Coiera, Centre for Health Informatics, UNSW

Professor Coiera, Director of the Centre for Health Informatics, UNSW was interviewed on July 26, 2007. He addressed the question under research and confirmed and clarified a number of the findings of the CHAA research team. Professor Coiera's opinions are highly relevant to New Zealand and Australian healthcare facilities as he conducts research in those health systems and is attuned to the particular characteristics including economic realities of those systems in addition to being familiar with the US and European contexts.

An extract from the Centre for Health Informatics website that provides invaluable insight into the world of informatics and healthcare facilities for the 21st century and illustrates the context for its research activities. http://www.chi.unsw.edu.au/

The Centre for Health Informatics (CHI) is Australia's largest academic research group in this emerging discipline. The Centre's work is internationally recognized for its groundbreaking contributions in the development of intelligent search systems to support evidence-based healthcare, developing evaluation methodologies for IT, and in understanding how communication shapes the safety and quality of health care delivery. Centre researchers also are working on safety models and standards for IT in healthcare, mining complex gene micro array, medical literature and medical record data, building health system simulation methods to model the impact of health policy changes, and developing novel computational methods to automate diagnosis of 3-D medical images.

Professor Coiera identified four elements that should be addressed when designing ICT for healthcare facilities.

- Pipes – wireless and cables.

- Output devices – viewing screens and other means of viewing data.

- Measurement systems – attached to the system, actually doing things.
- Identification of the 'mission critical' issues – that is the critical activities that cannot function at all if there is a computer malfunction and that could compromise patient care.

These elements are discussed in more detail below:

Pipes – Wireless and Cabling

There will be a whole host of areas where wireless technology will be used; however, it should not be used in mission critical areas as it still fails at times. Wireless will eventually be suitable for all purposes, but currently should only be used in non-critical areas.

High speed, high quality cables and bandwidth should be available in all wards and remote consulting facilities. Every clinical staff member will require access to a Picture Archiving Computer System (PACS) facility; screens must be placed to ensure wide access to the appropriate people whilst at the same time ensuring patient privacy.

Healthcare facilities are building their own networks, as publicly available networks cannot offer the speed, cutting edge technology that is required for operating the new era of ICT and healthcare.

CAT 5 and CAT 6 cabling is not sufficient to cover mission critical areas.

Output Devices – Viewing Screens

Professor Coiera does not recommend that special computer rooms be built for viewing. Computers and their screens need to be mobile and readily available.

Problems have occurred overseas where healthcare facilities have removed their radiograph viewing screens because they have implemented PACS. What was not taken into account was the need for wider digital viewing access across the healthcare facility. There are examples where doctors have not had PACS digital access close to the patient with obvious frustrations and complications.

Equipment needs are going to rapidly change and they will need cable and power. So the lesson appears to be to put the cabling in so that PACS screens and future technology can be widely available.

Measurement systems

Attached to the systems are such services as Electronic Health Records, Management Systems, Inventory, Radiology, Pathology, Robotic Surgery, Clinical Informatics, Patient Monitoring, Intelligent systems for neurosciences and cardiovascular as indications of ICT use.

Pharmacy Medication Vending machines are already quite standard within healthcare settings. An example is the eectronic medication dispensing system already available in Queensland Hospitals.

Outpatient Departments are good examples of where ICT can provide useful information for people with people being able to access appointments times, information, education, their health record. This type of service is readily suited to wireless technology.

Generally technologies are tending to converge, such as PACS with Health Informatics to form ‘Full PACS systems’. Robots can be used for inventory and restocking of wards. Palm pilots, robotic surgery, robotic monitors are already in use. It is certain that more rapidly changing technologies will become available. However, more importantly will be the identification of ‘mission critical’ services.

‘Mission Critical’ Areas

An example of a ‘mission critical’ area is a theatre where robotic surgery is being used. An example of a critical issue may be where a surgeon is performing an intricate procedure, the power fails and as a result the computer malfunctions - alternatively the computer could malfunction on its own. The potential outcome of this is critical and must be addressed.

Another example of a mission critical function is the electronic dispensing machine that may malfunction, and as a result medications cannot be dispensed. Medication dispensing is a critical function. So regardless of gadgets or the latest devices, a healthcare facility must identify mission critical services if ICT is to be successfully implemented.

One way to address power failures or system failures for mission critical areas is to have a “redundant system” alongside the mission critical system. The redundant system kicks in as soon as the critical system fails.

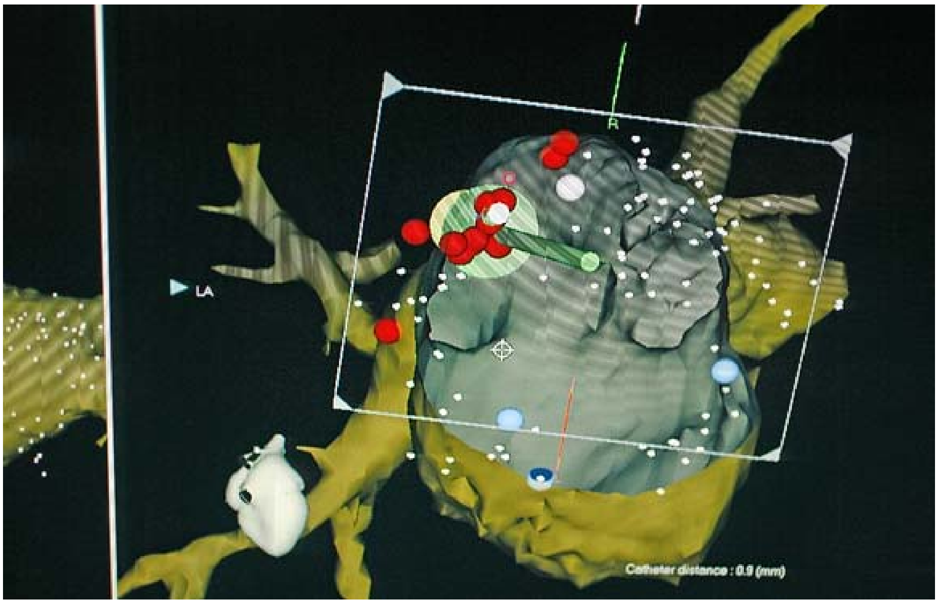
Example of patient information and monitoring system – Trondheim Norway

The St Olav’s Hospital at Trondheim, Norway has a fully integrated patient monitoring and information system available at every patient’s bedside including delivery rooms. These are flat screen monitors that provide in addition to patient electronic records and access to nurse call systems, patient entertainment including an internet connection, television, telephone and radio.

Bedside monitor at St Olav’s Hospital, Trondheim, Norway (Carthey, personal photo, apr07)

3.1.2 Diagnostics and interventional radiology: cardiac catheterization, real time cardiac modelling and interventions, MRI/operating theatres

- Cardiac ablation using magnets to remotely position the catheter in the heart to treat arrhythmias by ablation can be done from a control room panel and monitor without the need to gown up, or use lead aprons; takes less time than conventional procedures and is as effective; does require a steel lined room to stop the magnets affecting other equipment



Positioning the catheter onscreen
(http://www.sfgate.com/cgi-bin/object/article?f=/c/a/2007/01/21/CMGO9MRLUS1.DTL&o=1)

- Faster MRI through ‘compressive sensing’ - new algorithms are being developed that will allow MRI systems to capture images 10 times faster than today. In five to ten years the same technology could be used in mobile phone cameras to produce high quality poster size images.

MRI and other technology in operating theatres

The increasing use of technology will initially create a demand for larger theatres to accommodate the equipment and people to operate it. With the increasing development of remotely operated and non-invasive technologies, the size of theatres and possibly the number of them will also decrease. Many procedures are then likely to be conducted on an outpatient basis quite often in a doctor’s office and not in a hospital at all.

At that time, space occupied by operating theatres may become excess to requirements and reconfiguration for other uses may then be possible. Therefore it will be important to plan for future uses and reconfiguration of this part of an acute hospital, rather than continuing to anticipate an increasing need for a greater number of larger and more highly technologically equipped operating rooms in the future.

Case study: Boston Children’s Hospital
Architect Shepley Bulfinch and Abbott (Boston)

http://www.medicalimagingmag.com/issues/articles/2006-09_04.asp

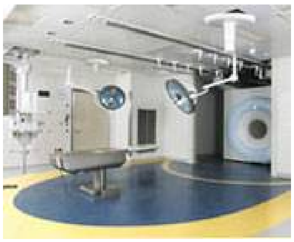
http://www.childrenshospital.org/clinicalservices/Site2131/mainpageS2131P0.html

In this operating theatre, the MRI moves in and out of the operating room as needed into a docking bay.

