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INTRODUCTION

The announcement of the National Broadband Network (NBN) in April 2009 spurred debate across the telecommunications sector and beyond. While much of the telecommunications debate focuses on the physical rollout and politics of the project, other sectors have been more concerned about the applications that will be able to be deployed using the new network. What are we going to use the network for and what are the implications for different sectors of the economy? The growing body of evidence suggests that there is a huge potential impact across most sectors of the economy. Health is one of the most important.

Even before broadband and the NBN, the health sector was a vast generator and hungry user of information and communication. It produces massive amounts of complex, personally sensitive data, requiring a high degree of accuracy, and needing to be exchanged by many individuals and organisations, stored for long periods and often transferred over time to new or upgraded information systems. Errors in collecting, storing, retrieving, analysing and communicating can have very serious, perhaps fatal, consequences – an appointment missed, a diagnosis misinterpreted, a treatment not delivered in time, the wrong drug or dose or combination of drugs administered.

A COMPLEX HEALTH SYSTEM

As the contributed papers to this issue on eHealth demonstrate, the health sector is enormously complex. Care is delivered through an intertwined ecosystem of general practitioners, specialists and allied health professionals. The business models range from small and medium enterprises in general practice and private clinics to the large enterprises that run public and private hospitals. Stakeholders include the Federal, State and Local Governments responsible for the delivery of health and health-related services, insurers, practitioners and allied health services, research institutions, universities, patients and their families, friends and carers. Broadband technologies and services can improve communications through inter- and intra- organisational entities, but bringing the entire health sector into a seamless system is fraught with technical, organisational, financial and legal issues.

Many of the drivers for a seamless, technology-enabled health care system, however, are clear. While Australia currently enjoys one of the best health care systems in the world, the strains on the system have become very obvious. Ask anyone who has dealt with multiple points of the healthcare system, and many will complain about providing the same information several times, carrying medical images between clinics or worse,
miscommunication between different points in the system. Step forward into the future, and it is clear that the looming aged care crisis, resulting from the retirement of the baby boomer generation, will impose further stresses. For example, the number of people over the age of 65 is expected to double in the next 45 years. Chronic disease burdens are also heavily affecting the system. One in three Australians experiences chronic diseases such as coronary heart disease, stroke, diabetes, arthritis, osteoporosis or asthma. These and many other issues are creating increasing strains on the health system, and placing growing pressure on the public purse. According to the Australian Institute of Health and Welfare (2010), health expenditure in Australia has increased from $10.8 billion in 1981–82 to $112.8 billion in 2008–09. As a proportion of GDP, this equates to a rise from 6.3% in 1981–82 to 9.0% in 2008–09, and this is only expected to rise into the future.

These pressures have prompted a number of health reforms, including those relating to ICT. The introduction of health identifiers as a first step towards a Personal Controlled Electronic Health Record, and Medicare rebates for medical consultations via video-conferencing, are tangible evidence that the medical sector is embracing technologies and is moving towards a digitally-enabled future. Combined with the rollout of the NBN, and the research, development and deployment of broadband applications, we are starting to see the full potential for change in the sector, as well as the many challenges that may be faced along the way.

This edition of the Telecommunications Journal of Australia focuses on the health sector, drawing out some of the opportunities and challenges presented by the introduction and application of ICT. It explores particular applications, research into user attitudes and impacts of an ICT-enabled health sector and the rise of information-based expertise.

**BROADBAND APPLICATIONS FOR HEALTH AND WELL BEING**

High-speed broadband is expected to enable a range of new and innovative health-related applications. Technologies existing today, however, can already significantly affect health outcomes for Australian consumers. Articles in this edition explore applications and technologies that are being researched and are in use today.

The papers by Cyarto, Kuys, Henwood & Blackberry and by Smith explore the benefits of adapting widely available active gaming technologies to promote health and wellbeing, reduce falls and assist with rehabilitation. Cyarto et al focus on the use of the Nintendo Wiimote gaming platform by older people, noting the potential for enjoyment but also the need for meaningful health outcomes to be captured. Smith’s article focuses on the use of the game Dance Dance Revolution to reduce fall risk in older adults. Both articles demonstrate how the higher bandwidth that the NBN will make universally accessible will significantly increase the quality of the interactive gaming activities available to improve the health and aid rehabilitation of ageing citizens.

Greenstock & Wickham explore how people with little or no speech communicate with GPs, and the potential for high-speed broadband to help. They discuss equity and access amongst minority groups in the Australian community, an important issue that needs greater consideration in the rollout of the NBN, and well as in the development of new applications.

The use of tele-medicine in treating acute stroke is reported by Nagao & Yan. The article notes the disparities in health services between regional and metropolitan areas in Australia, and the potential use of teleconferencing to overcome the tyranny of distance and provide equitable services in stroke treatment. The research team have successfully deployed a mobile ‘Telestroke’ project in regional Australia that connects to a major metropolitan hospital. The progress of the study is reported here, including the positive impacts on health outcomes. However financial, legal and technological barriers that impede the widespread utilisation of video-conferencing in medicine are discussed, raising important policy and implementation issues. These issues are also picked up in the articles by Paterson & Jones and Heath.
The article contributed by Szucs also addresses the use of video consultations in the health care system, based on the recent announcement of the availability of Medicare rebates for specialist video consultations. Szucs explores barriers to adoption and integration of broadband enabled video conferencing into the clinical and business workflows of GPs – a point that must not be forgotten if the full potential offered by high speed broadband is to be realised. General Practice is a highly computerised part of the health system and the place where most Australians receive health care. This positions it well to lead the adoption of telehealth. On the other hand, because this ‘island of computerisation’ is essentially a collection of thousands of independent small businesses, the adoption of new systems is especially challenging.

USER ATTITUDES AND IMPACTS OF AN ICT-ENABLED HEALTH SYSTEM

As discussed in the paper by Szucs, the user attitudes and impacts of ICT enabled health care are important as perceived or real barriers to adoption of eHealth. Patients need to understand eHealth systems if ICT is to be successfully adopted. This is particularly true from a legal perspective. The article by Paterson and Jones summarises legal issues arising from the use of ICT in the health sector, focusing especially on collaborative healthcare plans involving more than one practitioner, and the implementation of electronic health records. The author discusses privacy and security and the way negligence claims may arise and be dealt with.

The article by Wilson, Ambrose & Braithwaite provides insights into perceptions of video and other tele-health technologies amongst health professionals and patients. The authors report a relatively low understanding of the benefits, particularly for video conferencing, and discuss issues associated with this including the lack of awareness of the full potential of ICT in the health sector. The article raises the need for greater attention to be focused on implementation strategies if uptakes of technologies are to be high.

Tucker & Lodders discuss the importance of interdisciplinary research as a means to bridge the gaps between the appropriate configuration of network technologies, the development of e-health applications, the clinical deployment of new treatments, and methods for driving user uptake. The article focuses on case studies of multi-disciplinary work underway at the Institute for a Broadband-Enabled Society at the University of Melbourne, including stroke rehabilitation, mental health, and education and training in the health sector.

THE ROLE OF INFORMATION

Many of the articles discuss, and in some cases demonstrate, how the use of broadband-enabled technologies in the health sector changes the way health information is handled. The move away from paper-based information storage to a connected and seamless health system has the potential to transform healthcare outcomes by providing easier access to information and reducing repetition while enabling better monitoring of patients’ health. Martin-Sanchez & Gray argue that the discipline of health and biomedical informatics has a substantial role to play in ensuring that strategy, technology, accountability and usability are properly integrated in the design, implementation and evaluation of broadband enabled healthcare.

A more connected healthcare system can also mean that the consequences of error or inappropriate disclosure are magnified. Heath compares aspects of the 2010 Healthcare Identifiers Act to the Australian Law Reform Commission (ALRC) Unified Privacy Principles, warning that there are broader societal impacts from the use of identifiers that are not always immediately apparent. The use of patient health information by secondary entities such as data brokers, medical research and healthcare administrators has real implications for patients. More research into consumer expectations is needed to provide inputs to upcoming Government initiatives in eHealth and privacy.
Bennett discusses the experience of BT in the rollout of eHealth technologies in the UK and Hungary, calling for greater interoperability between different parts of the health system and a standard set of interfaces. The author notes the lack of companies with relevant experience in this area, and the need for a greater understanding of the interrelationships between standards. Although the interaction between patient and clinician and the needs of operational managers are very similar in any country and setting, technical solutions always require contextualisation to the country’s legal, financial, economic, demographic, geographic, technological and cultural landscape. There is no ‘one size fits all’ solution, but experience and lessons learnt are always reusable, especially in the areas of reliability, security, confidentiality and safety of information.

This same theme is drawn out by Hillard, who discusses the complexity of combinations of processes involved in the delivery of health care. He argues that the health sector can learn from other complex industries that have tried to integrate information across activities and processes. The result of the information revolution is a new paradigm: the “information-driven enterprise”, as opposed to the process-driven organisation.

CONCLUSION

The twelve papers in this issue of TJA have identify many of the opportunities and challenges faced by a broadband-enabled, connected healthcare system.

The potential offered through applications like interactive gaming and video conferencing point to the need for faster, ubiquitous broadband, particularly in regional areas. Not all applications, however, need to be high bandwidth. Many valuable low bandwidth applications can be made available and used today. Given the timeframe for the completion of the NBN, their maintenance and development will remain an important priority.

Several contributing authors have raised issues relating to uptake of technologies in the health sector. The patient has to be central to any technology implementation. To be successful patients have to see tangible improvements in health outcomes, whether that comes from simpler interactions with the health system, a better understanding of their health issues or better health outcomes. At the same time, patients need to be aware of the implications of an ICT-enabled health sector, and especially the electronic health record, for their own privacy.

Health practitioners must also see tangible benefits from the deployment of technologies in their workplaces. Incentives to drive uptake and force change in the health care sector must be carefully considered if the full potential of an ICT-enabled health sector is to be realised. Digital literacy amongst health professionals, including gaining an understanding of the possibilities offered by technologies, must also be key to transforming the health system.

The articles presented in this issue demonstrate that there is a lot of work to do to achieve an ICT-enabled health sector, but also an enormous opportunity for innovation.

REFERENCES


Dr Ian Oppermann in 2010 became director of the CSIRO’s Information and Communication Technologies Centre. Established in 2003, the ICT Centre’s research program includes wireless communications, information engineering, broadband networks and applications, and e-health and biomedical imaging.

Oppermann joined the CSIRO after eight years working and living in Finland, and a further five years travelling back and forth from Australia as a consultant. His career in Finland spanned executive positions with Nokia Siemens Network (2005-2009), and director/assistant director of the Centre for Wireless Communications which was attached to the University of Oulu and had the responsibility for researching mobile systems, including ultra wideband (2002-05). He became an adjunct professor at the University of Oulu in 2001. In Australia, he co-founded SP Communications, a Sydney-based company that developed network planning tools for 3G mobile systems (1996-2002).

He holds Bachelor degrees in Science (1990) and Electrical Engineering (1992) and a Doctorate (PhD) on mobile communications (1997) from the University of Sydney. In 2005, he received a Master of Business Administration (MBA) in international business management from the University of London.

Oppermann has made numerous contributions to academic books and journals. He is a Fellow of the Institution of Engineers Australia, a senior member of the IEEE, and a member of the Australian Institute of Company Directors.

Freelance communications journalist, Liz Fell, interviewed Dr Oppermann at the CSIRO’s ICT Centre in Marsfield, Sydney, in late July for the Telecommunications Journal of Australia.

**TJA:** Why did you decide to return to Australia and leave Finland, a nation known for both its mobile technology and culture of innovation?

**Oppermann:** Well, it’s great to go overseas and get an international perspective, and it’s wonderful to work in a country which really has a ‘can do’ attitude. Finland is a small country, and they really take the perspective that there’s no reason on earth why they can’t do it themselves. But every journey has a beginning and an end and, in terms of the stay in Finland, it was time to come back to Australia. And it actually turns out to be a good time to come back.

**TJA:** How long did you actually live and work in Finland?

**Oppermann:** I lived there for eight years, but I was there on and off from 1996.

**TJA:** And 1996 was when you had just finished your doctorate research on CDMA mobile technology at Sydney University. What happened to the job you had as an engineer at OTC?

**Oppermann:** Well, OTC was my first real job after my undergraduate degree. I worked there for a year in 1992 when it was on its way to becoming Telstra. I think we went through four or five different names the year that I was there! I worked in the store-and-forward fax group,
back in the days when people sent faxes. We worked with a 1988 message transfer agent standard, and the idea was that rather than just sending a fax that starts and ends at the same time, you could put it into the system and it would hop around and come out eventually when the receiving device was ready. It was really quite amazing! (laughter). I loved OTC.

**TJA:** Why did you leave?

**Oppermann:** I went back to the university to start a full-time PhD in 1993 and then, towards the end of my studies, it was a very ‘hot time’ in the world of CDMA because of the 3G standards which were coming, so I decided to do post-doc in Finland in 1996. I went to work for the Centre for Wireless Communications, a research centre which was part of the University of Oulu. It was self-funded by Nokia, a company called Elektrobit, and the City of Oulu, with strong support also from the Finnish Defence forces. The intention was to look at next generation communication systems.

**TJA:** Was that an important learning experience?

**Oppermann:** It was an incredible experience. I had come from Australia where, as a PhD student, you were a cost centre – your value to the community was not necessarily recognised. In Finland, quite honestly, I found myself sitting in the sauna with very senior executives from Nokia, and they were asking me what I thought about this upcoming 3G standard! I spent a great deal of time looking at signal design for 3G systems. We looked at a variety of alternatives, and we also looked at the one that was becoming UMTS or 3G, and compared and contrasted different data rates and so on. The work was not only interesting, it was extremely relevant because Nokia was a substantial player in 3G and mobile communications, so they really wanted to know the outcomes of the work we were doing.

**TJA:** How long did you stay this first time?

**Oppermann:** After six months, when I decided to go back home, they said,’ We’d like you to stay, and we can be flexible about how we work with one another.’ The Finns were extremely interested in looking at new working models, so they said, ‘You can live in Australia provided you come back a certain number of times a year, and you have to work for us.’ I said, ‘Great, fantastic.’ So I did that.

**TJA:** Did you learn Finnish?

**Oppermann:** That happened. I learned a little bit, enough to get by.

**TJA:** On your return to Sydney you co-founded a small company called SP Communications. How did you manage to fit in all the work for the Centre for Wireless Communications?

**Oppermann:** I travelled backwards and forwards to Finland, and I was able to manage a group in Finland from Australia.

**TJA:** How were the international communications links between Sydney and Finland?

**Oppermann:** Not as good as today. We had a dial-back modem so I could ping this modem in Finland and it would call me back, and there was a secure server. I had quite good access.

**TJA:** What happened to the company? Did it make a fortune for you?

**Oppermann:** It didn’t make a fortune, but it did OK. We got as far as 2002, so it lasted for about six years. We managed to live through the challenging days of 2000, and we headed down the path of IPOs, which was very exciting. We lived through 2001 and 2002 started to look promising, like the world was picking up! But the world wasn't quite ready! We had diversified and had fairly substantial contracts with a number of different companies by this stage.

**TJA:** What sort of clients were they?

**Oppermann:** We worked with NEC, with Inmarsat through local companies, with Sonera, Finland’s major mobile phone operator, and we did a lot of work for Nokia and for Elektrobit through the Centre for Wireless Communications. But the spectrum auctions caused a lot of grief for a lot of people in Europe. It was the days, if I remember correctly, when BT spent 20 billion pounds on spectrum. Finland gave spectrum away – it was a beauty contest – so
Sonera received spectrum in Finland, but they spent a very large amount of money buying spectrum in Germany and, as a consequence, they did very badly. When the bust came, everyone did badly, and unfortunately that reflected the experiences in my own little company too. Eventually it was wound up, and I moved over to Finland.

TJA: And I see that the Finnish government recently passed a law that came into effect in July making access to broadband a legal right.

Oppermann: Yes, one megabit per second, and the plan is to grow that to 100 megabit/s by 2015. Finland is quite an amazing place. About 68 to 70 percent is covered by forest, and Finns enjoy very much taking time out and sitting in the forest in their summer cabins being part of nature, but they still want to be connected while they’re doing it.

TJA: I recall the Finnish Director-General of the ITU, Pekka Tarjanne, calling for the United Nations to establish the right to communication as a human right at one stage.

Oppermann: Yes, it’s remarkable what you can do with good access. It’s remarkably liberating. I guess that’s what some human rights are actually like: you don’t necessarily notice while you’ve got access, but if it’s taken away you suddenly feel very constrained and limited. One of the places where I lived was in a little tiny town...

TJA: Excuse me, but I don’t think I can pronounce, let alone spell that name...

Oppermann: (Laughter) It doesn’t matter! It was a beautiful spot and I had eight megabits per second access to DSL while I was there in a tiny cabin very, close to the sea, sitting with forest all around me. It meant I could do anything because I was connected. It’s surprising how many things I could do online. I moved there in 2002 and my little cabin had a sauna, of course, and all the essentials that I needed. I was doing my MBA at the time, so when I came home from work I could sit and stay connected, I could carry out my work tasks and responsibilities, I could do my lessons online, I could submit – all of the things I liked to do when I was connected.

TJA: In researching your activity in Finland, I saw that you presented a number of academic papers at conferences in Europe and other parts of the northern hemisphere on ultra-wideband (UWB) technology research which was a major interest for you.

Oppermann: Oh, yes, and there’s a few books on the bookshelf also if you would like a quick browse through them! As for ultra-wideband, the FCC in the US said in 2002 that communications over the band which was about 3.1 GHz to 10.6 GHz – approximately 7 GHz of spectrum I think – could be used for very low power transmission. This band had typically been set aside for unintentional radiators, things like this recorder or a variety of low power devices like laptops, any electronic device which unintentionally radiates some sort of power levels, but very, very low power. So the US said, ‘Well, as long as this spectrum is available, why don’t we use it for intentional communications?’ The idea was that if you could transmit at very low power so it was at the same noise level produced by a device like this recorder, why not use it for communications?

TJA: Given ultra-wideband was seen as a very promising low cost and low power technology, what happened to it?

Oppermann: Well, it was extremely promising. The US set the way with its 2002 statement; then in Europe, because it actually was as low as around about the 2 GHz bands, this was very close to the bands used for 3G communications, and the view was that the expansion up to the 3 GHz bands should be used for 4G communications. Ultimately, it was allowed in Europe but it had to drop power level by a factor of 1000, which meant that, instead of having distances of hundreds of metres you talk about hundreds of centimetres, if you were lucky! It effectively becomes a very short-range communications system. At best, it would be one or two metres. So the communications was effectively killed through the spectrum argument. It was a fairly political decision, primarily because the lower end of that band was seen as very valuable spectrum.

TJA: Was the amount of energy used by wireless technologies a research interest at that stage?
Oppermann: Well, one of the great things about this technology was that the amount of energy per bit of data you transferred was lower than any other, partly because you transmitted it at such incredibly high data rates, and partly because you could build very simple transmitters and receivers. We even built a chip to demonstrate just how simple this technology was. That was the great joy of ultra-wideband. It was so simple.

TJA: Why did you move from the Centre for Wireless Communications to work for Nokia?

Oppermann: I had been working with Nokia since 1996, so eventually I crossed that barrier and went into Nokia. In 2005 I moved from running the Centre for Wireless Communications, which was now about 100 people and had become quite a significant Centre, to running Nokia’s Radio Access Performance business. It was really the radio part of the network, and the business line that I ran had network planning, network optimisation, and configuration management for the network.

TJA: Then when the Nokia Siemens Network joint venture got going, I think you moved on to head the Sales Partnering unit that seemed to require a quite different set of skills. Is that right?

Oppermann: Yes, the joint venture came along, and even though we were modelling, planning and optimising the mobile network, it was software products that we were developing and using internally and externally. So when the joint venture started there was an opportunity for me to move to a business unit that was really the next level up. We knew we were very good at doing software for Nokia networks, and we now had access to Siemens’ networks, so there was an opportunity to expand the portfolio from the vendor space as well as increase functionality. We weren’t going to do that by ourselves, but we could do it by partnering with companies. So I started what was known as Sales Partnering, which meant that in this space we could partner with companies, build bigger solutions, and not only could our own folks sell them, other companies could sell these solutions as well, so we developed solutions that could be sold by different groups.

TJA: Were you still doing technology research at this stage or was your time taken up with partnering?

Oppermann: There was a strong technical component to it because I needed to understand what software we had, but it became more and more sales.

TJA: Did you enjoy the sales side?

Oppermann: You can’t have your own company without having a sales aspect, so there had always been a sales component to what I have done. But it definitely wasn’t used car sales. It was understanding the value proposition and talking it through with your partners and the end-customers: what it was that you bring, why it’s beneficial to them, and the difference it makes to running their network. One particular product was network optimisation, and the big selling point was that we could decrease the dropped call rate from 10 percent to .3 percent, for example, and that this had the exact impact on the bottom line, on customer satisfaction and on customer churn rate. These arguments actually became quite compelling because they were all based on technical arguments.

TJA: Did that position mean you travelled out of Finland?

Oppermann: Yes, extensively. I had a team in India, Brazil, the US and Budapest towards the end.

TJA: What about the small Australian market?

Oppermann: I made it out here a few times, but it was always a little challenging travelling to Australia because I had an interest, so there was extra scrutiny that I would apply to myself.

TJA: Ethics?

Oppermann: Yes, Nokia was and is a very ethical company.
TJA: Moving on to the CSIRO’s ICT Centre, where researchers have demonstrated a new ‘rural wireless broadband’ network called Ngara, why is NBN Co so lacking in its interest to use it, and what is your view on this?

Oppermann: Well, we’ve spent quite a bit of time talking to the folks from the NBN, and we’ve certainly kept NBN Co informed as to what it is we’re doing. We have now got, separately, an MoU with NBN Co in conjunction with NICTA to look at some of the applications we can run on the NBN, so there’s been some good conversations.

TJA: But isn’t the MoU with NICTA quite separate from the Ngara broadband system?

Oppermann: Yes, so there’s been some good conversations that have taken place, but NBN Co have said that they won’t take leading edge technology. They really need technology that has proven support by a vendor.

TJA: And standardised?

Oppermann: And standardised. Well, actually, standardised is less important than being supported by a large international vendor.

TJA: And you haven’t been able to sell the Ngara access system to Ericsson with whom NBN Co has announced a 10-year 4G fixed wireless contract using LTE technology in the rural broadband market where there is no fibre to the home.

Oppermann: Interestingly, we see what we’ve got as something which has been designed specifically for fixed communications systems, fixed wireless, and we’ve got something which is really a technological advantage.

TJA: Are you arguing that Ngara is ideal for people living beyond NBN’s fibre?

Oppermann: Yes, it’s essentially for anybody who doesn’t have optical fibre who would benefit from high-speed communications and who lives in an environment where they don’t move: a lot of Russia and China and Africa look like the parts of Australia that are beyond fibre. We have our eye on a global market, and that’s the basis of the conversation we’ve had with the vendors. I think it’s fair to say we’ve spoken to all major vendors, and continue to speak to them, but there’s always an interesting point between when the technology is mature enough for it to be picked up and when it is transferred.

TJA: Have you started to look at standards?

Oppermann: That’s a very interesting question. To some extent, we have avoided the discussion around standards, thinking that will come when we partner with one or more vendors...

TJA: ...and you’ll hand over to the private sector partner for that?

Oppermann: That’s the thinking that we’ve had. Now to date, we’ve not referred to this as either WiMax or LTE. In practice, it’s looking more and more like LTE but, in fact, the access layer is actually built on a WiMax bit so it’s something of a hybrid. The intention is that whoever picks it up can make it into a flavour of LTE or a flavour of WiMax depending on their own motivations. So we’ve tried to be technology agnostic, though the most recent conversations are looking more and more like LTE. But to some extent, in the Australian context for NBN, LTE is not the perfect solution.

TJA: Still, NBN Co has chosen to go with Ericsson’s LTE-Advanced.

Oppermann: That’s right. My own perspective is, ‘OK then, now that NBN has made the decision, we can make it look like LTE.’ That’s what we’re running with at the moment.

TJA: It sounds as though you are trying very hard to find an NBN use for Ngara! Doesn’t Ericsson have a ten-year contract with NBN Co?

Oppermann: Well, Ericsson has a first phase NBN contract – I think it’s for approximately $100 million – then the next part is the billion dollar part and that’s where the ten years come in. So there’s still a point where Ericsson needs to demonstrate their value first. It’s not as signed and sealed as it appears!
**TJA:** Are your researchers going to set up a trial that shows the value of the Ngara technology over Ericsson’s LTE?

**Oppermann:** Well, again we’re talking to all the vendors! And if you look at how big Australia is, my personal guess is that $1.1 billion is not enough to do 4 percent here, in particular, if you use 4.3 GHz which they’ve got at the moment. There is, of course, the spectrum auction plan for the 700 MHz digital dividend. But when you look at how you would plan a network if you used 700 MHz versus 2.3 GHz, the 700 MHz attenuates far more slowly than 2.3 GHz, so you could cover more of the land mass and therefore get more of that four percent.

**TJA:** So where are you at with Ngara right now?

**Oppermann:** We're talking to all the vendors, and to the operators in Australia, and to every major stakeholder so that, at least, they’re aware of what’s possible. From our perspective, there is a minimum position, and that is to ensure, at the very least, that people understand what’s possible. People believe quite strongly that the symmetry in data rates makes a very big difference so that if they have high upload rates as well as high download rates they can generate content as readily as they can consume content. The NBN is offering 12 megabit/s down and 1 megabit per second up, so if we can get a requirement for the network so that the upload rates for people living beyond fibre are similar to the upload rates for people who have access to fibre, then that’s the minimum result we’re looking for. The best result, of course, is for our technology to be included in the NBN.

**TJA:** The ICT Centre has lots of ongoing wireless research here such as the ‘green’ wireless base station work being done by the Australia China Research Centre, the joint venture with Beijing University. Is the issue of energy, including for Ngara, crucial these days?

**Oppermann:** Sure, when you start offering people very high data rates, the energy consumption goes up very dramatically. Looking not only at the bits going through the electronics but also the bits flying through the air, and trying to ensure the bits are efficient as possible, has a very substantial impact on energy consumption when you scale up to network size.

**TJA:** What is happening with the ‘green’ base stations?

**Oppermann:** We spend a lot of time looking at what makes a difference inside power consumption for a base station, so that’s the program.

**TJA:** What about ‘cognitive networks’, a concept that I see you used while in Finland?

**Oppermann:** It’s one of the next big things, and it’s partly because spectrum is so heavily utilised, particularly in urban environments. The point quite simply is that if you have access to this bit of spectrum and you’re not using it, than I as another device can use all the other bits around it, and maybe even use, provided you're not using it for one instant.

**TJA:** Is it a way of getting around interference?

**Oppermann:** No. If you actually put your spectrum analyser into a bit of spectrum and look at it from a tiny perspective, there’s a lot of the time when it’s not being used. It might happen millisecond by millisecond or, in fact, during various times of the day there could be fairly large chunks of time where it’s not being used. So if you can Detect and Avoid, then you can utilise that spectrum without interfering with the primary licence holder.

**TJA:** Is that development a long way away?

**Oppermann:** Detect and Avoid in this lower frequency area is part of the ultra-wideband activity in Europe. So if you’re the secondary user of a bit of spectrum, and you listen for the primary user and you don’t hear them, then you transmit. That exists now, but what’s coming is a far more comprehensive solution where you look across a broad range of spectrum and use whatever bits aren’t being used right at this instant.

**TJA:** Moving to the NBN, you referred to the MoU between NICTA and the ICT Centre which, along with NBN and the NSW government, comprise the new Australian Centre for Broadband Innovation (ACBI). I saw an early press release saying that NICTA was testing a
'social' TV service and set-top box for the ABC in a fibre-to-the-home trial. Are you involved with this, and what is it all about?

**Oppermann:** ACBI’s focus areas are e-Health, e-Government, education, entertainment and smart infrastructure, so we have set up a couple of projects to begin with. One is the smart connected farm in collaboration with the University of New England, another is helping elderly people stay in their homes longer, and there’s also the set-top box activity being driven by NICTA, working with the ABC, to see if delivery of content is a major aspect of what people are looking for from the NBN. Then you’ve got this challenge of having a large amount of information being distributed to a lot of different people across many different sites. The idea is that they can store a lot of this technology near the edge of the network, and then download it based on demand. So it’s a way of shifting very substantial amounts of information. It’s a little bit like store-and-forward fax, a very good idea!

**TJA:** (Laughter) That’s an interesting historical link. What is the NSW government looking for from ACBI?

**Oppermann:** The NSW government is looking really for the innovation and the applications. I think people are now assuming some sort of national broadband network is coming, and they care about the applications that ultimately will make a difference to people. The reason for choosing these focus areas is that these are the areas we already work on and we know they work well – there’s value in their own right. So if we move them into a broadband context, we would look to ensure that they can take advantage of that broadband and, if everyone has access to broadband, we could look at how we change our service delivery, and how people engage with the technology. The big idea is that we change the way people engage with the technology so it’s not about sitting in a laptop-type environment and downloading faster better-directed web pages. It’s actually changing the interface, changing the human aspect of the technology consumption, and people in the home or on the farm generate content, hence this issue about symmetry for data rates.

For example, it’s 10 o’clock, you turn on the TV and, rather than Ray Martin, you get a regional nurse or someone from the aged care facility, who says, ‘Hi. How are you? Stand up, walk around.’ She gets all the visual and audio cues of health – a look at skin tone, a look at how you move – and then she says, ‘Great, you’re fine, I’ll talk to you again tomorrow at 10 o’clock’. Switch off the TV, turn back to the regular programming. So the person sitting in their home is generating the content.

**TJA:** Wow! What if someone prefers to meet up physically face-to-face? Surely there needs to be a balance so that not all communication is electronic!

**Oppermann:** True. We certainly don’t believe that issues of social inclusion, issues of health and so on would all be based on the delivery of services through a high speed net, but it means you can take some of the problems away, make life a little easier.

**TJA:** And governments may save money too! I see that you sit on the board of the Australian e-Health Research Centre (AEHRC), a joint venture between the CSIRO and the Queensland government, which is looking at advanced medical imaging technologies.

**Oppermann:** Yes, it’s pretty exciting stuff. One of the big activities is imaging, imaging of the brain, and they’ve also done a lot of work on the imaging of soft tissue body parts. Imaging of the brain is particularly relevant when we look at Alzheimer’s, so we have developed an atlas of the brain and looked at the brain as it ages, with and without Alzheimer’s in particular, and you can look at the levels of atrophication so therefore you can look to detect earlier stage Alzheimer’s disease. It’s remarkable stuff: mining MRIs and various other sorts of imaging techniques, measuring the thickness of the myelin sheath, and looking for the build-up of amyloid plaques. We also do quite a lot of work on platform technologies which means just moving bits around – your patient data record, my patient data record – so that we can make a semantic meaning map. And this platform technology means we can access large amounts of information.

**TJA:** Are you involved with the National E-Health Transition Authority?
Oppermann: Yes, we work very closely with the folks there. We do quite a lot of work on mapping of a language called SNOWMED CT, which describes conditions and body parts and injuries. It’s a medical terminology which is relatively standardised, so that an ambulance driver means the same thing as an admitting person who means the same thing as a specialist doctor!

TJA: Does everyone using it have to gain typing skills?

Oppermann: No. We’ve developed something on top of that which is useful for fast mapping of SNOWMED. There’s a dictionary, a language out there, that helps people graphically use the language far more rapidly. We’ve got a product called Snapper, the SNOWMED mapper, and we have a little version for mapping the SNOWMED terminology called Minnow, which you can download for free. So that’s the platform technology. On the application layers, we have developed the Patient Admission Prediction Tool. You have ambulances bringing people into the Emergency department, and you have elective and other surgeries in Emergency, so this tool allows you to predict what you would expect in terms of how many beds you would need to reserve to avoid ambulance bypass or, effectively, bed blockage. That’s now in all reporting hospitals in Queensland, and the principle is that, based on historic information, some other information, and understanding of the hospital’s workflow, you can minimise the number of beds you need to reserve so the ambulance can actually get to the hospital and deliver what is necessary.

TJA: And it saves money...

