

The ViCCU Project:

Using Ultrabroadband Internet in a critical clinical application

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Overview

The ViCCU (Virtual Critical Care Unit) Project sought to address the problems of shortages of Critical Care staff in regional and rural areas by developing a system that could use the capabilities of Ultrabroadband networks so as to have a Critical Care Specialist virtually present at a distant location. This is not possible in a clinically useful way with current systems. A new system (ViCCU) was developed and deployed. Critically ill or injured patients are now routinely assessed and managed remotely using this system. It has led to a more appropriate level of transfers of patients and the delivery of a quality of clinical service not previously available.

History

The New South Wales Department of Health Metropolitan Hospitals Group of the Greater Metropolitan Services Implementation Group (GMSIG) identified shortages of trained staff particularly in Emergency and Intensive Care as being a major impediment to the provision of care in smaller Sydney suburban hospitals.¹ A similar situation was found in rural areas by

the Rural Group. The CeNTIE (Centre for Networking Technologies in the Information Economy) project coordinated by CSIRO,² a successful applicant for Federal funding under the BITS (Building on IT Strengths) programme had health applications as one of its four principal areas of interest.

The authors conceived a plan (the Virtual Critical Care Unit or ViCCU Project³) to address this specialist shortage by leveraging off available specialist expertise in the Principal Referral Hospitals using the capabilities offered by high bandwidth connections being developed as part of the CeNTIE Project. In the Wentworth Area Health Service this need was seen at Blue Mountains District Anzac Memorial Hospital (BMDAMH), which is supported by Nepean Hospital as its Principal Referral Hospital. After Institutional ethics committee approval had been obtained, the project began in early 2002 with the initial development of technical specifications and was first used for patient care on 27 December 2003.

Why Ultrabroadband?

Telemedicine has been in use for many years but has not been used in Critical Care applications beyond talking head videoconferencing consultations and remote monitoring such as VisICU.⁴ The ability to provide multiple very high quality television channels by using an Ultrabroadband

Internet connection is what now makes telemedicine possible for critical care use in direct patient care.

The system

A purpose built cart is placed at the foot of the patient's bed in BMDAMH. Using new specifically developed hardware and software five 'near broadcast' quality digital television channels derived from cameras on the cart and in the room relay images of the patient, staff and the resuscitation area together with excellent audio, vital signs monitor output, images of patient records, x-rays etc. over a one gigabit per second Ultrabroadband (second generation Internet or I2) Ethernet connection to a specialist in Nepean Hospital who uses the system to directly supervise care of the patient. The Nepean specialist in turn is seen and heard in the BMDAMH using a further channel and displayed on a monitor on the cart so as to be seen by the patient and those around the bed.

What is Ultrabroadband Internet?

One frame of a high quality television picture is 768 by 1024 pixels in size. For clear, flicker free television it has to be refreshed 25 to 30 times a second. This equates to between 19 and 24 megabits (Mb) of data per second. If transmitted uncompressed, quality is maintained. However, cur-

rent telemedicine applications use ISDN telephony to transmit data. This means that television images have to be compressed at one end and then decompressed at the other end since ISDN at best only transmits between one and three Mb of data per second and introduces clinically distracting latency. By using Ultrabroadband Internet based on fibre-optic cable ViCCU is able to transmit 1000 megabits (one gigabit) of data per second and hence avoid the problems that compression causes. The fibre-optic cable used is from the NSW State Rail ARGUS network which is the basis of the rail network security system installed for the Olympic Games in 2000 and provides a one gigabit per second Ethernet link.

Quality of television

Compression and decompression causes pixelation (where a number of the pixels or tiny coloured dots that make up the image coalesce to make big dots) and blurring / loss of detail (both of which usually occur with movement), and loss of the range of colours necessary to produce skin tones. Additionally, frames

can be lost in the process of compression/decompression producing the flickering images frequently seen with conventional ISDN-based videoconferencing. Further, the computing time necessary to compress and decompress the image leads to latency or delay in transmission which can be very distracting and compromise the level of communication necessary for safe patient care by the team in a resuscitation. By utilising the bandwidth available over second generation Internet connections we are able to avoid compression/decompression and provide 'near broadcast' quality television with minimal latency. It is the quality of the television that enables the central clinician to confidently direct patient care at the remote site.