Design Issues to be considered include:

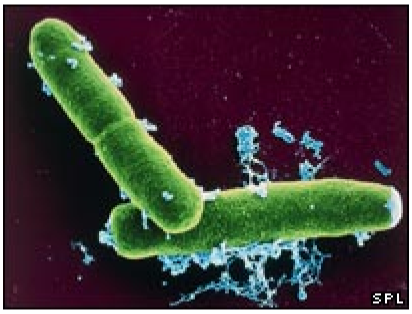
- structure required to support the 7.4-ton magnet;
- containment of the fringe magnetic fields associated with the scanner within the room;
- isolation of vibration and sound;
- accommodation of adjacent spaces not typically found in ORs, such as the docking and control rooms.

- Secured entry and provisions for ease of circulation for the patient, equipment, and different types of clinicians involved in the intraoperative procedure



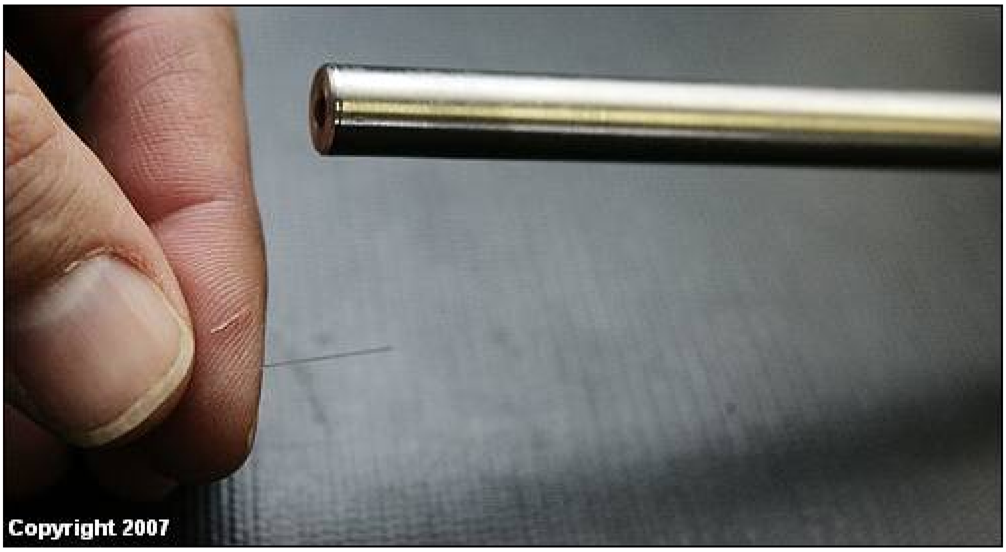
Future technologies still being developed that may impact on care delivery

- Computerised diagnosis – e.g. use of computers to detect changes in brainwaves that accompany epileptic seizures to be able to anticipate and prevent them
- Bacterial light detector – custom polymer molecules that change shape and emit light when bound to bacteria; could be used for wound healing – identification of a type of bacteria, counter terrorism e.g. detection of the presence of anthrax, MRSA detection, etc.



Rapid detection of anthrax bacteria could be vital in a terrorist attack

- Breath test for lung cancer – lung cancer cells give off volatile organic compounds. This sensor is the size of a large coin and would be able to detect these with 75% sensitivity with spots changing colour depending on the chemical with which they come into contact.
- Cellular level cancer diagnosis is being researched through the identification of proteins at cell level that differ between cells with or without cancer, and also those where the cancer is more likely to spread – this is 10 to 20 years away.
- Virtual biopsy with Raman Spectroscopy – can determine whether tissue is cancerous without painful biopsies leaving most of the organ intact; uses reflected light and identification of the shift in wavelength to determine whether the right tissue is being tested, and whether it is normal, benign or malignant. It could also be used to assess whether burns victims require skin grafts. Currently the size of a small coin, it eventually will be the width of a hair on the end of a surgical instrument. Will be used in operating rooms for real-time cancer detection while patients are in surgery. Eventual use in doctors' offices once price comes down. Accuracy is being tested; appears to compare favourably with normal pathology testing.



A hair-thin photonic crystal fiber and Raman portable probe could aid in cancer detection (http://www.detnews.com/apps/pbcs.dll/article?AID=/20070219/LIFESTYLE03/702190343)

Virtual healthcare delivery: remote diagnostics/monitoring, robotic surgery, robot doctors

- Robots with emotions are now being developed that take sensory input from the humans around them and adapt their behaviour accordingly.

The robots exhibit imprinted behaviour - following the 'mother around' (http://news.bbc.co.uk/2/hi/technology/6389105.stm)

A humanoid wearing an apron picks up a cup of tea after University of Tokyo Professor Tomomasa Sato drank it during a demonstration at the campus.
Photo: *Katsumi Kasahara*

(http://www.smh.com.au/news/technology/ageing-japanese-turn-to-robots/2007/10/05/1191091336398.html, 11 Oct 2007)

- Clinical simulation and virtual care delivery – the virtual world of ‘Second Life’ (IBM) is investigating how better to link real and virtual worlds – use of mobile phones, messaging and chat; connect virtual people and objects to the real world via communication networks
- Gaming software and ‘ray tracing’ as per Lord of the Rings is becoming increasingly sophisticated in order to produce special effects images for much more realistic games and medical simulations
- ‘Virtual people’ are now available. These are 3D life-size representations of people who can look you in the eye, examine your body language, consider voice nuances and phraseology of your questions and then answer you in a way that is so real you would consider that the images are alive. It will be able to preserve virtual people whose critical or unique knowledge is vital to corporations or other institutions.
- Cell phone heart monitors are becoming more widely used. CardioSen’C is a ‘12-lead portable EKG that can transmit data on a patient’s heart activity to physicians by cell phone. Patients attach 12 electrodes to their chest and upper body and strap a battery-powered unit on the front of their chest. The latter digitizes the readings from the EKG sensors and transmits them via cell phone simultaneously to a “dedicated medical control center” and to the patient's cardiologist, who can talk to the patient while viewing the data. Patients can even travel abroad yet be connected to their hometown doctor.’ (HFN, July 2007) Can ‘help drastically reduce morbidity and mortality following an acute myocardial infarction or other severe cardiac incident’. (http://www.shl-telemedicine.com/site/Content/t2.asp?pid=267&sid=75)

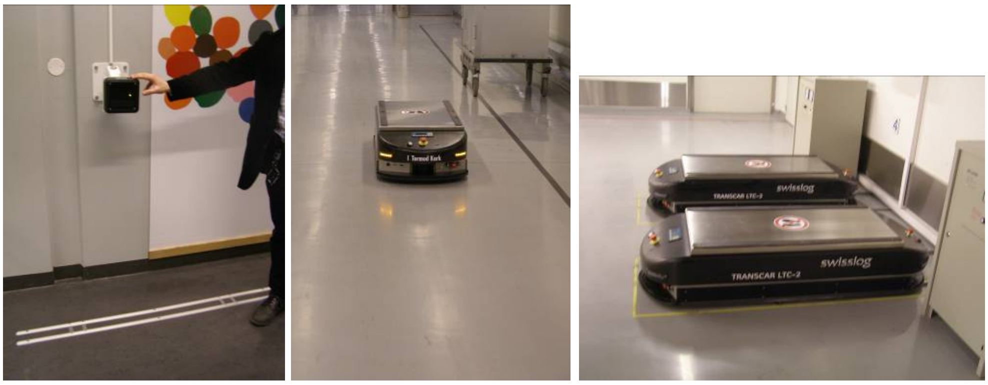
The device is being marketed first in Israel, where it was developed, then in Europe and eventually in the US, where it is expected to cost several hundred dollars. Mobile EKG machines that transmit data by phone to physicians are already available in the US, but they have only two or three leads, the Israeli company claims. 12-lead EKGs can diagnose many more types of cardiac events.

Drugs supplementing/replacing interventional treatments are becoming increasingly common e.g. drugs effectively used to clear many blockages prior to treating with angioplasty and stents. In many cases these can now dissolve all clots including small ones, and thus subsequently remove the need for angioplasty. (Health Futures Digest, July 2007) says that this ‘shifts the argument from which stent to use to whether to use them at all’. Next generation stents may be ‘drug-eluting’ which reduces the risk of clotting associated with the use of some stents. This may impact on future need for cardio thoracic surgery and surgeons.

3.2 *Impact of Technology on Non-clinical and Support Services*

3.2.1 Goods Delivery and Stores

Automated delivery systems using robotic devices (AGV) are the main hospital 'workhorse' at St Olav's Hospital, Trondheim, Norway. These units are guided by lasers and microchips implanted in the devices and along corridors. They run automatically to various stations in the ward and other areas delivering trolleys of supplies, food and other goods. They run silently, can 'talk' and are often programmed to deliver goods in the middle of the night when there are few people about and night staff have time to unload goods when the ward is quiet. When their internal batteries are running low, they take themselves to a charging station until battery power is restored. They share elevators with patients.