Oppermann: It has an impact on lives as well! Twenty ambulance bypasses were avoided in a trial at a Gold Coast hospital. I think it was a six-month trial. And because it’s a work flow-on efficiency, there’s also a potential dollar saving. Now that utilises a lot of information so, on an individual basis, you gather all your statistics, you crunch your number, and say, ‘For this hour, for the next day, you should reserve four beds as opposed to twenty.’ The big improvement is the accuracy improvement versus what someone would schedule based on a pencil and paper exercise. But you can imagine that if you can share information among hospitals, and do it on a state-wide basis, you can start to do some pretty big things in terms of the type of information you can gather. So if you do something in isolation, you optimise locally, but if you work with all the other hospitals around you, then you can optimise on a much larger scale.

TJA: Finally, I understand that on one occasion you told the staff here to switch off their email for the day. Why did you decide on that?

Oppermann: Well, email in general relies on the working assumption that you’ve got a letter. It’s really just an electronic version of a letter – easy to send, sit, read and process. I personally go through a very challenging stage of staying on top of my email. So this was a little draconian, but the idea was to pick up the phone and talk to one another – unless, of course, they had an attachment or were using file transfer. If we’re changing the way people engage with technology, we’ve got to start with ourselves.

TJA: Fascinating. I could go on and on asking questions and listening to you. Thank you very much for your precious time.

Virtual reality is the computer-generated simulation of a real-world environment. For over 20 years, this technology has been used for health-related and rehabilitation purposes. The new generation of wireless gaming consoles has brought low-cost, easily accessible virtual environments to lounge rooms, physiotherapy clinics and aged care facilities. The purpose of this paper is to review the emerging literature on the use of active gaming technology (Nintendo Wii™) with older people. The results of a recent qualitative study on the acceptability and feasibility of implementing Wii™ in aged care settings will also be presented. As broadband-enabled healthcare expands and gaming technology advances, gaming consoles could be used for more than recreation. In addition to the potential health benefits, connecting older people to peers or health professionals in this way may be a strategy to counteract the social and physical isolation experienced by a growing number of those living in the community.

**BACKGROUND**

Virtual reality (VR) is the computer-generated simulation of a real-world environment ([Holden 2005](#)). It has established applications in many diverse fields, including aviation, architecture, medicine and education. In some occupations, real-life training can be dangerous or difficult to monitor. Because of its immersive and interactive properties, VR is commonly used by pilots, surgeons, fire-fighters and soldiers as part of their vocational training. A user interacts with their virtual environment using specially designed computer software and a human-machine interface such as a remote control, a computer mouse, a glove or headgear ([Holden 2005](#)).

Virtual reality technology has been used for health related research and clinical purposes since the early 1990s. In the area of rehabilitation of motor impairments, VR systems have been developed for those suffering stroke ([Holden 2005](#); Lam et al. 2006; Merians et al. 2006; Yang et al. 2008) and for people with acquired brain injury ([Holden 2005](#); Thornton et al. 2005) or Parkinson’s disease ([Weghorst 1997](#)). Other applications include balance training ([Cruz-Neira et al 1993](#); Keshner 2000; Whitney et al. 2002) and memory rehabilitation ([Brooks and Rose 2003](#)). Incorporating virtual environments into rehabilitation has been shown to promote motor learning and transfer to real world tasks, decrease pain, and improve mobility, balance, and enjoyment of therapy ([Holden 2005](#)). Therapeutic VR environments
can be as large as an entire room and completely immersive, such as the Computer Assisted Rehabilitation Environment (CAREN) system (van der Eerden et al. 1999) or the CAVE™ system (Cruz-Neira, Sandin, and DeFanti 1993). However, due to cost and complexity, these VR environments are limited to research or specialised clinical settings.

More recently, the video gaming industry has bridged the gap between the lab and the lounge room with its new generation of wireless gaming consoles and “active gaming”. Advanced VR technology has been coupled with simple user interfaces and controllers. Now these “off-the-shelf”, low-cost, and easily accessible virtual environments are found in hospitals, physiotherapy clinics and aged care facilities despite the fact that there is little evidence to support their use with functionally impaired individuals (Smith et al., 2010). There is a burgeoning market for the development of “games for health” or “exergames”. To date, the Nintendo Wii™ (Nintendo Corp., Kyoto, Japan) gaming system has generated the most popular interest.

Since its launch in 2006, Nintendo has sold over 86 million Wii™ systems worldwide (gamrReview 2011), including over two million in Australia (Nintendo Australia 2010). Wii™ consists of a console, a hand-held wireless controller (Wii Remote™) and gaming software (Wii™ Sports). The controller detects changes in acceleration and direction in three dimensions, which enables a player’s hand, wrist and arm movements to interact with the games. Up to four controllers can be used at once and each player creates a virtual self (Mii™) which appears on the monitor or television screen. Players receive feedback on their performance through their Mii™. Wii™ Sports is a package of five simulated sports, including 10-pin bowling, tennis, boxing, golf and baseball. Wii Fit™, released in 2007, is a package that includes yoga, balance, aerobic and muscle conditioning programs. Players stand on a balance board in which pressure sensors have been embedded to monitor centre of balance and shifts in weight/balance.

For older people, Wii™ offers new and entertaining ways of becoming more active. Individuals may ‘virtually’ return to physical activities they once enjoyed but have had to give up due to physical limitations or a lack of local facilities, such as a tennis court, golf course or bowls club. To date, most of the published research using Wii™ has involved younger populations (Deutsch et al. 2008; Graves et al. 2007; Graves, Ridgers and Stratton 2008). In adolescents, energy expenditure playing Wii™ Sports was significantly higher than playing sedentary computer games, but they did not expend as much energy as playing the sport itself (Graves et al. 2007). Clark and colleagues (2010) demonstrated the reliability and validity of the Wii Fit™ balance board (WBB) for measuring balance. In healthy young adults (mean age 23.7 ± 5.6 years), the WBB was found to be comparable to a laboratory grade force plate. Nitz et al. (2010) reported improved balance and lower limb strength in women, aged 30-58 years, who used Wii Fit™ twice weekly for 10 weeks. The purpose of this paper is to review the emerging literature on the use of active gaming technology (Nintendo’s Wii™ Sports and Wii Fit™) to promote rehabilitation and wellbeing amongst older people. The results of a recent qualitative study that examined the acceptability and feasibility of implementing Wii™ in aged care settings across three Australian states will also be presented.

METHOD

LITERATURE REVIEW

The following electronic databases were searched for articles published since Nintendo launched Wii™ in 2006: MEDLINE (PubMed), CINAHL, Web of Science and Sport Discus. Key words used in these searches were ‘Nintendo’, ‘Wii’, ‘Nintendo Wii’, ‘Wii Fit’, ‘Wii Sports’, ‘Nintendo Wii AND older adult’ and ‘active video game’. Studies that included adults aged 60 years and older in the sample were selected.
QUALITATIVE STUDY

Telephone interviews were conducted with staff members from residential aged care facilities (RACF) and community day centre or respite programs that had been using Wii™ with their residents/clients in Victoria, Queensland and New South Wales. With the participants’ consent, the interviews were audiotaped. Participants were asked about their experiences with Wii™-based activity programs and the reaction of their residents and clients to active gaming (see Appendix 1 for interview questions). Transcriptions from interviews were subjected to content and thematic analysis (Tuckett 2005).

RESULTS

From the literature search, 20 studies were identified for review: 12 featuring Wii™ Sports and eight examining Wii Fit™. Only one completely qualitative study has been published to date. Studies using Wii™ Sports will be presented first, followed by the published literature on Wii Fit™. Finally, the findings from the new qualitative study on Wii™ will be reported.

WII™ SPORTS

Wollersheim et al. (2010) conducted a pilot study using Wii™ Sports with clients of a Planned Activity Group (PAG). These groups are offered by community health services in Victoria to provide older people who are isolated and/or have physical limitations with social and recreational activities in a supportive environment. The Wii™ games were added to the PAG program twice a week for up to two hours over a six-week period. The majority of participants were seated during play. Eleven women (age range 56-84 years, mean age 73.5 ± 9.0 years) wore an accelerometer (activity monitor) three times for 20 minutes during a six-week baseline period and then whilst playing Wii™ to measure energy expenditure during PAG and gaming activities. The mean duration of play was 51.1 ± 27.1 minutes per session (38 - 660 minutes in total over 12 sessions). Although participants expended more energy whilst using the Wii™, there was no significant increase in energy expenditure compared with baseline. The mean rate of participation was 70.5%. Focus groups were held to explore the psychosocial benefits of playing Wii™. Participants reported that they got to know each other better, they had fun and one woman said that playing Wii™ made her feel more alert. Other benefits mentioned included a stronger connection with grandchildren, self-reported physical effects, and learning to use technology.

Sohnsmeyer, Gilbrich, and Weisser (2010) examined whether playing Wii™ can improve lower body strength in community-dwelling older people. Forty, healthy volunteers (age range 70-86 years, mean age 76.9 ± 4.8 years) were assigned to either a Wii™ bowling group or a control group. The intervention consisted of two, 20-minute sessions of bowling for six weeks. At follow-up, the researchers reported a statistically significant increase in maximal isometric strength of the quadriceps muscle (p<0.01), after adjusting for baseline muscle strength, in the intervention group relative to the control group. Leg strength increased 38%, on average, in those who participated in Wii™ bowling.

In an observational study in an assisted living facility, Weybright and colleagues (2010) investigated the effects of Wii™ bowling on attention to task and positive affect in two female residents with mild cognitive impairment. An ABAB design was used; where watching a pre-recorded bowling competition on television was the baseline phase (A) and Wii™ bowling comprised the intervention phase (B). Participants spent 15 minutes (the duration of one game of Wii™ bowling), four times a week for two to three weeks in each phase. Each session was videotaped and then scored by two trained observers. Participants were interviewed at the end of the trial to evaluate the acceptability and practicality of the Wii™. One participant had high attention to task (fixed eye gaze towards the TV screen) across all four conditions whilst large increases were observed from baseline to intervention in the other participant. An increase in positive affect (smiling) was observed between the baseline and intervention phases for both women. Feedback from both participants on their
experience with Wii™ bowling was positive. Staff noticed an improvement in one participant’s ability to recall routine tasks and in the attention span of the second participant.

Several studies have focused on the therapeutic use of Wii™ with older people. Rosenberg and colleagues (2010) recruited 19 community-dwelling older adults with subsyndromal depression (age range 63-94 years, mean age 78.7 ± 8.7 years) for a 12-week trial of Wii™ Sports. Participants used the Wii™ three times a week for 35 minutes. After 12 weeks, significant improvements were observed in quality of life and cognitive functioning. A significant reduction in depressive symptoms was also reported and this was maintained up to 24 weeks post-baseline. Participants attended 84% of the total Wii™ sessions. Tennis and bowling were rated as the most enjoyable of the games. In two case reports, playing Wii™ bowling helped a RACF resident improve her balance, mobility and balance confidence (Clark and Kraemer 2009) and it assisted a stroke patient with his fine motor dexterity and hand strength (Drexler 2009). Yong Joo et al. (2010) also reported that Wii™ complemented conventional upper limb stroke therapy.

Saposnik et al. (2010) compared the feasibility, safety and efficacy of Wii™ gaming with recreational therapy (playing cards or bingo) in stroke patients. Twenty-two inpatients at a stroke rehabilitation centre (age range 41-83 years, mean age 61 years) were enrolled within an average of 25 days post-stroke and randomised to each intervention arm. The groups were asked to complete eight, 60-minute sessions over a 14-day period. The total time receiving the intervention was used as an indicator of feasibility and participants completed 76% and 80% of the scheduled time for Wii™ and recreation therapy, respectively. There were no serious adverse events in either group. Outcomes for efficacy measured post-intervention and at four weeks after the final intervention session included activities of daily living, arm motor function and quality of life. A statistically and clinically significant improvement in arm motor function was observed in the Wii™ group. In another rehabilitation setting, Mouawad and colleagues (2011) recruited seven stroke patients (mean age 65.3 years) who were in the chronic period post-stroke (mean 15.3 months). They had one hour of supervised Wii™ therapy on 10 consecutive weekdays over a 14-day period. Each participant also progressed to three hours of gaming on a Wii™ system installed in their home. All participants successfully completed this intense protocol. Statistically and clinically meaningful improvements in upper limb functional ability and movement were reported (Mouawad et al. 2011).

Using a cross-over design, Hsu and colleagues (2011) recruited 34 residents (mean age 80 years) with self-reported arm dysfunction (pain, weakness, or stiffness) in two aged care facilities to participate in a standard exercise group (SG) and SG plus Wii™ bowling. The SG was offered two to four times per week and consisted of strength exercises for the upper and lower body and balance and coordination exercises. In addition to the standard exercises, participants in the Wii™ group played the bowling game, in pairs, twice a week for 20 minutes. Outcome measures included a six-item measure of physical performance, pain intensity and bothersomeness, and enjoyment of physical activity. After the first reassessment at four weeks, those who had been randomly assigned to the SG added Wii™ bowling to their regime whilst those in SG plus Wii™ continued with the standard exercises only. Participants were assessed again after the second four-week period. The Wii™ bowling was acceptable to residents, with 92% completing at least six of eight sessions. Only enjoyment of physical activity was significantly greater in the Wii™ group compared with the SG.

In a study conducted in a Singaporean RACF, Jung et al. (2009) randomly assigned 45 residents (age range 56-92 years) to either a Wii™ group or a group that played board games. Activity sessions for both groups took place for 90 minutes, three times a week for six weeks. Participants in the Wii™ group scored significantly higher on measures of affect, self-esteem, and physical activity and lower on the loneliness scale (p<0.05). However, the results should be interpreted with caution as self-report measures were used and all were translated from English into several dialects.

Staff perceptions of Wii™ and their experiences with implementing it across four settings of an aged care and disability service in Queensland, Australia were explored via structured
telephone interviews (Higgins et al. 2010). A total of 53 individuals (78% over the age of 40 years) participated from 29 residential care facilities, 18 respite centres, five day therapy centres and one retirement village. Because the sample of facilities included centres specifically for young clients with disabilities and the authors grouped the results from all the services together, findings particular to older adults could not be ascertained. Setting up the Wii™ system was not problematic for most services in the Queensland study; however staff who were unfamiliar with gaming technology were slower to get it operational. Use of the Wii™ ranged from site to site, however clients/residents at half of the facilities played at least weekly. One high care facility reported infrequent use of the Wii™. A minority of staff interviewed (15%) reported only individual use of Wii™, however most services (83%) provided staff supervision at all times. The most popular games were bowling, tennis and golf. Seven sites used the Wii™ as an adjunct to physiotherapy and occupational therapy programs. Although not directly measured, staff associated physical benefits with Wii™ use such as distraction from pain and improved mobility. They also mentioned psychosocial benefits including greater social interaction, improved self-confidence and a connection with previous physical activities. Higgins et al (2010) reported that many older participants were hesitant with the technology. Operating the controller was reported as the main difficulty with the Wii™, particularly with clients/residents with dementia. The speed and complexity of some of the games were also frustrating for older players.

WII FIT™

Graves and colleagues (2010) conducted a cross-sectional study to measure the energy expenditure and heart rate of young and older adults whilst engaged in Wii Fit™ activities, inactive video gaming, brisk treadmill walking and jogging. A sample of 13 older adults (mean age 57.6 ± 6.7 years, range 45-70 years) was recruited for the testing sessions, excluding jogging. The researchers found the energy cost and intensity of the Wii Fit™ activities to be greater than sedentary gaming (p≤0.001), which was similar to their earlier findings (Graves et al. 2007). However, energy expenditure and heart rate measurements were significantly lower than the treadmill walking (p≤0.001). Of note, at 3.2 metabolic equivalents (METs), only Wii™ aerobics was classified as moderate intensity activity (3-6 METs). Older adults enjoyed Wii™ balance more than yoga, muscle conditioning and aerobics.

Two groups of researchers have explored the potential for the WBB to be used for balance testing and falls risk assessment with older people. Young et al. (2011) extended Clark and colleagues (2010) work with the WBB to develop two games for functional balance training and to assess static balance. The games require participants to control their centre of pressure, which is measured by the WBB. Young et al. (2011) pilot tested the games with six healthy older adults (mean age 84.1 ± 5.1 years, none had fallen in the previous year). Participants attended 10 sessions held over a four-week period and played each game for 20 minutes. Anterior-posterior and medial-lateral sway were measured, with eyes open and eyes closed, whilst participants stood on the WBB for 30 seconds. There was a significant decrease in sway in the anterior-posterior plane in the eyes closed condition (p=0.03). All participants enjoyed the gaming experience. However, a limitation of this study is that the researchers inserted the WBB into a larger platform, which is not how it is used in the “real world”.

Yamada et al (in press) tested the reliability and validity of two of the Wii Fit™ balance activities, Basic Step and Ski Slalom, as measures of falls risk. The Basic Step involved stepping on and off the WBB at a set pace and Ski Slalom involved weight shifting to navigate through flags whilst downhill skiing. The researchers recruited 45 community-dwelling women (mean age 81.3 ± 7.4 years, 16 had fallen in the previous year) for this trial. Although moderate, yet significant, correlations were found between the Basic Step and two criterion measures (dual-task walking and dual-task Timed Up and Go test), both Wii Fit™ activities were performed with the participant seated (WBB placed in front of feet or beneath buttocks). The researchers did not provide a rationale for why seated activity was chosen over standing when they were particularly interested in dynamic balance.
There has also been research interest in Wii Fit™ as an intervention to ameliorate balance and balance confidence in older people. In three case studies, after playing Wii Fit™ balance games improvements were found in static and dynamic balance in a stroke patient (Brown et al 2009), in an individual with a history of multiple falls (Pigford and Andrews 2010) and in 14 older people with and without balance problems (Bomberger 2010). Williams et al. (2010) recruited 15 community-dwelling fallers (mean age 76.6 ± 5.0 years) for a Wii Fit™ program (individual exercise visits twice weekly for 12 weeks), another six participants received standard care (12-week, physiotherapist-led exercise/education program). Balance and falls efficacy were measured at four weeks and 12 weeks post-baseline. Program adherence and a structured interview provided data regarding the acceptability of the intervention. A significant improvement was reported for one of the two balance measures in the intervention group, but only at the four–week assessment. Between-group comparisons were not possible given baseline differences in participant characteristics. Williams et al. (2010) reported that 80% of participants attended 75% or more of the Wii Fit™ sessions and all participants found the program to be enjoyable.

Eight community-dwelling older adults (mean age 75.0 ± 9.7 years) with a perceived balance deficit were asked to participate in two, 30-minute sessions of Wii Fit™ yoga and balance exercises for six weeks (Bainbridge et al. 2011). Of note, two participants withdrew from the study due to exacerbations of a pre-existing hip problem and low back pain. The outcome measures assessed balance, balance confidence and limits of stability (multi-directional reaching). The researchers did not find any statistically significant improvements.

CAN WII™ WORK IT OUT? A QUALITATIVE STUDY

In the present qualitative study, interviews were conducted with 15 participants from 13 sites. Five of the interviews were with staff in RACF and the remainder were with staff working in day centre programs. Eight participants were located in Victoria, six were in Queensland and one was from New South Wales. The Queensland sites were all managed by the same aged care and disability service provider. All participants were female with an average age of 50.7 ± 10.7 years (range 28-62 years). Six were program coordinators, three were service managers, three were personal carers, two were diversional therapists (DT), and one was a physiotherapist. The period of time that they had been using Nintendo Wii™ Sports with their residents or clients prior to the interview ranged from three months to 20 months.

When asked what prompted them to purchase the Wii™ system, their decision was far from evidence-based. They read positive reports in the grey literature, one DT heard about it at an industry forum, and recommendations came from other staff who had one at home. In Queensland, the Wii™ consoles were given to each site by the service provider. No one reported any problems with installation or set-up, although some interviewees were assisted by colleagues who had a Wii™ at home. One interviewee did report that she found the initial set up burdensome:

“We didn’t want to set up our clients as individual people in the system...we wanted to basically go straight to a program without all that initial set up.”

Most interviewed offered Wii™ as a group program, however, a DT from a psychogeriatric RACF and a physiotherapist from a day therapy centre provided individualised sessions. At two RACF, high school students were paired with residents and they played the Wii™ together. Typically, Wii™ was played once per week for 30 to 60 minutes, although some of the Queensland respite centres reported only using it once a month as part of an overall activity program. A few of those interviewed said that the novelty wore off after a few months and they were not using Wii™ as frequently.

The researchers were most interested in the feasibility and acceptability of Wii™ in RACF and day care settings. At all locations, staff needed to navigate through the menus to start the games. Up to two people were required for supervision. In the group programs, there were as many as 15 participants plus others just content to watch. The majority of participants were women 80 years of age or older. The games were mostly played whilst people were seated,
however some of the day centre clients preferred to stand. Bowling was the most popular program in all the facilities. No injuries were reported. From an evaluation perspective, no one was documenting or measuring any outcomes related to physical functioning or quality of life.

In most settings, participants enjoyed using Wii™ and staff noted increased interaction and engagement between residents/clients and with staff. One program coordinator was able to increase physical activity during Wii™ bowling, for both players and observers, by creating a catch-phrase:

“Hands in the air for a spare!”

Everyone cheered when someone bowled a spare or a strike. Wii™ became a point of conversation amongst residents/clients and got them talking to people they did not know very well:

“The interaction is just lovely because it’s giving them something apart from...just talking about the weather. It’s opened up a new avenue of friendships...”

After introducing Wii™ into her activity program, one person interviewed realised that her residents still had a healthy sense of competition:

“Win the game or knock over the pins, I don’t know which gives them the biggest satisfaction!”

Staff from only one day-centre reported that the residents did not enjoy the Wii™ or want to use it:

“That’s what they look at it as, watching telly.”

“...it was too removed from reality for them.”

Teaching residents/clients how to use the Wii™ controller was the greatest challenge mentioned by each person interviewed. For example in bowling, it was very difficult for them to grasp the concept of releasing the button on the back of the remote whilst they swung their arm to release the ball. This was particularly problematic for cognitively impaired players. In the residential care settings, the staff reported having to fully assist at least half of their participants to use the controller:

“...we need something that’s much simpler to operate for them, I think that’s what let us down more than anything else.”

Interestingly, however, one resident became skilled at using the controller whilst playing Wii™ bowling:

“I have a resident who can’t operate the remote control for the TV but by the end of the session she has the A-B button down pat because it’s the repetition.”

In some cases, there was a lack of acceptance of active gaming technology on the part of residents/clients and other staff in the facility, particularly nursing:

“The biggest obstacle is your staff attitude.”

Finally, those interviewed reported less success with tennis, golf, boxing and baseball:

“We did try the tennis, that was probably a lot harder for them, that’s why we ended up back at the bowls.”

“We tried golf one day, but we got lost...they couldn’t hit it [golf ball].”

**DISCUSSION**

Until recently, VR technology was quite complex, expensive and task oriented. The video gaming industry has brought VR into people’s homes with the current generation of gaming consoles and active gaming software. As it was the first commercially available active gaming system launched, Nintendo’s Wii™ has garnered much media attention and, more
recently, research interest. Early studies conducted using Wii™ focused on youth (Deutsch et al. 2008; Graves et al. 2007; Graves et al. 2008). With Wii™ now embraced by managers of retirement communities, seniors’ centres, aged care facilities and rehabilitation centres for recreational and therapeutic purposes, 20 studies have recently been published.

The literature review findings generally support the feasibility of Wii™ as an intervention with older populations, however sample sizes were small, a diverse range of outcomes were investigated and the “dose” of activity (duration and frequency of sessions) varied widely between studies. Further, the longest active intervention period was only 12 weeks. Due to limitations in study design, the evidence of the physical and psychosocial benefits of playing Wii™ must be interpreted with caution. Smith and colleagues (2010) have also noted the lack of objective data regarding the effectiveness of off-the-shelf exergames, particularly from a rehabilitation perspective. Only three randomised controlled trials have been conducted to date (Hsu et al. 2011; Jung et al. 2009; Saposnik et al. 2010), but all used another form of activity as the control group (exercise or another form of recreation). In contrast, most researchers reported good adherence to Wii™ interventions and participant enjoyment which supports the acceptability of Wii™ to older adults across the continuum of care.

The findings from our qualitative study and those reported by Higgins et al. (2010) point to increased social interaction amongst residents/clients and engagement with staff during Wii™ sessions. Bowling was by far the most popular program in all the facilities, probably because it was the easiest for residents/clients to learn. This is also the game most research teams selected for their intervention (Clark and Kraemer 2009; Hsu et al. 2011; Sohnsmeyer et al. 2010; Weybright et al. 2010). Interestingly, it was only in the qualitative studies that difficulty or frustration with the technology was mentioned (Higgins et al. 2010). There are no established guidelines for the safe and effective use of Wii™. From a safety perspective, this has serious implications given the emerging literature on injuries associated with Wii™ use (Sparks et al. 2009). Wii Fit™ holds promise for balance testing and training to reduce falls risk in older people, without the need for expensive equipment and clinical settings. However, the WBB needs more rigorous testing in real world conditions to determine its reliability, validity and use as an intervention to improve balance abilities. In only two studies has the energy cost of playing Wii™ Sports and Wii Fit™ been measured in older people (Graves et al. 2010; Wollersheim et al. 2010). Further, just the aerobics exergame could be classified as moderate-intensity physical activity. With the exception of aerobics, most games involve sporadic bursts of activity (Graves et al. 2010) or are played whilst seated (Wollersheim et al. 2010). However, finding any of the games enjoyable may change older adults’ attitude towards physical activity and enhance their belief in their capability to be physically active, possibly leading to the adoption of an active lifestyle in other ways.

Since the release of Wii™, there have been further advances in gaming technology. Nintendo developed a new controller, the Wii Remote™ Plus. A gyroscope has been added which determines rotational motion more accurately, thus capturing complex motion. In Wii™ bowling, for example, a player no longer has to release a button on the back of the controller whilst swinging their arm. This improvement may overcome one of the barriers to participation mentioned by aged care staff interviewed in the present qualitative study and also reported by Higgins et al. (2010). Both Sony (Sony Computer Entertainment Inc., Tokyo, Japan) and Microsoft (Microsoft Corporation, Redmond, Washington) have developed hardware and software for the active gaming market.

Sony’s PlayStation® Move is a motion-sensing game controller platform for the PlayStation® 3 video game console. Based on a handheld motion controller wand, PlayStation® Move uses the PlayStation® Eye camera to track the wand’s position and inertial sensors in the wand to detect its motion. Microsoft released Kinect™ for Xbox 360 at the end of 2010. Kinect™ has been called a “webcam on steroids” (Wilson 2010). It is equipped with a microphone and video chat software that allows users to interact in real time using their televisions. More importantly, Kinect™ uses invisible infrared light to track the player’s movement. Without the need for a handheld controller, Kinect™ for Xbox 360 may be more suitable for use with older populations than PlayStation® Move and Wii™.
As broadband-enabled healthcare expands and gaming technology advances, gaming consoles could be used for more than recreation. In addition to the potential health benefits, connecting older people to peers or health professionals via broadband may be a strategy to counteract the social and physical isolation experienced by a growing number of those living in the community (Findlay and Cartwright 2002).

CONCLUSIONS

Nintendo’s Wii™ is acceptable to older people and feasible to implement in both rehabilitation and aged care settings. However, there is a need for more rigorous evaluations to assess the functional benefits of active gaming, particularly in the group settings that were found to be common in practice. Research evidence will assist practitioners working with older people to make an informed decision regarding the suitability of the various gaming systems for their residents/clients. Further research will also inform the development of guidelines for safe and effective use of active gaming technology. Games for health represent a growing field in software development. However, given the findings from our qualitative study and the survey conducted by Higgins and colleagues (2010), game developers need to ensure that games for older people are tailored to their physical and cognitive abilities. Within a broadband-enabled society, there is great potential for active gaming technology to play an important role in health promotion initiatives for older people. First, however, the fun and enjoyment of virtual physical activity must be translated to meaningful improvements in function and mobility.

ACKNOWLEDGEMENTS

The authors wish to thank the staff from the RACF and day programs for sharing their views with us, and Ms Niruthikha Mahendran, a doctoral student in the School of Health and Rehabilitation Sciences at the University of Queensland, for conducting the Queensland interviews.

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**APPENDIX 1 – CAN WII™ WORK IT OUT? INTERVIEW QUESTIONS**

1. When did you/your facility purchase the Wii™ system?
2. Did you have any difficulty first setting it up or learning to use it? Probe for: problems with hardware/software, installation problems, finding a suitable location
3. How have you incorporated Wii™ games into your recreational/diversional/therapeutic programmes? Probe for: frequency, duration, group or one-to-one programs, games most/least popular, development of training materials/guidelines for staff
4. How feasible has it been to use Wii™ with residents? Probe for: number of residents participating, seated or standing to play, amount of supervision, any injuries/problems, strengths (positive experiences) and limitations
5. How acceptable has your Wii™ program been to residents? Probe for: any benefits mentioned by residents or noticed by staff, sustainability (still popular or has the novelty worn off), new participants to the program, barriers and enablers

More than fifteen years have passed since early intravenous thrombolysis was proven to improve functional outcome in acute ischaemic stroke. However, this effective treatment is still poorly utilised in rural areas where there is a shortage of stroke specialists required for safe thrombolysis. Due to long travel times from rural hospitals to stroke centres offering thrombolysis, rural patients often fail to present within the 4.5 hour eligibility window for thrombolysis. Furthermore, the delay in receiving thrombolysis is associated with more resultant disability, as time to treatment is critical in determining functional outcome.

“Telestroke,” the application of telemedicine in assessment and management of acute stroke patients, is one solution to combat the rural-metropolitan stroke care disparity. These systems utilise real-time videoconferencing technology to provide stroke specialist guidance for rural clinicians inexperienced in acute stroke care and increase rural accessibility of thrombolysis. Both site-dependent and mobile web-based Telestroke systems are already in place overseas and have demonstrated safety, diagnostic accuracy and improvement in long-term functional outcomes. In this paper, we describe the current progress of Telestroke in Australia, including a pilot mobile system successfully set up in rural Victoria.

STROKE

Each year approximately 60 000 Australians suffer from new or recurrent strokes (NSF 2009a), with three quarters of this population aged over 65 years (NSF 2009a). Over eighty percent of patients suffer an ischaemic stroke, with the remainder caused by haemorrhage (NSF 2009a). Stroke is the second leading cause of mortality and fifth highest cause of disability-adjusted life years (DALYs) in Australia (AIHW 2010). It is responsible for 11 000 Australian deaths annually and an average loss of five quality-adjusted life years (QALYs) due to disability after a first stroke (AIHW 2010; Cadilhac 2010). DALYs and QALYs are methods by which the burden of diseases can be quantified and compared, and includes both years of life lost to death and years impaired with significant disability. For many patients, the disability from stroke leads to physical dependence on others and prevents them working or working effectively (Sturm 2002).

Disability from stroke arises from impaired perfusion of neurons that control language, movement, sensation and higher level functioning. Importantly, the duration of time for which blood flow is compromised correlates with the level of resultant disability. This suggests that time to reperfuse neurons is critical, as almost two million neurons are irreversibly lost for each minute that the cerebral circulation is compromised (Saver 2006).

In addition to the health costs of stroke, there is also a significant financial burden. The direct and indirect costs of treating stroke patients include acute hospitalisation, rehabilitation and extra expenses incurred by caregivers. For every first-ever stroke patient, the average cost of stroke care amounts to approximately AUD $57 000 over their lifetime (Cadilhac 2009).
INTRAVENOUS THROMBOLYSIS

In acute stroke, blood flow can be rapidly restored to the cerebral circulation by injecting recombinant tissue plasminogen activator (rt-PA) through the veins. This agent lyses or breaks down the clot that is occluding the cerebral arteries, and has proven efficacy in improving functional outcome (NINDS 1995; Hacke 2004). However, the danger of administering rt-PA to unsuitable patients is the risk of haemorrhagic transformation of strokes. This risk can be minimised by the involvement of an experienced stroke specialist in decision making regarding thrombolysis.