The remote end – the cart

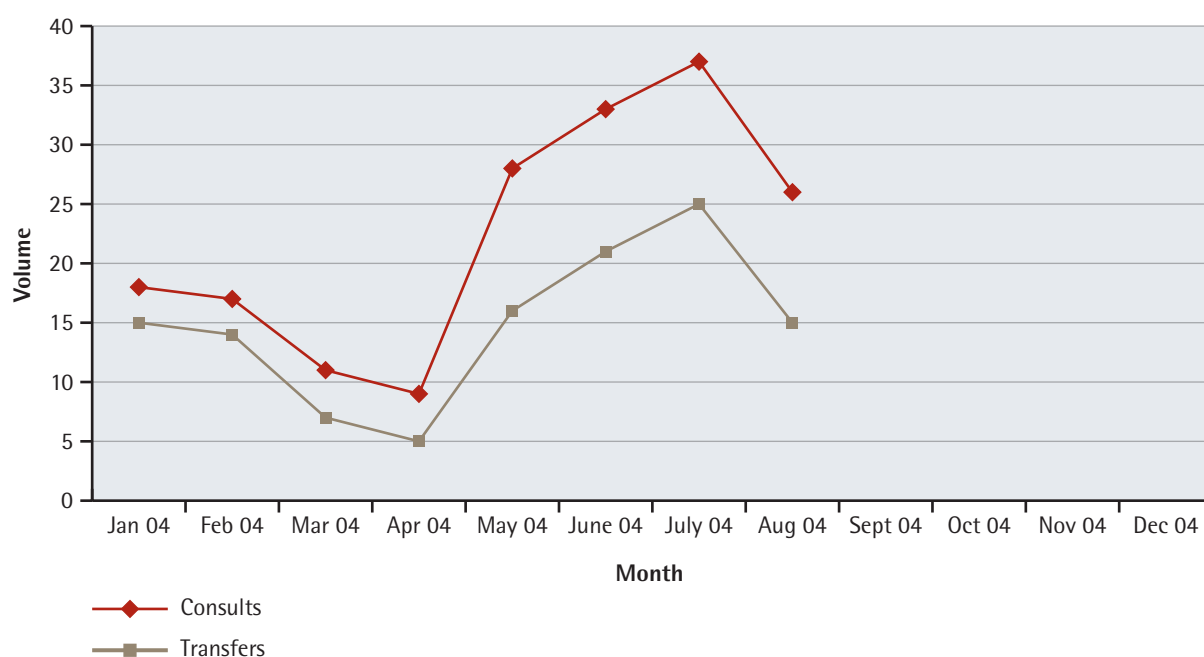
At the heart of the system is a purpose-built cart. The actual cart is seen in Figure 1. It contains:

1. The computers and modems for connection to the fibreoptic network;
2. Two of the cameras – 'Room View' and 'Document';
3. Connections for the other two cameras – 'Over patient' and 'Hand held';
4. Connection for the Vital Signs Monitor;
5. Inputs for other data sources, e.g. ultrasound;
6. Boom microphone and speakers with sophisticated echo cancellation required due to the harsh audio environment of a resuscitation bay;

Figure 1. The cart



Figure 2. ViCCU Utilisation



7. Monitor displaying image of the centrally located specialist
8. Monitors showing the views being transmitted to the central location
9. Display box for x-rays and flat surface for reading the patient's paper-based information such as clinical notes.
10. A headphone setup to allow private conversation with a member of the remote location team or the patient / relative.

The cart is placed at the foot of the bed in the position usually occupied by the team leader in a resuscitation and is connected to the hospital's internal communications links and thence to the Broadband network and the Principal Referral Hospital's work station. The technology was designed to be totally transparent. It is always on and requires only a phone call to ask the Central specialist to go to the work station to activate it.

Results

The numbers of patient consultations and transfers are shown in Figure 2. There has been a steady increase in the number of activations of the system. Staff have found it easy to use, reliable and it is reassuring for the BMDAMH staff. Unnecessary transfers have been reduced and early, more timely transfers occur for the sickest patients. Further, they are better resuscitated for their transfer. The quantification of this is occurring as a case controlled study over the calendar year 2004. An example of this is provided by the case of an 85-year-old driver involved in a motor vehicle crash who had a prehospital asystolic cardiac arrest as a result of his injuries. He was resuscitated at BMDAMH by Nepean staff using the VICCU system and transferred for definitive care. He survived his injuries where the expected mortality in this setting is in excess of 90%.

Discussion

The formal evaluation has been concluded and is being finalised, but the improvement in care is so clear that plans are being developed to extend the system across the whole of the Area Health Service and other Area Health Services, interstate and international interest is such that commercialisation is being undertaken at an accelerated rate.

Competing interests

None declared.

References

1. <http://www.health.nsw.gov.au/policy/gap/metro/GMSIGmetro.pdf> (last accessed 23 October 2004)
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3. http://www3.ict.csiro.au/ict/content/display/0%2C%2Ca16254_b16412_d41654%2C00.html (last accessed 23 October 2004)
4. <http://www.visicu.com/> (last accessed 23 October 2004)



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