Automated Guided Vehicles – St Olav's Hospital, Trondheim, Norway (Carthey, personal photos, apr07)

Pneumatic tube delivery systems are used at St Olav's, Trondheim, Norway. These are large enough to carry blood products and 190 stations are provided across the hospital. It takes about three minutes for a delivery across the hospital.

Pneumatic tube station – ward (Carthey personal photos, apr07)

pneumatic tubes in pathology unit

3.2.2 Waste Management

St Olav's Hospital, Trondheim, Norway

All waste is sorted at source, including at ward level and taken by chute to the basement area; exhaust systems remove odours while waste is awaiting removal.

(Carthey personal photo – apr07)

3.2.3 Linen Management, Staff Uniforms

St Olav's Hospital, Trondheim, Norway use RFID chips for staff work clothes and uniforms management. Staff have an individual locker which contains their allocated complement of uniforms which are all implanted with an RFID chip. As items are removed from the locker, they are scanned and the locker is restocked each day automatically with items to replace those removed.

staff lockers, St Olav's, Trondheim, Norway (Carthey personal photo, apr07)

3.3 Redirection of care away from the immediate hospital setting – assisted by technology, telemedicine, remote diagnostics

3.3.1 Virtual Critical Care Unit (VCCU) at Nepean Hospital, NSW

(http://www.archi.net.au/e-library/health_administration/awards06/access/virtual_care_unit , 11 Oct 2007)

'Abstract: There are multiple small isolated hospitals across NSW lacking Emergency Medicine or Intensive Care specialists. The Blue Mountains Hospital (BMH) at Katoomba is one such hospital. Nepean Hospital (NH) is a principal referral hospital for SWAHS which has such specialist services. A solution using a novel ultra broadband internet approach was established as a pilot project to improve access to these services.

Current videoconferencing does not provide the level of "telepresence" required in complex critical clinical settings. Collaboration was established between SWAHS and CSIRO Centre for Networking Technologies for the Information Economy (CeNTIE). This resulted in the ViCCU® (Virtual Critical Care Unit) Project. We developed an ultra-broadband link between BMH and NH for broadcast quality telepresence support. Collaboration with the Sydney Medical Simulation Centre at Royal North Shore Hospital developed system training. The project was evaluated by the Centre for Health Informatics (CHI) at the University of New South Wales.'

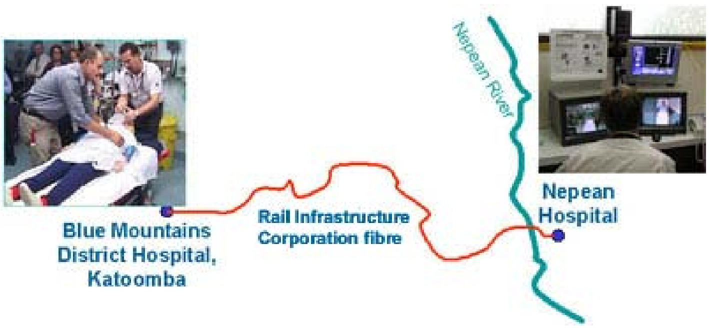
Evaluation results: '…Clinicians at BMH reported improved specialist support, praising the immediate access to specialists via ViCCU®, which had previously been missing. BMH nursing staff described increased perceptions of their autonomy and 'less stress'. The majority of clinicians at both hospitals confirmed that inter-hospital relationships and communication had improved.

The results of the ViCCU® technical evaluation were positive with the system being reported as being reliable and easy to use. Over two years the system experienced less than 1% down time. Despite minimal or no training, three quarters of the BMH clinicians reported that ViCCU® was easy to use and 63% of the staff thought that ViCCU® was comparable to having a specialist physically present [2].'

- 2. S. Hansen, J. Li and L. Wilson, Virtual Critical Care unit (ViCCU®) *Technical Evaluation; Final Report, 2006*. Commonwealth Scientific and Industrial Research Organisation, Australia.

'Future scope: The ViCCU® model is suitable to all other health services both metropolitan and rural, with the potential for greatest impact for those in rural and remote communities. With a whole of government approach to the supply of ultra-broadband being explored, a potential for access to large regionalised consultation networks is enormous.'

In collaboration with Wentworth Area Health Service and NSW Health, CSIRO has developed and installed a "Virtual Critical Care Unit" (ViCCU®). This allows a specialist intensivist located at one hospital to supervise a resuscitation team located at a peripheral hospital.



http://www.ict.csiro.au/page.php?did=16, 11 Oct 2007

3.3.2 Queensland Tele-hospital link – 'Coeenet Project'

(http://www.townsvillebulletin.com.au/article/2007/08/01/5168_hpnews.html, 11 Oct 2007)

In Northern Queensland 16 rural and regional centres will be linked to each other and to major hubs such as Townsville Hospital to enable doctors and nurses to communicate over superfast internet. It will enable doctors to monitor patients' vital signs remotely and also e.g. to undertake breast screening. The broadband link will enable doctors to teleconference with specialists and share patient records and X-rays in real time.

This effectively means patients in rural areas will no longer have to travel long distances to consult with their doctor. They will be able to be treated in their own communities including having access to diagnosis in an emergency situation. This will also take patient pressure off major centres.

3.3.3 Telepaediatric Robots – Queensland rural hospitals

(http://www.uq.edu.au/coh/index.html?page=43012&pid=43012&ntemplate=457 , 11 Oct 2007)

Due to the lack of staff paediatricians or sub-specialists in most Queensland rural and some regional hospitals, many specialist referrals result in the patient travelling to a tertiary paediatric hospital in Brisbane which can be up to 3000km away. The telepaediatric robots are wireless and mobile and can be taken to the patient's bedside for specialist consultations. The robots provide general paediatric support for hospitals without a local paediatrician and/or sub-specialist paediatric support and professional education and support for regional clinicians. The project started in Gladstone Hospital in 2004 with Roy the Robot and now has been extended to Mt Isa (Eliza) and Emerald (Emma) Hospitals.

3.3.4 Tele-rehabilitation projects in Queensland

- Speech pathology, physiotherapy, occupational therapy and supports multidisciplinary projects; Parkinson's Disease, childhood issues, brain injury, etc. (http://www.uq.edu.au/telerehabilitation/physiotherapy-projects, 11 October 2007)

Physiotherapy project (gait assessment)

3.3.5 Robot Doctors

- Robotic units are being used in the US and Canada to provide consultations or ward rounds in some US hospitals. The doctor can be located in any part of the world but can still see his patients and check on their progress. A simple joystick enables navigation of the room even with obstacles. (http://www.nationalreviewofmedicine.com/issue/2007/06_15/4_advances_medicine01_11.html, 11 Oct 2007)

Dr Mendez, Dept of Neurosurgery, QEII, Halifax, Canada

3.3.6 Robotic Surgery

The 1990's saw the development of minimally invasive surgery. Progress and innovation has continued to the development of robotic surgery. A name that frequently came up appears in the research is the *da Vinci System*, which is a proprietary product. However, the product material does provide useful information about robotic surgery features. (http://www.intuitivesurgical.com/index.aspx, accessed 29 Oct 2007)

As the image shows, the surgeon is located at a console that provides 3D intuitive visualization. The surgeon's hands are scaled and filtered within the console that then permits precise surgical manoeuvres to be undertaken. The surgeon is remote from the operating table and the patient. Through an intuitive interface, the four robotic arms are manipulated to conduct the surgical procedure. Apparently, robotic surgery is useful with prostate surgery.

Image taken from 2007 Weill Cornell Prostate and Robotics Symposium online enrolment form

A team of military, telecommunication and surgical experts in combination with the University of Cincinnati, USA, are taking robotic surgery one-step further. The team are developing a prototype where robotic surgery can be undertaken kilometres away and potentially in remote regions using a Drone aircraft as the electronic vehicle. A surgeon in America could conduct surgery on an injured soldier in Iraq. This would have benefits in war zones or potentially after a major disaster.

3.3.7 Biotextiles

The European Commission has formed a project team that includes Information Society Technologies and Nanotechnology and nanosciences to work on knowledge based materials, new production processes and devices.

One of the projects is BIOTEX that integrates new type sensors on textiles. At the moment, sensors are being located on a small patch of a garment. The future goal is to extend the sensor to the whole garment.

It is proposed that health-monitoring tools will be integrated into textiles to remotely monitor vital signs and provide diagnostics to improve the early detection of illness and metabolic disorders. One component of the sensor is to read fluid loss, such as blood and sweat or other targeted body fluids. Another interesting area is wound exudate. One can imagine how wounds could be assessed for healing rate or whether a breakdown or bacterial growth is occurring. Benefits would be invaluable to skin grafts and burns patients. The sensors will also be able to read oxygen concentration levels in the blood.