More than fifteen years have passed since the landmark National Institute of Neurological Disorders and Stroke (NINDS) rt-PA study demonstrated a 30% improvement in three month functional outcome over placebo (NINDS 1995). The therapeutic three hour time window used in the NINDS trial has since been extended to 4.5 hours, expanding the rt-PA eligible stroke population (Hacke 2008). Even within the 4.5 hour time window, the benefit is not static, with greater functional improvement correlating with earlier thrombolysis (Hacke 2004).

Beyond 4.5 hours, the risk of intracerebral haemorrhage (ICH) outweighs the functional recovery from thrombolysis. This was demonstrated by Hacke et al, who reported a hazards ratio of 1.45 when patients were thrombolysed between 271 to 360 minutes following a stroke (Hacke 2004). The increased risk of haemorrhage in thrombolysis patients was also found in the NINDS trial, which had a ten-fold higher haemorrhage risk in the rt-PA over the placebo group without a higher mortality risk (NINDS 1995). According to the International Stroke Thrombolysis Register (ISTR), current rates of intracerebral haemorrhage following thrombolysis are 6 to 8% in Australia (Simpson 2010).

In addition to functional recovery, thrombolysis also provides a net savings to the health care system (Fagan 1998; Moodie 2004). A Markov modelling approach evaluating the cost effectiveness of rt-PA showed that although hospitalisation costs increased by AUD $1.7 million, this was more than compensated for by a reduction in nursing home and rehabilitation costs (AUD $4.8 million and $1.4 million respectively for every 1000 thrombolysed patients) (Fagan 1998).

WHY TELESTROKE SYSTEMS ARE REQUIRED

The tragedy of stroke is not that an acute treatment is unavailable, but that it is poorly accessible to many rural Australians. Considering that almost 7 million (31.3%) of Australians live outside of the major cities and in Victoria, 1.4 million (25%) live in rural or remote areas (ABS 2010), this is an unacceptably large population that is deprived of gold standard stroke care. In the 2009 National Stroke Audit conducted by the National Stroke Foundation (NSF), 39% of Australians presenting to any hospital with ischaemic stroke did so within 4.5 hours but only 3% received thrombolysis (NSF 2009a). This reflects the low proportion of hospitals that have the intensive resources, equipment and stroke specialists recommended to administer thrombolysis. In Australia, only 28% of hospitals are able to offer thrombolysis. This situation is even worse in rural areas, where a mere 9% have the resources to adhere to current thrombolysis guidelines (NSF 2009b).

The NSF and American Stroke Association thrombolysis guidelines recommend rapid cerebral imaging and assessment by a physician experienced in stroke prior to thrombolysis (Schwamm 2009; NSF 2010). Unfortunately, many rural hospitals lack the expertise of an on-site stroke specialist to support rural clinicians in acute stroke management. This lack of stroke specialists is highlighted by a 2009 workforce survey, in which only 7 of 130 Victorian neurologists were found to be based outside of Melbourne (ANZAN 2010).

Compounding the problem of specialist shortage are the long distances between rural hospitals and thrombolysis capable stroke centres. Although there are numerous exclusion criteria for rt-PA use, including stroke severity, rate of improvement, and risk factors for...
haemorrhage (NINDS 1995), time from symptom onset to presentation remains the most common reason to withhold rt-PA (van den Berg 2009). This is exemplified in a study of rt-PA use, in which only 22% of patients attended the emergency department within three hours, and 5% between three and six hours (Kleindorfer 2004). Interestingly, rural patients were found to present earlier to hospital than urban patients following a stroke (Audebert 2006a), but the additional patient transport time to a hospital offering thrombolysis pushed many rural patients outside the eligibility time window.

TELESTROKE

Telemedicine is one solution to facilitate specialist-patient consultations without unnecessary transport time and to increase rural thrombolysis uptake. Telemedicine involves the application of technology to enhance remote delivery of health care (Khandheria 1996). The driving force behind its implementation is the need for health care equity in rural areas, and improved communication between clinicians at different sites. The term Telestroke was first put forward by Levine and Gorman in 1999 referring to the use of telemedicine in stroke assessment to maximise the stroke population receiving effective treatment (Levine 1999).

They envisaged communications technology being used not only for diagnostic and treatment purposes but also for educating health professionals, and enhancing recruitment of rural patients into clinical trials (Levine 1999). In this paper, we discuss only the use of Telestroke in acute stroke assessments.

In time-critical acute stroke assessments, the primary role of Telestroke is to facilitate timely stroke specialist assessments of acute stroke patients and their CT scans, and to reach a recommendation regarding thrombolysis. In practice, this involves setting up an on-site or laptop based videoconferencing system linking a rural or remote hospital to a tertiary stroke centre. The activation of this system would be initiated on the rural side by the emergency physician and CT images digitally transferred to enable a rapid decision for thrombolysis to be made by the off-site stroke specialist.

Physician attitudes towards Telestroke are encouraging. In a 2004 survey, 100% of emergency physicians reported feeling confident when managing acute stroke patients via Telestroke (Schwamm 2004). Stroke specialists and emergency physicians were optimistic that Telestroke could bridge the gap between rural and urban stroke care (Moskowitz 2010). This positive attitude was reciprocated by 85.7% patients, who believed that a Telestroke assessment by an off-site stroke specialist was as good as a direct face-to-face review (Schwamm 2004).

EXISTING TELESTROKE SYSTEMS

Telestroke systems have been introduced in America and Europe with success. Most are based on a “hub and spoke” model of care (Fisher 2005), with systems outreaching from a central stroke centre or ‘hub’ hospital to multiple rural ‘spoke’ hospitals that lack specialist stroke care. There are two broad types of Telestroke systems. When Telestroke was first introduced, systems were mostly fixed at a single site, requiring point-to-point data transmission using an integrated services digital network (ISDN) with stable bandwidth. However, more recent systems are web based and accessible from any computer with broadband access, increasing flexibility and acceptability for the remote specialist, as well as cutting down specialist travel time to the hub hospital. This means that Telestroke consultations can be conducted at any time or place by laptop alone. The accuracy of decision making using mobile systems has been validated by Audebert et al (Audebert 2008) in a controlled trial comparing hospital based and mobile systems. This particular system had inferior image resolution and only unidirectional videoconferencing capability, but mobile systems have since evolved to high quality two-way video transmission. In both fixed and mobile systems, the Telestroke work station at the ‘spoke’ site consists of a laptop with a webcam, which can be wheeled to the patient’s bed side, and from which the videoconferencing system can be uploaded (Figure 1 – Telestroke work station).
Safety and functional improvement resulting from Telestroke has been assessed using standard outcome measures in randomised and prospective trials. Common outcome measures are mortality rate, symptomatic ICH and 3, 6 or 12 month functional outcome. Functional outcome or disability is quantified by specialised scales that rate the ability to carry out certain activities of daily living, such as modified Rankin scale (mRS) or Barthel Index (BI). Other outcomes measured in the trials are the time intervals between arrival at the emergency department and CT scan or between arrival and thrombolysis. These outcomes act as a marker of efficiency of the Telestroke protocol.

Benchmark outcome levels are taken from the NINDS trial and more recently the Australian Safe Implementation of Thrombolysis in Stroke International Stroke Thrombolysis Register (SITS-ISTR) (NINDS 1995; Simpson 2010). To enable objective comparison of patients within and between stroke trials, the National Institute of Health Stroke Scale (NIHSS) was used. This is an objective scale which grades signs such as strength, speech and sensation and is used due to its high inter-rater reliability (Goldstein 1989), both between neurologists and non-neurologist physicians (Goldstein 1997). It is also the only scale that has demonstrated strong positive correlation between bedside clinician assessment and videoconference mediated remote specialist examination (Shafqat 1999; Wang 2003).

Telestroke systems overseas have shown comparable functional and safety outcomes to the NINDS trial and SITS-ISTR. The Telemedic Pilot Project for Integrative Stroke Care (TEMPiS), a point-to-point Telestroke system in Germany had an 8.5% incidence of symptomatic ICH and an in-hospital mortality rate of 10.4% (Audebert 2005). Encouragingly, the mortality rate in the TEMPiS trial ‘spoke’ hospitals were similar to results from the ‘hub’ stroke centres (Audebert 2006a) and were better than the Australian ISTR and NINDS trial, which had mortality rates of 18.6% and 17% respectively (NINDS 1995; Simpson 2010). To reinforce this finding, a 2006 non-randomised interventional study of Telestroke networked and control hospitals reported an odds ratio of 0.62 for death, institutionalisation or severe disability (Audebert 2006b).

Whilst the safety outcomes are reassuring, the TEMPiS study showed that there are still significant differences in thrombolysis rates and door to treatment times between ‘hub’ and ‘spoke’ hospitals. Thrombolysis at the ‘spoke’ hospitals occurred in less than half the proportion of patients at the ‘hub’ hospitals (2.4% vs 5.8%, p<0.01) and door to treatment time was also significantly longer in the ‘spoke’ hospitals (65min vs 57min, p=0.03) (Audebert 2006a). Despite these differences, long term functional outcomes from both ‘hub’ and ‘spoke’ hospitals were comparable. At 6 months, 39.5% ‘spoke’ and 30.9% ‘hub’ hospital patients had a good functional outcome following thrombolysis as reflected by the mRS scores (Schwab 2007).
In comparison to the fixed TEMPiS system, The Stroke Doc (Stroke Team Remote Evaluation using a Digital Observation Camera) trial conducted by Meyer et al used a web based, two-way videoconferencing system (Meyer 2005). This successfully demonstrated that audiovisual assessment resulted in superior accuracy of decision making regarding thrombolysis over telephone consultation alone (Meyer 2008).

Another mobile system based on broadband Internet for data transmission was used in the REACH (Remote Evaluation for Acute Ischaemic Stroke) trial involving five ‘spoke’ hospitals in rural Georgia (Wang 2004). This system was even further advanced, utilising an integrated system with a user friendly interface that incorporated digital CT images, patient vital signs and ability to input data and recommendations (Wang 2004). The most encouraging aspect of the REACH trial was the improvement of Telestroke efficiency with experience, reflected by a drop in onset to treatment time from 143 min in the first 10 patients to 111 min in the last 20 patients (Hess 2005).

TELESTROKE IN AUSTRALIA

Australia has lagged behind its overseas counterparts. To our knowledge, there is only one operational Telestroke system serving rural Victoria. The RMH-NHW Telestroke Project, a pilot mobile Telestroke system was set up in October 2009 between the Royal Melbourne Hospital (RMH) and its rural partner, Northeast Health Wangaratta Hospital (NHW) in Victoria (Nagao 2011). NHW is a regional hospital servicing a catchment population of 90 000 people and did not have rt-PA experience, a stroke care unit or stroke specialist prior to implementation of Telestroke (Northeast Health Wangaratta 2011). The system used was a two-way high-resolution videoconferencing system (30 frames per second video), which could be accessed by any computer with wireless broadband Internet (download speed 1.5 Mbps, upload speed 720 kbps). Mounted on the laptop was a web camera (Logitech Pro C910, HD 1280 x 720 pixels).

In its first year of operation, of 119 acute stroke patients, 8 (6.7%) received thrombolysis through Telestroke facilitated consultations by RMH neurologists. Importantly, there were neither symptomatic ICH nor deaths attributable to thrombolysis. The one unfavourable outcome was the longer than expected door to CT time of 70 minutes, compared to the median of 15 minutes in the TEMPiS study (Audebert 2006a; Nagao 2011) and highlights potential for further improvements with streamlining of the Telestroke protocol.

BENEFITS

Facilitating thrombolysis is only one aspect of enhancing stroke care, and Telestroke can aid in other domains including subacute care, secondary prevention and rehabilitation. By facilitating a clinical review of stroke patients and their radiology by specialist neurologists, unnecessary patient transfers can be avoided. On the other hand, early identification and transfer of patients appropriate for interventions such as intra-arterial clot retrieval or hemicraniectomy can also be facilitated (Tatlisumak 2009). Telestroke also raises the opportunity to recruit rural patients into acute stroke treatment trials and entice young physicians to rural hospitals with the opportunity for Telestroke consultation (Tatlisumak 2009).

COST

Thrombolysis is a cost effective intervention, confirmed by cost analysis studies. Initial analyses are promising, with the REACH trial costing US $6000 for the telemedicine cart and Internet connectivity when starting up, with minimal ongoing costs, mainly to maintain broadband internet access and CT scanner (Hess 2005). Locally, the Telestroke system between NHW and RMH cost AUD $7 300 to set up. This included the cost of the videoconferencing system, and wireless broadband. In addition, the two existing laptops cost
AUD $5000 in total and the pan-tilt-zoom web camera cost AUD $300. Estimated maintenance costs were AUD $2 000 per annum for the videoconferencing soft ware and wireless modem (Nagao 2011). These costs do not vary according to usage and do not include reimbursement costs of the specialist neurologists.

BARRIERS

Medicolegal and financial barriers to Telestroke were raised as early as 1999 by Levine and Gorman who identified a range of issues to be addressed in order to develop a sustainable system. There is still ambiguity regarding who will reimburse and insure specialists for remote consultations conducted via Telestroke, and questions regarding medical liability, licensing, and patient confidentiality (Vyborry 1996; Levine 1999). A survey of stroke specialists and emergency physicians perceived common barriers to be medical liability, the ambiguity of reimbursement and costs of installation (Moskowitz 2010). Stroke specialists were also concerned about possible increase in workload whilst emergency physicians worried about management of rt-PA side effects, perceived patient preference for physical consultations and level of technology required (Moskowitz 2010). With regards to the technology, a standard of minimum specifications for Telestroke systems to replicate successful functional and safety outcomes needs to be determined, including the bandwidth required for data transmission and screen resolution. This should be accompanied by a method for ongoing evaluation or audit of systems to ensure that they comply with safety standards. Patient concerns regarding the privacy of medical records and security of data transmission need to be addressed as well (de Bustos 2009). Finally, initial failures in telemedicine occurred due to reliance on grants (Levine 1999), raising the importance of sustainable funding to maintain Telestroke systems once they have been implemented.

FUTURE DIRECTIONS FOR TELESTROKE

Much has been learned from evaluating the teething problems of initial Telestroke systems, and as a result, evidence based recommendations have been put forward for the development of future systems. The American Stroke Association recently provided a comprehensive review with suggestions including the use of NIHSS for remote rating of stroke severity, review of digitalised CT by stroke specialists or radiologists, and a stroke specialist opinion regarding rt-PA following assessment via high quality videoconferencing systems (Schwamm 2009). Building on these recommendations, Switzer et al’s vision is of “Telestroke 2.0” a web-based system, which integrates audiovisual technology, electronic medical records, teleradiology, real-time patient observations, laboratory data and clinical guidelines, as well as the capability to input data and recommendations (Switzer 2009). Several studies have also set down recommendations for technological specifications, suggesting high resolution 1280 x 1024 pixel monitors, videoconference quality of 25-30 frames per second, a stable bandwidth of at least 300 kbps per second and remote control camera with rotation, tilt and zoom (Audebert 2006; de Bustos 2009). Further studies are needed for evidence based technology specification standards.

CONCLUSION

Telestroke has presented itself as an important element in the future of rural health care. First in the USA and Europe and now in Australia, safe, feasible Telestroke systems have been implemented, with improvements in health outcomes and accessibility to rt-PA in previously disadvantaged areas. By bypassing the rural specialist shortage through two-way interactive videoconferencing systems, the nature of traditional physician-patient interactions has changed without compromising the quality of health care. Ongoing advances in technology have seen a shift from fixed point-to-point data transmission systems to web-based systems that can be accessed anywhere there is broadband Internet connectivity. However, financial, legal and technological barriers remain to impede a wider spread utilisation of Telestroke.
There is no doubt that Telestroke systems can be implemented with significant health benefits. Now the issue is whether these systems can be maintained. It would be negligent not to invest in this rapidly progressing field to finally bridge the rural-urban stroke care disparity.

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The authors present the findings of a small exploratory pilot study investigating how people with little or no speech communicate with General Practitioners (GPs) and whether there is any potential for high-capacity broadband to facilitate communication in this context. A focus group with four individuals with little or no speech and three interviews with GPs were conducted in Melbourne in 2011. Thematic analysis of the data collected indicated that the main challenges to effective communication were the time allocated to face-to-face consultations, patient frustration at being misunderstood, patients’ experiences of communicating with GPs through receptionists and other staff, and GPs’ understanding of the patient’s unique communication needs. Factors said to support effective communication included having an ongoing relationship with a regular GP, allocating patients a longer appointment time-slot, and training in communication disability for all primary health care staff. Patients and GPs felt there was potential for the use of telecommunications, including high-capacity broadband, in this context but their views differed. Patients expressed a concern that broadband was not affordable and a desire to use email to communicate with GPs. GPs were open to considering the use of email in principle but expressed concerns about security of transmission, staffing infrastructure, determining urgency, and medico-legal constraints. The authors conclude that research surrounding the future of telehealth must be firmly grounded in the needs of the user (patient/GP) and the communicative function the technology is designed to enable. Further rigorous research on this topic is needed.

INTRODUCTION

This paper documents a small exploratory pilot study funded by the Institute for a Broadband-Enabled Society (IBES). The authors explore the role of high-capacity broadband in connecting people with little or no speech (LONS) with General Practitioners (GPs) and present the findings of a focus group and three interviews with participants from both of these populations. Conclusions are then drawn about the issues surrounding communication and the role of Internet technology in this context.

BACKGROUND

The federal government announced in 2009 that it would fund a national network connecting Australian premises to a high-capacity broadband service (NBNCo 2011). One of the central justifications was the capacity to provide sophisticated and reliable applications for Internet-based healthcare. High-capacity broadband could facilitate communication among and
between patients, health professionals and health services, addressing issues of access, availability, workforce distribution and distance. The National Broadband Network (NBN) is expected to help patients overcome barriers including distance, cultural and linguistic differences and disability. While some services already exist, such as the National Relay Service (NRS), “a phone solution for people with hearing or speech impairment” (NRS 2011), they face unmet challenges that need to be addressed.

While most Australians interact with the health system by a visit or two to a GP each year, there are many with complex needs who engage with a wide range of healthcare providers. Many people with and without disabilities require regular access to health services and in some cases people with disabilities experience a number of additional barriers and access issues.

One in seven Australians has a communication disability (Speech Pathology Australia 2011). Some of these individuals experience difficulties with the physical production of speech sounds (expressive speech), which may be due to a physical impairment such as Cerebral Palsy. In some cases people may only be able to produce a little unintelligible speech. The authors refer to this population as having little or no speech (LONS). Research has shown that people with LONS due to a physiological disability can experience sub-standard care due, directly or indirectly, to their disability (O’Halloran, Hickson et al. 2008; Aulagnier, Verger et al. 2005). This research aimed to explore the potential of high-capacity broadband to facilitate communication between people with LONS and health professionals, specifically GPs.

LITERATURE

A narrative literature review was conducted with the aim of exploring what is currently known about:

1. communication needs in healthcare,
2. the standard of healthcare provided for people with a disability, particularly those with LONS and their interaction with their GP, and
3. the use of technological solutions that enable communication in healthcare (Greenstock and Wickham 2011).

These aims involved a number of overlapping and interrelated areas of research which would inform a small pilot study. A number of studies concluded that communication is a critical part of healthcare and that breakdowns can have severe consequences for patient safety. For example, in a review of surgical malpractice cases, 60 out of the 444 cases, 13%, were found to be related to an incidence of communication breakdown (Greenberg, Regenbogen et al. 2007), indicating the severity of the costs of poor communication.

Receiving meaningful communication that is “open, timely and appropriate” is a formally acknowledged right for patients in Australia (Australian Charter of Healthcare Rights 2010), yet there are a number of patient groups for whom communication in this context is challenging. People representing linguistic minorities and people with communication disability may be among those most at-risk of communication breakdown in healthcare (Balandin, Hemsley et al. 2007; Greenberg, Regenbogen et al. 2007; Smith 2009). Research has shown that persons with disabilities are at “an increased risk of experiencing ineffective patient-physician communication” (Smith 2009, 206). Healthcare professionals can be misled by their perceptions and misunderstandings of disabilities (Addington-Hall and Kalra 2001; Aulagnier, Verger et al. 2005), which can result in difficulties in accurately understanding the patient’s communication needs. The impact on these patients can be significant and there is also evidence to suggest that these populations “use primary preventive health services less than general populations ... have poorer overall health outcomes ... more preventable emergency room visits and hospitalisations ... and they report more unmet needs and dissatisfaction in the services they do receive” (Hwang et al. 2009, 28). Patients with disabilities may be most at risk of “injury through neglect, delayed diagnoses, or inadequate
treatment” (Kirschner, Breslin et al. 2007). Patients with disabilities report a poorer standard of care (Balandin, Hemsley et al. 2007; Nieuwenhuijsen, van der Laar et al. 2008).

People with LONS suffer from an inequity of access to the higher level of quality healthcare that most non-disabled Australians take for granted. There is evidence to suggest that access to healthcare for this cohort is even poorer than that of the broader disabled population, and that their health and right to actively participate in decisions about their healthcare can be directly compromised (O’Halloran, Worrall et al. 2009, 601).

The existing literature indicates that people with communication disabilities are at risk of substandard care and adverse events, possibly even resulting in harm or maltreatment. Very little literature was identified which explored these risks in any detail or identified possible ways to address this issue, other than having a family or caregiver present in consultations (Aulagnier, Verger et al. 2005). Many patients with LONS depend on specialised equipment to overcome their difficulties with speech. This equipment ranges from relatively low-tech (e.g. electronic ‘pads’ that speak aloud typed symbols) to very high-tech (technology exists that is able to respond to the tiniest muscle contraction).

Though these technologies exist in a health care context the communicative preferences of the patient may come up against a lack of appropriate infrastructure and varying levels of adoption by health professionals, and other staff. There is very little research on this topic.

Despite the complexity inherent to the sector, there are examples that demonstrate technology’s capacity to contribute to better healthcare. Ehealth has been conceptualised as a broad overarching move towards increasing and improving the role of electronic systems in health. A major review by the Swedish Ministry of Social Affairs entitled “eHealth for a Healthier Europe” concluded that the application of ehealth in actual clinical settings improved patient safety and clinical efficiency and reduced costs (Gartner 2009). For example, electronic systems reduced duplicated laboratory tests, reduced hospital admissions through the use of telehealth home monitoring systems and reduced prescription errors.

To be more specific, telecommunication technologies afford significant opportunities for LONS patients, particularly in situations when it is possible to provide healthcare at a distance. However, telehealth models of care appear to be under-researched and so there is little to inform the development of strategies that would empower patients with healthcare professionals. Many telehealth solutions rely on a suitable standard of Internet connection. Current research indicates that this is another barrier to redressing the inequity of access. Amichai-Hamburger et al. (2008) referred to the ‘disability divide’ in Internet access and use and there is evidence to suggest that people with disabilities are less likely to have an Internet connection at home or use a mobile phone (D’Aubin 2007; Amichai-Hamburger, McKenna et al. 2008).

**METHODOLOGY**

The research was given full ethical approval by the Human Research Ethics Committee at the University of Melbourne (reference number 1034339.1).

The research adopted an exploratory qualitative study design and utilised an inductive approach in the collection and analysis of data. A combination of one focus group and three one to one semi-structured interviews were used.

**Participants**

Participants were recruited from two population groups identified in the sampling criteria below.
Population Group 1
People who meet the following criteria:
Have little or no speech (self report) (focusing on individuals with Cerebral Palsy and Acquired Brain Injury)
Use or have used the Internet (self report)
Live in Victoria

Population Group 2
People who meet the following criteria:
General Practitioners who have, or may have, patients with little or no speech (self report)
Use or have used the Internet (self report)
Live and work in Victoria

Figure 1 – Sampling criteria

The population of individuals with LONS were identified by Communication Rights Australia, an organisation that has professional links with, and provides advocacy, for a number of these individuals. It initially identified potential participants for Population Group 1 (people with little or no speech). A number of individuals with LONS had previously consented to sharing their contact details with Communication Rights Australia prior to this study. A representative from Communication Rights Australia sent the initial project information to individuals meeting the sampling criteria. Contact details were not shared with the researchers or any third party. Participants sent a return email to Communication Rights Australia indicating they are interested in taking part.

After responding to the advertisement through Communication Rights Australia, participants with LONS were invited to take part in a focus group. The four participants took part in a focus group two hours in length, which was audio and video-recorded with their full informed consent. Chief Investigators followed a framework of questions (see Appendix 1) and ensured all participants had the opportunity to respond. Two participants spoke unaided during the focus group, one used a communication aid (a Polyana Communication Device supplied by Technical Solutions Australia) in addition to unaided speech, and the fourth used speech interpreted by a facilitator (the CEO of Communication Rights Australia). Participants were reimbursed for their travel costs and were remunerated with a sitting fee for their time and participation.

For Population Group 2, an advertisement was simultaneously sent to GPs via the Victorian Primary Care Practice-based Research Network (VicReN) coordinated by the Department of General Practice at The University of Melbourne. GP members of VicReN received information about the project by email. There was no response from GPs to this advertisement. One of the Chief Investigators was employed by, and positioned at, General Practice Victoria. The advertisement was then sent to GPs using a weekly bulletin operated by GPV. Three GPs made contact as a result of sending the information out through this medium.

Two interviews were conducted over the phone and one was conducted face to face at the GP clinic in the suburbs of Melbourne. The Chief Investigator followed a framework of questions (see Appendix 2) and encouraged participants to speak openly about their experiences surrounding the interview topics. Interviews were audio-recorded with the full informed consent of the participant.

The focus group and interviews were transcribed and anonymised. Transcripts were then thematically analysed with the support of QSR NVivo data management software. Coding was discussed by the researchers and meanings were negotiated to ensure inter-rater reliability. The most prevalent nodes were developed into themes and passages were extracted.
FINDINGS

Four main themes arose in the interviews. In descending order of prevalence, these were:

1. communication in health care,
2. disability awareness and training,
3. the Internet and email, and
4. patient-centred care and continuity of care.

1. COMMUNICATION IN HEALTH CARE

All of the participants placed a great deal of importance on the ability to effectively communicate in their interactions with a GP or a patient. Communication in the General Practice healthcare context was seen to be of critical importance.

GP1: \([\text{communication is}] \text{ critically important, that's what makes people doctors as opposed to vets isn't it [laughs]? }\) (GP1)

All of the GPs and patients interviewed had experienced the complexities of patient-doctor communication when the patient was experiencing communication difficulties. The presence of difficulties with expressive speech was not seen as an insurmountable barrier to effective communication. Factors supporting doctor-patient communication were related to who was communicating with whom, what was being communicated, where the communication was taking place, why the communication was necessary, and how the message was being communicated.

Outside of a face-to-face consultation, patients were largely making contact to request an appointment or ask a question based on a health concern. During the face-to-face consultations the length of the appointment was sometimes seen as an issue.

\[\text{“a lot of extra time is required to be able to give that person the full attention and do everything that you need to do within a consultation ... ... The biggest challenge is having allocated enough time” (GP3)}\]

Communication between patients and GPs took place at various locations. Most often patients initiated contact from their home via the telephone or went into the clinic to make or attend an appointment. Similarly, GPs were almost always in the clinic at their current place of work when communicating with patients with LONS. Most frequently, patients made contact with the GP, via the clinic receptionist, in order to request an appointment. Messages were communicated between patient and GP using a variety of methods or communication modes and channels including: standard telephone calls, text messages (SMS), written notes, paging, email, fax and the National Relay Service (NRS). In many cases a blend of these communication channels was used to meet the needs of the patient and the GP.

\[\text{“for somebody with expressive difficulty, there is a range of techniques that we would use” (GP2)}\]

Face to face verbal communication was commonly referred to by all of the participants but patients and GPs alike had experienced difficulties with this, mostly relating to the patient’s difficulties with expressive speech.

\[\text{“Hopefully I can make myself understood but my speech quality varies considerably” (FG3)}\]

Telephone also held the same challenges of negotiating meaning as were experienced when communicating verbally face to face. Several of the patient participants had received information about appointments with the GP by SMS/text message but several of the GPs raised concerns about the accuracy and interpretation of the message contained within a text and the difficulty in clarifying the intention of the message.
“generally we make an appointment ... and the day before they will send a text to confirm” (FG2)

“It’s all very well for people to text, but if they don’t text the practice appropriately for somebody that’s going to answer them then they’re wasting their time” (GP1)

Diagrams and visual systems were sometimes linked to communication aids used by some individuals with communication difficulties. Two of the patient participants were interested in the idea of a diagram designed to allow patients with difficulties with expressive speech to point to a picture of the human body and indicate what type of symptoms they were experiencing.

“that diagram idea ... if you could put that up on an interactive Website that would be terrific ... you would have to have the GP at the other end ... you could just mouse click wherever you were feeling pain” (FG1)

Email was raised by many interviewees and has been developed into Theme 3 (see below).

2. DISABILITY AWARENESS AND TRAINING

Patient participants spoke in detail about their experiences of how well- or un-trained health professionals were in the area of disability awareness. Understanding the nature of various ‘types’ of communication disability was an issue that some patients and one of the GPs felt was lacking for some health professionals. In particular, the sensitivity of the differences between individuals with expressive and receptive language difficulties was mentioned by several of the participants, patients and one GP.

“A lot of GPs don’t understand or haven’t thought about the differences in receptive and expressive abilities” (GP2)

Two of the patient participants expressed a great deal of emotion relating to interactions they had had with medical professionals in the past. In several cases, they had been offended by being judged as intellectually disabled because of their speech.

“... their (GPs) education seems to be on prescribing or picking bones ... surely you can teach a bit of bedside manner before you let them loose on the public” (FG1)

Patients’ experiences of receptionists and ‘gatekeepers’ indicated that training and improved disability awareness were important for these professionals as well.

“the attitude of some Receptionists in General Practice that seem to regard themselves as gate keepers and ... getting past them to the Doctor can be pretty confrontational as well” (FG1)

“The receptionist is the front person, the first port of call. Sometimes, far too often, receptionists probably don’t get the kind of induction and in-service training that they really need in order to play that important role, particularly for vulnerable people” (GP2)

3. HEALTH, THE INTERNET AND EMAIL

Having discussed the factors influencing communication between GPs and patients with LONS, participants were asked to explore their thoughts and experiences of the role of the Internet in facilitating these interactions and the transmission of information between the patient and GP. The two major themes that emerged were email and online teleconsultations. Email was more of a prevalent theme among the patient participants, while GPs discussed the concept of online teleconsultations.
“With this new broadband ... they're talking about the possibility that it's going to be like having somebody virtually in the room with you ... that sort of scenario ... would make it ... more realistic, for people, the health professional and the patient” (GP3)

GPs expressed caution overall at the notion of ‘replacing’ face to face consultations with online consultations and suggested that some of the same issues would remain, for example, needing longer consultations if the patient has a communication difficulty. GP2 felt strongly that online consultations should not become the standard for people with disabilities as this may contribute to further social exclusion.

“You’ve got the same time issues face to face as you would on a video conference type thing. But I don’t think that would ... make it better or worse. But it might make it easier at the other end (patient end)” (GP1)

“One wouldn’t want to see people with disabilities sort of always having these teleconferences instead of seeing their doctor in person” (GP2)

In contrast to GPs, patients did not raise the concept of online consultations and did not outwardly express a link between having mobility difficulties and seeking an alternative to face-to-face appointments at the clinic. This finding may be partially related to the patients’ concerns about the affordability of broadband, which was a theme within the data.

“I think at least three of us here are on Dial-up ... .... if you are on Dial-up you can sit there for 10 minutes waiting for it to load” (FG3)

“I would like Broadband. Like everyone else” (FG1)

“I would like] broadband ... to be able to use it to send a message to ... local GP” (FG2)

Patients’ conversations about the role of the Internet in facilitating communication with GPs were primarily related to the increased role of email. All four patient participants were very interested in using email to send and receive messages from their GP and other health professionals for various communicative purposes. Initiating contact and making appointments was the main circumstance in which this would apply. For patients with communication disability the benefits of using email was that they could compose a message in their own time and could read and check the message they had composed.

“Maybe it would have been better if I could have emailed the specific Doctor” (FG2)

“I find it easier if I email the relevant ... ... I ... express myself better in email” (FG4)

GPs were generally in support of using email in principle but expressed concerns about the security of email for sensitive health-related information, their medico-legal rights.

“We could have an exchange of e-mail without any difficulty at all ...” (GP2)

“There’s no reason why we couldn’t set up an email but we don’t want an open slather” (GP1)

A concern for GPs was the lack of existing infrastructure and appropriate staffing arrangements to support email communication with patients. It was generally agreed that an email system would require a dedicated member of staff attending to the emails being received at all times.

“if it was going to be something that somebody used where they required an immediate response, you’d need to have something set up so if you weren’t there somebody else could take that email” (GP3)
A further concern for GPs was the negotiation of the urgency of the information contained in the email, which, it was argued, would be difficult to determine through purely the email content.

“it would be quite hard for a receptionist to work out from an email sometimes the urgency of it” (GP2)

This would largely relate to who was receiving the email, for example, the doctor at the clinic would be more appropriately trained to further explore the urgency of the matter.

“it’s not going to work in an emergency situation or an urgent - I need an appointment today situation. But it might work I need an appointment within the next two weeks to have my blood pressure checked and repeat some prescriptions” (GP1)

Patients also reported problems with using email in a health care context. Several of the patient participants had experienced emails ‘bouncing back’ and in several cases there was a delay in receiving a response, which further supported the GPs’ concerns about addressing the urgency of the matter.

“I have actually had a problem twice and it hasn’t been the message but it has been the over-zealous filter ... ... you don’t expect them [emails] to bounce with a Health Service” (FG1)

“my email will bounce, I keep trying and trying” (FG4)

Some GPs had concerns about the medico-legal factors involved in using emails and expressed caution over adopting an email system in dealing with patients.

“I guess with using email, my first response would be to check with my medical defence organisation” (GP3)

4. PATIENT-CENTRED CARE AND CONTINUITY OF CARE

There was a general consensus among the participants that having a regular GP was best for ensuring continuity of care and learning the best way to communicate effectively so that the patient’s needs are met. GPs made clear that they prefer to ‘know’ something about the patients they meet and the more detailed this information the better. This was also the patients’ preference.

“I have known my GP for 20 years and go there every month ... He drops in every month ... I deal with him directly ... He knows my communication” (FG4)

“I think it is important to keep the same GP as far as possible but at the same time as well as keeping a good relationship” (FG3)

One of the reasons that GPs and patients favoured the development of a continuous patient-doctor relationship was the time taken to negotiate meanings and ensure that both conversation partners have been able to make their meanings understood.

“Most of the time I think we end up with the right answer but it takes a longer to get there” (GP1)

DISCUSSION

This research found that patient-doctor communication is central to patient satisfaction. The patients in this study did not appear to interpret their experiences of healthcare as ‘substandard’ but expressed some strong opinions about the training of GPs and other professionals in understanding types of disability. The most severe ‘adverse events’ reported were related to insensitive assumptions about the nature of the patients’ abilities or disabilities, namely a health professional assuming that a patient has an intellectual
impaired. Patients who had interpreted a GP’s style of communication as insensitive or disrespectful appeared distressed by this experience.

GPs in the study appeared committed to accommodating the communication preferences of patients and adhering to the Charter of Healthcare Rights for communication in healthcare. All three GPs, however, were very cautious about the constraints of infrastructure, staffing and legal factors. There was a slight mismatch in how patients wanted to communicate with GPs and what GPs thought was currently ‘possible’ or ‘allowed’.

All four patient-participants appeared to have developed ways to navigate the health system effectively by developing a relationship with a GP. Having a regular GP who was familiar with their communication preferences was one such strategy. The research found that patients and GPs are frequently flexible in negotiating how to communicate and would be open to considering the role of high-capacity broadband and other technologies. The execution of any form of broadband-facilitated communication would depend upon the patient being able to afford the technology and installation, and the health setting having a staffing, infrastructure and legal framework in place.

LIMITATIONS

This study had a number of limitations relating to its size and duration, the researchers’ understanding of the needs of the research populations, and the lack of conclusive evidence on which to base future testing of broadband solutions. In the future the researchers would endeavour to collect baseline quantitative data about access to broadband technology in the research populations to guide the formulation of research projects grounded more fully in the needs of the research populations.

CONCLUSION

In conclusion, all patients deserve access to the same level of health care. Communication is an essential component of effective healthcare, yet patients with LONS are often disadvantaged by barriers to communicating with healthcare professionals and from the misunderstandings often propagated within the healthcare setting. This study suggests that when communication is not optimal, both healthcare providers and patients must make allowances and develop suitable methods for overcoming the deficiencies.

Technology has been shown to improve health care, but the mere existence of technological infrastructure does not intrinsically guarantee benefit. Great care must be taken to design and develop solutions that will appropriately and suitably address the needs of specific patient groups. The design process must include consultation with all stakeholders, particularly the patients and clinicians who are the ultimate users of ehealth systems.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the generous funding contribution made by the Institute for a Broadband-Enabled Society and the support and guidance of Jan Ashford at Communication Rights Australia.
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APPENDIX 1 – FOCUS GROUP TOPIC GUIDE

Focus Group 1 – Participants with little or no speech

Topic Guide

Introduction
Ethical considerations: How the reference group will operate
Aims of the reference group

1. Participants with little or no speech are invited to say a little about how they make contact with their GP and how their GP makes contact with them
   Comments/discussion invited

2. Participants with little or no speech asked to talk about the challenges they have experienced in making contact with their GP
   Comments/discussion invited

3. Participants with little or no speech asked to talk about what would make it easier for them and what would be their preferred method of making contact
   Comments/discussion invited

4. Participants are asked about their experiences of using telecommunications in their communications with GPs
   Comments/discussion invited

5. Participants invited to discuss their thoughts about the role of the internet in connecting them with GPs
   Comments/discussion invited

6. Further discussion of the points raised

7. Researcher summarises key points and shares with group to confirm

8. Final comments
APPENDIX 2 – GP INTERVIEWS TOPIC GUIDE

Focus Group 2 – General Practitioners

Topic Guide

Introduction
Ethical considerations: How the reference group will operate
Aims of the reference group

1. GP participants are invited to say a little about how their patients with little or no speech make contact with them and how they make contact with their patients
   Comments/discussion invited

2. GPs asked to talk about the challenges they have experienced in making contact with their patients with little or no speech
   Comments/discussion invited

3. GPs asked to talk about what would make it easier for them to make contact with their patients with little or no speech and what would be their preferred method of making contact
   Comments/discussion invited

4. Refer to key themes from focus group 1 and ask participant to respond

5. Further discussion of the points raised

6. Researcher summarises key points and shares with group to confirm

7. Final comments

In this article we address the health-related barriers to independence of older adults and review the evidence for the use of telehealth technologies to facilitate and promote continued independence. In particular we outline a program of research at Neuroscience Research Australia which aims to (1) design, develop and implement of broadband-enabled videogame technology framework to facilitate independent living in older adults and (2) assess the effectiveness of home-based videogame technologies to impact upon age-related health issues that significantly reduce independence in older adults. We show as an example work we are doing to address the issue of postural instability and falls in older adults.

INTRODUCTION

The majority of the world’s increasingly older adult population requires some form of care due to loss of function following failing health and the costs associated with this care are steadily increasing. In Australia, more than a quarter of Australian government spending is currently directed to health, age-related pensions and aged care. Without an intervention to curtail the increasing financial impact of aged healthcare, the Australian government spending on these areas is projected to increase significantly, pushing total spending to almost half by 2049-50 (Intergenerational Report 2010).

Declines in physical or cognitive function are associated with age-related degeneration of, or injury to, the brain and nervous system. Neurodegeneration and neural injury contribute to parallel declines in self-confidence, social interactions and community involvement. A cycle is set up, where social isolation leads to further loss of confidence, leading to further isolation. The social circle contracts as friends age or pass away, and a greater emphasis on family is often a result. Fear of a major incident such as a stroke or a bone-breaking fall (Delbaere et al 2009) can lead to the decision to move into a supported environment. Moving from an individual’s private home into an aged care setting is then viewed as a major step in the loss of independence and quality of life.

Continued successful independent living is a high priority for older people and those who work with and for them (LeeSon et al 2003). Therefore monitoring the physical, cognitive and social markers of health, and comparing them to clinical models, enables us to draw conclusions about the current physical, cognitive and social health of the individual and their capacity to remain living independently. However, assessment of these variables usually depends on labour intensive and obtrusive manual assessment by clinical professionals that require the individual to travel to a central clinic or hospital facility. In remote and rural communities, especially in a country like Australia, the distance, inconvenience and expense of travel often make routine assessment of health very difficult. There is therefore a pressing need to develop automated or semi-automated measures of health status that can be gathered from peoples’ home environments, especially for those living in regional, rural or remote Australia.
Daily, weekly or monthly home-based monitoring of health provides the ability to detect and act upon changes in these markers of health should they deviate significantly from an individual’s history or accepted clinical models of good health (Basilakis et al. 2010). Telehealth (or telemedicine) technology, which combines digital data acquisition, information and communication technologies and the internet to monitor health status in the home, is gaining attention as a promising strategy for acquiring accurate, reliable and time critical health marker data (Koch 2005), reducing healthcare costs (Noel et al. 2004), empowering patients and promoting disease self-management with resultant improved health care outcomes (Suter et al. 2011). Furthermore, a recent systematic review of studies on telemonitoring of patients with congestive heart failure concluded, “patients were living longer without increasing their use of health-care facilities” (Clarke et al. 2011). For individuals who may be isolated, either by distance in regional, rural or remote Australia, or functional impairment following neurological damage or disease, broadband-enabled telehealth technologies will also be critical for researchers to fully understand the progression of disease course, or the effectiveness of intervention strategies, over the long term (Moffatt and Eley 2009).

While telehealth technologies can provide opportunities to significantly alleviate the burden of healthcare and facilitate continued independence of the elderly, implementation of technology also faces barriers related to acceptance and use by older adults, their family and clinical support networks. Barriers may include lack of awareness of available technologies, problems in use of technology amongst older adults, lack of financial incentive/capacity to use or invest in technology, lack of adequate training or support, lack of consensus on the value of the technology, cultural obstacles and absence of adequate technology infrastructure (Mattke et al. 2010). To overcome these barriers it will be important for designers of telehealth technologies to work closely with older adults throughout the design and development process in order to learn how their preferences, attitudes and capabilities relate to technology adoption and how products and services can be designed to promote their widespread and long-term use (Demris et al. 2010; Bouwhuis 2003).

The dominant information and communication technology already adopted widely by older adults is the ubiquitous home television set. With the advent of digital television, apart from delivering news, information and entertainment, the television will soon also become the technology platform for delivery of health services to the homes of older adults (Blackburn et al. 2011). In a new research program underway at Neuroscience Research Australia (NeuRA) we extend this concept one step further and consider ways in which devices that connect to the television, namely videogame consoles, can be leveraged as a telehealth technology. Videogames have already been proven to improve cognitive abilities of older adults (Gamberini et al. 2008), shown to be a feasible alternative to more traditional aerobic exercise modalities for middle-aged and older adults (Guderian et al. 2010) and can be used to train stepping ability in older adults to reduce the risk of falls (Smith et al. 2011). In particular we explore ways in which videogames can be used to address a major health issue that significantly impact upon the continued independence of older adults: injury and disability resulting from a fall.

**BUT, AREN’T VIDEOGAMES BAD FOR YOU?**

In the popular media, as well as the scientific research literature, the playing of video games has often been associated with negative health outcomes such as increased aggression and violence (Anderson & Bushman 2001), problems with addiction to gameplay (Grüsser et al. 2007), social withdrawal (Gentile et al. 2009), increased sedentary behaviour (Hardy et al. 2009), increased risk of cardiovascular problems (Gwinup et al. 1983) and even increased risk of epileptic seizures (Chuang 2006). With the popularity of exercise-based gaming systems such as the Nintendo Wii, there has also been a rise in reports of “Wii knee” (Robinson et al. 2008), haemothorax (Peek et al. 2008), ruptured tendons (Bhangu et al. 2009) and fracture of the metatarsal (Eley 2010).
Despite the gloom surrounding the negative health consequences of engaging in video gameplay, there is an increasing interest in the potential application of video game and virtual reality technology to various health domains. A quick search using the terms “video”, “games”, “medicine, “rehabilitation”, “pain” and “health” on the primary medical research database available from the US National Library of Medicine (Pubmed) reveals over 1000 recent research articles, many of which report significant beneficial effects of the application of video games to health. In the following we present readers with an overview of the serious side of videogame play, in particular with respect to rehabilitation of brain injury. We then outline a model for how video games could find a place as a telehealth technology could be used to facilitate and promote independent living in older adults or those living with a disability. Finally we explore how this technology could make use of the National Broadband Network.

**NOT AT ALL, GAMES CAN BE SERIOUSLY GOOD FOR YOU**

The use of video games in health is one example of the emerging use of games for “serious” applications. Serious games offer an alternative to traditional means of informing and educating people across a range of domains from medicine to the military (Bergeron 2008). In health contexts, video games have been used to: train surgeons in laparoscopic surgery (Rosser et al 2007), teach children about a range of health and dietary issues (Lieberman 2001), educating medical students about fall risk in older people (Duque et al 2008) through to improving cancer-related knowledge in adolescents with cancer (Beale et al 2007).

**GAMES FOR HEALTHY WEIGHT**

Many exercise videogames (exergames) or interactive gaming systems that are commercially available have had significant impact on the increasing problem of obesity and diabetes in children, adolescent and adults. Videogames are being used to promote healthy diets in young adults (Peng 2009), increase energy expenditure in young children (Graf et al. 2009), promote physical activity and decrease sedentary time (Maloney et al 2008) as well as promote weight loss among overweight children and adolescents and increase overall fitness (Warburton et al 2007). In a recent systematic review of the area, Barnett and colleagues (Barnett et al 2011) report that while exercise-based videogames can elicit physical activity levels of recommended intensity, sustainable play has yet to be demonstrated. They conclude that there is a need for high-quality investigations of maintenance of exercise-based videogame play, and the effect of this play on total physical activity levels and enhancement of bone and muscle strength.

**GAMES FOR PAIN DISTRACTION**

One of the most interesting uses of video games is as a distraction therapy for the treatment of pain. Pain tolerance (in response to a cold pressor stimulus) has been shown to be improved while children and young adults (Anderson & Bushman 2001) play video games. The fear of pain (needlestick) in children has also been shown to be significantly reduced while children play self-distracting video games (Windich-Biermeier et al 2007). Distracting video games have also been shown to significantly ameliorate the subjective level of pain experienced by children in paediatric burns units during dressing changes (Hoffman et al 2000). Roy Kimble and colleagues at the Royal Children’s Hospital in Brisbane have recently demonstrated that a handheld multimodal “game-like” platform is capable of reducing pain experiences for young children during burn care procedures (Miller et al 2011).

**VIDEO GAMES AS A REHABILITATION TOOL**

In recent years one of the emerging rehabilitation tools that appears to meet the challenge of finding therapeutic interventions that are both purposeful and motivating, is the use of virtual
reality (VR) technology (Jack et al 2001). Virtual reality systems involve the use of a three dimensional computer simulation of the real world, or imaginary space, and allow the user to engage with this simulated environment through the use of various multimedia peripherals such as a keyboard and mouse, joystick controller, video camera tracking, inertial sensors (accelerometers), cybergloves and dance mat. Most recently, the Nintendo Wii controller has become a popular, low-cost method for providing individuals with an engaging virtual reality input device. Users experience virtual environments by interacting with displayed images, moving and manipulating virtual objects, and performing other actions in a way that engenders a feeling of actual presence and immerses their senses in the simulated environment. Users are provided with visual, audio and, in some instances, haptic (i.e.: tactile), feedback of their performance to further enhance the experience (Nash et al 2000).

Although virtual reality applications have been used in research and entertainment applications since the 1980’s, it was only during the late 1990’s that VR systems began to be developed and studied as potential tools to enhance and encourage participation in rehabilitation (Holden 2005). The use of virtual reality in rehabilitation has slowly been expanding since then, and is now being used successfully as a treatment and assessment tool in a wide variety of applications, most notably in the fields of motor, and cognitive, rehabilitation. For example, Merians and colleagues (Merians et al 2006) found that exercise conducted using a virtual reality interface enhanced the training of hand movements in patients post stroke, resulting in improved function of the fingers, thumb, and overall range of motion. The researchers also found that these improvements were later transferred to real world tasks, demonstrating that VR based therapy has the potential to encourage a level of exercise intensity and participation that is comparable to conventional interventions.

Virtual reality has also been used successfully in the cognitive rehabilitation of patients with traumatic brain injury (TBI). For example Grealy and colleagues (Grealy et al 1999) conducted research trials with TBI patients which required them to navigate around a variety of virtual environments, and found that patients performed better than no-exercise controls on verbal and visual learning tasks, as well as demonstrating improved reaction times. The researchers were able to conclude that exercising in a virtual environment offered the potential for cognitive gains; however it is not clear if the gains would have been observed using the same exercises in a conventional environment. It is also uncertain if the gains achieved were transferred outside the experimental setting, or lasted longer than the duration of the study. Virtual environments can also be used as a flexible assessment tool to safely determine patients’ levels of ability in a variety of real world tasks prior to their return to a community setting, for example. Cristiansen and colleagues. (Christiansen et al 1998) found that a virtual reality kitchen proved to be effective in assessing the ability of TBI patients to operate safely in such an environment during a meal preparation task. Even though the research involved a prototype virtual environment it does highlight the potential utility of virtual reality in the training of very practical skills and patterns of behaviour that will allow patients to function successfully in the real world.

Although these examples provide only a brief overview of the variety of applications of virtual reality in rehabilitation, the end goal of these initiatives is to encourage and motivate patients to participate to their maximum capacity during therapy, and thereby develop the skills they need to function in their own real world environments in a more independent manner. Weiss and colleagues (Kizony et al 2005) suggest that virtual reality platforms provide a number of unique advantages over conventional therapy in trying to achieve this aim. First, virtual reality systems provide ecologically valid scenarios that elicit naturalistic movement and behaviours in a safe environment that can be shaped and graded in accordance to the needs and level of ability of the patient engaging in therapy. Secondly, the realism of the virtual environments allows patients the opportunity to explore independently, increasing their sense of autonomy and independence in directing their own therapeutic experience. Thirdly, the controllability of virtual environments allows for consistency in the way therapeutic protocols are delivered and performance recorded, enabling an accurate comparison of a patient’s performance over time. And lastly, virtual reality systems allow the introduction of “gaming” factors into any scenario to enhance motivation and increase user
participation (Holden & Todorov 2002). The use of gaming elements can also be used to take patients’ attention away from any pain resulting from their injury or movement. This occurs the more a patient feels involved in an activity and again, allows a higher level of participation in the activity, as the patient is focused on achieving goals within the game (Sanchez-Vives & Slater 2005).

VIDEO GAMING SYSTEMS FOR HOME-BASED REHABILITATION AND TRAINING

While the use of VR technology has been proven to be effective in laboratory or clinical based settings, the equipment used is often expensive, requires expert users and has a dedicated purpose. Furthermore, once a patient returns to their home environment following acute rehabilitation care, partial and unmet rehabilitation needs may ultimately lead to a loss of functional autonomy, which increases utilisation of health services, number of hospitalisations and early institutionalisation, leading to a significant psychological and financial burden on the patients, their families and the health care system (Vincent et al 2007). The potential for rehabilitation at home will enable patients and their clinicians to tailor their program of rehabilitation and follow individual schedules, potentially leading to a reduction in subsequent health care service provision. For example, Golomb and colleagues (Golomb et al 2011) recently reported on the maintained improvement in hand function and forearm bone health in a child with hemiplegic cerebral palsy 14 months after an in-home VR videogame hand rehabilitation intervention. Undergoing treatment at home gives people the advantage of practicing skills and developing compensatory strategies in the context of their own living environment. By leveraging the connectivity enabled by broadband technology and video game technology, it should be possible to build distributed communities of individuals undergoing rehabilitation as well as providing a mechanism for remote measurement and assessment of function.

Consumer driven forces for new ways to interact with videogames have lead to development of sophisticated video capture and inertial sensing devices for measuring movement of the human body. Until recently, such technology could only be found in expensive and dedicated laboratory facilities. Devices such as the Nintendo Wii and Microsoft Xbox Kinect are now at a price point ($400) that it is possible to inexpensively deploy motion capture and feedback technologies directly into the homes of patients for use in training and rehabilitation. Much of the recent work in home-based rehabilitation has been driven by the adoption of Wii-style videogames by rehabilitation therapists. For example, Gil-Gomez et al (2011) have recently shown that a modified balance training system based on the Nintendo Wii Balance Board improved standing balance in a sample of 17 patients with acquired brain injury. Furthermore McNulty and colleagues (Mouawad et al 2011) have shown that an intensive 2-week intervention using off-the-shelf Nintendo Wii videogames resulted in significant and clinically relevant improvements in functional upper limb motor ability in people recovering from stroke. By combining video images and inertial sensor data with videogame technology, sophisticated analyses of an individual’s movements will be possible and remotely located rehabilitation clinicians will be able to simultaneously provide meaningful and engaging feedback to their patients. This is particularly important for those people living in regional, rural and remote Australia where access to therapy is currently restricted or non-existent. In a new research program at NeuRA, (ViGILANT) we are exploring the effectiveness of videogames as a viable telehealth technology.

VIDEO GAMES FOR INDEPENDENT LIVING: AN NBN TECHNOLOGY (VIGILANT).

ViGILANT is an integrated multidisciplinary technology program that aims to support older people to live longer and more independent lives, to enhance their general quality of life, to reduce their dependence on the healthcare services and on family and friends. It builds upon a framework for research established by the Technology Research for Independent Living
(TRIL) center in Ireland. TRIL is an active collaboration between researchers in academic, clinical and industry settings to tackle the problems associated with demographic ageing. ViGILANT significantly extends the TRIL framework by introducing the novel use of broadband-enabled videogames as a telehealth technology. It is an iterative, collaborative endeavour with 3 themes.

1. Human Centred Design. We draw from the field of Interaction Design to generate design specifications and prototypes of videogames that older adults will engage with. Interaction Design applies knowledge for creating solutions that connect people and their technological environments (Martikainen et al. 2010). It is an iterative, creative process based around the “building up” of ideas where there are no judgments early on in the design process. This approach encourages maximum input and participation in the process. We work with older adult interest groups, such as the Australian Seniors Computer Clubs Association, to significantly engage them throughout the design process. The games we design are “owned” by older adults in the sense that they drive the conceptual design and development of the games and provide feedback throughout.

2. Technology Development. We engage with national and international videogame developers to work with researchers and clinicians to develop videogames that can be used in a health context. For example we have worked with the Brisbane-based HalfBrick Studios, developers of the popular Fruit Ninja game for the Apple iPad. Following our guidance, HalfBrick have modified Fruit Ninja sufficiently that individuals being rehabilitated for upper limb function following stroke are able to engage with the game. Initial pilot studies indicate that both patients and therapists alike enjoy using the game and spend considerable time using the game outside of normal rehabilitation gym times. We have also recently embarked on a partnership with Professor Glenna Dowling, from the University of California San Francisco and Red Hill Studios in California to modify a game their team has developed for balance training in Parkinson’s disease patients for use by older adults. Professor Dowling’s work has been supported by the National Institutes of Health and represents an example of how academic researchers can engage with industry partners to build videogames for health.

3. Health Research. As one of the fundamental aims of ViGILANT is to assess novel videogame technologies to facilitate independence of older adults, we have a strong empirical focus. At the core of our research programs are randomised controlled trials (RCTs) to assess the effectiveness of home-based videogame interventions for preventing falls. Systematic review of RCT studies have demonstrated that exercise can significantly reduce the risk and overall number of falls that occur in older people. In the following we describe one of ViGILANT’s current National Health and Medical Research Council funded project which explores the use of exercise-based videogames to engage older adults in daily exercise to reduce the risk and incidence of falls.

FALLS IN THE ELDERLY: AN EXAMPLE OF HOW VIDEOGAMES CAN ADDRESS A GROWING HEALTH ISSUE.

A recent report commissioned by NSW Health (Watson et al. 2010) has shown that in 2006/2007, an estimated 507,000 falls occurred in 251,000 people aged 65 and older living in NSW. The number of people in NSW aged 65 and older is estimated to be just over 931,000, which means that around 27% of the older population fell at least once during the 2006/2007 period. While the majority of older people live independently in the community, the 5.6% of older people who live in residential aged care facilities accounted for 10% of all those who fell.

Around 28% the falls that occurred in older people resulted in injuries requiring some form of medical treatment. One third of medically treated injuries presented to a hospital emergency department for treatment and of these, nearly 60% were admitted. For residents of aged care facilities who had fallen, the rate of hospitalization of 3.3 times the rate for those living in the community. Of the people previously living independently in the community and who were
admitted to hospital following a fall, 7% were then transferred directly to residential aged care rather than returning to their own home.

THE COST OF FALLS

According to the NSW Health report, the total estimated cost of health care associated with medically treated fall injuries in older adults living in NSW during 2006/2007 was $558.5 million. 85% of the overall cost of injuries resulting from falls was spent on hospital admissions. Overall falls in older women accounted for $384.93 million and 15% of the total cost was for falls that occurred in residential aged care settings. The report also shows that the average health care cost of medically treated, fall-related injuries in older people living in NSW was $3906 per fall injury treated. Hospital admissions accounted for the highest average cost at $18,454 versus $369 for non-hospital treatments.

While the economic costs from this comprehensive report are sobering, the total burden of falls injury is likely to be significantly higher as the estimates do not include the intangible and indirect costs of fall injuries among older people. Falls can result in people experiencing a loss of confidence, self esteem and reduced independence. Falls can also often result in a 'long lie' for a person who is unable to get up from the floor. This can have potentially serious consequences such as hypothermia, broncho pneumonia and pressure sores. A 'long lie' of 12 hours or more can seriously affect a person's recovery from a fall.

WHAT CAN BE DONE ABOUT FALLS?

The NSW Health report provides us with a comprehensive population-level estimate of the incidence and economic costs of falls amongst older people living in NSW from which we could extrapolate an estimate for the overall costs to the Australian community. Falls are a significant public health issue and therefore cost-effective fall prevention strategies and programs are required. Research conducted by the Falls and Balance Group of Professor Stephen Lord at Neuroscience Research Australia has shown that reduction of fall risk and prevention of medical complication resulting from falls is possible. Identification of those older adults who are highly at risk for having a fall is an important first step at Prof Lord’s team have developed a well validated test of fall risk that is capable of predicting older people at risk of falling with 75% sensitivity and specificity in community settings (Lord et al 1994).

Once an older adults risk for having a fall is identified, it is important to put in place a strategy to ensure that their chance of having a fall is minimized. As with most things in life, exercise is the key to better health, and no more so than in relation to fall prevention. A number of randomised control trial studies have demonstrated that exercise, particularly of a kind that challenges the balance control system, can significantly reduce the risk and overall number of falls that occur in older people. While randomised control trials that include muscle strengthening and balance training show that the risk of falls can be significantly reduced, compliance with fall prevention interventions is often disappointing, suggesting some reluctance on the part of older adults to take part in such programs. Barriers to adherence to exercise programs may include lack of interest in the program, low outcomes expectation, fear of falling and even the weather.

SO HOW WILL VIDEOGAMES HELP PREVENT FALLS?

In the Falls and Balance Research Group at Neuroscience Research Australia, we are exploring the possibility of using video games to reduce the risk and incidence of falls in older adults. The activities of every day life frequently involve moving about in one’s environment and the ability to make timely, appropriately directed steps underpins our ability to maintain our balance and move unaided through our environment. Stepping (changing the base of support (BOS) relative to our centre of mass (COM)) also provides the means by which we are able to counter potentially destabilising events such as slips, trips and missteps.
and avoid obstacles. Protective stepping may be initiated volitionally when a threat to balance is perceived, or induced reflexively when a disturbance moves the COM relative to the BOS at a speed that prevents engagement of volitional strategies.

Initial studies suggest that both volitional and induced stepping abilities are significantly impaired in older versus younger individuals and are good predictors of falls. Compared to younger adults, older adults, particularly those with a history of falling, tend to be slower in initiating volitional step responses (Lord and Fitzpatrick, 2001), make inappropriately directed or multiple short steps in response to an external perturbation of balance (McIlroy and Maki 1996) and in response to lateral perturbations have an increased chance of collision between the swing and stance legs during compensatory stepping (Maki et al 2000). Lateral falls are those which are most likely to result in hip fracture and as such, lateral balance control is of particular importance for fall prevention strategies (Sambrook et al 2007).

Like any physical function, stepping ability can be trained. We also know that any exercise that specifically challenges balance is successful in reducing the risk of falls in older adults, the challenge however is to get people to adhere to their exercise routines. We are therefore exploring use of a modified version of the popular Dance Dance Revolution (DDR) video game to engage older adults in a step training program (Figure 1).

Figure 1 - Dr Stuart Smith and NeuRA volunteer, Mr Kieran Young, with a modified Dance Dance Revolution step training system.

Dance Dance Revolution involves “players” stepping onto panels of a flexible sensor mat in time with a visual stimulus presented on a television screen. The game can be programmed such that photos of grandchildren, favourite pets or any image of interest can appear on the screen. In addition, any music of the person’s choice can be played in time with the stepping patterns. By engaging older people in the design of their own step training system, we hope to further promote adherence to their training.
Results from our initial investigations (Smith et al 2011) have shown that older adults really enjoy playing DDR-style video games. Furthermore, we’ve shown in a recent pilot study (manuscript in preparation) that stepping performance can be improved in older adults, even those relatively frail adults found in rehabilitation wards of hospitals. Of the 44 patients in the pilot study, 19 (43%) were able to successfully complete the initial level of DDR difficulty and progress to higher, more complex levels of interaction with the game. In addition to increasing physical activity and engaging in older adults in step training, we are also exploring the possibility that performance on gameplay can provide us with an indication of the older players’ risk of having a fall in the future (Schoene et al 2011). If used on a regular basis by older adults in their own homes, we will be able to track changes in fall risk over time and respond as a consequence, playing video games may therefore be a novel approach to facilitating continued independent living in older adults.

The system we have developed provides older adults with a “set top box” computer attached to their television. Videogames can be selected and played through a user friendly interface that does not require the player to learn complex computer commands, use a keyboard or mouse nor will it require constant updating of virus definitions like most PCs. Data from games or clinical tests deployed on the home-based system can be sent back to researchers at Neuroscience Research Australia via an internet connection for longitudinal monitoring of fall risk. If an increased level of fall risk is identified, a video consultation session with a remote falls prevention clinician could be initiated and an appropriate intervention plan developed and put in place. We have integrated a telepresence-quality videoconferencing solution (VidyoDesktop™ ) into our set-top box system which enables a low latency HD-quality video for natural communications between remote clinical and research staff and study participants who may live in regional, rural or remote areas.

MAKING USE OF THE NATIONAL BROADBAND NETWORK

To address delivery of such health services (such as video consultations) to people living in regional Australia, the Federal Government plans to roll out a high-speed broadband network. This national infrastructure project will provide significant opportunities to transform the delivery of fall prevention services such as the delivery of formal, supervised rehabilitation and training sessions from a remote location and simultaneously capture the data stream from the videogame solutions developed by ViGILANT. In the next phase of ViGILANT we will explore use of the Microsoft Kinect camera technology to engage remotely located older adults with trainers in metropolitan Sydney in real-time fall prevention exercise classes. The Kinect is a "controller-free gaming and entertainment experience" by Microsoft for the Xbox 360 video game platform, and will soon be supported by PCs via Windows 8. It enables users to control and interact with the game console without the need to touch a game controller, through a user interface using gestures and spoken commands. Kinect enables full-body depth-based 3D motion capture, facial recognition and voice recognition capabilities. As such it offers full-body motion tracking as compared to previous generation hand-motion (Wii) or remote control technologies. According to information supplied to retailers, the Kinect is capable of simultaneously tracking up to six people, including two active players for biomechanical motion analysis with a feature extraction of 20 joints per player. This means that a centrally located therapist or trainer will be able, in real-time, monitor and analyse the movement profiles of a remotely located patient and provide instantaneous feedback and guidance to the patient. To engage remotely located participants in exercise-based videogame play with each other and with trainers based in metropolitan Sydney, it will be necessary to have high speed, low latency broadband connections available of the kind offered by the NBN. A key conclusion of a recent report by NICTA into the use of NBN for delivery of telemedicine states “The NBN will provide a unique opportunity to catalyse change in the way health care is delivered” (Hanlen and Robertson 2010). ViGILANT’s innovative use of broadband-enabled videogames for delivery of telehealth services is well positioned to capitalise upon this opportunity.
INNOVATIVE DELIVERY OF HEALTH INFORMATION TO OLDER ADULTS

Recommendation 119 of the Hospital and Health Reform Commission report (Bennet 2009), states “Ensuring access to a national broadband network (or alternative technology, such as satellite) for all Australians, particularly for those living in isolated communities, will be critical to the uptake of person-controlled electronic health records as well as to realise potential access to electronic health information and medical advice”. A feature of ViGILANT videogame solutions will be integrated, easy to use feedback mechanisms for older adults to track game-based correlates of health and function via their home television set. Longitudinal monitoring of videogame-based markers of health status, combined with clinical decision support systems, could be used to effectively alert older adults to a change in their risk of falling and provide encouraging feedback for continued adherence to rehabilitation exercises at home. The broadband-enabled videogame solutions developed by ViGILANT will make possible delivery of health information to older adults, their families or support networks.