(http://www.biotex-eu.com/, accessed 12 Oct 2007)

3.4 *International Search for Exemplary Hospitals and ICT*

3.4.1 China

Shanghai Traditional Chinese Medical University

The Shuguang Hospital is interesting because it is the first healthcare facility in China that incorporates traditional Chinese medicine and state-of-the-art western medicine in a 750-bed hospital. It was difficult to obtain photographs or information on the ICT technology used in Shuguang Hospital. Contact was made with the architects and Chinese Embassy, Canberra. It would be interesting to see how a rapidly developing country applies ICT in healthcare facilities, particularly in major centres.

Location
Shanghai, China

Smithgroup Architect

Reference:
http://www.healthcaredesignmagazine.com/ME2/dirmod.asp?sid=&nm=&type=Publishing&mod=Publications%3A%3AArticle&mid=8F3A7027421841978F18BE895F87F791&tier=4&id=11F1C945C18B49CC928457080E5EE200 (accessed, 30 Nov 2007)

Shuguang Hospital, Shanghai, China

Teda International Cardiovascular Hospital

Location
Tianjin, China

http://www.tedaich.com/language/english/e_index.htm, accessed 12 Oct 2007

The TICH is a publicly owned not for profit hospital that offers cardiovascular services focussing on open-heart surgery and interventional therapy to cure congenital and acquired cardiovascular diseases. Ultimately it intends to conduct over 10,000 surgical procedures per annum and up to 15,000 interventional procedures per annum. This would make it one of the most productive hospitals of this type in the world, surpassing Cleveland Clinic in the US which did 7,614 cardiac operations and 12,936 interventional procedures in 2004.

The hospital covers 76,000sqm; it has 600 beds, 16 operating theatres, 80 ICU beds, 5 catheter rooms and 40 CCU beds. It is equipped with the latest technology for diagnosis, treatment and medical research

Equipment includes the latest magnetic resonance imaging (twin speed MRI), multi-slice CT (light speed 16), the new electron beam CT (E-Speed, that is the third installation in the world), ECT, flat plenum equipment for angiography, real-time three dimensional echocardiography, magnetocardiography (on clinical trial in Mayo Clinic, Johns Hopkins Hospital and Cedars-Sinai Medical Center in USA), high power electronic microscope and a variety of advanced medical and research equipment.

It uses an automatic tablet counting and dispensing robot, the first in China to improve the efficiency and quality of patient medication dispensing. The clinical laboratory is equipped with PAM for high accuracy diagnostic testing. It is the first Chinese paperless and filmless hospital with an advanced image storing and transferring system (PACS) and hospital information system (HIS). All the outpatient departments use a one-card system to synchronise transations.

The hospital also undertakes research and trains cardiovascular clinicians and postgraduate students. Research facilities include laboratories and animal operating rooms.

It treats patients with many different conditions and of different ages from newborns through to the elderly. It offers a range of accommodation options ranging from cheap smaller shared rooms for low-income patients which start at about $10 Aus per night through to bigger two-bed rooms, small and big one-bed rooms, suites and a luxury VIP suite that has a floor area of 1200 sqm and has its own private elevator. All rooms are designed to be 'patient-oriented' with air conditioning, disabled access bathrooms, Japanese sliding doors, telephones, thin screen TVs and adjustable beds. All patients are provided with meals, pure water, daily fruit, etc. The VIP suite has its own kitchen, living and office areas plus a private gymnasium.

The treatment of patients in the VIP and luxury suites is supported by the Chinese government as a means of supporting free or low cost health services for orphans and other indigent patients who are also treated by the hospital.

Procedures offered include complex congenital heart disease correction, valve replacement, CABG, great vessel procedures and heart and heart-lung transplantation. Interventional procedures available include PCI, radiofrequency catherter ablation, pacemaker embedding and vascular stenting for great artery and peripheral arteries.


Model of TICH

General Plan - TICH


Outpatients waiting area


Clinic room


Automated pill dispensing machine


Bedroom in VIP suite


Gymnasium in VIP gym


Rooftop garden


Kitchen in VIP suite


Lounge area in VIP suite

Equipment – TICH

http://www.tedaich.com/language/english/e_index.htm, accessed 12 Oct 2007

The first advanced PAM of clinical laboratory in China

The first automatic tablet counting and dispensing robot in China

3-D Real-Time Ultrasound Machine

H-7500 Electronic Transmission Microscope

Multi-Functional Catheter Lab.

3.4.2 Korea

Yonsei University Medical Centre

Location
Seoul, Korea

Ellerbe Becket (Architects)

http://www.ellerbebecket.com/portfolio_template_251.html, accessed 30 Nov 2007

Yonsei University Medical Centre (YUMC) is one of the leading healthcare and teaching facilities in Korea that includes four specialist hospitals. The Eye and ENT Hospital, the Severance Cancer Centre, a Rehabilitation Hospital and the Cardiovascular Hospital. YUMC has 2000 beds and handles about 6000 patients a day in outpatients.

YUMC aims to become a world-class institution and has adopted a mid to long term project of using intelligent systems, security systems, expansion of infrastructure and digital management to achieve this objective. The steps to achieve this include the integrated management of information within YUMC, the standardization of user interface and systems analysis.

The first step has been to prepare the four hospitals for integrated operation through the implementation of physician's Order Communication System (OCS), Electronic Medical Records System (EMR), securing management information through data warehousing and providing both internal and external patient services through a variety of mobile technologies. YUMC is of the view that the integration of these services will improve workflow, provide customer focus and increase operational efficiency.

The implementation of EMR is phase one of a two phase project that forms the basis for Electronic Health Record (EHR). The EHR captures medical history of an individual and a family from birth to death. This provides a complete health history that is invaluable for treatment, prevention and research as well as reducing the likelihood of medical errors. The dispensing of prescriptions is also part of the integrated electronic system

The infrastructure consists of integrating and interconnecting:

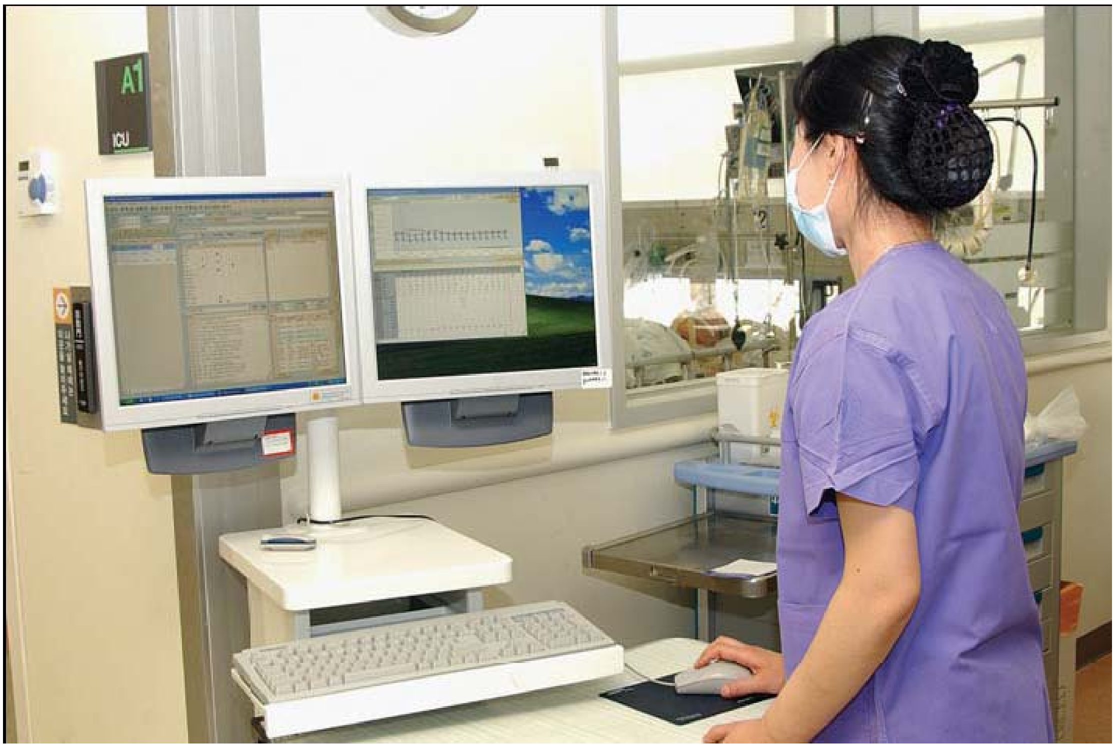
- Order Communication System (OCS)
- Electronic Medical Records System (EMR)
- Picture Archiving and Communications Systems (PACS) and
- Enterprise Resources Planning (ERP) systems