SOCIAL CONNECTIVITY AND INDEPENDENCE

The social encouragement provided by videogames developed by ViGILANT may also be leveraged to build greater social connectivity with older adults. For example, a grandfather could compete in a videogame against his grand daughter when she visits him or he could play against other older adults living in Dubbo, Darwin or even Dublin. Inadequate social connectivity is associated with an increase in mortality, morbidity and psychological distress, older people who report a lack of social contact have been shown to be more likely to die than those with higher social support (Holt-Lunstad et al 2010). In their submission to the Productivity Commission report (Productivity Commission 2011), The Benevolent Society said, “In older age social exclusion can result in poor quality of life, avoidable illness and disability, higher rates of hospitalisation, premature institutionalisation and premature death. … Most older people want to live as independently as possible, continuing to do the things they enjoy and staying connected to their community” [p80]. The videogames developed by ViGILANT can therefore also be used to address important issues of social connectivity in older adults.

A NEW INDUSTRY FOR AUSTRALIA

Worldwide there is an increasing use of videogame technology for addressing health issues. Australia is well placed to be at the forefront of this revolution, both in terms of fundamental research and its commercialisation. Whilst the Australian videogame development industry is world class, in recent years the industry has experienced the closure of many major local development houses with subsequent retrenchment of highly skilled employees. Of compelling interest to many industry observers is the opportunity that exists for individuals possessing high-end skills within the interactive media industries to apply their knowledge into ‘non-entertainment’ industry sectors such as health. ViGILANT offers a new avenue for creation of a “Games for Health” industry in Australia, which will have significant export potential.

SUMMARY

Independent living supported by smart technologies offers the potential for substantial savings in community and residential aged care and in reduced admissions to hospitals, by providing early alerts to changing health patterns and by minimising falls and other accidents in the home. Many technologies for elderly-friendly housing depend on information and communication technologies to address social communications, personal health monitoring, telehealth, shopping and education. The program of work outlined by ViGILANT aims to
develop innovative videogame technologies that make use of the National Broadband Network to achieve these goals.

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General Practice is a highly computerised part of the health system and the place where most Australians receive health care. This positions it well to lead the adoption of telehealth. On the other hand, by supporting computerisation in general practice to a greater extent than in other health sectors, we may have created an island of computerisation in a sea of paper. Because this island is essentially a collection of thousands of independent small businesses, the adoption of new systems is especially challenging. Each general practice can choose to participate or not. This article discusses the adoption of technology in the sector so far, and examines what will be required to ensure that the current investment in telehealth succeeds.

INTRODUCTION

Telehealth promises to improve health outcomes and address serious equality and access issues, particularly in rural and remote Australia. Interest in telehealth is increasing. The Federal Government announced Medicare rebates for health care services delivered via video conferencing and healthcare benefits have featured prominently in the debate about the National Broadband Network.

In order to see any of this benefit however, clinicians across the health system need to adopt the enabling technologies required for telehealth. General practice is a highly computerised part of the health system and the place where most Australians receive health care. This makes it an interesting case study. This article discusses the adoption of technology in the sector so far and examines what will be required to ensure that the current investment in telehealth succeeds.

TELEHEALTH

WHAT?

Telehealth is defined as the use of telecommunication techniques for the purpose of providing telemedicine, medical education, and health education over a distance (ISO 2004).

That rather broad definition can include anything from a telephone call by a doctor to a patient to remote virtual surgery, and everything in between. The criteria for claiming the recently announced Medicare rebates (MBS 2011) limit this definition substantially to a video consultation delivered by a specialist to a patient by referral from a GP. It is anticipated that once this limited application of telehealth is embedded in general practice, additional uses such as consultations with patients in their home will follow.

WHY?

The Medicare rebate mentioned above is squarely targeted at Australians living in rural, regional and outer metropolitan areas, and with good reason. In Australia, a person’s postcode
is a significant determinant of their health outcomes. A study by the Australian Institute of Health and Welfare (AIHW 2003) for example has shown that Australians living in the bush have lower overall cancer survival rates than people living in metropolitan areas and rural cities. This was attributed to later diagnosis, poorer treatment, a shortage of healthcare providers and higher proportion of disadvantaged groups such as Aboriginal and Torres Strait Islander peoples.

Telehealth technology has the potential to address a number of these issues, particularly those relating to a lack of access to health professionals. Currently an individual living in rural Australia is regularly faced with the choice of travelling hundreds of kilometres and spending extended time away from their family to access health services or to miss out entirely and go untreated. Many of these health services could easily be delivered via telehealth.

DEPENDENCE ON HIGH SPEED INTERNET?

It is often argued that health care outcomes will be improved by high speed, reliable Internet services, supplied through initiatives such as the National Broadband Network. This argument is often valid, particularly for data intensive applications involving high quality video conferencing or the transfer of large documents such as in medical imaging.

There are however many innovative telehealth opportunities that do not require such infrastructure. An example is the use of digital imaging for remote wound management in remote Western Australia (Santamaria et al. 2004). A trial conducted in the Kimberley region on healing rates in chronic lower leg ulcers showed both improved healing and considerable savings in treatment cost through the application of low bandwidth technology that does not require a real time link to a clinician.

As we strive to leverage new and emerging infrastructure such as the National Broadband Network, we should not overlook initiatives that do not require such infrastructure but provide considerable benefit and improved health outcomes all the same.

TELEHEALTH IN CONTEXT

While telehealth has considerable potential it is one piece of a much larger eHealth picture, which in turn is an enabler of a better health system. To gain maximum benefits from investment in telehealth infrastructure, telehealth must be considered within these broader contexts of health reform and a national eHealth system.

HEALTH REFORM AND EHEALTH

The Government is currently implementing a considerable reform to the Health system. It aims to create a more transparent, efficient and, most importantly, patient-centric system. A key focus of this agenda is primary health care and improving access to health services for people in their local communities (DoHA 2011).

Australia has one of the best health systems in the world based on the health outcomes of its citizens. With increased cost and demand pressures and a shortage of skilled healthcare workers, maintaining or improving the health outcomes of Australians will require a fundamental change to the way health care is delivered. The National eHealth Strategy shows how a connected health system built on shared health information can deliver this fundamental change (Deloitte 2008).

eHealth systems are already in use across Australia. But until Australia has a truly national system operating to the highest standards of safety and security, the safety and quality benefits that eHealth can bring to the Australian healthcare sector will not be realised – notably the potential to improve direct patient care due to timely access to, and transfer of, more accurate clinical information. One organisation working to deliver the building blocks of such a system is the National E-Health Transition Authority.
The National E-Health Transition Authority (NEHTA) was established by the Australian, State and Territory governments in 2005 to develop better ways of electronically collecting and securely exchanging health information. As the lead organisation supporting the national vision for eHealth in Australia, NEHTA has focused on establishing a national eHealth infrastructure.

Key components include the national Healthcare Identifiers Service which commenced operation on 1 July 2010; the development of a standard clinical language (or terminology) SNOMED CT-AU; the development of the Australian Medicines Terminology (AMT) which uniquely codes and describes all commonly used medicines and is to be used in clinical software applications to facilitate interoperability between systems; the implementation of the National Product Catalogue (NPC), a central repository of complete product and pricing data published by suppliers of medical devices, medicines and medical consumables; development of conformance test specification and automated open-source test tools released to help software developers implement new Australian standards for secure message delivery (SMD); coordinating the progression of the most commonly exchanged health information including e-discharge summaries, e-referral and the Electronic Transfer of Prescriptions (ETP).

As well as delivering the national infrastructure, NEHTA is delivering the key components of the Department of Health and Ageing’s (DoHA) Personally Controlled Electronic Health Record (PCEHR) program ensuring that from 1 July 2012 Australians will be given the option of registering online for their electronic health record.

While there is benefit in the ability to deliver a health consultation via video conferencing, it is considerably more valuable when it is combined with a more complete eHealth system. This may include the PCEHR, enabling important health information about a patient to be available at both ends of the video consultation.

**GENERAL PRACTICE – CURRENT STATE OF PLAY**

**THE GOOD**

The Royal Australian College of General Practitioners defines General Practice as providing person centred, continuing, comprehensive and coordinated whole person health care to individuals and families in their communities (RACGP 2011).

A key characteristic of general practice is that concept of person-centred care. More so than any other clinical profession, general practitioners tend to establish long-term relationships with patients and to play a central role in the coordination of patients’ care.

General practice is the primary avenue for community-based care delivery. Over 125 million general practice consultations take place annually in Australia and 83 percent of the Australian population consult a GP at least once a year (Britt et al. 2010).

General practice is considered to be one of the most computerised clinical professions. Recent statistics put the number of general practices with computers at 98% (Britt et al. 2010). Most general practitioners use these computers for billing purposes, and two thirds of general practices are reported to have gone completely paperless. The extent to which computers are used for clinical purposes however varies. Most GPs use them to generate prescriptions but decision support systems are used by fewer than a third of GPs.

This combination of high computerisation and its place as the primary avenue for care delivery for the majority of Australians means general practice is well placed to lead the adoption of telehealth.
THE BAD

General practitioners have a role as care coordinators for their patients, working within teams of allied health and specialist clinicians. The levels of computerisation across these professions vary but, when compared to general practice, are considered to be low. By supporting computerisation in general practice to a greater extent than in other health sectors, it can be argued that we have created an island of computerisation in a sea of paper. To realise the benefit of investment in telehealth, all parties will need to adopt the technology and use it effectively.

THE UGLY

Driving and supporting adoption of new technology across general practice is challenging. General practice is essentially a collection of thousands of small businesses, each operating independently. Unlike a hospital, where a new system can be implemented across the board, each general practice can choose to participate or to not.

Current systems used by general practice rarely interoperate. Information cannot be readily exported from one system and imported into another. Further, secure electronic messaging systems from different vendors cannot communicate with each other. This is akin to a phone on the Telstra network not being able to call a phone on the Optus network, creating a scenario where GPs are maintaining a suite of messaging clients in order to achieve sufficient levels of communication.

SUPPORTING GENERAL PRACTICE – A CASE STUDY FOR TECHNOLOGY ADOPTION IN THE HEALTH SECTOR

The fact that general practice is highly computerised is no accident. Considerable investment has been made over more than a decade to achieve it. To understand what will be required to ensure national infrastructure such as the National Broadband Network works to deliver improved health outcomes, it is useful to discuss this investment and the path general practice has travelled to date.

FINANCIAL SUPPORT

General practice has been provided with a number of financial incentives to drive computerisation and the adoption of eHealth systems. These include the eHealth Practice Incentive Payment which rewards a practitioner for maintaining Public Key Infrastructure (PKI) certificates for the purpose of secure messaging and other activities. Historically general practice has been offered cash payments to invest in technology, heavily subsidies to encourage broadband connectivity, and cash incentives to conduct security audits to ensure electronic clinical information is kept safe.

The current Medicare rebates for specialist video consultations are structured in a similar manner (MBS 2011). The ability for a general practitioner and a specialist to claim for a clinical consultation delivered via video conference removes a considerable barrier to uptake of telehealth. The addition of an incentive for the initial consult compensates the clinician for the initial investment in the technology and reduces the risk of investment for the early adopters. This is critical to achieve the ‘tipping point’ where there are sufficient clinicians able to conduct telehealth consultations to ensure sustainability and continuing uptake.

CHANGE MANAGEMENT SUPPORT

Financial support removes the disincentive to act but doesn’t in and of itself drive behaviour change. In many instances adopting new technologies requires fundamental changes to the
Change management means supporting people through change. Traditional organisational change management, according to the Prosci model (Prosci 2011), involves a three-stage process; prepare for change; manage change; reinforce change. While this holds true in a general practice environment, consideration must be given to the fact that, as independent private companies, each general practice can choose to participate or to not.

In the case of general practice computerisation, this change management intervention was mainly delivered by the General Practice Network.

**GENERAL PRACTICE NETWORKS**

The General Practice Network is a network of 110 local organisations (GPNs), eight State Based Organisations (SBOs) and one national peak body, the Australian General Practice Network (AGPN) with a mission of improving the health and wellbeing of communities through supporting improved general practice. The Network is involved in activities including health promotion, early intervention and prevention strategies, chronic disease management, medical education and workforce support.

The General Practice Network has played a central role in supporting general practice computerisation with an understanding that in doing so, improvements in the quality of health outcomes could be realised. During this period of computerisation, the General Practice Network received funding from Government to employ IT Officers. These individuals worked directly with general practices assisting them to implement new IT infrastructure and clinical software solutions. These IT Officers were highly regarded and the support they delivered was invaluable in achieving the levels of computerisation we currently see across general practice.

The current incarnation of these IT Officers are known as eHealth Support Officers (AGPN 2011). While fewer in number (situated at state and national offices rather than the 110 local organisations) they have a considerably broader scope of operation. The objective of the eHealth support officers is to drive eHealth adoption across general practice and the broader primary health care sector. They achieve this through the local GPNs by providing training, education and change management support to general practice and working with them to adopt new technologies and integrate them into their day to day clinical and business work practices.

The successful rollout of telehealth technology will similarly require this dual pronged approach. Financial support is needed to remove the disincentive and risk associated with investing in a new technology and model of clinical service delivery. Training, education and change management support is required to assist with adoption and integration of these new systems into clinical workflow.

**GLIMPSES OF INNOVATION – TELEHEALTH IDEAS AND OPPORTUNITIES**

The Australian General Practice Network conducted a survey of member GPNs earlier this year seeking information about levels of interest in participating in telehealth projects. The purpose of this survey was to determine whether or where opportunities existed for telehealth projects in partnership with telecommunication and technology vendors. Of the 110 GPNs, over a third expressed interest and outlined proposals for potential projects. The sample of responses below gives some indication of the varied potential applications of telehealth.


- **Virtual Rural Outreach Services** (Rockingham Division of General Practice): Situated just south of Perth Western Australia, Rockingham is faced with a shortage of specialists. Rockingham Division of General Practice would leverage relationships
with local GPs and Perth based specialists to deliver consultations via video conference to Rockingham based patients.

- **Expanded Youth Mental Health Services** (General Practice Association Geelong): Headspace is a national deliverer of youth mental health services. General Practice Association Geelong would extend these services to surrounding regional areas by establishing safe video consulting facilities in local and regional schools.

- **Home based Case Conferencing** – (Melbourne East General Practice Network): Case conference is where three or more clinicians who are members of a multi-disciplinary team involved in a patient’s care conference together about that patient. Melbourne East General Practice Network would through the application of video conferencing connect the patient in their home into this conferencing event.

- **Chronic Disease Management** – (Melbourne General Practice Network): Through a combination of remote patient monitoring and consultations delivered via video conferencing, holistic care can be delivered to a patient in their home. It is expected that this model of care delivery would considerably reduce hospitalisation and adverse outcomes for high need patients suffering from complex and chronic conditions.

- **Palliative Care in the Home** – (Murray Malley Division of General Practice): A principal focus of palliative care is to provide patients with individual control and choice over their end of life care. For a large majority this means staying in their own homes for as long as possible. Murray Malley Division of General Practice would deliver palliative care consultations via video conferencing allowing a patient to remain in their home for longer.

**CONCLUSION**

Telehealth, as part of a national eHealth system, has the potential to deliver substantial benefits in improved health outcomes, particularly to those living in rural and remote Australia. Across the country, a staggering number of innovative telehealth implementations and ideas exist in local areas begging to be scaled. For telehealth to deliver on its potential it must be actively adopted and used across the healthcare profession. The computerisation of general practice suggests it that this adoption will require considerable change and adoption support through financial assistance, training and education and on-the-ground change management. It is only through leveraging solutions such as telehealth that we can ensure the Australian health care system maintains and improves the quality of health care.

**REFERENCES**


Technology offers the potential for collaborative treatment of chronic diseases involving clinical partnerships between multiple health care providers based on web-based care plans. However, collaborative regimes may increase the potential for medical negligence suits. Possible issues include responsibility for ensuring the appropriateness of any care plan, the accuracy, security and continued integrity of any information entered in the system and responsibilities to follow up patients.

INTRODUCTION

This article explores legal issues arising from the use of collaborative health care plans supported by information technology, especially electronic health records. The convergence of collaborative care models and electronic health records was highlighted in nine new eHealth projects based on the new personally controlled e-health records (PCEHRs), announced in March by the Minister for Health and Aging (Roxon 2011). These projects include the roll out of PCEHRs to patients with chronic illnesses, to help facilitate team-based care.

This article draws on a research conducted over the period 2007-9 for a major project which piloted the use of a broadband system operated by a private sector intermediary to facilitate the development and electronic transmission of electronic care plans to care teams treating patients with chronic diabetes in regional Victoria and Western Australia (see DBCDE 2011). The issues have been further explored from a multi-disciplinary perspective in a roundtable discussion of clinical, legal and ethical experts. The full results of the roundtable were published in June 2011 (Paterson et al 2011).

BACKGROUND

The large and growing cost of chronic disease is encouraging the use of collaborative healthcare models. Chronic disease is expected to grow significantly in line with the aging of the population and increasing prevalence of shared risk factors such as overweight and obesity, poor nutrition and physical inactivity. On current projections Australian health care expenditure for cancer, cardiovascular disease and diabetes will nearly triple from $14.4 billion in 2002/03 to $41.3 billion in 2032/33 (Goss 2008).

Local and overseas research suggests that collaborative, multidisciplinary care may help in the treatment of patients with chronic illness (see for example Zwar 2008, Rothe 2008). Successive Australian governments seem to agree. In 1999, general practitioner (GP) enhanced primary care (EPC) item numbers were introduced for enhanced multidisciplinary primary care planning, requiring collaboration between GPs, other providers and patients with
chronic illnesses. In 2005 new item numbers for general practitioner management plans (GPMPs) and team care arrangements (TCAs) were added. GPMPs are used for patients with a chronic illness who would benefit from ‘structured care’, which is based on a structured preventative approach as opposed to episodic acute management. TCAs are intended for patients needing complex care involving collaboration among providers. They allow patients to claim rebates for allied health (healthcare provided by clinical health professions other than medicine, dentistry and nursing) and dental care. According to Medicare statistics, GPs prepared more than 645,000 GPMPs in 2005–06 and almost 300,000 multidisciplinary care plans (enhanced primary care and team care arrangements) (Medicare Australia).

At the same time, the Australian government developed eHealth strategies. In 2005, the National E-Health Transition Authority (NEHTA) was created to coordinate the implementation of these strategies. NEHTA’s Strategic Plan for 2009-2012 identifies four priorities: “... to develop the essential foundations required to enable e-health; coordinate the progression of the priority e-health solutions and processes; accelerate the adoption of e-health, and lead the progression of e-health in Australia” (Dearne 2009).

NEHTA has developed unique health identifiers for all patients, practitioners and Australian healthcare organisations and established the Health Identifiers Service within Medicare on 1 July 2010 (NEHTA 2010). Health identifiers are numbers assigned to uniquely identify healthcare providers and recipients. The Healthcare Identifiers Act 2010 permits the use of identifiers only for healthcare and related management purposes, and penalises their misuse.

Healthcare identifiers provide an important building block for the PCEHR announced in the May 2010 Federal Budget. It is intended that all Australians will have the option of applying for a PCEHR by July 2012 (Woodhead 2011). PCEHRs will contain summaries of patients’ health information such as regular medications, key elements of treatment history and current diagnoses and provide a means for secure access to patients’ eHealth records. The Government intends to provide “rigorous governance and oversight to maintain privacy” although the precise measures for this have not been clearly spelt out.

One of the new PCEHR implementation projects involves patients who are chronically ill. The Medibank Private Limited Project...

will implement a consumer-oriented portal, which integrates consumer entered information into a ‘Health Book’. The ‘Health Book’ will be initially made available to all Medibank Private customers and their healthcare providers enrolled in Medibank’s Health Management and Chronic Disease Management programs (Commonwealth Department of Health and Aging 2011).

The use of electronic health records for the collaborative treatment of the chronic disease diabetes was illustrated via the trial of the CDM-Net (Chronic Disease Management Network) project. CDM-Net uses shared electronic care plans as a basis for the multidisciplinary treatment of diabetes patients. A secure, collaborative web-based service is used by several practitioners to create, share, track, monitor, and manage patients’ care.

Key elements of that system include:

- an Intelligent Application Service, which provides support for the GP, care team, and patient; by providing an interface to enter and read information;
- a Health Services Bus, which provides an open infrastructure to enable different broadband-based services and other systems to ‘plug in’ to the network and to communicate and interact with each other; and
- connectivity infrastructure, which allows applications and existing systems (such as GP’s clinical desktops and hospital systems) to securely connect to, and exchange data, with the Bus (CDM-Net Final Report).

A vital feature is the collection and sharing of information about each patient, including medications and immunisations, and inactive as well as currently active health problems. This information comes from a variety of sources, including the GP’s clinical desktop, other
members of the care team, the patient, some hospitals and emergency services, and some pathology laboratories.

The system uses standardised templates to create draft GPMPs and TCAs, and GPMP and TCA reviews, for approval by the GP. It also continuously monitors patients’ health parameters, such as blood glucose levels and medications, and is designed to assist them adhere to their care plans by sending SMS reminders and alerts.

Although collaborative health care plans, supported by electronic health records, offer significant benefits, they also raise legal issues in two main areas: privacy and security, and negligence.

**PRIVACY AND SECURITY**

Information privacy laws limit the collection, use and disclosure of personal information. They give individuals the right to access their own information and to require incorrect or misleading information to be amended. The aim is to allow individuals to exercise informed control over the collection and processing of their data. For example the Victorian Health Records Act 2001 contains a set of Health Privacy Principles which, among other things, limit the collection, use and disclosure of identifiable health information.

The right to privacy is recognised as human right and is generally acknowledged as being an important aspect of autonomy and human dignity. Australia is a signatory to the International Covenant for Civil and Political Rights which requires in Article 17 that everyone has a right to the protection of the law against “arbitrary or unlawful interference with his privacy”. The Victorian Law Reform Commission (VLRC) has said:

> Privacy is invariably associated with the terms ‘autonomy’ and ‘dignity’.... autonomy can be defined as self-government and dignity as that human quality which distinguishes people from property; that which makes people ‘subjects’ not ‘objects’ (VLRC 2002).

Information privacy also serves an important instrumental value in protecting individuals from discrimination, for example by employers. This issue generally receives most attention in the context of genetic information (Mainsbridge 2001).

Health information is a particularly sensitive form of personal data. Some conditions or treatments carry special stigma. For example:

> Mental health consumers are particularly sensitive to data security, confidentiality and privacy issues. This is because of the prevailing stigma and discrimination which surrounds matters which may arise in the mental health field, like clinical diagnoses, drug and other addictions, sexual practices, dysfunctional relationships and antisocial behaviours (Rivers 2010).

Likewise, women believe information about pregnancy termination is sensitive because it may result in stigma based on preconceptions about their sexual behaviour. Even information about less inherently stigmatising conditions or treatments can result in discrimination, for example, by an employer who prefers to employ individuals with no past history of major illnesses or injuries.

If privacy issues are not appropriately addressed, lack of patient candour can undermine healthcare. As noted recently by a clinical leader at NEHTA,

> Every doctor is concerned about the clinical risks if patients are reluctant to share information with them because they thought – somewhere, sometime – that information might be accessed inappropriately (Lord 2010 and see Terry 2007).

The rationale for the use of electronic health records is that they facilitate sharing of detailed information about patients. It is not surprising therefore that they generate privacy concerns, given the sensitivity of the information that they contain. What is of fundamental concern over and above any issues relating to security, however, is that they enable the sharing of
more information than might normally take place in the context of a team care arrangement based simply on referrals.

A Newspoll phone survey conducted in March 2010 found that while patients are generally in favour of an individual electronic health record, they also want to be able to exercise control over what is in it and who gets access to it. Of the 1208 randomly selected Australians aged 18 years and over for this study commissioned by CSC (an IT service provider), 89% nominated the ability to select which healthcare providers view their information as being of value (Pettigrew 2010). For example, they may prefer that ancillary care providers do not have automatic access to more sensitive information such as information about past mental health issues (see Paterson and Mulligan 2003; Sankar, Mora, Merz and Jones 2003). There are a number of different mechanisms that may be used to regulate information sharing but to date these have been considered primarily in the context of electronic health records more generally (see Coiera and Clarke 2004; Paterson 2004).

The collection and use of identifiable health information is regulated in Australia by a tapestry of information privacy laws. GPs and other private sector health providers are currently regulated via the private sector national privacy principles in the Privacy Act 1988 (Cth). (In 2010, the government issued an exposure draft for a combined set of Australian Privacy Principles which would replace both the private sector National Privacy Principles and the Information Privacy Principles which regulate Commonwealth public sector bodies.) In the ACT, New South Wales and Victoria, health providers are also regulated via sui generis health records laws. State and territory public sector health providers are regulated by state and territory laws in most states and territories.

While these laws differ in their detail, they embody principles which, among other things, impose limits on the collection, use and disclosure of identifiable personal information. In the case of the private sector and sui generis health records laws, data may generally be collected only with consent. In addition, data collected may only be used consistently with the purpose of collection, except with consent or subject to other limited exceptions. Other requirements include the need to ensure that data is relevant and up-to-date and that it is kept secure.

It follows that data should be collected only with informed consent and used and disclosed consistently with the purposes for which it is collected. Informed consent requires that patients should have an accurate understanding of what information is being processed for sharing on each occasion that the information is transferred into the system. They also need to have a general understanding of how shared records are used and who has access to them. The time required to do this must be factored into the time available for consultations. Another significant matter that is often overlooked is the extent to which data on the shared record can leak into the health provider’s own treatment records.

What is collected should be relevant to the purpose of collection, that is, the patient’s treatment within the context of the care plan. It should not exceed what is required for effective patient treatment. The extent to which this can be achieved may be affected by constraints inherent in the software used on GPs’ computers. To the extent that the software has not been developed with selective sharing in mind, as is currently the case, what may be required is a wholesale transfer of existing information with selective omission of specific data taking place prior to the transfer of information. While it might be expected that a GP would be alert to the sensitivity of information in categories such as sexually-transmitted diseases, the sensitivity of specific information may vary according to the patient and the context.

The use of computer systems linked to the internet or accessible by people other than health care providers raises further security issues (Win Khin Than 2005). These may affect other professionals, laboratories or owners of software used to record data. Transmission of data to third parties via email or in other electronic forms raises issues about the security of transmission and the need for encryption. Privacy laws do not provide details of what is required because needs vary according to context. In general terms, it is important to ensure there are security measures in place appropriate to the sensitivity of medical records. These may include authentication mechanisms that comply with current standards for health records.
(see OFPC 2001), and measures addressing the issue of third party access by any information technology provider, for example via contractual provisions and the implementation of appropriate protocols.

NEGLIGENCE

Negligence issues may also arise due to the use of a shared treatment plan and reliance on an IT-based system of communication and patient management (Terry 2004; Evans et al 2008). It is therefore important to consider carefully what duties are owed to patients and the nature of the duty of care that arises in each case. The key issues fall into five broad groups:

- computer error;
- the suitability of a system of treatment based on a computer-generated care plan;
- miscommunication;
- shared responsibility; and
- duties to recall and follow up patients.

Computer error

Electronic care plans are dependent on effective software design, the use of computer hardware appropriate to the effective functioning of the system, the correct input of data and the maintenance of appropriate security measures to prevent authorised access to patient data and to guard against viruses and other malware which can delete or alter patient data. Failures in any of these may result in liability where they jeopardise patient treatment.

Suitability of care plans and reliance on them

A care plan sets out a proposed schedule of treatment. This may provide a document that can be used by the patient in litigation.

A decision of the Victorian Court of Appeal makes it clear that treatment plans must not only accord with what a respectable body of other professional opinion says was appropriate to offer but must also be appropriate in light of the particular circumstances of the patient. In the case of a care plan generated using a standardised template, therefore, it is important to ensure both that the template is based on current best practice and that it allows sufficient flexibility to address the specific needs of individual patients.

A further issue is the extent that the care plan can, or should, be relied upon as a sole basis for treatment. This may depend on which team member is using it. If a team member is involved in a patient’s treatment only as part of the care team, such as a podiatrist involved in the treatment of a patient only in respect of the symptoms of diabetes, then reliance on the plan may be appropriate. The position would be quite different, however, for a GP involved in other aspects of a patient’s treatment as well.

The case of O'Shea v Sullivan and Macquarie Pathology illustrates the dangers of incorrect reliance on a single source of information, although it was not concerned with a care plan. The doctor relied on a false negative screening result as a basis for not carrying out further urgent investigation of a patient with unexplained symptoms of post-coital bleeding. Although it was accepted that the laboratory had been negligent in misinterpreting the patient's cervical smear, the court concluded that the doctor had also been negligent in relying totally on the results, particularly in the light of evidence that there could be up to a 20% possibility of a false negative result.

A similar line of reasoning could be raised to argue inappropriate reliance had been placed on a care plan document as a basis for care. This relates to the issue of abrogation of responsibility discussed below.

Liability for miscommunication
Another issue can be described as the ‘illusion of communication’. A member of a care team may enter data into the shared information system and assume this is sufficient to draw it to the attention of others on the team. In practice, however, there may be reasons why that data is not viewed and acted upon by others in a sufficiently timely manner. There may be errors in entering data, system error, or design limitations that are insufficiently understood. For example, a team member may assume any new data entered into the system is immediately drawn to the attention of the GP when in fact the system alerts the GP only when he or she next reviews the patient’s file.

The available case law on liability for miscommunication relates to issues such as illegibility of handwriting, but it suggests that both parties to the miscommunication may share liability. In one case, a GP was found 25% responsible when a pharmacist misread his script for Amoxil and dispensed a dose some fifty times the permitted daily maximum.

Shared responsibility, abrogation of responsibility

Duties may be inappropriately delegated. Questions may arise about who is responsible for ensuring a patient receives appropriate treatment in accordance with their care plan or that the plan is varied where it is found to be inappropriate.

There is always a danger when several people are involved that they may incorrectly abrogate their duties on the assumption that someone else is responsible. Once again, liability may be allocated between team members if something goes wrong.

It is therefore vital for someone – most logically, the GP – to have overall responsibility and for each team member to have a very clear idea about their specific responsibilities.

Duties of recall and follow up

There seems to some confusion about the standards expected for patient recall and follow-up and how far the duty extends (see Harcourt 2001). Three key Australian cases shed light on this issue.

In 1996, the New South Wales Court of Appeal upheld judgment against a doctor who failed to follow up on a patient’s failure to attend an appointment with a gynaecologist to investigate prolonged vaginal bleeding. When the patient’s cancer was later discovered, it was too late for a hysterectomy and she required radical radiation, which resulted in serious side effects. The court held that the doctor’s failure to refer her to a specialist in another town, when he found that she was unable to make arrangement to travel to Tamworth, constituted negligence. In finding against Dr Kalokerinos, the court accepted evidence by the patient that she would have attended the appointment had she been adequately informed of the potential consequences of not attending. However, the court found the patient was partially responsible for the outcome because she continued to ignore the vaginal bleeding for quite a long period despite knowing that it could be a potential symptom of cancer. Therefore, damages were reduced by 20%.