The second phase is the implementation of Electronic Health Records (EHR) with service enhancements. The third phase involves expanding the knowledge base for research and medical care and extending it to the Clinical Decision Support System (CDSS). *Professor Byung-Chul Chang Head of the YUMC medical information office*

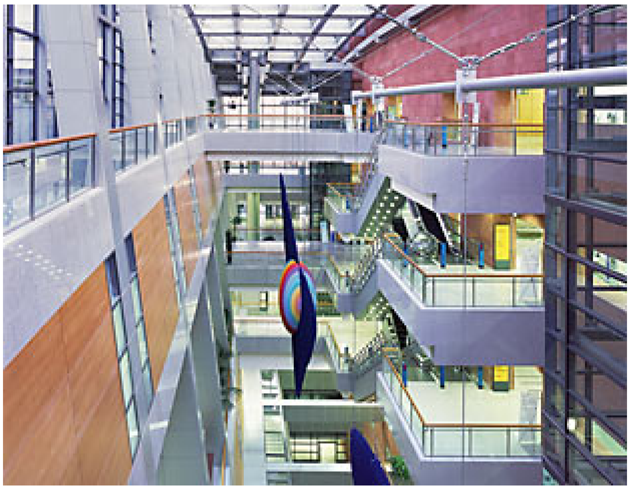
Yonsei University Medical Centre, Seoul, Korea, internal view of high dependency unit

Yonsei University Medical Centre, Seoul, Korea, showing the new tower

Yonsei University Medical Centre, Seoul, Korea, showing the new tower



Yonsei University Medical Centre patient monitoring unit

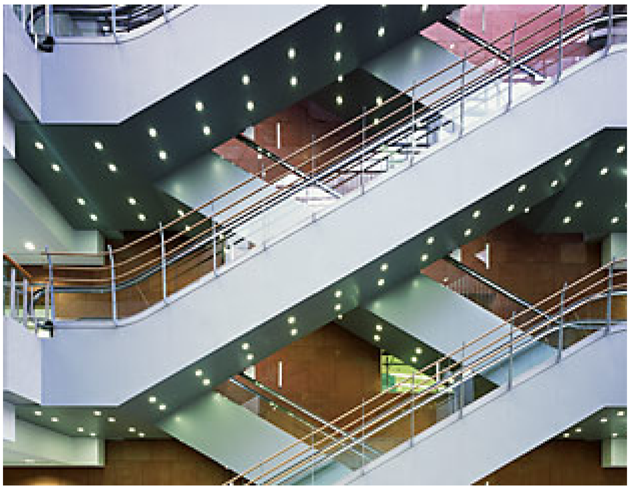


Yonsei University Medical Centre interior view of new tower, photo by Kim Yong Kwan

Yonsei University Medical Centre internal view of seating alcoves and gently falling waterfalls, photo by Kim Yong Kwan

Yonsei University Medical Centre auditorium that accommodates medical lectures and artistic performance such as theatre and musical programs, photo by Kim Yong Kwan

Yonsei University Medical Centre inpatient entry, photo by Kim Yong Kwan



Yonsei University Medical Centre outpatient and diagnostic services are separated from inpatient beds by the seven-story atrium, photo by Kim Yong Kwan

3.4.3 United States of America

Center for the Intrepid: National Armed Forces Physical Rehabilitation Centre

SmithGroup (Architects)

Faced with an urgent need for this mission-critical physical rehabilitation center, SmithGroup designed and constructed this specialized facility in just 18 months. The most advanced facility of its type in the world, the Centre provides state-of-the-art rehabilitation therapy for soldiers wounded in the ongoing war on terror combined with sophisticated research in prosthetics, robotics, virtual reality and biomechanics. Physical training areas include an indoor pool, elevated running track, climbing wall, uneven terrain and obstacle simulations. The facility also houses one-of-a-kind technology such as a 300-degree virtual reality immersion environment and an advanced gait analysis laboratory.

Location
Fort Sam Houston, San Antonio, Texas
Cost: US$50million

Reference: http://www.smithgroup.com/index.aspx?id=536&section=34, accessed 12 Oct, 2007

The first of its kind, the CAREN system is a 300-degree, virtual reality environment is used to rebuild a patient's confidence to self-balance, that dramatically cuts rehabilitation time.

The Gait Lab is fitted with 24 motion capture cameras, mounted on a custom-designed automated truss, which use infrared light to analyze human motion across different terrains. Force plates in the floor, parallel bars and treadmills measure ground reaction forces.

University of Arizona College of Medicine

SmithGroup (Architects)

By way of background information, Arizona is the sixth largest state, in size, within the USA. The Arizona College of Medicine is located in three buildings following a recent (2006) restoration and redevelopment of an historic 1911 building. The interesting point from the research perspective is the number of ICT services that are being conducted within this environment.

University of Arizona College of Medicine, Phoenix, Arizona

All three buildings contain advanced data technology and video conference capabilities to support current and future demands of advanced ICT medical education. There are student surgical stimulation suites, examination rooms with real time video that allows for immediate feedback. Plasma monitors allow for connectivity to hospitals and other institutions across the country.

> "Previously, the only way that students were able to be tutored by the surgeons was to be physically in the operating room, Now, from inside the MedPresence Conference Room (MCR) or from the MedPresence Mobile Unit, students can observe surgery from a variety of angles and can talk to the surgeon during surgery. Multiple screens within the MCR give students the ability to access and reference patient history, physician notations, images, and three-dimensional moving illustrations, giving students the ability to compare them to

the images they are seeing from the actual surgery. Physicians also have the capability to present live surgical cases to international neurological conferences taking place throughout the world." *From Smithgroup Architect July 2007*

Arizona Telemedicine/Telehealth and NECTAR

Network for Clinical Research – Federal Program

Located within the University of Arizona College of Medicine is the large, multi-disciplinary, university based tele-health and telemedicine program that provides telemedicine services, distance learning, informatics training, and telemedicine technology assessment capabilities to communities throughout Arizona, known as 'Thealth'.

SmithGroup informed CHAA that Thealth is located within a state-of-the- art telehealth education centre. Its mission is to create next-generation innovations in healthcare delivery and education, especially those that influence advances in medical informatics, wireless telecommunications, telemedicine/ telehealth, simulation, and robotics. The Centre aims to address the shortage of skilled healthcare staff and underserved, remote vulnerable communities through Thealth.

The Thealth program commenced with 8 pilot sites in 1996 and has now extended to over 150 sites. The sites share clinical and education information as well as linking into state-wide medical records. The communication is two way using telecom connectivity; it is interactive with real time video. The system can also store and forward all radiology information digitally. An example of research and education conducted by Thealth includes the 503 diabetes programs that have been initiated on a state-wide basis.

a portable tele-health video conferencing cart (image provided by SmithGroup)

Thealth video conferencing control panel (image provided by SmithGroup)

Arizona Biomedical Collaboration

In addition, the University of Arizona College of Medicine is in partnership with the Arizona Biomedical Collaborative, Phoenix. This provides a research complex that will provide clinical investigators with specialized environments including the infrastructure to conduct sophisticated patient-oriented research, including wet and dry laboratories for biology, chemistry, and bioinformatics. This is all being facilitated by ICT that creates a shared environment for information exchange.

Specified systems include

• Audiovisual Presentation (LCD Projection, Integrated Instructor's Station, Program Audio Reinforcement)

• Acoustics, Noise & Vibration Control

• Analog Video & Audio Recording/ Production

• 384kbps H.320 (30fps) Videoconferencing

• Category 6/Optical Fiber Telecommunications Cable (Voice, Data, RF Video)

• Community Antenna Television System

• Audiovisual Remote Control

http://proav.pubdyn.com/2007May/EducationInstallMedicalSchoolGoestheDistance.htm , accessed 15 May 2007

Colour Specification

Color of the space is important for proper video image (light blue room, light grey lab coats). Technical data provided by SmithGroup and is further detailed below in Attachment 1.

Technical data provided by Smithgroup Architects

T-Health at the Arizona, Phoenix campus consists of a room with 17 tiered seats that are grouped for team exercises. The tiered room was designed to provide the best sight lines and camera shots for distance education and collaboration.

Each seat in T-Health features an AKG GN15E gooseneck microphone, a Panasonic GP-KS822H desktop camera, a Crestron TPS-2000 5" color touchpanel capable of video preview, an Extron MDA 3V audio amplifier, a custom Panelcrafters audio I/O plate, and pair of Sony MDR V600 headphones.

Each student can control the volume and listen to his or her own audio feed via the Crestron touchpanel's built-in speakers, and also can store a laptop in the recessed "laptop garage," a custom creation by furniture manufacturer KI.

The focal point for the room is an immersive, 12-cube video wall consisting of 50-inch Mitsubishi display cubes. Holaday says the number of displays was sized to the needs of the program, the size of the room, and based on required image quality. Two cameras in the room — a Grass Valley Cameraman 3e CPC and a Sony EVI-D100 — capture full room shots from the front and back walls. "The video wall measures 18 feet wide by five feet tall. You can fit the feeds from all 17 cameras on the video wall plus all remote sites," he says.