The South Australian case of Kite v Malycha concerned the duty of a surgeon to follow up on a pathology report in relation to a needle biopsy of his patient’s breast. The report indicated the specimen was highly suspicious of an underlying carcinoma. However, it was not seen or followed up on by Dr Malycha and Mrs Kite was not followed up when she failed to attend her next appointment. As a result, the cancer had spread to other parts of Mrs Kite’s body before the lump was ultimately removed.

The court awarded Mrs Kite and her husband over $500,000 damages and concluded that, on the balance of probabilities, the cancer would either have been cured, or Mrs Kite would have had a much greater life expectancy, had she received appropriate treatment immediately following the biopsy. In finding against Dr Malycha the court commented that he should have recorded the biopsy procedure in his notes and should have made some inquiry to find out what had happened to the report. Furthermore he should at least have become aware of the absent report when Mrs Kite missed her next appointment.
The court did not find any contributory negligence on the part of Mrs Kite due to the failure to counsel her about the potential significance of the test. In reaching this conclusion Justice Perry commented:

In general terms, Mrs Kite owed a duty to exercise reasonable care for her own safety and well being. But her conduct must be judged in the light of the circumstances as a whole. Dr Malycha concedes that he reassured her as to her condition when she saw him on 2 December 1994. Very likely his reassurance would have led her to believe that a follow-up consultation was not so important as it might otherwise have been. As I have said, irrespective of whether she rang up about it, she was entitled to assume that if the outcome of the testing of the biopsy gave cause for concern, she would be informed. No doubt she would then have sought further advice.

A similar approach was taken by the New South Wales Court of Appeal the following year in Tai v Hatzistavrou. In this case, the doctor ordered tests to exclude the possibility of cancer. However, there were delays and errors by hospital staff in arranging the tests. Once again, neither the doctor nor the patient followed up on them. As a consequence, the cancer spread to other parts of her body before a test was ultimately carried out.

The Court of Appeal upheld the decision of the Supreme Court finding Dr Tai liable for negligence. In his judgement, Priestley JA commented that:

If the doctor thinks it necessary, even for only prudential reasons, that the patient should submit to a particular surgical procedure, then the doctor has a continuing duty to advise the patient to submit to the surgical procedure, so long as the doctor/patient relationship is on foot.

There was no finding of contributory negligence because the patient was not counselled about the need to have the procedure.

To summarise, while each case depended very much on its individual facts, important principles are clear:

1. The key issue is whether the doctor acted reasonably in the circumstances. What is reasonable must take into account the fact that patients do not always do as they are told.
2. There needs to be sufficient communication to ensure that the patient understands what is at stake.
3. What is reasonable will also be affected by the ease with which a follow-up system can be implemented.

An electronic system able to generate reminders can serve a valuable role in avoiding liability for failures to follow up or recall patients. However, there is also a danger that it may create additional expectations and therefore affect the judgment of what is reasonable in the circumstances. In Kite v Malycha the fact that a patient expected to be contacted in the event of an adverse report was sufficient to exclude any liability on her part. There may be a danger that patients who are aware that an information system can generate reminders will have a reasonable expectation that this will always occur.

There is also a risk that team members may rely on an information system inappropriately and be liable if a patient suffers adverse consequences because of it. This may be because the system is not designed to generate all of the reminders required or because something goes wrong such as an entry error or some technical problem.

**CONCLUSION**

A range of important issues need to be resolved when implementing IT-based collaborative treatment models.
Privacy and security are both important. It is essential to implement appropriate technical and procedural security measures and to ensure that patients provide fully informed consent to participation and retain the ability to exercise control over subsequent inputs of information.

It is also vital to manage the risk of negligence claims. This requires appropriate protocols which are reviewed regularly to ensure that they meet current best practice, clear allocation of responsibilities and obligations across a care team, a thorough understanding of what can realistically be expected of such a system, and how it fits in with a patient’s overall care. All of this requires time to ensure that each team member fully understands the system and not simply how to operate it. Equally, it requires time with patients to ensure they also have a realistic understanding of it.

ACKNOWLEDGEMENTS

This article is based on a paper presented at the 8th Greek Legal and Medical Conference, Corfu, September 2009.

The CDM-Net project was funded by the Department of Broadband, Communications and the Digital Economy under its Clever Networks program. Project partners are the Victorian Department of Innovation, Industry and Regional Development, Victorian Department of Human Services, Multimedia Victoria, CSIRO e-Health Research Centre, IBM, Intel, Cisco Systems, Global Health, Monash, Deakin and Victoria Universities, Barwon Health, Diabetes Australia (Victoria) and the GP Association of Geelong.

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ENDNOTES

1. The CDM-Net project was funded by the Department of Broadband, Communications and the Digital Economy under its Clever Networks program. Project partners are the Victorian Department of Innovation, Industry and Regional Development, Victorian Department of Human Services, Multimedia Victoria, CSIRO e-Health Research Centre, IBM, Intel, Cisco Systems, Global Health, Monash, Deakin and Victoria Universities, Barwon Health, Diabetes Australia (Victoria) and the GP Association of Geelong. The first author provided legal consultancy services for that project and was a co-author of a chapter on Medico-Legal Studies in the CDM-Net Final Report. The second author managed the research component of the project and was an author and/or co-author of most chapters of the Final Report.


The implementation of new strategies in healthcare, including electronic health records and telemedicine, require thoughtful change management to deliver optimal implementation. We surveyed staff and patients to determine the perceived needs of each group and to identify the benefits they perceive will flow from new initiatives. Staff and patients agreed on benefits that included SMS appointment reminders, but were indeterminate about video-consultation and SMS reminders for medication. It is likely that concerns regarding unmet needs such as skill-base, funding and reliability led to skepticism regarding the value of new interventions.

INTRODUCTION

Governments, healthcare managers and health professionals are increasingly turning to electronic health (eHealth) information and communication technologies to meet growing demands on the healthcare system, optimise healthcare delivery and drive better healthcare outcomes (Jha et al 2009; Berger 2010; Hazin & Qaddoumi 2010).

The health needs of many patients living in rural and remote areas are currently not being met. Access to essential services, including specialist care, diagnostic and imaging services and expert chronic disease centres are restricted by the distance to metropolitan healthcare centres (Smith et al 2005).

Many rural and remote communities find it hard to recruit and retain an appropriate and adequately trained medical and health workforce. Residents face increasing difficulties accessing appropriate care in situations where integration and continuity of care are essential.

Health information and communication technologies can improve access to care for the community, and access to education for professionals. The reduction in professional isolation may significantly enhance the recruitment and retention of health professionals (Kilpatrick et al 2007). Particularly important applications are likely to include electronic health records and video-conferencing.

Little is known of the attitudes and barriers to the use of new ICT solutions (Leung et al 2003; Braithwaite et al 2011). We therefore conducted a survey to identify staff and patient attitudes to the implementation of health information and communication technologies and to determine the benefits (if any) perceived to be associated with their use. We hoped that a better understanding of these attitudes would help in developing plans to implement new ICT solutions.
METHODS

The study was conducted at a major public teaching hospital in a capital city in 2010. Staff and patients participated in focus groups and a survey to determine attitudes to and perceived benefits from the use of eHealth strategies.

Focus groups were conducted to identify domains about which more detailed information was sought in the voluntary anonymous survey. Thematic analysis utilised pattern recognition within the data, where emerging themes became categories for analysis using a previously described method (Braithwaite et al 2011; Daly et al 1997). The domains identified were:

1. current usage,
2. barriers,
3. attitudes,
4. benefits and
5. current systems.

Individual's responses were scored from 0-10 on a Likert scale (where 0 represented strong disagreement, 10 represented strong agreement and 5 an indeterminate response). Terms used such as ‘video-conferencing’ were not defined and the telemedicine experience of respondents was not recorded.

Separate surveys were made available to staff and patients. Each included sections collecting information about demographics, background skills, current use of digital communication systems, barriers to implementation of electronic information systems, attitudes to storage retrieval and security of information, as well as perceived benefits to the individual and organisation. The questions were based on the five domains determined in focus groups.

Staff were invited to participate through randomly selected departmental meetings. Patients were invited to participate while attending outpatient clinics. Before commencing the study, ethics approval was sought and granted from the Alfred Health Human Research Ethics Committee.

Results are expressed as mean±SD, comparisons were made using parametric methods and results were considered significant where p<0.05.

RESULTS

A total of 267 participants (130 patients, 137 staff) completed the survey. There was virtually no difference between ages for staff and patients surveyed. The mean (± SD) age for patients was 32.9 ± 10.5 years, (50.0% males, 50.0% females). The mean (± SD) age for staff was 32.2 ± 10.5 years, (33.7% males, 66.3% females). The proportions of males and females in the two survey groups is broadly consistent with the respective populations of patients and hospital-based clinical-care workers in Australian public hospitals.

The majority of survey respondents (54% of staff and 68% of patients) indicated that they were more comfortable with a password-protected electronic health record compared to standard paper-based systems for storing confidential patient information.

Staff and patients agreed that SMS appointment reminders would be beneficial, however did not believe that medication reminders were useful. Neither video-conferencing nor tele-conferencing were recognised as beneficial by either staff or patients (see Table 1).
<table>
<thead>
<tr>
<th>Service</th>
<th>Patients (Mean ± SD)</th>
<th>Staff (Mean ± SD)</th>
<th>p Value</th>
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<td>SMS medication reminders would be of benefit to patients</td>
<td>5.99 ± 2.97</td>
<td>6.00 ± 2.86</td>
<td>NS</td>
</tr>
<tr>
<td>SMS appointment reminders would be of benefit to patients</td>
<td>7.87 ± 2.93</td>
<td>7.24 ± 2.50</td>
<td>NS</td>
</tr>
<tr>
<td>Video conferencing would be of benefit to me</td>
<td>5.55 ± 2.86</td>
<td>5.80 ± 2.69</td>
<td>NS</td>
</tr>
<tr>
<td>Telephone conferencing would be of benefit to me</td>
<td>5.58 ± 2.82</td>
<td>5.87 ± 2.70</td>
<td>NS</td>
</tr>
</tbody>
</table>

Table 1 - Perceived benefits of SMS, videoconferencing and telehealth

A total of 71.6% of staff and 88.3% of patients agree (score of 6 and above on Likert scale) that health professionals should be able to send information, including patient data and medical records, electronically to other providers/health professionals. Together, staff and patients agreed (85.3% of all respondents) that priority should be placed on implementing ehealth applications that allow patient information to be exchanged electronically among different services within the same hospital. Staff and patients concurred that the majority of patient information and medication history should ideally be contained in an electronic patient record. As shown in Figure 1, the majority of respondents from both groups believed that electronic access of this information should always (score of 6 and above on Likert scale) be made available to health professionals during appointments.

DISCUSSION

The relative low response rates to the benefit of video-conferencing may reflect a belief that healthcare relies essentially on face-to-face contact. Possibly, limited access to computers, areas for confidential discussion and slow or inadequate Internet access within the workplace may have contributed to the perceived limited value of video-conferencing for patient care. However, it is not known if staff and patients understood the full potential and objectives of
information systems (including electronic health records and video-conferencing) that have been designed for healthcare.

Reminders systems have been shown to improve adherence to treatment plans in clinical studies (Saleem et al. 2005). Our study did not determine effectiveness of SMS or telephone reminders, but showed that both patients and staff were ambivalent in their response. Possibly, staff saw themselves as patients in some situations, as their responses were closely matched. Interestingly, among both staff and patients, demographic and attendance data were seen as more important to be included in electronic health records than medically relevant information on allergies or immunisations.

In summary, this study found that staff and patients agreed about the indeterminate value of SMS appointment and medication reminders and video- and telephone-conferencing. They also broadly agreed about the content of personal electronic health records. It is likely that opinions expressed are based on assumptions by healthcare workers and patients, rather than personal experience.

We conclude that strategies for implementing ehealth solutions like SMS reminders, video- and telephone-consultation and electronic health records should take into account the maturity of the target population. The rate of uptake by staff and patients may depend on the content and quality of specific interventions (Granatham 2010).

ACKNOWLEDGEMENT

We wish to acknowledge support from the Australian Research Council for this work.

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High-speed broadband provides a platform for a wide range of applications, including e-health. The development of e-health applications has to take into account diverse bodies of knowledge, from the appropriate configuration of network technologies through to the clinical deployment of new treatments. Thus, interdisciplinary research is central to e-health. The Institute for a Broadband-Enabled Society (IBES) was established at the University of Melbourne to support interdisciplinary research that leverages the benefits of ubiquitous high-speed broadband networks, such as the emerging National Broadband Network. Research into health and wellbeing is central to the Institute. This paper discusses how interdisciplinary research drives the development of e-health solutions focusing specifically on three case studies — stroke rehabilitation, mental health, and education and training.

INTRODUCTION

The University of Melbourne recognises the importance of interdisciplinary research in tackling some of the major problems facing contemporary society, and has established a number of interdisciplinary research institutes to achieve this goal. The aim of these institutes is to cultivate interdisciplinary research in the areas of broadband technologies (Institute for a Broadband-Enabled Society), energy (Melbourne Energy Institute), materials science (Melbourne Materials Institute), neuroscience (Melbourne Neuroscience Institute), and sustainable society (Melbourne Sustainable Society Institute). This paper discusses the research at the Institute for a Broadband-Enabled Society that is advancing e-health.

The Institute for a Broadband-Enabled Society (IBES) supports research that leverages broadband technologies by aligning industry and research to drive innovation in broadband applications and services that benefit Australian society. IBES supports a number of research projects that explore technologies, services, and end-user experiences of broadband including many that relate to e-health, e-education, and social inclusion outcomes. The unifying feature of these research projects is their interdisciplinary nature. This research model enables IBES to harness talent from across the University of Melbourne and partner institutions. This is supported by engagement with industry through the Institute’s Industry Partner Program, providing research with linkages to external collaborators and opportunities to develop and commercialise their research.

Interdisciplinary research is central to developing e-health applications that combine the appropriate mix of technical, clinical and social knowledge. The IBES research model ensures that e-health research projects at the Institute are interdisciplinary in nature with teams comprised of researchers from across the clinical, social and engineering disciplines. This paper discusses the importance of interdisciplinary research and how it can be used to foster collaboration and drive innovation. The paper then illustrates how the interdisciplinary
approach is used at IBES to support e-health research by providing three case studies. The first case study explores how a haptic robot device can be used to support stroke rehabilitation. The second examines how e-health technology can prevent the relapse of young people with first episode psychosis, and the third outlines the Uni TV project that is exploring how IPTV delivered over high-speed broadband can enable new ways to deliver education and support e-health such as through the remote training of rural medical practitioners.

INTERDISCIPLINARY RESEARCH

Why is interdisciplinary research important? Many complex problems do not fit neatly within disciplinary boundaries, resulting in the need to draw upon diverse bodies of expertise. There are gains to be made from collaboration, and research centres such as IBES provide an ideal location to foster interdisciplinary research. However, in order to understand the question why interdisciplinary, the concept of academic disciplines should be discussed.

Disciplines have long established histories and cultures (Huber 1990). They are the key organisational unit for structuring research at universities. The exploration of the cultures of disciplines has been subject to anthropological study, itself a discipline in its own right (Brew 2008, 424). Distinctions between disciplines have produced different forms of knowledge creation, organisation and cultures (Brew 2008, 424). Differences between disciplines can extend to social and political attitudes (Huber 1990, 243). Academic structures are usually aligned to academic disciplines. A key criterion for promotion, publication, occurs within peer review journals that conform to the disciplinary body of knowledge. For example, political scientists working on networks will publish their findings in a disciplinary journal such as Governance (Considine 2002). By contrast electrical engineers working on networks will publish in their disciplinary journals such as Network published by the IEEE (Gibson 2002). The core components holding disciplines together include: a community of scholars, a history of inquiry, a methodology for inquiring, publication requirements that shape new knowledge, and an intradisciplinary communications network (Davies & Devlin 2007, 1).

Interdisciplinary research on the other hand is fostered through collaboration transcending discipline boundaries to create new knowledge. The term interdisciplinary is regularly confused with the terms multidisciplinary and cross-disciplinary; however, each of these terms represents a distinct method of inquiry (Davies & Devlin 2007, 1). Multidisciplinary research comprises the “co-existence of a number of disciplines”, where each acts autonomously in their discipline with little knowledge of the work of other participants, (Davies & Devlin 2007, 3) while cross-disciplinary research is itself a form of disciplinary research, occurring when “a topic normally outside a field of study is investigated with no cooperation from others in the area of study concerned (Davies & Devlin 2007, 3).”

Interdisciplinary research, however, takes on forms that allow for the blending of knowledge from a number of disciplines. The importance of this research is that it exists to tackle problems that go beyond any one disciplinary boundary. In order to attract funding, research projects at IBES must demonstrate how they are fostering interdisciplinary research. At IBES research is divided into three distinct areas: broadband network technologies; the development of applications that make use of high-speed broadband to solve problems; and exploring how broadband is used within society. For example, a medical researcher might see the potential in offering a clinical service remotely but not have the technical knowledge to leverage high-speed broadband to create and develop an appropriate application. The solution to the researcher’s problem necessitates an interdisciplinary approach.

Collaboration between disciplines provides the basis for interdisciplinary research. As research problems bridge the engineering-science-health and humanities-social science divide, close collaboration is needed to ensure consensus. These approaches have different understandings in their approach to interdisciplinary research: engineering and science based projects tend to emphasise ‘teamwork’ while the humanities focus more on developing ‘critical understanding’ (Borrego & Newswander 2010, 80). Good interdisciplinary projects
combine teamwork with critical understanding. As the following case studies demonstrate, the Institute for a Broadband-Enabled Society applies interdisciplinary techniques to develop solutions to research problems.

**CASE STUDIES**

To date, IBES has provided competitive seed funding to over fifty projects as part of its research program. Interdisciplinary teams drawn from the wider university community develop research proposals submitting them for funding. Successful teams then undertake their research with the funding provided by IBES. A criterion for each research project is that it must be interdisciplinary in nature. The research environments draw on the existing strengths of researchers while enabling greater engagement and cross-fertilisation of ideas, breaking down discipline boundaries to foster innovative solutions to complex problems. The following three case studies demonstrate how the interdisciplinary research teams tackle and solve complex problems to harness broadband technologies for the benefit of Australian society.

**CASE STUDY: HAPTIC TELE-REHABILITATION**

Stroke is a major public health problem in Australia with approximately 60,000 people per year having a stroke. The cost of strokes in Australia is $2.14 billion annually (National Stroke Foundation 2011). Of those who suffer from strokes, eighty-five percent have an initial deficit in arm function and there is clear evidence that early rehabilitation of the arm and hand after the stroke is highly effective. However, for a number of reasons, arm training is frequently given a lower priority than walking training in hospitals and clinics, with a recent study finding that only 6% of rehabilitation time is allocated to the affected upper limb. The loss of hand function impacts greatly on the ability of a person to lead an independent life. Given this, the application of broadband technologies in the provision of alternative rehabilitation methods for stroke survivors has the potential to significantly improve health care services and health outcomes in Australia.

The Haptic Tele-rehabilitation project brings together a number of disciplines under the one umbrella to tackle issues in remote stroke rehabilitation. The project brings together researchers from the University of Melbourne’s Departments of Mechanical Engineering, Health Informatics, Computer Science and Software Engineering, Physiotherapy, and Electrical and Electronic Engineering. By drawing on the collective knowledge of these disciplines researchers have been able to develop a prototype haptic tele-rehabilitation system that can be used to rehabilitate a victim after stroke.
The system involves a rehabilitation robot, pictured in Figure 1, which is placed in the patient’s home. The patient then connects to their clinician via a broadband connection. The clinician can dial up a number of different exercises for the patient on the rehabilitation robot. The clinician can also control the level of the exercises, adjusting the assistance or resistance of the robot to fit the patient’s rehabilitation regime. To optimise the robot’s performance, it was tested in the IBES Laboratory to understand how it will function on real world networks that contain various levels of delay. This is important in considering what, if any, implications the network has for the clinical efficacy of the rehabilitation robot. Bringing together this research has involved close collaboration between clinicians who need to manage the rehabilitation process and engineers who have managed the development, software and network elements.

CASE STUDY: THE HORYZONS PROJECT – ONLINE RECOVERY FOR YOUTH ONSET PSYCHOSIS

Around a quarter of young people in Australia suffer from a mental disorder (Australian Bureau of Statistics 2007). Broadband technologies can provide opportunities for young people to cultivate online social networks and engage in activities that connect them with their peers, clinicians and the wider community. The HORYZONS project at IBES is exploring how broadband technologies can be used to assist in the treatment of patients who have suffered first-episode psychosis.

First-episode psychosis represents a major crisis in the lives of patients and their families. Clinical remission is obtained by 90 percent of patients within the first twelve months of treatment; however, 80 percent of patients will experience a relapse within five years of the initial episode. Relapse means that young people disconnect from their school, work and friends. It also dramatically increases the risk of developing chronic psychosis, permanent disability and homelessness. The economic and social costs of psychosis place it among the world’s top ten causes of disability, costing the Australian economy $1.85 billion annually.

Clinical trials have demonstrated that specifically designed relapse prevention therapy has been effective in dramatically reducing the rate of relapse (Alvarez-Jimenez et al. 2009). The implementation of this therapy is costly, limiting its availability (Alvarez-Jimenez et al. 2009). There is an additional stigma associated with mental health treatment that adversely affects seeking help and compliance among young sufferers. Broadband enabled technologies
enable novel psychological interventions, addressing accessibility and compliance issues at a low cost.

The HORYZONS project is first to use broadband technology in the early treatment of psychosis. One focus of the project is to test the effectiveness of an advanced web-based and mobile interactive psychosocial tool for relapse prevention and promotion of social recovery for young psychosis sufferers. The project team has developed an interactive and flexible tool comprising moderated social networking, online relapse prevention therapy and intervention via mobile devices that are highly customisable to end user needs. The welcome page is shown in Figure 2. Patients interact with the tool by regularly recording their experiences, joining and contributing to groups and sharing their activities with peers. Through this information, the system detects young people at high-risk of relapse, alerting moderators and case-managers who can then devise an appropriate intervention.

Figure 2 - Horyzons welcome page

Young people are typically heavy users of technology. This approach to e-health draws upon already existing knowledge and understanding about broadband technologies, and tailors them in a way that tackles a specific health problem, in this case, preventing relapses from first-episode psychosis. It is envisaged that this project will pave the way for the expansion of e-health in addressing the medical needs of young people and the wider community.

CASE STUDY: UNI TV

Universities produce a large quantity of content: lectures, symposiums, workshops, tutorials and demonstrations to name just a few. The University of Melbourne produces a vast amount of content for the public, such as research videos and public lectures. However, accessing this content is not always easy. The Uni TV project is developing new ways to enable end users to access a range of educational content over high-speed broadband.

Currently tertiary education is predominantly delivered to students and clinicians at a physical location via traditional lectures, seminars or tutorials. Participation is limited for students who
cannot attend on campus, such as students in regional areas who have to travel, often at their own expense, or for those students who have work or family commitments, to access education. Remote access to educational materials online is limited to recorded lectures, generally at a non-broadcast quality. New online and on-demand services, such as those being developed by the Uni TV, based on IPTV, can provide access to world class educational services through the provision of broadcast quality content and real time collaboration between students and teachers regardless of their locations.

Another aspect of this project is using new technologies to explore different ways to deliver content for educational purposes. 3D technology has the potential to transform education by enabling students to access knowledge in new and different ways. 3D visualisation can be used for a number of educational purposes in fields as diverse as archaeology, engineering and medicine. An e-health example could include a dental procedure that can be recorded in 3D and then transmitted with accompanying information to clinicians located in regional areas for their professional development. Viewing the information in 3D enhances the educational experience for students, enabling them to experience the techniques in greater detail than that available by 2D video.

Figure 3 - IBES Researcher Ken Clarke demonstrates haptic virtual surgery via Uni TV

The educational experience can be further enhanced by other modes of interactivity and learning. An example is the use of haptic virtual surgery tools, demonstrated in use by Figure 3. The use of haptic tools will enable students and novice surgeons to refine their craft under the expert guidance of a master surgeon. This technology further extends the capabilities of using IPTV and high-speed broadband to support education development.

The development of the Uni TV project is interdisciplinary in nature, involving the expertise of staff from the University departments of Electrical and Electronic Engineering, Culture and Communication, Dentistry, Education, Otolaryngology, Law, Chemistry together with the University Library, the University’s Marketing and Communications group, and the Victorian College of the Arts. Industry partners are also actively involved in the project, with Ericsson playing a lead role in providing technical assistance to the project.

There is a large potential for IPTV to help transform the delivery of education, especially to rural and regional Australia. However, it needs to be backed by access to world leading educational knowledge and research to ensure that the content it delivers is relevant to the end users of the system. The interdisciplinary approach to such development at IBES is ensuring
that the Uni TV project will deliver relevant content to a number of audiences, including members of the general public accessing new knowledge from events held on campus, students seeing to catch-up on lectures or watch 3D tutorials, and practitioners needing continuing professional development.

CONCLUSION

The Institute for a Broadband-Enabled Society supports interdisciplinary research to foster the development of innovative applications that maximise the benefits of high-speed broadband to society. Through the careful cultivation and planning of projects, IBES is able to provide funding for projects that transcend traditional disciplinary boundaries. The three case studies mentioned in this paper demonstrate how interdisciplinary approaches can be used in different research contexts in relation to health. These include creating new techniques and tools to manage stroke rehabilitation, demonstrating how e-health can support young sufferers of first episode psychosis, and pioneering the way that broadband can transform the delivery of educational services using IPTV. Research at IBES is leveraging the benefits of high-speed broadband for Australian society.

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BROADBAND ENABLED HEALTHCARE
THE ROLE AND CONTRIBUTION OF HEALTH AND BIOMEDICAL INFORMATICS

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One way to think about broadband enabled healthcare is as a system where the use of health information is facilitated by ultra-high-speed, high-capacity, ubiquitous, ‘always-on’ connectivity. Broadband marks a radical departure from the way information can be used in healthcare currently, and is anticipated to transform healthcare outcomes in terms of access and equity, safety and quality, sustainability and innovation. In Australia a national broadband network is recognised as a key to achieving a suite of national health system reforms collectively described as the national ehealth system. The information aspects of broadband enabled healthcare are clearly within the scope of health and biomedical informatics. The fundamental place of health and biomedical informatics in broadband enabled health has also been recognised in a major broadband research centre (IBES), which has harnessed the discipline of health and biomedical informatics to coordinate the health and wellbeing piece of its research program. This paper argues that the discipline of Health and Biomedical Informatics has a substantial role to play in ensuring that strategy, technology, accountability and usability are properly integrated in the design, implementation and evaluation of broadband enabled healthcare.

INTRODUCTION

THE INFORMATION ASPECTS OF BROADBAND ENABLED HEALTHCARE

One way to think about broadband enabled healthcare is as a system where the use of health information is facilitated by ultra-high-speed, high-capacity, ubiquitous, ‘always-on’ connectivity. Such health information can include many different kinds of data from a pathology result or hospital stay record to a computed tomography (CT) scan or real-time measures from physiological monitoring devices.

While computerised hospital and other health information systems have been in use for several decades (Haux 2006), new broadband technology is enabling widespread high-volume access to high speed broadband in homes and organisations, and the linkage of large volumes of complex health data rapidly across these systems, and is also increasing connectivity among medical devices (the so-called “Internet of things”) and across clinics, labs, homes and mobile users of health information (for example, Chowdhury et al. 2010). Broadband marks a radical departure from the way information can be used in healthcare currently, and is anticipated to transform healthcare outcomes in terms of access and equity, safety and quality, sustainability and innovation (Neuberger 2007).

Those who will be affected by these new ways of using health information include patients and their carers, clinicians from all health professions and those who educate them, managers of healthcare services and facilities of all types, their commercial partners and providers,
healthy citizens, public health authorities, health policy-makers, and health and biomedical researchers.

AUSTRALIAN PERSPECTIVES ON HEALTH AND BIOMEDICAL INFORMATICS IN RELATION TO BROADBAND ENABLED HEALTHCARE

In Australia a national broadband network is recognised as a key to achieving a suite of national health system reforms collectively described as the national ehealth system (Department of Health and Ageing 2010). The information aspects of broadband enabled healthcare are clearly within the scope of health and biomedical informatics as it is defined by the Health Informatics Society of Australia (2010); that is, “the science and practice around information in health that leads to informed and assisted healthcare”.

In the National E-Health Transition Authority’s (2010) blueprint for the development of the essential information infrastructure for a national ehealth system, health and biomedical informatics concepts appear prominently, in the description of:

- foundations (i.e. identifiers for individuals and organisations; authentication; secure messaging; clinical terminology; supply chain);
- solutions (i.e. pathology, diagnostic imaging, medication management, referral and discharge summaries);
- capabilities (i.e. the personally controlled electronic health record (PCEHR); care planning and coordination; registries and research; professional decision support; telehealth platforms).

Moreover, ontologies for describing data, algorithms for mining and analysing data, visualisation of data for experts and non-experts and other core aspects of health and biomedical informatics knowledge have been characterised as the "smarts" behind ehealth (NICTA 2010). Consistent with this acknowledgement of the role of informatics expertise, efforts to increase the number of qualified health informaticians have been identified as critical to successful implementation of the national ehealth work program (National Health and Hospitals Reform Commission 2009).

The fundamental place of health and biomedical informatics in broadband enabled health has also been recognised in a major broadband research centre, which has harnessed the discipline of health and biomedical informatics to coordinate the health and wellbeing piece of its research program. This program has conducted exploratory studies on ageing well, youth mental health and wellbeing, electronic health records and telehealth, and is expected to expand into the emerging field of personalised medicine (Institute for a Broadband Enabled Society 2010).

OUTLINE OF THIS PAPER

This paper argues that because of the way that the discipline of health and biomedical informatics sits at the intersection of at least four fields of research - health science, computer science, information science and knowledge management – it has a substantial role to play in ensuring that strategy, technology, accountability and usability are properly integrated in the design, implementation and evaluation of broadband enabled healthcare.

The balance of this paper provides a short introduction to the discipline of health and biomedical informatics. This is followed by a brief overview of the evolution of health and biomedical informatics as a profession. Next this paper reviews health and biomedical informatics work on broadband enabled healthcare internationally. Lastly, it sets out future directions for a synergistic relationship between health and biomedical informatics and broadband enabled healthcare.

WHAT IS HEALTH AND BIOMEDICAL INFORMATICS?
THE DISCIPLINE OF HEALTH AND BIOMEDICAL INFORMATICS

Health and biomedical informatics is the body of knowledge that concerns the acquisition, storage, retrieval and use of information in, about and for human health, and the design and management of related information systems to advance the understanding and practice of healthcare. As a discrete knowledge domain it can be conceptualised in various ways, as illustrated by a few recent examples.

Martz, Zhang and Ozanich (2007) found that:

Several different definitions of health informatics exist. For example, Imhoff et al. ... define health informatics as the “development and assessment of methods and systems for the acquisition, processing and interpretation of patient data with the help of knowledge from scientific research.” Peel ... defines health informatics more broadly, as the discipline that integrates biomedical sciences, computer sciences, healthcare policy, management, and organisation. In this way, providing better healthcare has moved into proactive areas such as education, statistics, research, and cost management.

DeShazo, LaVallie and Wolf (2009), focusing on the term “medical informatics”, reported that:

"Medical Informatics" is defined in MEDLINE as "The field of information science concerned with the analysis and dissemination of medical data through the application of computers to various aspects of health care and medicine." In 1990, Greenes and Shortliffe described medical informatics as "the field that concerns itself with the cognitive, information processing, and communication tasks of medical practice, education, and research, including the information science and the technology to support these tasks."... Most descriptions and definitions of the field are consistent in pointing out the "multidisciplinary" and heterogeneous characteristics of the field. There is some disagreement with use of the term "medical" in reference to the field as "medical informatics" because the field encompasses all of healthcare, public health and biomedicine....