A Jupiter 980 processor works the video. It was chosen for its performance with real-time video as well as the quantity of inputs and outputs available. T-Health uses three Tandberg 6000 MXP codecs with multiple-site capabilities for videoconferencing. In addition to the collaborative technologies in T-Health, the room also can run in "lecture mode," with a presenter addressing the room and controlling the AV via a Crestron TPS-12 12" color remote control panel. Two Tannoy iw62 TDC in-wall loudspeakers provide sound reinforcement for presentations.

Other room inputs include a Wolfvision Visualizer VZ-C32 ceiling-mounted document camera, a Tascam CDRW750 CD-R burner, a Philips HDRW 720/17 DVD player/recorder, a JVC SR-S365U VHS deck, and a Sharp XG-PH50X 4000 lumen LCD projector. For those wishing to observe the activity in T-Health, a glass-paneled section at the rear of the room offers visitors a walk-up location with AV interfaces. In the hallway, the university plans to install five video displays with overhead parabolic speakers and 4" Crestron touchpanels to serve as interactive kiosks to offer visitors more information about the school.

"The Tucson campus is 100 miles away. As a satellite campus, it is important that the interaction between professors in Tucson and students in Phoenix remain strong," says Siegert. "AV technology plays a large role in that interaction. Before the creation of this campus, the students had to drive to Tucson to take classes, and then drive back to do their rotations in Phoenix-area hospitals."

Flexible Auditorium

Some of the AV technology at the University of Arizona's College of Medicine include, top, features on the rear wall of a mediated classroom; below left, a telemedicine portable videoconferencing cart; below right, a classroom control console.

While a room such as T-Health is made for distance education and collaboration, the university's auditorium must fill that role and more. The system design for the auditorium had to accommodate many diverse uses, such as distance education, lectures, conferences, musicals, banquets, and movies. The three renovated buildings come under historic preservation laws, so the AV team had limited options for acoustical treatments for the auditorium.

"The auditorium is a shared space for the university, as well as other groups in the Phoenix area," says Corraine. "It is a very reverberant space, but we were limited in what we could do." Says Siegert, "The auditorium is used frequently, and all is working well. Since it was a historic preservation, we were only allowed to touch one of the six surfaces in the auditorium by covering a back wall with acoustical paneling. The room is cavernous, so speech intelligibility continues to be a challenge."

The auditorium is two and half stories tall, with a seating area measuring 94 feet wide by 50 feet deep plus the stage. To help control reverberation, Corraine used an acoustical ceiling treatment called

BASWAphon, which resembles drywall. The future addition of heavy fabric curtains is expected to help with the acoustics. In a reverberant space, sound system components can make all the difference. The university chose two Tannoy V15 loudspeakers mounted to the left and right of the stage. Two additional Tannoy iQ10 ceiling speakers provide speech reinforcement at the rear of the seating area, and four Tannoy 110TB offer low frequency coverage.

For movie nights or other applications that call for surround sound, a Tannoy V10 loudspeaker serves as the center channel with four Tannoy V6 loudspeakers used for surround. For distance education, students and faculty can use one of the 84 distributed floor boxes for power, data and microphones.

‘Since people outside the university also use the AV systems, we took great care in the Crestron touchpanel layout and design,” says Holaday. “We tried to automate and use presets as much as possible, so that the system is accessible and easy to use for virtually anyone.”

The custom-built 12’ tall by 32’ wide rear projection screen is nonretractable and was designed for three projectors. Users have a choice of either two 4 x 3 images via two Sharp XG-PH50X 4000 lumen DLP projectors, or a single 16 x 9 image via the Sanyo PLV-WF10 wide screen projector. Siegert says that by using AV technology to communicate, he has seen social barriers fall away. “One example is using telemedicine with Native American tribes. There are some tribal leaders who won’t sit down next to each other. With telemedicine, they will interact and ask questions in the same forum,” he said. “The other example is connecting communities from Northern Arizona and towns on the Mexican border. You can see the kids asking each other questions and interacting in a way they normally would not.”

In the medical community, telemedicine and AV technology has broken down communication barriers among doctors, nurses and pharmacists. The university is working on a project to combine those parties into rapid-response telemedicine teams. “Telemedicine also has made a difference in providing medical care in correctional facilities,” says Siegert. “By eliminating the need to transport patients, telemedicine has made the process easier, faster and safer.”

Civista Medical Center in La Plata, Maryland, USA.

Civista Medical Center, photograph by Jeff Katz

The Civista Medical Centre is a 117 bed healthcare facility –a Nongovernment/Nonprofit Centre that provides emergency, critical care, cardiac rehabilitation, obstetrics, same day surgery, cancer care, radiological and pathology services to the local community of La Plata.

When the new Civista Medical Centre was first commissioned in 2005, the clients and facility planners ensured that a range of ICT facilities were integrated across the healthcare facility. The informatics used is known as Clinical Systems informatics Integration (CSII). CSII involves the integration of financial, clinical, and patient care systems to facilitate easy access to data.

The first phase of the ICT project included the implementation of a wireless network to aid in point-of-care clinical documentation; implementation of an integrated electronic medical record, including document imaging for paper records, online clinical documentation, bedside medication verification, and physician-order–management software; and the establishment of access to the electronic medical record (EMR) for physicians.

The second phase of the project encompassed a network replacement, the extension of the wireless network, the addition of wireless voice-over-IP telephones, and the integration of the nurse call system to the wireless phones at the point of care.

The aim is that with the full implementation of CSII all of the hospital's clinical equipment—such as physiologic monitors, IV pumps, ventilators, anesthesia machines, the nurse call system, Pyxis or Omnicell automated medication-management cabinets, and even beds will be able to communicate with Civista's in-house IT systems and, ultimately, to the EMR.

The reasons for the implementation of integrated healthcare data included the decentralization of care, business imperatives of controlling cost and improving the quality of care, improving patient safety, healthcare data reporting to government agencies, operational efficiencies and improving patient satisfaction.

Reference: Melanie Townshend, Leed Ap, Project Manager, Gilbane Building Co

Image sourced from http://www.civista.org/index.htm, 20 Nov 2007

The entrance to Civista Medical Centre's new Emergency Department.

Image sourced from http://www.civista.org/index.htm

The waiting area within the Emergency Department

Image sourced from http://www.civista.org/index.htm

Toys, games, videos are provided for children.

Image sourced from http://www.civista.org/index.htm

Patients and family members are provided with pagers within the Emergency Department so that they can have the flexibility of movement, whether for a minor or major emergency.

Image sourced from http://www.civista.org/index.htm

Computerized digital systems have been installed hospital-wide to ensure fast tracking of urgent cases, and automated medication systems.

Image sourced from http://www.civista.org/index.htm

Civista Medical Centre’s Emergency Department uses wireless technology. The Electronic Medical Record (EMR) system allows staff to access medical histories of patients, access test results and get up-to-date information on a continual basis.

Image sourced from http://www.civista.org/index.htm

Diagnostic facilities, ‘state of the art’, with soft, coloured lighting.

Information sourced from http://www.civista.org/index.htm, accessed 20 Nov 2007

Memorial Sloan-Kettering Cancer Centre

http://www.perkinseastman.com/Pages/Projects.cfm?subcategoryname=%2A%3A%5DF%3BLI%2D%5B%24%25%3EAE%40%20%20%0A

The Memorial Sloan-Kettering Medical Centre houses a 21,945 s/m operating suite that houses 21 operating rooms.