Bernstam, Smith and Johnson (2010), in their review of an array of authoritative definitions of the term “biomedical informatics”, noted three sorts of definitions – information technology oriented; role, task or domain oriented; and concept oriented – and proposed a new definition:

Defining the central object of study of informatics as data + meaning allows us to distinguish informatics as a science from computer science, mathematics, statistics, the biomedical sciences and other related fields. It also clarifies the role of each of these fields in informatics.....Biomedical informatics is the application of the science of information as data plus meaning to problems of biomedical interest.

HEALTH AND BIOMEDICAL INFORMATICS AS A PROFESSION

Bernstam, Smith and Johnson (2010) also joked that “biomedical informatics has been an ‘emerging field’ for decades”. Much of its history is linked to applied roles and practices in healthcare workplaces (Collen 1986). For example, its American origins can be traced from the 1879 initiation of the monthly index of publications Index Medicus by medical librarians; the 1928 establishment of the American Association of Medical Record Librarians, now the American Health Information Management Association; and the 1951 organisation of the Professional Group in Bio-Medical Electronics of the Institute of Radio Engineers. The field acquired its name through European developments, with departments termed informatique de medecine or informatique medicale established in the 1960s in France, Holland and Belgium. The International Medical Informatics Association (IMIA) was originally established in 1967 as Technical Committee 4 of the International Federation for Information Processing (IFIP).

Since the emergence of national and international interest groups in the 1970s, there have been significant advances in recognising health and biomedical informatics as a distinct
profession, and there are trends in many parts of the world towards certification of its practitioners, with involvement from organisations such as:


The International Medical Informatics Association (Mantas et al. 2010) maintains a detailed set of recommended competencies for professional practice at various levels in various health settings. Formally trained health and biomedical informaticians can be expected to have highly developed knowledge and skills for working with the building blocks of broadband enabled healthcare, such as:

- data standards to facilitate the exchange of health data types, including controlled vocabularies and technical standards;
- databases, such as those that underpin electronic health records, clinical decision support systems, health registries, trialbanks and biobanks;
- networks and devices for information and communication, e.g. in health provision, governance and research; and
- human-computer interactions among health information custodians, users and other stakeholders

**HEALTH AND BIOMEDICAL INFORMATICS WORK ON BROADBAND ENABLED HEALTHCARE INTERNATIONALLY**

There exist several international examples that specifically illustrate the huge potential for health and biomedical informatics to accelerate the translation of biomedical research results and to improve clinical practice through the use of broadband technologies:

*Digital Britain.* The UK government has outlined plans to ensure every home has a high-speed broadband connection as part of plans to boost the UK digital economy (Digital Britain 2009). The UK National Health Service’s (NHS) National Program for Information Technology (NPfIT) includes N3 as a major infrastructure for national broadband connectivity. N3 is one of Europe’s largest virtual private networks with over 40,000 connections, connecting 1.3 million employees across every hospital, medical centre and GP surgery in England, and medical centres in Scotland.

*The European Commission’s Digital Agenda.* The Digital Agenda is Europe’s strategy for a flourishing digital economy by 2020. It outlines policies and actions to maximise the benefit of the Digital Revolution for all. To achieve these goals, the Commission is working closely with national governments, concerned organisations and companies. This roadmap includes a listing of 100 actions that will guide the development of this Agenda. Among them, specifically Pillar VI (“Very Fast Internet”) includes eight actions (42 to 49) dealing with the deployment of broadband networks, and other actions, scattered on other pillars, are related with aspects such as education, ehealth (75 to 78) or biomedical research (Digital Agenda for Europe 2010).

The term “Ambient assisted living” (AAL) has been used by the European Commission to refer to this new Joint Programme. Its main objective is to enhance the quality of life of older people through the use of Information and Communication Technologies (ICT). The AAL Joint Programme is initially set up from 2008 to 2013. The programme’s planned total budget is 700 M€, of which approximately 50% is public funding - from the AAL Partner States and the European Commission - and approximately 50% is private funding from participating private organisations (e.g. enterprises). Broadband networks will play a central role in the advent of these new approaches, providing a platform on which it is possible to extend the time that elderly individuals can live in their homes, assisting them to maintain healthy
lifestyles, increasing their security, preventing isolation and supporting their carers and families.

The 2010 US National Broadband Plan’s Healthcare chapter lays a foundation for classical health and biomedical informatics research and practice, using headings such as: the promise of IT; maximising IT utilisation; closing IT adoption and connectivity gaps; and unlocking the value of data. This Plan also lays out a roadmap to the future with initiatives that are expected to stimulate economic growth, spur job creation, and boost capabilities in healthcare and other sectors. The report also provides recommendations for several areas that are considered critical to leveraging the value of Broadband and Health Informatics: reimbursement model, regulation, data capture and utilisation and connectivity. (Connecting America 2010).

The US Nationwide Health Information Network (NHIN) is an initiative for the exchange of healthcare information being developed under the auspices of the U.S. Office of the National Coordinator for Health Information Technology (ONCHIT 2011). Its aim is to provide a secure, nationwide, interoperable health information infrastructure that will connect providers, consumers, and others involved in supporting health and healthcare.

The US Biomedical Informatics Research Network (BIRN) is a national initiative to advance biomedical research through data sharing and online collaboration (Helmer 2011). The Biomedical Informatics Research Network (BIRN) was designed as the first national cyber-infrastructure for biomedical research. Created in 2001 by the National Centre for Research Resources, a unit of the US National Institutes of Health, BIRN initially was funded for more than $20 million. BIRN is a collaborative effort between the NCRR and a consortium of universities and hospitals. It provides data-sharing infrastructure, software tools, strategies and advisory services and it is focused on the biomedical research community’s needs.

The U.S. Cancer Biomedical Informatics Grid (caBIG) aims to develop a collaborative information network that accelerates the discovery of new approaches for the detection, diagnosis, treatment, and prevention of cancer. Sponsored by the National Cancer Institute (NCI), its activities are supervised by the National Cancer Institute Centre for Bioinformatics and Information Technology (NCI-CBIIT). It connects over 50 cancer centres, other NCI-supported research endeavours, and other federal, academic, not-for profit and industry organisations.

**FUTURE DIRECTIONS FOR BROADBAND HEALTH AND FOR HEALTH AND BIOMEDICAL INFORMATICS**

The development of a broadband network is seen from the biomedical and health care sector as an opportunity not only to consolidate existing applications (clinical records, telehealth, remote surgery, education, access to clinical information and knowledge) with the required quality of service and reliability, but also to facilitate a vision of new medical practice in the future. New avenues for health care and research are based on the availability of several enabling technologies in the not so distant future: personal genome sequencing, integrated personal health records, sensors of different kinds (environmental, physiological) and wearables or other intelligent textiles which can collect real-time information about our basic health parameters (for instance, heart beat and breath rate).

The extremely fast increase in the amount and complexity of available knowledge about inter-individual genetic variation as well as about the molecular causes of diseases will also benefit from the existence of high-throughput computing and data storage resources connected to the broadband network. If we want this scenario to become true, it will require empowering and educating patients with reliable information which will allow them to assess their health profile and genetic risks and to make informed decisions about their lifestyle or need for medical follow-up. Health practitioners will demand more training, improved access to biomedical knowledge (through the Internet) and better decision-making support tools. We call this scenario “digitally enabled personalised medicine”. Personalised medicine refers to the tailoring of medical treatment to the individual genetic characteristics of each patient. It does not literally mean the creation of drugs or medical devices that are unique to a patient
but rather the ability to classify individuals into subpopulations that differ in their susceptibility to a particular disease or their response to a specific treatment. Preventive or therapeutic interventions can then be concentrated on those who will benefit, sparing expense and side effects for those who will not (PCAST 2008). Broadband technologies and networks can efficiently transmit data and knowledge from home to the health practitioner and vice versa and will enable the processing of this deluge of data. Personalisation of healthcare offers enormous opportunities for improving preventive, diagnostic and therapeutic solutions, therefore it has a potential impact on improving healthcare outcomes, reducing costs and increasing patient safety.

Broadband could also play a key role in the area that could be called Clinical Research 2.0. Several factors are promoting a new way of conducting studies and clinical investigations. These include: the need to empower the patient, advances in personalised medicine, the success of social networks and the phenomenon known as crowdsourcing, or wisdom of the masses. Thus, we are witnessing a transition from research information systems centralised at hospitals and clinical research centres to distributed systems that reach out to the residence of any citizen/patient who opts in.

This trend can be seen at least in three examples:

- From the EHR to the Personally Controlled EHR (the patient is able to maintain and control access to their own health information).
- From gene-disease association studies to personal genomics (the patients ask for genetic analysis of their DNA through the Internet and receive reports on various aspects of their health).
- From conventional clinical trials to crowdsourced clinical trials (the patient voluntarily shares information on treatments and evolution of his/her illness with other patients using social web tools).

In all these cases, the high connectivity, reliability and speed offered by broadband is necessary to make these models of interaction more efficiently and frequently used.

The development of Australia’s National Broadband Network (NBN) offers a great opportunity to carry out some exciting projects in the field of medicine and biomedical research. But looking in more detail at the possible interactions between the developments associated with high-performance networking and the advancement of ehealth and biomedical informatics, one can identify a synergistic effect (see Figure 1).
The NBN provides a platform on which it is possible to consolidate existing applications with the required levels of reliability and service quality. It also offers the possibility of designing and implementing applications that were previously unthinkable. Among current applications we can include access to educational content, remote monitoring of patients, video consultation, tele-surgery or accessing electronic health records. Among the new applications, the NBN will allow us to achieve the sustained ultra-high speed for data transfer that is necessary to connect massive data storage resources with supercomputing facilities to facilitate personalised medicine, rational drug design, new diagnostic methods based on molecular or functional imaging, or new approaches within public health programs (e.g. early detection of biological alerts).

Moreover, eHealth and biomedical informatics can be considered as facilitators that bring many of their methods and techniques to support the use of broadband to build innovative applications in healthcare and biomedical research. To cite a few examples, biomedical informatics can provide the standards and protocols for sharing administrative, research and clinical data; methods and techniques that guarantee the security and privacy of data; tools to facilitate interoperability between devices and sensors; expertise in change management in health information technologies; and methods for data analysis in the context of health outcomes research.

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Aspects of the 2010 Healthcare Identifiers Act (HIA) are compared to the Australian Law Reform Commission (ALRC) Unified Privacy Principles. The opportunity for improved healthcare delivery through the enabling healthcare identifiers is acknowledged and discussion moves beyond such justifications to consideration of broader implications for Australian society. Law Academic Roger Magnusson’s three broad, sequential conceptual shifts in health privacy provide a framework for the discussion. Lost opportunities for Australian consumers are also highlighted.

INTRODUCTION

The introduction of electronic health records (EHR) has proven to be a challenge in Australia, as it has elsewhere in the world (Kalra 2006; Baird et al 2011; Gunter and Terry 2005; Hayrinen et al 2008; Ludwick et al 2010). Healthcare professionals strongly argue the case for EHR in terms of the benefits to both individual healthcare consumers and society as a whole. (National Electronic Health Records Taskforce 2000) An important step towards the introduction of the Australian EHR was undertaken in 2010 with the passing of the Healthcare Identifiers Act (HIA) through the Australian Parliament.

In parallel to the above developments in the health care sector the Australian Law Reform Commission (ALRC) has wrestled with the concept of privacy in the Information Age. Following extensive consultation with community members, policy and law makers the ALRC proposed a set of eleven Unified Privacy Principles (UPPs) for Australia. (ALRC 2008) The main objective was to unify and enhance the provision of the Commonwealth sector Information Privacy Principles (IPPs) and the private sector National Privacy Principles (NPPs).

The UPPs moved through consultation to become the final thirteen exposure draft Australian Privacy Principles (APPs). Health related provisions that were previously covered by IPPs and NPPs are, however, not covered by the APPs. The Healthcare identifiers and privacy: Discussion paper on proposals for legislative support (2009) referred to the UPPs and included them as an appendix. Table 1 provides a timeline to illustrate the parallel journey these two important national endeavours have taken over the last few years.

The release of the Exposure Australian Privacy Principles came 11 months after the release of the healthcare identifiers and privacy discussion paper. The Healthcare Identifiers Act was finalised in the month following release of the exposure APPs. The Australian Government is yet to release law reform proposals to deal with specific privacy protections for information relating to health. (Companion Guide to APPs 2010, 4)
As the APPs have not yet been finalised, and given that the UPPs did not aim to exclude health care provisions and they were used in the healthcare identifiers discussion paper, they are used in this paper to facilitate discussion.

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<tr>
<th>Published</th>
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<tr>
<td>July 2009</td>
<td>Healthcare identifiers and privacy: Discussion paper on proposals for legislative support.</td>
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<tr>
<td>Due July 2011</td>
<td>Senate Committee report on Exposure Australian Privacy Principles.</td>
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Table 1 - Influential documents in two parallel activities with national importance: ALRC Privacy and health sector identifiers.

In contrast to the Australian approach the US Government reserved support for a unique, national health identifier until Congress had enacted comprehensive legislation to protect consumer privacy. (Ng 2000)

This paper highlights several tension points regarding privacy in these Australian national endeavours. It moves the discussion beyond the EHR objectives to consider Magnusson’s “mother of all function creeps” and broader societal impacts.

MAGNUSSON’S 3 CONCEPTUAL SHIFTS IN HEALTH PRIVACY

Roger Magnusson argues that the challenges to health information privacy are best understood by considering three very broad, sequential conceptual shifts from a relationship between a single clinician and a patient, to more complex scenarios with multiple clinicians (Magnusson 2004). The essential components of the health information privacy transitions perceived by Magnusson are summarised below.

CONCEPT 1: PATIENT-CENTRED HEALTH RECORDS

Clinical care is delivered by a sole practitioner who receives or generates sensitive information during the care of a patient/consumer. Information is stored on hardcopy health records. Protection of confidentiality within the bilateral doctor/patient relationship is paramount. The hardcopy nature of the health record aids in restricting access to the consumer’s information. The clinician consults with the patient in the ‘gatekeeper’ role, seeking consent where necessary to release records for secondary purposes, meaning those purposes that do not pertain to the direct delivery of healthcare to an individual. (Safran et al. 2006)

Within this paradigm, the law focuses on offering consumers protection by imposing penalties on the doctor for unauthorised disclosure of personal information.
CONCEPT 2: MULTI-FUNCTION HEALTH DATA HOLDINGS

Clinical care is typically delivered in a “corporate” environment including hospitals, medical centres and community-based practice groups. Patient information is recorded in a centralised, shared record which can be accessed by a range of clinicians and administrators. The need for specialised and efficient care results in many team members widely accessing the individual’s health record. In institutional contexts the treating physician does not broker access to patient records. There will rarely be a single ‘gatekeeper’ allowing access.

Within this paradigm, the focus of the law shifts from protecting confidentiality in a relationship to protecting the actual medical information.

On the shift from bilateral to multilateral confidentiality Magnusson states:

‘The growth of computers and the revolution in information technology has made this transition inevitable. Privacy legislation goes beyond confidentiality to regulate other elements of the “information processing cycle”; namely the collection of personal information, its accuracy, security and storage; the right of the subject to access it, as well as use and disclosure’ (Magnusson 2004, 683)

CONCEPT 3: TRANS-ORGANISATIONAL HEALTH DATA FLOWS

Patient health records are stored in electronic health records in a manner to facilitate national linkage and potentially more surveillance. Management of privacy extends beyond one organisation’s health care environment. In Australia this includes the national health insurance scheme, Medicare, General Practitioners and Super-Clinics, prescriptions details held in the Pharmaceutical Benefits System, private health insurance organisations, public and private hospitals and allied health agencies.

The argument for electronic health records, which characterise Magnusson’s third conceptual shift, is usually pitched in terms of improved health care outcomes for individuals. The benefit to the government is the way health information networks enable the monitoring and measurement of the national health system performance.

On the matter of secondary uses of medical data Magnusson is very clear. Under the initial patient-centred model the use of a patient’s health information for secondary purposes can be considered extraordinary. His prediction for the future direction of secondary uses is foreboding for privacy advocates:

‘The mother of all “function creeps”, but only likely to become increasingly apparent over the next decade or so is the gradual absorption of patients’ health records within a broader public health infrastructure whose goals explicitly include the protection and promotion of population health’. (Magnusson 2004, 686)

In this final trans-organisational concept Magnusson anticipates strong pressure for a surveillance architecture permitting linkages between health systems, environmental, demographic and socio-economic surveillance data – thus truly achieving the Orwellian future feared by privacy advocates. The broader, more recent research of M.G. and Katina Michael (Michael and Michael 2010) reflects on the need to carefully consider the adoption of new technologies and perhaps “... reject its rampant application and diffusion without studied consideration as to the potential effects and consequences.” The notions of Úberveillance posited by M.G. and Katina Michael resonate with the future envisioned by Magnusson.

CURRENT AUSTRALIAN POSITION

The HIA is moving Australian society towards Magnusson’s third conceptual shift of Trans-Organisational Health Data Flows. Writing in 2004, Magnusson anticipated that it would take...
almost a decade to see evidence of the conceptual shifts. To date discussions and justifications for creation of healthcare identifiers and EHR have largely focussed on the potential, positive aspects associated with improved health care. Adopting a broader view Magnusson draws our attention to uses beyond direct healthcare, including performance monitoring by governments. The notion of monitoring Australian health system performance is currently under debate in the Medical Journal of Australia (Braithwaite and Mannion 2011; Jorm and Frommer 2011). Individual and Provider Identifiers are fundamental building blocks of the information systems that provide the vast volumes of data needed for corporate and trans-organisational and national performance monitoring.

The next section of this paper compares and contrasts the Identifier Principle of the ALRC UPPs and the 2010 Healthcare Identifiers Act. This enables a multi-dimensional perspective to allow reflection on both the immediate EHR drivers and broader societal impact.

IDENTIFIERS - ALRC PRIVACY PRINCIPLES

In developing the proposed UPPs, the ALRC considered many aspects of privacy in the Australian context including: the background to privacy regulation; achieving national consistency; regulating privacy; impacts of developing technology on privacy and associated matters. ALRC Recommendation 30.3, clarifies the term ‘Identifier’:

‘The “Identifiers” principle should define “identifier” inclusively to mean a number, symbol or biometric information that is collected for the purpose of automated biometric identification or verification that:

(a) uniquely identifies or verifies the identity of an individual for the purpose of an agency’s operations; or

(b) is determined to be an identifier by the Privacy Commissioner’

On the issue of the Identifiers Principle the ALRC states

‘It is not desirable for organisations to refer to individuals by an identifier that is assigned by an agency, nor is it desirable to facilitate data-matching between agencies and organisations through the use of an identifier’. (ALRC 2008, Vol2, 1029)

It is clear here that the ALRC is warning that organisations should not be allowed to adopt unique, individual identifiers that have been allocated by Government agencies. Allowing numerous organisations to adopt the same Government generated unique, individual identifier enables data from disparate organisations information systems to be readily linked. The level of individual surveillance and secondary data use that is possible with such architectures is for many members of society quite alarming – hence the ALRC strong position here.

The development of national identity numbers is not a notion endorsed in any way by the ALRC, published discussion specifically refers to preventing the creation of de facto national identifiers:

‘The policy objectives underlying the recommended “Identifiers” principle—preventing an identifier that is assigned by an agency from becoming a de facto national identity number, and restricting the use of an identifier to facilitate data matching programs—are also relevant to the handling of identifiers by agencies’. (ALRC 2008, 1034)

The Australian Privacy Commissioner provided a concise description of the importance of identifiers in a submission to the ALRC,

‘The privacy risks of sharing unique identifiers are not always immediate. The risks accumulate as more organisations or agencies adopt the number for their own purposes, and as greater amounts of otherwise unrelated personal information become associated with that number. Accordingly, individuals may not always be
conscious of the inherent risks of consenting to incrementally greater uses of their unique identifier’. (ALRC 2008, Vol2, 1047)

Moving on from the UPPs the Companion Guide to the Australian Privacy Principles (2010) provides very clear guidance on the use of identifiers issued by government agencies via Australian Privacy Principle 9 – adoption, use or disclosure of government related identifier:

‘This principle is aimed at ensuring that organisations (not agencies) do not refer to individuals within their own systems according to identifiers (for example, Medicare numbers) issued by government agencies. Further, it prevents the facilitation of unlawful data-matching by organisations through use and disclosure of such identifiers.

The key goal of this principle is to restrict general use of identifiers issued by government agencies and prevent such identifiers from becoming de facto national identity numbers’. (Companion Guide APPs 2010, 11)

The substantial consultation undertaken by the ALRC in the development of the Model UPPs and subsequent progress to Exposure Australian Privacy Principles indicates a real engagement with the issue of privacy in the Information Age. There is a recognition that adoption of information and communication technologies is not always in the best interests of individuals as they inevitably leave electronic footprints through their day-to-day activities. The notion of undesirable citizen surveillance is acknowledged by the ALRC and prevention of such is a clear objective throughout its three-volume report (ALRC 2008) and Exposure Australian Privacy Principle 9.

IDENTIFIERS - 2010 HEALTHCARE IDENTIFIERS ACT

The Healthcare identifiers and privacy: Discussion paper on proposals for legislative support was issued by the Australian Health Ministers’ Advisory Council in July 2009. This paper described legislative proposals to support the creation and implementation of Australian national healthcare identifiers and associated arrangements for privacy of health information. Included in this proposal is the creation of an Individual Healthcare Identifier (IHI) for every Australian.

The Discussion Paper puts forward the case for establishment of the national healthcare identifiers with the associated Health Identifier Service expected to be operational by mid 2010. As noted in the Executive Summary to the Discussion Paper:

“Discussions between governments about a national privacy framework across all jurisdictions and its implementation may not be completed by that time”. (Discussion Paper 2009, 3) This is a lost opportunity for consumers as a stable, well established national privacy framework would have been advantageous for consumers both now and in the future as the identifiers are more widely adopted.

The Discussion Paper stated that “assignment of IHI’s will be authorised by legislation and individual consent will not be sought”. (Discussion Paper 2009, 25) The arguments for this are sound from an information systems point of view, that is from the outset the health data management goals would be best served by a complete, valid and comprehensive set of individual identifiers. Assigning health care identifiers on a voluntary basis is rejected in the Discussion Paper as it “…would create numerous implementation problems and complexities, placing increased burden on healthcare providers and consumers, and resulting in poor uptake”. (Discussion Paper 2009, 11) Authors of the Discussion Paper go on to state that “Limited or inconsistent uptake will mean that many of the efficiency gains for health care providers and important quality and safety benefits for patients will not be realised.” (Discussion Paper 2009, 11)

This approach can be seen as very ‘heavy-handed’ and somewhat paternalistic and an ‘opt-out’ option for Australian consumers who did not wish to participate in the de facto national identifiers could also have been supported from a privacy-protective perspective. Arguments against the failed Australia Card are pertinent here but will not be revisited in this paper.
The Discussion Paper also explains that healthcare providers will be given approval to adopt the new Individual Healthcare Identifiers in their health information systems. This suggestion is in **direct conflict** with the ALRC policy objective, UPP 10 and APP 9 that prevents the adoption of such identifiers due to concern regarding data linkage and the future potential for surveillance. This is also in **direct conflict** with the risks raised by the Australian Privacy Commissioner, as presented above, where the issues with shared identifier use are not initially obvious but become more apparent over time with broader adoption by a growing number of organisations.

The Discussion Paper also acknowledges that this aspect of the Healthcare Identifier proposal is **at odds** with the Commonwealth Privacy Act 1988:

> ‘Specific authority will be given to private sector healthcare provider organisations to adopt, use or disclose and IHI or HPI-I for health information management and communication purposes. This is to overcome a restriction in the present Commonwealth Privacy Act 1988’. (Discussion Paper 2009, 3).

The draft Exposure Healthcare Identifiers Bill was available for scrutiny and comment across the Christmas-New Year period from mid-December 2009 to 7 Jan 2010. The brief consultation across the traditional holiday period was not ideal for consumer engagement. The 2010 Healthcare Identifiers Act was enacted in July 2010 with all Australians allocated a 16 digit unique identifier.

Within the HIA, **Division 3 Section 25 Adoption by healthcare**, authorises healthcare providers to use the national identifier within their own information systems:

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25 Adoption by healthcare provider

A healthcare provider is authorised to adopt the healthcare identifier of a healthcare recipient (including a healthcare identifier disclosed to the healthcare provider for any purpose under section 24) as the healthcare provider’s own identifier of the healthcare recipient.
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Using this de facto national identifier as a possible primary key or foreign key within healthcare provider’s disparate information systems could at a later date readily facilitate data linkage and surveillance. The impact of this on future Australian society is alarming yet this legislation has passed fairly quietly through Federal Parliament.

There is a note in the legislation attached to this section that states that this approval only relates to the identifier not the associated consumer personal health information. The associated health information is to be dealt with by ‘other’ legislation including the Privacy Act 1988. When using information technology it is the identifier that is needed for linkage and it is somewhat inadequate to refer back to the Privacy Act 1988 seeking protection for the remainder of the held personal information. Australian researchers have recently noted the complexity in navigating privacy legislation (O’Keefe and Connolly 2010) and this splitting of the individual healthcare identifier and the associated medical information between two (or more) Acts may not assist.

As Magnusson foreshadowed in Concept 3, the gradual absorption of individual’s health records within a broader public health infrastructure is evident in the HIA. Specifically, **Section 24 Use and disclosure for other purposes** authorises release of health identifiers for a range of secondary purposes including but not limited to: management, funding, monitoring or evaluation of healthcare; provision of indemnity cover for a healthcare provider; conduct of research that has been approved by a Human Research Ethics Committee and to lessen or prevent serious threats to public health. Clearly the healthcare identifiers alone would be insufficient to facilitate such secondary uses and the associated personal and medical data is also required.

Within **Section 24** the HIA is strengthened by the inclusion of four excluded secondary uses:

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Certain purposes excluded
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This section does not authorise the use or disclosure of the healthcare identifier of a healthcare recipient for the purpose of communicating or managing health information as part of:

(a) underwriting a contract of insurance that covers the healthcare recipient; or
(b) determining whether to enter into a contract of insurance that covers the healthcare recipient (whether alone or as a member of a class); or
(c) determining whether a contract of insurance covers the healthcare recipient in relation to a particular event; or
(d) employing the healthcare recipient.

The exclusion of these secondary purposes reflects Australian consumers concerns regarding secondary use of medical data by insurance organisations and employers as gathered by a pilot consumer survey in 2009. (Heath 2010)

CONCLUSIONS

By looking beyond the healthcare drivers that led to the 2010 Healthcare Identifiers Act, it is possible to recognise that there are broader societal impacts that, as the Privacy Commissioner and Magnusson have warned, are not always immediately apparent. Ideally the Australian Privacy Principles (APP) would have been finalised and supported by legislation prior to tackling the complex issue of creation of Australian Healthcare Identifiers.

Looking to the future we can expect increased interest in secondary uses of Australian consumers medical data as the adoption of the IHI facilitates linkage of disparate datasets. Secondary uses include: commercial activities such as those offered by data brokers; medical research; clinical audit and healthcare administration. Research is currently underway to explore Australian consumer’s expectations regarding secondary use of their medical data (Heath 2010). The outcomes of this research should assist by providing consumers voices in upcoming Government initiatives concerning eHealth and privacy.

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This article discusses two of the many eHealth implementations done by BT: the English National Programme for IT (NPfIT) and Hungary IKIR. BT has found that the interaction between patient and clinician and the needs and pressures of operational managers and policy makers are very similar in any country and setting. Any supporting technical solution, however, always requires contextualisation to the country’s legal, financial, economic, demographic, geographic, technological and cultural landscape. There is no ‘one size fits all’ solution, but experience and lessons learnt are always reusable, especially in the areas of reliability, security, confidentiality and safety of information.

INTRODUCTION

There are many reasons for having reliable person-centric health records. They can reduce risks of error and clinical misadventure due to a lack of information about the patient and diseases, drug to drug interactions and contra indications. Patients can be better informed and exercise more control over their own health and healthcare living longer and fuller lives, and patients do not have to repeat themselves or risk forgetting things where they deal with several healthcare professionals. According to one estimate, as much as AUD$2050 million could be achieved from computer interpretable interoperability. (Sprivulis et al 2007).

Improved efficiency can help the aging healthcare workforce cope with increasing patient workloads, enabling the delivery of more complex care with less staff. As healthcare is increasingly delivered in the home and the community, using telemetry, biometrics and a mobile workforce crossing organisational boundaries, information about patients must be available when and where it is needed, and not tied up in individual organisations or locations.

The benefits, however, need to be balanced against concerns over confidentiality (NEHTA 2008). In finding the balance, the concerns of all those involved in healthcare delivery need to be addressed. Individuals want reliable clinical information immediately, to care for themselves and their family, and clinicians want it to maximise clinical effectiveness, safety and the use of their own time. Others need clinical management information, usually anonymised, for secondary purposes. Operational managers of health services need an overview of complex individual and aggregate patient activity to best use resources such as theatres, beds and community nurses to meet demand. Policy makers considering how and where to invest to improve the health and healthcare experience of those they are responsible for need to know of interventions and outcomes, whether it be in health education or the use of a new cancer drug.
Policy makers and strategists already have access to health data, such as disease registries for cancers, chronic diseases and infections, to identify areas in need of investigation and intervention, but these are silos of information which are not captured in “real time” and do not enable meta analysis. Fast, reliable information is also increasingly important because of the growing incidence of co-morbidity (a primary disease(s) accompanied by others) in aging populations, and because some infections are presenting epidemic consequences. To meet everyone’s needs and concerns, information needs to be shared reliably, securely, confidentially and safely.

This article discusses two of the many eHealth implementations done by BT (British Telecom): the English National Programme for IT (NPfIT), and Hungary IKIR. BT operates in over 170 countries and has been delivering health projects in the UK, Spain, Netherlands, Hungary, Singapore and more for several years.

The company has found that the interaction between patient and clinician and the needs and pressures of operational managers and policy makers are very similar in any country and setting. Any supporting technical solution, however, always requires contextualisation to the country’s legal, financial, economic, demographic, geographic, technological and cultural landscape. There is no ‘one size fits all’ solution, but experience and lessons learnt are always reusable, especially in the areas of reliability, safety, security and confidentiality of information.

A NATIONAL SOLUTION: ENGLISH NATIONAL PROGRAMME FOR IT (NPfIT)

Today, BT sits at the heart of the biggest-ever IT programme for the National Health Service (NHS) - the NPfIT. Commencing in 2003 the project essentially puts England's health system 'on-line' and supports the drive to improve care by allowing authorised clinical and administrative staff, as well as patients, to have the right information, at the right place, at the right time. At £12.7 billion affecting 1.3 million healthcare workers and more than 50 million patients, the NPfIT is reported by Gartner to be the largest civil IT project in the world (Burke 2008).

The high level solution set provided by BT includes the following blend of COTS products and bespoke Java code through Java EE Technologies: Service Orientated Architecture (SOA), Web Services (SOAP), Health Language 7 v3 (HL7 v3) formatted message embedded in ebXML. It is pattern based, using both synchronous and asynchronous messaging patterns, facades and orchestrated patterns to deliver complex services to internal and external services.

RELIABLE: TRANSACTION MESSAGING SERVICES AND PATIENT IDENTIFICATION

Prior to the NPfIT, technology development and deployment in the NHS had been uncoordinated. The result was a multitude of systems of varying quality and capabilities, even including some old systems running on operating systems that were no longer formally supported.

At the centre of the NPfIT lies the ‘Spine’. It gives authorised healthcare professionals faster, secure access to reliable information about patients, helping the NHS to operate more efficiently. The basis of the Spine is a gigantic Transaction Messaging Service (TMS) connecting over 20,000 system instances from more than 300 suppliers of hospital, GP and community systems. This central infrastructure is now processing 2 trillion messages a year. At the core of safely exchanging all this information is the ability to correctly identify the patient.