The operating rooms have Full PACS systems and Centre for Intelligent Monitoring Systems (CIMS) that provide real time audio and visual communications between operating rooms, Pathology, Radiology and other Departments. Full broadcast capabilities can transmit information to the world via the internet. Cameras and microphones are located in the operating booms. Special workstations allow for staff to visualize procedures and document at the same time. The operating theatres house what is known as “a wall of knowledge” where surgeons are provided with real time patient info, vital signs, PACS and other images, all whilst the surgeon is operating. The CIMS system facilitates this “wall of knowledge”

3.4.4 Canada

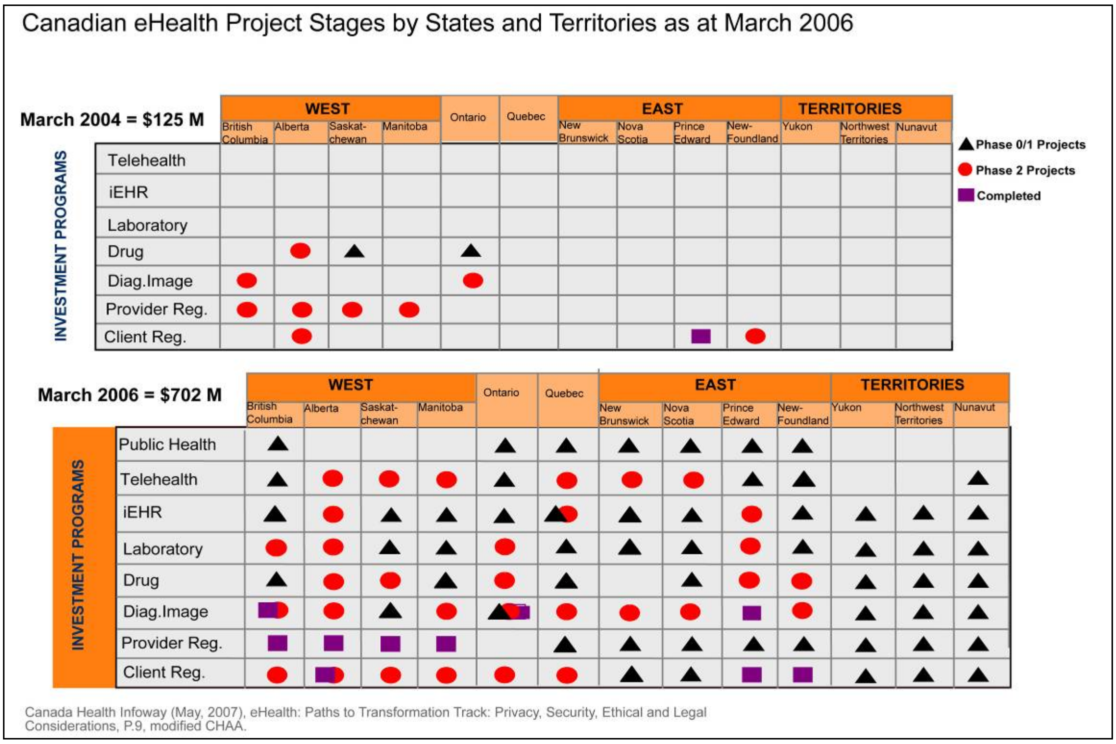
Introduction of Informatics in Canada

A range of very useful information was sourced electronically from the Canada Health Infoway. http://www.infoway-inforoute.ca/

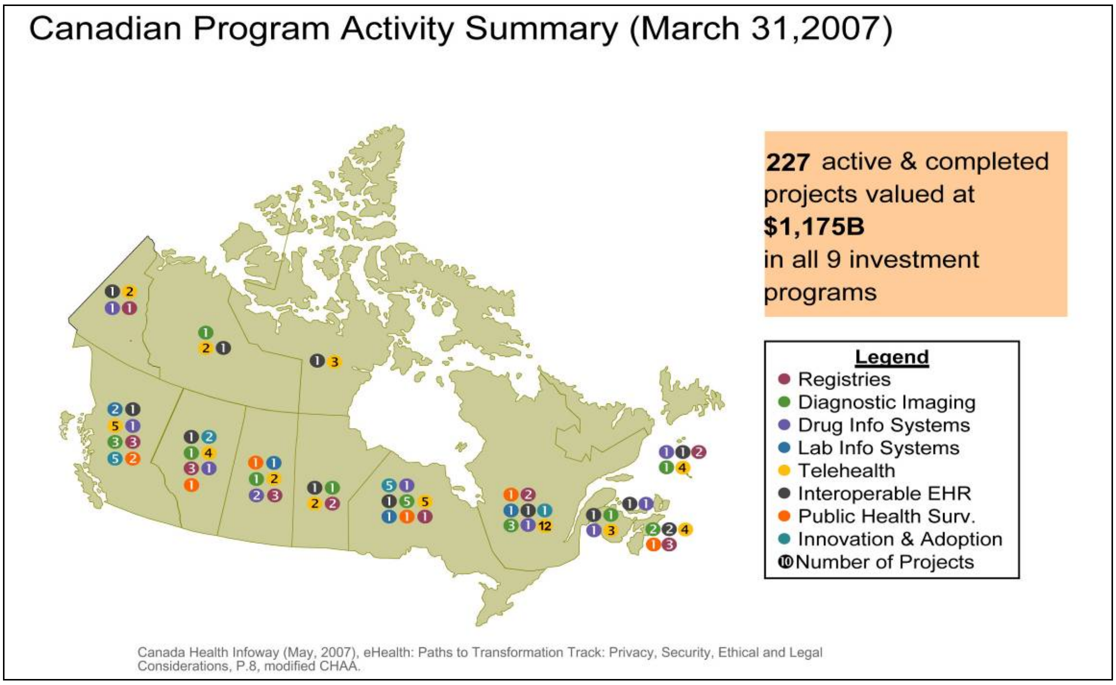
From reviewing the online information it became quite clear that Canada, at a national level, is well on the way to introducing ICT across a range healthcare fields - electronic health records, diagnostic imaging, medication dispensing, medical imaging, provider registration, telehealth and pathology.

The next two images, taken and modified, from the Canada Health Infoway website, provides a visual of ICT project implementation in Canada for 2006 and 2007. The implementation and financial commitment to ICT and healthcare settings is quite advanced.

2006

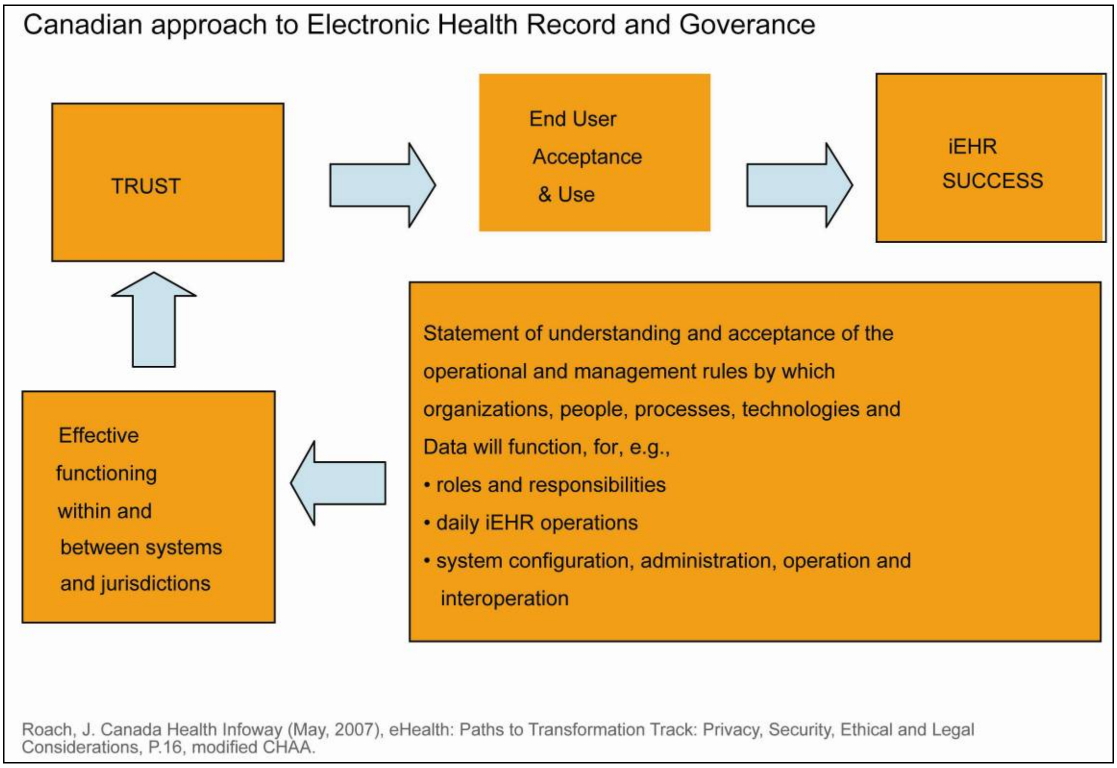


2007



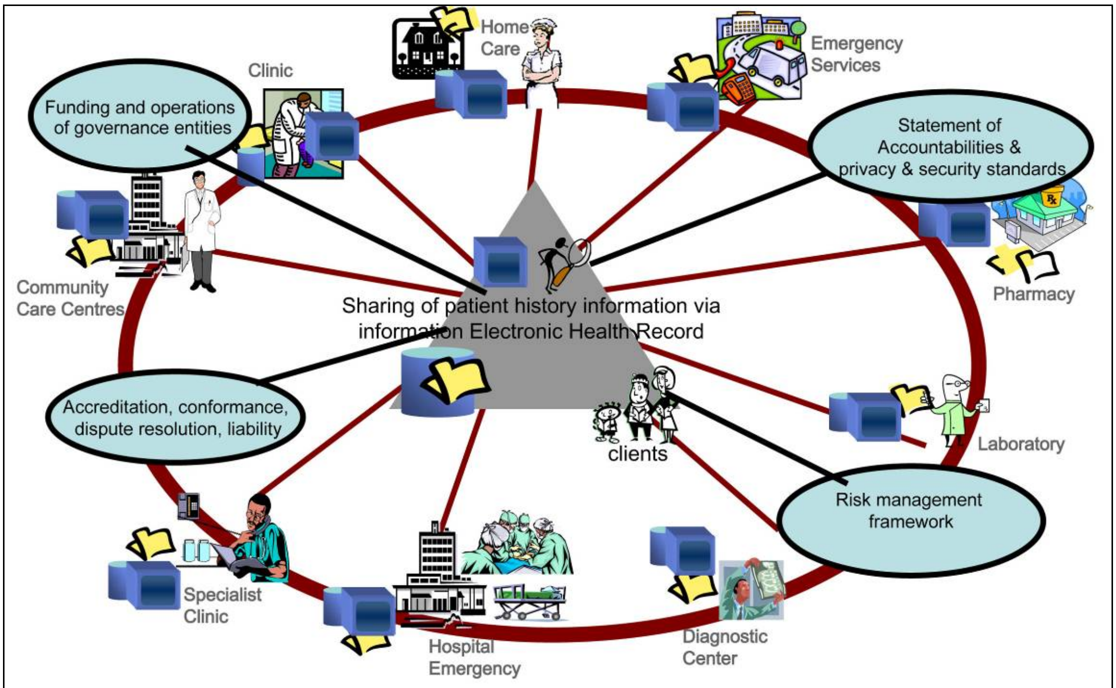
Combined with the Canadian implementation of ICT has been the development of a governance framework. Addressing privacy, security, legal issues is considered to be vital. The development of trust with people is seen to be essential if the implementation of electronic health record is to be successful. The next image provides a framework as how Canda Health Infoway plans to address governance issues.

Governance



The Big Picture

The following image, also from Canada Health Infoway provides a succinct view of the inter-connectedness of the electronic health record, both the benefits and the critical areas for security breakdown. It seems logical that there must be real value in a person's health record being documented once, with operations, medication, allergies, family history, diagnostics that can be accessible anywhere should one move or multiple admissions to different hospitals occur. However, the biggest issue is privacy, and the processes put in place to protect information. These issues must be addressed for acceptance of the Electronic Health Record to occur.



Canada Health Infoway (May, 2007), eHealth: Paths to Transformation Track: Privacy, Security, Ethical and Legal Considerations, P.6, modified CHAA.

3.4.5 United Kingdom

Introduction of Informatics in the United Kingdom

There is much happening in the UK and in particular the program known as "GP2GP… the NHS Connecting for Health Project". The following web link provides a great deal of information, in particular the Power Point presentation provides full details about the project and implementation.

mailto:http://www.connectingforhealth.nhs.uk/systemsandservices/gpsupport/gp2gp?subject=nhs and e-health

The Electronic Health Records system or GP2GP is currently being rolled out to General Practitioners across the UK. The aim is to ensure that people's health records can be electronically available when they move to a new clinic. It is principally available at the primary healthcare level. The project has already been successfully trialed in 650 practices.

Further research could be undertaken to identify ICT use in UK hospitals.

3.4.6 Norway

The Norwegian Ministry of Social Affairs and the Norwegian Ministry of Health Norway has produced a National Strategy known as *National Te@mwork 2007 Electronic Cooperation in the Health and Social Sector.* ICT development is seen as not only the physical availability of health records and imaging but also a way of improving communication, coordination, continuity of care and providing prompt information. The National Strategy aims that activities *"be done properly rather than halfway"*.

The first aim is to improve the flow of information within the healthcare structure and assumes that an information structure, information security, electronic health records, exchange of electronic messaging and professional support is already in place.

Consultation concerning ICT has already been developed between health enterprises, general practitioners and the National Insurance Service. The second aim of the National Strategy is to include a wider group in the consultation process. It is recommended that patients, relatives, pharmacies, municipal health and social services be included in the consultation process of ICT and health. Specific benchmarks have been established to achieve these aims.

Further research could usefully be undertaken to identify innovative use of ICT in Norway that has unfortunately beyond the scope of this study at this stage.

4. CONCLUSIONS

This report demonstrates the huge breadth and depth of the current trends in ICT development that will impact on the future delivery of healthcare and hence on the design of facilities to accommodate it. Due to the sheer quantity of information available it is difficult to know where to draw the boundaries in considering what will have a major influence and what may be merely a passing trend.

Yet due to the clearly negative ramifications of being unprepared it becomes increasingly necessary to scan the technology environment for developments that will impact on care delivery and to understand the changing nature of physical facilities required to support this. There are many and varied sources and methods for doing so. These include internet scanning/review of digests of information, use of specialist consultancies to review developments from an organisation's unique perspective (an expensive yet potentially valuable option), study tours of exemplary facilities, etc.

Whatever method is adopted, consultation with clinicians and practitioners at local level will also be extremely useful in highlighting trends in individual discipline areas and obviously much experience and expertise can be tapped into in this manner. However all such advice should be considered and reviewed from a strategic organisational perspective that looks at both the costs and benefits associated with the various technology focused options for future care delivery. This will then allow decisions to be made both in terms of the technology to be adopted and the facility requirements associated with the implementation of such technology.

5. ELECTRONIC REFERENCE SOURCES

American Telemedicine Association: http://www.atmeda.org/

Architects: http://www.smithgroup.com/

Bio-sensing Textile for Health Management: http://www.biotex-eu.com/

British Journal of Healthcare Computing: http://www.bjhc.co.uk/aboutbjhc.htm

Canada Health Infoway: http://www.infoway-inforoute.ca/

Center for Health Design: http://www.healthdesign.org/

CSEM Centre Suisse d'Electronique et de Microtechnique: http://www.csem.ch/

da vinci surgical systems: http://www.intuitivesurgical.com/index.aspx

DuPont Healthcare and Medical: http://www2.dupont.com/Health_Care_and_Medical/en_US/

European Health News: http://www.ehealthnews.eu/content/view/537/27/

ICT and e-Business in Hospital Activities - ICT adoption and e-business activity in 2006: http://www.ehealthnews.eu/content/view/466/62/

€1bn in digital technologies for Europeans to age well, June 2007: http://www.ehealthnews.eu/content/view/594/27/

European Health Telematics Association, 2007: http://www.ehtel.org/SHWebClass.ASP?WCI=ShowCat&CatID=1

Ellerbe Becket (design architects in association with Pelli Clarke Pelli for the Sidra Medical Research Centre, Qatar): http://www.ellerbebecket.com/portfolio_template_260.html#specs

Elmhurst Hospital Centre New York: http://www.nyc.gov/html/hhc/html/facilities/elmhurst.shtml

Fujitsu signs £220 million contract with National Health Service to modernise medical imaging: http://www.fujitsu.com/uk/news/pr/fs_20040521.html

http://www.gehealthcare.com/auen/

European Federation for Medical Informatics: http://www.gsf.de/imei/efmi/

Healthcare Software Solutions: http://www.projectevita.com/sectors/telehealth.aspx?gclid=CNvF1aO1uI4CFQLSYAodHSFTyQ

Health Futures Digest: http://hfd.dmc.org/

Health Informatics Society of Australia: http://www.hisa.org.au/

NHS Connecting for Health: http://www.connectingforhealth.nhs.uk/

Healthcare Informatics: http://www.healthcare-informatics.com/ME2/dirmod.asp?sid=&nm=&type=Publishing&mod=Publications%3A%3AArticle&mid=8F3A7027421841978F18BE895F87F791&tier=4&id=0C7DB17BA62A4F59A162010ED4D628DD

Perkins Eastman Architects: http://www.perkinseastman.com/Pages/Projects.cfm?subcategoryname=%2A%3A%5DF%3BLI%2D%5B%24%25%3EAE%40%20%20%0A

Norwegian Centre for Telemedicine, University Hospital Norway, WHO Collaborating Centre of Norway: http://www.telemed.no/

Singapore Hospital:
http://www.digitalopportunity.org/article/view/127715/1/8644?PrintableVersion=enabled

Tele health medical systems:
http://www.inline.com.au/medical/medical_telehealth.html

Tele-medicine information exchange: http://tie.telemed.org/default.asp

TEIS and UK Telemedicine and E-Health Information Service, run by the University of Portsmouth and part of the Confederation of e-health websites:
http://www.tis.bl.uk/orgs/cew/index.htm

UK eHealth Association – provides links to other useful sites:
http://www.ukeha.co.uk/links.asp

United States Baylor Healthcare Systems:
http://www.axis.com/success_stories/viewstory.php?id=17

What is PACS?:
http://www.connectingforhealth.nhs.uk/systemsandservices/pacs/whatispacs

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