Before the NPfIT, there was no single source of patient information, which was dispersed between legacy systems with duplication and incomplete data held in multiple places. The Personal Demographics Service (PDS) is focussed on the creation of a master Patient
Demographic Database, the master patient list that contains non-clinical information critical to the process of identification before clinical care can be provided. It is not a single service but is comprised of many interrelated services that triangulate to mutually assure and improve data quality and accuracy and thereby safety. Some of these services are:

- **PDS Manage Practice List Service** centrally manages general practitioner practice lists
- **PDS Records Tracking Services** tracks and controls the paper and electronic records of patients between physical locations. Previously paper records were sent between GP practices by post, and not tracked, often not reaching their destinations
- **PDS NHS Number Issuing Service (NIMS)** controls the NHS numbers that are issued for new patient records centrally. This ensures no duplicate or incorrect numbers are issued or allowed into PDS. A unique identifier is issued to all patients to be used in all eHealth systems that are replacing legacy systems. This identifier is also sent to the legacy systems that will not be replaced to ensure forward and backward linking of new and legacy data
- **The PDS Tracing Service** allows end users to trace (search) against the PDS database. The integrity of address, gender and date of birth are critical in identifying patients. These traces include the ability to identify babies, verify NHS unique identifier number, verify address, names and other more complex traces. These include an algorithmic advance trace which uses a Cartesian join algorithm and rates the results to identify those that closely fit the search criteria
- **PDS Data Quality Service** uses data from legacy systems and institutions such as the Royal Mail, in addition to business rules and work item tasks to improve the data quality of the PDS database. As more institutions join the NHS NPfIT, so more – but potentially incomplete, out of date or conflicting – information becomes available. With all the patients in a single database a lot of duplications and confusions can be resolved using merge, unmerge, confusion resolution and address update components
- **The Data Migration Service** is part of the PDS. Up to 70 million records are migrated and cleansed from each legacy system before loading into the master database

BT learned several lessons from its experience in these areas. If a single Patient Master Index (PMI) does not exist, early implementation of it is crucial. Data quality is critical and legacy data requires deep cleaning before it can be utilised with integrated services. New data quality issues such as duplicate registrations will occur, and back office type functions are always needed at local and national levels to resolve them. The concept of personal accountability and responsibility for data quality needs to be embedded into the culture of all those involved in healthcare data input. Technical solutions need to be constructed in such a way that they mutually enforce data quality. Business continuity plans must be in place to address integrated solutions, not just local solutions. Demographic data grows stale over time for reasons such as postcode changes for the same property, gender change of the individual or name change through deed poll or marriage. Continual monitoring and improving of data quality is essential.

**RELIABLE: SECONDARY USES**

The NPfIT Secondary Uses Service (SUS) will be one of the largest clinical data warehouses in the world, providing anonymised patient-based data: a powerhouse for public health and medical research, development and business planning. NHS confidentiality policy now requires that pseudonymisation is used in all NHS based secondary use data handling however that information is garnered.
SECURE AND CONFIDENTIAL: ACCESS CONTROL FRAMEWORK

All data that passes within the NPfIT is subject to a stringent Access Control Framework (ACF). The ACF itself uses information within the PDS, care records service, identity management and SUS with all activity informing the audit service. ACF is not just about technology. Most importantly, it is about people and process. Intended users must first give evidence to a Registration Authority (RA) as to who they are, and along with sponsorship from their employer(s), what access they need so that they can undertake their role(s) within healthcare. Directory services are also needed to enable the validation of healthcare practitioners and organisations transmitting, receiving or accessing data.

Role Based Access Control (RBAC) is concerned with controlling which users can have access to which application functions, based on the roles(s) they perform, and consequently what kinds of data they can access. It forms a vital piece of the information security jigsaw along with legitimate relationships, patient consent, sealed envelopes for information, audits and the existing professional, legal and ethical controls supported by disciplinary procedures.

Many lessons were learned from this experience. The complexity and diversity of healthcare roles needs to be acknowledged, with the implications understood and communicated in terms of people and processes before the technical solution is tailored. Obtaining agreement of a set of “standard” user roles between regions is a lengthy process; time invested “up front” will be amply rewarded in later stages. There needs to be a balance between defining sufficient roles to accommodate the granularity of rights associated with these and a model that becomes untenable to maintain practically. Health organisations change over time through merging and other restructures. This has an impact on RBAC, identity management and access control generally. Such changes are often very complex to change in production systems if these are not designed to accommodate change from the outset.

Access Control Framework: Legitimate Relationships

A user must have a ‘legitimate relationship’ with a patient in order to gain access to the NHS Care Record Service clinical records of that patient.

The patient will be seeing, at different times, unexpected members of care teams, visiting specialists, community intervention teams and so on. This requires the ability to create new legitimate relationships at all times and is especially beneficial at times of crisis when emergency care is required by new care teams. Functionality exists to support the creation of a Self-Referral legitimate relationship allowing a user to select a patient for care. This also allows care professionals in the same workgroup to access the patient’s appropriate clinical record. This self-declaration of course requires oversight to ensure there is a genuine legitimacy. However, if every relationship is reported to an information guardian, then the risk is that inappropriate access is lost in the white noise created.

BT has learned that data guardianship, mechanism, process and anticipated volumes need to be debated and made clear to all stakeholders. The patient’s right of and mechanism for being informed over their data being accessed must be explicit early in any programme. Each jurisdiction will need to carefully plan the governance of information guardianship.

Access Control Framework: Consent

The evolution of healthcare has often resulted in sharing patient data without their explicit consent of the patient. With the transition to electronic records and changing privacy legislation, this aspect has had to be considered very carefully. Patients must give explicit contemporaneous consent before a clinician can open a shared record. BT has learned several lessons about the opt-in or opt-out choice offered to patients. Changing custom and practice is never easy, and the idea of a clinician or organisation being the sole owner of individual patient data has become questionable in most of the world. The concerns of professional groups must be addressed, and any change in practice and education of staff addressed. Clinical risk aspects of opt in and opt out models need to be understood by all. The impact of legislation must be assessed and a public debate held before healthcare IT solutions are integrated.
Access Control Framework: Audit

By far the largest amount of information held in the Spine is the audit log. For every piece of data sent, retrieved or viewed, there is a full audit trail of who did what, where and when and, in the case of Legitimate Relationships and referrals, also why. As a result, for every data item held about the patient, there is a related audit log of 4 to 5 times the volume.

Information governance structure, rules and processes must be in place prior to programme design and deployment. The implications of storing this volume of data and how it is to be accessed need to be fully understood by purchasers and providers of solutions.

SAFE

Connecting tens of thousands of local systems and facilitating clinical information flows between them needs governance over the sharing of clinical information to know not just who sent what to whom and when, but that the content of the message is consistently captured to assure no inadvertent technical event has altered the intended clinical message in any way.

The solution was to define a set of interoperability standards and services that have been implemented and integrated within the entire healthcare ecosystem. Open standards are used whenever possible to enable the interoperability that the NHS requires and the diversity to meet individual business needs.

However this multiplicity of standards, such as Health Level Seven (HL7) version 3, clinical document architecture (CDA) version 2, Systematised Nomenclature of Medicine (SNOMED) and Electronic Business XML (ebXML), have rarely been used together in integrating national and local systems. Compliance to standards is readily achieved by most products independently, but to work in an integrated way, the standards need to be constrained to ensure technical robustness and to maintain clinical and semantic integrity.

INTEGRATED NATIONAL SERVICES

BT learned many lessons about reliability, security, confidentiality and safety from this large project to provide integrated national services.

On reliability, creating inclusive technical boards from an early stage encourages negotiation and compromise between integrating parties. The non-functional requirements such as message volumes and performance targets are frequently more challenging than the functional integration requirements. Version control and ensuring compatibly with previous releases as the service evolves is challenging. Integrated solutions and shared clinical data are new ways of working. Governance structures need to reflect these changes, with new structures created where these are absent. A collaborative approach needs to be fostered with organisations newly adopting health IT standards, involving clinicians as much as possible. As much standardisation as possible needs to be enforced and local tailoring of systems needs to be limited.

On security and confidentiality, compliance, and accreditation of vendor solutions needs to include adherence to access control frameworks. Information sharing is always complex. Sharing protocols often reflects local service circumstances which will include electronic and other communication media requirements.

On safety, data quality is a key aspect of a health system and should be validated both at source and at point of update. Early clinical engagement to standardise clinical content to support semantic interoperability, messaging content and information exchange needs is essential. Technology is merely the enabler of change. Change management and clinical transformation is crucial in providing continuous services.
A REGIONAL SOLUTION: HUNGARY

BT developed a regional solution in Hungary under the umbrella of the European Union’s IT Development in Healthcare in the Disadvantaged Regions (HEFOP 4.4.1 initiative). Called IKIR (Inter-Institutional Information System), this solution connects 38 healthcare institutions in Southern Transdanubia, Northern Hungary and Northern Plain, 15,000 medical practitioners. A population of 1.5 million benefits from the system.

The electronic health record (EHR) service is a central index service with federated clinical information in repositories requiring a different architecture to the UK. This model is similar to that used by other countries with state or regional autonomy of health services. The information is fully accessible between domains, but is not collated as a care summary. While this may be perceived as still leaving the clinician with the burden of having to collate information from several sources, it is a significant step forward in delivering safer and more effective care with no delay caused by a debate about who has the responsibility of providing a care summary. For countries where the GP is not the locus of ongoing patient responsibility, this model provides a fast and effective solution. Patients are also able to access the solution via a portal and can check data held, thus improving its accuracy.

RELIABLE

Just as in the UK, the core of the system is a message-transmitting engine which supports the secure transmission between healthcare institutions, with searching and downloading of documents, handling appointments, transmitting healthcare service requests and answers. The solution is predicated on Hungarian healthcare ICT standards, most of which are imbedded within ISDO standards.

The business flow is as follows. The patient registers through a Government Electronic Portal, using its authentication technology. The registration is then cross-validated against the National Health Insurance Service at a local primary care service and this becomes their record “home” organisation. All services now have local components (KRM modules) held in each institution. Messages are transferred to the local IKIR servers that are connected to the local hospital information system.

Two main lessons were learned from this experience. First, whilst the TMS needs contextualising to meet country-specific rules, the principles of adherence to standards and rigorous verification of conformance and compliance remain a fundamental requirement in every solution. Second, technical integration brings into focus the need for standardised understanding and representation of clinical information held. Standardisation of clinical content must be undertaken if semantic integration is to be achieved.

SECURE AND CONFIDENTIAL

The most significant difference between the solution sets in the UK and Hungary is that in Hungary, while most clinicians use their own hospital information systems for patient information, the solution does allow them to search and access healthcare documents held by others using a secured web connection via a portal. It also allows patients to consent or not to sharing and for all to apply the data protection law which demands that no patient data be stored centrally, including their unique patient identifier. Healthcare data can only be stored by specific organisations such as hospitals, clinics, GP surgeries and the National Health Insurance Fund.

Under the constitution, Hungarians have three unique IDs. Healthcare is one of these. It is this number that the healthcare providers use as a unique ID, whereas the patient portal access uses the citizen ID as the unique identifier. The cross-validation between the two government bodies is part of the IKIR service. As in many countries, data protection law had not been tested in earnest and there are multiple opinions on its interpretation. The current business
solution has been to create and utilise another identifier number derived from the unique healthcare ID. This is held in the IKIR service which is not categorised in existing law.

Two main lessons were also learned from this experience. Policy and process need to be addressed alongside evolving eHealth plans. Solutions must be tailored to local legislation, with the flexibility to adapt to policy development.

SAFE

Significant improvements in care have been made possible by allowing documents and other information to be requested and retrieved from other systems using a central index. The lesson from this experience was that mandating and adoption of international and national standards is imperative for safe transference and retrieval of data, including the context and semantic intent.

CONCLUSION

Interoperability between diverse constituents in a health ecosystem, enabled by a set of standard interfaces, is achievable. BT’s has succeeded by developing and understanding the interrelationships of these standards, and learning that all solutions must be based within the local context, reinforced and supported by local governance and decision making structures.

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It might seem obvious that information is central to the provision of health services, but most providers have inherited process-centric approaches from an era that predates the availability of large amounts of electronic information. The importance of information is reflected in the prominence of the health informatics discipline. However, putting information at the centre of twenty-first century medicine requires: a greater understanding of the potential of technology; a common understanding of what information actually is; and ways of measuring whether proposed technical solutions are capable of delivering the information that clinicians, administrators and patients are going to require.

INTRODUCTION

In the era of electronic information, we expect information from different health-related activities to be recorded and shared in a way that is usable by those who care for us. Anecdotally this turns out to be harder than most people expect. Health is the ultimate combination of processes, involving a multitude of steps which can each involve expert knowledge and information. At a time when organisations traditionally associated with technology and information are trying to dominate health as well, the health sector can learn from other complex industries that have also tried to integrate information across activities and processes.

WHAT IS INFORMATION?

The seemingly easy task of defining the concept of information turns out to be quite hard to pin down. Without a common definition, different practitioners who work with information don’t have any foundation to support important discussions around the content that overlaps their areas of expertise. Over time, many aspects of the language associated with information need to be standardised by professional consensus.

One of the more succinct definitions has been suggested by Robert M Losse from the University of North Carolina: “Information is produced by all processes and it is the values of characteristics in the processes’ output that are information” (Losse 1998).

This definition captures the concept that information results from events or processes. Just as importantly, it is the number of unique states of each output (the values) that correspond to information. For instance, a diagnosis might have three states – “confirmed”, “cleared” or “unknown” – resulting from a patient testing process. No process exists which does not create information. Similarly no information exists that did not result from a process.

This definition implies values based on the context of the information. There was a time when it was argued that, in some disciplines, the context of information was irrelevant. For instance, the only thing a general practitioner (GP) cared about from a specialist to whom a patient was
referred was the specialist’s diagnosis. With the complexity and options that come with 21st century medicine, we now know that the context of the information is just as important, because it is often being compressed or summarised in the absence of other key information. A patient’s GP is likely to care which testing process was used and may want to ask for some of the additional information about the test scores to decide whether there was sufficient clarity in a “cleared” outcome.

Losee goes on to recognise that processes are simply algorithms of varying levels of complexity. It can be argued that information is more closely tied to algorithms than it is to static metrics. Information is dynamic or complex.

INFORMATION-DRIVEN

To understand the opportunity that health professionals have today, we need to go right back to the industrial revolution and the changes that triggered an exodus of people from agriculture to manufacturing, from rural to urban settings. During this time, there was an explosion of knowledge brought about by engineering innovation and mass mechanisation which fed into every branch of science including medicine. However, the industrial revolution created a society that was fundamentally organised around sequential processes. Manufacturing, agriculture, government and health all operate on a series of logical steps.

Today we are in the midst of an information revolution. This is affecting many of the same types of people who were affected by the industrial revolution. It is moving of jobs across global borders and removing many unskilled roles from the workforce. Further, an enormous quantity of information has moved into the hands of people who provide services through databases and integrated technology. Previously much of this information would have just belonged to government. If individual professionals held it, they were severely limited in how they could compile or analyse it because it would have been written on paper buried in filing cabinets.

Despite this information revolution, we have retained the industrial revolution’s process orientation in most areas of business and government, including health. We should wonder, however, whether this is still the right approach. Just ask anyone who has tried to arrange to see a specialist or deal with two different health-related issues at the same time.

Other modern innovations seem to have evolved past the process-driven model. The traditional telephone network is very efficient at joining two people together by analysing source and destination. Social networks are very efficient as evidenced by the small number of steps required to connect anyone with anyone else on the planet. It doesn’t seem to matter what cultural or social norms are in place between the two people (just think “six degrees of separation”).

INCREASING COMPLEXITY OF TECHNOLOGY

Information technology budgets are consuming an increasing proportion of the budget of most organisations, despite the continuing drop in the cost of processing technology required to meet a particular level of technical performance (Moore’s Law).

The added cost could be argued to be due to additional functionality such as flexible interfaces, multiple platforms and more complete storage of data. However, when this is stripped away and only core functions are maintained, such as with financial reporting or core business services, the result still seems to be a dramatic rise in the cost of information technology.

A new system isn't really a failure until users find it either has the wrong data or that the content is linked in a way that doesn’t meet their needs. Hillard (2010) proposes a system lifecycle model, as shown in Figure 1, based on the principle that users are generally forgiving of difficult user interfaces if the content is relevant to their objectives, but are ruthless in their criticism of even the most ergonomic interface if the content is irrelevant or, worse, wrong.
When they are first built, good systems are designed well for user input, but more importantly, their content is highly relevant to the business of the enterprise. Almost inevitably, organisations change and over time the content of the system becomes less relevant. As that happens, the usability of the system inevitably falls, ultimately to the point where it is irrelevant and hence virtually unusable. The correct next step is to make the content more relevant and this will inevitably lead to a much better user experience.

All too often, good systems are replaced for the want of a little more information that would make them highly relevant. When a new system is demonstrated, typically the user interface is combined with dramatically usable information. If the same information was available inside the existing system, the question needs to be asked whether it should be replaced.

The sensitivity of systems to information changes provides a clue to the underlying cause of increasing cost of systems: information complexity. In the health sector, we expect to see the same information being used in many different ways. Personal information is associated with an individual and, for example, should be accessible for privacy checks and one-on-one consultations. This information needs to have a long time horizon and it is critical that there are no false positives (that is, one person should not be given another’s data by mistake).

The same data also needs to be available for a whole range of clinical purposes, including statistical analysis and follow-up reviews. It is important that record linkages are not lost as they form an important part of the timeline and population history – in other words, there should be no false negatives. In addition, the running of health organisations requires some of the same information to be collated and aggregated to support funding and other payer activities.

The needs of each of these sources are slightly different and constantly changing but applied to the same underlying data. In effect, the same data needs to be linked across a number of complex (or non-linear) systems. Mathematicians know that when you combine three or more non-linear systems you have the underlying prerequisite of a complex system. The author’s prior research has shown over many years that information systems have a tendency to display the characteristics of a chaotic system (Hillard et al 1999).

**“SMALL WORLDS” DATA MEASURE**

The massive growth in raw data volumes available to the health sector is creating a new problem for those responsible for ensuring the right information is available when and where it’s needed: how to know whether the electronic content is stored in a way that makes it available for every stakeholder and potential purpose. Many of those responsible have no way of determining whether it is being stored in a way that is readily accessible.

Information technology experts know that the accepted technique for storing structured data is in a Relational Database Management System (RDBMS) using normalised relational modelling techniques, while unstructured content should be indexed using an enterprise taxonomy (a filing system or catalogue). Health stakeholders, on the other hand, know that
they need to have access to information but seldom have any understanding of the techniques used by the technologists or how they can strategically evaluate the quality of the data held by the enterprise. It is a sign of the growing importance of information in health that the discipline has its own name and governing bodies: health informatics.

The “small worlds” measure can help to bridge the gap between all stakeholders and the technology experts by providing a metric which can be used by anybody overseeing technology projects to estimate whether the database design is likely to work for the applications they plan to apply them to. The small worlds network theory was formally born out of research by Stanley Milgram (1967) and it has continued to evolve. Milgram’s work is best known popularly as “six degrees of separation”: the idea that every member of society is separated by no more than six social steps. The theory has been extended to show that any network (be it technical, biological or social) is only stable if there is a logarithmic relationship between the number of nodes and the number of steps needed to navigate between any two points.

This model holds true for programming languages. Most software development tools are designed to make it easy to navigate between code units (through the use of objects or subroutines). Physical storage technologies are designed to make it easy to request the retrieval of data regardless of whether it is adjacent or distributed over a substantial distance. The Internet is the ultimate example of a distributed system with a logarithmic between distance and complexity.

The model also holds true for successful business models. For example, sales teams rely on internal communications to mirror the large accounts against which they are applied. Good organisation hierarchies support communication from any obscure part of an enterprise to any other, with only a few managers required to complete the contact.

The one example that consistently breaks this principle is the network of relationships in a data model that is used to link all of the context information described earlier. Typical data models within a single function database require dozens of steps to join together even closely related concepts, and hundreds or even thousands of steps to link across the enterprise in new ways.

The value of data is as much in its relationships as in its content. Described another way, the value is in the network of data relationships and, while data exists on the computer network, its relationships are not necessarily appropriately networked.

Sponsors can direct technology staff to use appropriate data management techniques to improve the data network across the enterprise, but it is difficult to promote good behaviour without a mechanism to measure its adoption. Technical staff know that they are being measured by their productivity in solving individual tasks and they also know that it is as likely that executives examine the way they store data in data models as it is that they will read the program code that sits behind the business applications.

Sponsors need a set of measures to ensure that new content is loaded onto the corporate network in a way that simplifies its application to new business functions rather than hindering new development. The metrics need to be a level above the concepts of normalisation and general database management. This can be done by taking any data model and converting it to a mathematical graph (network) as shown in Figure 2

![Figure 2 - Converting a data model to a mathematical graph](image)
Next build a table to record the degree of each node (formally called a vertex) and the distance between each pair of vertices. The format of such a table is shown below.

<table>
<thead>
<tr>
<th>Vertex</th>
<th>Degree</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
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<td>2</td>
<td>1</td>
<td>2</td>
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</tr>
</tbody>
</table>

Columns 1 and 2 record the vertex of the graph and the number of connections (formally called edges) attached to each. Columns 4 through to 10 show the number of steps required to traverse the graph between any two vertices.

The **Average Degree** is calculated by averaging the second column (1, 1, 4, 2, 1 and 1) giving an Average Degree of 1.67. This indicates how likely it is that a future application could have an ambiguous path through the model (causing confusion and mistakes). The higher the number, then the greater the potential confusion.

The **Maximum Distance** is determined by looking at the right side of the table (columns 4 to 10) and finding the highest separation between any two vertices. In this case, the largest separation is between either A and F or B and F, both of which require 3 steps being the Maximum Distance.

The **Average Distance** is calculated by averaging the same separations examined when calculating Maximum Distance and is 1.87.

Armed with these three metrics, a project sponsor can determine whether the model is likely to cause confusion (through a high average degree), be difficult to apply in some cases (through a high maximum distance) or difficult to apply to as-yet unknown future problems (through a high average distance).

**FOUR LAYERS OF INFORMATION**

At the top of the management tree are a group of executives. Each has a short tenure, often less than two years. During that time, they need to streamline the information they have to achieve an agenda. At the bottom or foundation of the enterprise are the operational processes, systems and people who make the business run. These processes and systems are rich in raw data. This data is highly de-normalised, meaning there are many duplications of content and little integration across business processes. Between these two extremes sits an army of administrators who spend vast amounts of time responding to requests for information by mapping the operational data into metrics.

Every enterprise, and in particular every leader, has a preferred strategy for tackling organisational challenges. This strategy needs to be measured in terms that can be easily communicated and usually involve straightforward metrics. The metrics used to measure the performance of the organisation change rapidly as both the leadership and organisational strategies evolve.

Because of the rushed nature of the requests made for data (after all, they only have a small window of opportunity to demonstrate their success), few quality controls are put in place along the way. The lack of controls is despite the move to greater regulation, since these controls have almost exclusively been applied to operational activities of the enterprise.

While the tenure of the executive team is usually short, the ranks of administrators usually include a substantial number who have been in place for an extended period of time and have considerable corporate memory. These staff are usually frustrated by the requests for the same
data with small differences between the requirements. Similarly they are frustrated that there is usually little appetite to put in place a more strategic framework to provide this content.

At a logical level, every organisation has four layers of information. At the top and bottom as already described are the metrics and operational data respectively. To make sense of the operational data there has to be a layer of normalisation: it is simply the only abstract tool available which integrates and describes data in atomic terms.

For all the reasons described, it is difficult to interpret a normalised model. The natural tendency is to create dimensions and formally or informally define a dimensional model. Such a view of the enterprise sits between the normalised and metric layers of the enterprise.

Considered together, the four layers can be visualised as a pyramid as shown in Figure 3. Of course, without a proper architecture, the picture looks more like Figure 4 with each layer of integration requiring substantial manual effort using spreadsheets and other tools.

Each layer of information has its own characteristics. Metrics are dependent on both the organisational structure and the strategy of the organisation, with both changing periodically. The dimensional view streamlines products and divisions into consistent Conformed Dimensions, however, the particular schemas that are defined are dependent on the metrics that are required, hence the strategy of the day. As a result, the dimensional view also changes rapidly. Given that the organisational structure usually changes marginally more often than the strategy, the dimensional view is slightly more stable than the metric view.

The principles of third-normal form modelling mean that the normalised view of the enterprise should be independent of both strategy and organisation structure. The normalised model should describe the fundamental business data as generated by the underlying business processes and not be biased towards the information that is required for analysis. For this reason, the normalised view that develops over time should be very stable.

The operational data is geared towards to front-end systems which are operated within individual departments or divisions, hence is highly dependent on the organisational structure.

**CONCLUSION – A MODEL FOR GOVERNING THIS COMPLEXITY**

The challenge, from a governance perspective, is that the same data will be provided in literally hundreds of different ways. Each source of entry is generally defined as a process – and today we govern the process, not the data.

Once organisations have been freed from their process straightjacket, we have the opportunity to create a much more dynamic service that is tailored to the patient rather than the organisation structure.
Applying the techniques of this paper leads to a set of metrics which reflect the state of information in the organisation without being biased by the current processes against which they are applied. The best way of managing these metrics is to create a data governance "board" or executive team who reflect on the metrics and their implications without allowing themselves to be drawn into individual technical solution debates. Supporting this team should be a working group that ensure consistent application of the design principles and in turn help project and domain teams to develop specifications and solve specific problems. A model for this is shown in Figure 5.

The result of the information revolution is a new paradigm: the “information-driven enterprise”, as opposed to the process-driven organisation. This new form of enterprise is engineered around information without being tied to an individual process or activity.

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OUTCOMES FROM THE ACS-TSA NBN POLICY FORUMS, JUNE 2011

Peter Gerrand and Allan Horsley
The Telecommunications Society of Australia

This paper summarises the principal outcomes from the NBN (National Broadband Network) policy forums held by the Australian Computer Society’s chapter, the Telecommunications Society of Australia, in Melbourne and Sydney on June 28 and 30 respectively, with twelve speakers and a total audience of 121.

The forums, stimulated by eleven papers on NBN policy gaps published in the May 2011 issue of the Telecommunications Journal of Australia, were designed to get industry reaction and contributions to NBN policy gaps that need to be fixed to ensure successful commercial outcomes together with confident and satisfied customers, as well as identifying opportunities for socially valuable high-speed broadband applications.

The key outcomes focus on the need for further action by Australian federal government agencies on technical regulation, support of an updated Regulated Telephone Service (to replace the Standard Telephone Service), and raising awareness of broadband’s benefits amongst the community.

INTRODUCTION

Unlike previous reforms of telecommunications infrastructure or regulation in Australia, the initiation of the National Broadband Network in 2009 was not preceded by a White Paper or other process designed to harness widespread public comment and feedback on a new government policy (Horsley & Gerrand 2011).

The government’s emphasis on early implementation of the NBN during the 2010 election year appears to have led to its prioritising most of its resources on overcoming the the major hurdles of

(a) getting the enabling legislation passed and

(b) achieving the necessary agreement with Telstra to progressively withdraw its copper Customer Access Network and hand over to NBN Co via a lease its physical infrastructure (pits and pipes), as well as operationally separating its wholesale fixed access business from its retail businesses.

The supply side of the industry, through the forums of the Communications Alliance, rose pro-actively to the occasion by developing the technical and operational arrangements needed for the interconnection of the NBN, most of which have been adopted by NBN Co. But as a result, arguably neither the government nor the supply side of the industry have given sufficient attention to the impact of the NBN on the end users during the eight or so years of the transition from current network arrangements to the compete rollout of the NBN.

As a result, the Editorial Advisory Board of TJA in late 2010 thought it timely to invite experts from across the industry, and especially user groups, to contribute papers to the May
2011 issue of the *Telecommunications Journal of Australia* (TJA) on perceived policy gaps that might threaten its widely sought after benefits.

The positive reaction to the eleven papers on NBN policy gaps published in the *May 2011 issue* of TJA led the ACS-TSA to organise public forums on NBN policy gaps in Melbourne on 28 June and in Sydney on 30 June 2011. The authors of the May TJA articles were supplemented with presentations by additional experts. The lecture slides by the presenters have been subsequently made available as pdf files on the membership website of ACS-TSA.

There was lively participation by 61 audience members in Melbourne and 60 in Sydney, and the most controversial issues raised were taken up subsequently by online industry newsletters (CommsDay, Exchange Daily, PCWorld) and websites (iTwire). The authors of this paper, as the organisers of the forums, noted that there was widespread support for raising the following *three key issues* with the relevant Australian federal government agencies, as representing policy gaps that need to be fixed in the near future, to ensure the successful take-up and performance of the much-awaited National Broadband Network.

1. **TECHNICAL REGULATION**

The key success factor for the emerging NBN is considered to be that its end users’ expectations will be met on receiving good quality service and a rewarding experience.

As a consequence there was strong support for ensuring that end-to-end Quality of Service (QoS) is achieved over the multi-carrier service environment that will be typical for broadband services, both nationally and particularly internationally. There was also a broad belief that this will not happen naturally if the market is left to itself, as individual wholesale carriers will be commercially motivated to optimise their internal QoS at the expense of the end-to-end service when sharing the delivery of services with other wholesale service providers.

There is therefore the need for ACMA (the Australian Communications and Media Authority), as the technical regulator, supported by Communications Alliance, as the relevant industry standards and codes development body, to take a lead in developing an industry standard or code of practice that would establish adequate end-to-end performance parameters including guidance on the appropriate allocations of the international IP network performance characteristics for broadband services when carried over multiple networks including NBN Co’s high-speed access networks.

(In the past this work was successfully undertaken by the Technical Regulator, formerly Austel and subsequently the Australian Communications Authority, for analogue and digital transmission services.)

The argument is as follows. Retail services using NBN building blocks will generally involve at least one wholesale network service provider (WNSP) in addition to the Retail Service Provider (RSP), in order to provide backhaul from the RSP’s core network to the relevant Points of Interconnect (POIs) of the NBN. In some cases the RSP will be the same company as the WNSP; in other cases two distinct WNSPs may be required, in addition to the NBN, to provide end-to-end connection within Australia. And in some cases one of the WNSPs may be a mobile cellular radio network.

An average end-user with a connection to the NBN will not be able to tell who is responsible for service performance, including poor QoS or a network failure. They will tend to blame NBN Co, as its Network Termination Unit is quite visible, even if the QoS and reliability of the NBN Co segments of the service are quite adequate and meet NBN’s specifications.

**Poor reliability** can be the result of inadequate duplication of transmission resources between the relevant POIs, or between the POI and the terminating non-NBN end-user.

**QoS problems** can arise in several ways.

The first concerns undesirable delays in transmission of synchronous voice calls that pass from one switching medium, e.g. from the NBN’s IP voice service, to another, e.g. Time
Division Multiplexing (as in the residual PSTN) or to digital cellular mobile networks. The codecs employed to cope with each transition introduce significant delay, and transmission delay across Australia is not negligible either. It is easy to construct scenarios in which the round-trip delay – between Caller A finishing a phrase, and waiting for an affirmative response from the other party – can exceed 300 ms, i.e. greater than a single satellite hop, which can cause a conversation to become psychologically undermined, with one’s interlocutor appearing to be cold or even calculating in their delayed responses.

The second concerns excessive jitter in both low and high speed synchronous services (e.g. voice and high definition video respectively) when one of the multiple carriers jointly delivering the service uses the maximum transmission performance quota available end-to-end; and another also uses a sizeable quota, the combination well exceeding the tolerable maximum.

The solution is for ACMA as the technical regulator to apply some resources to identify the nature of the potential problem for end-to-end services, which is actually addressed by particular ITU Recommendations (Rocke & Wignall 2011). ACMA can then call upon in-depth expertise from the Communications Alliance as the industry forum for the supply side to create a work plan to assist ACMA in developing a set of industry rules, (standards or codes) to avert the probability of worst-case QoS arising for unsuspecting end users of the NBN.

2. THE NEED FOR A NEW REGULATED TELEPHONE SERVICE

The current telephone service is available to users across Australia as ‘the Standard Telephone Service’, defined by legislation and regulation to include both telephony and associated services (such as a teletypewriter for those unable to use the voice service) (Darling 2011). Legislation introduced with the advent of network competition and subsequent Telstra privatisation tranches has given Telstra the responsibility of provision of the standard telephone service as the Universal Service Provider. Telstra has generally met this Universal Service Obligation (USO) via its copper Customer Access Network (CAN).

Under the new agreement between Telstra, the NBN Co and the Government, most of the copper CAN will be replaced by the NBN Co’s optical fibre CAN. NBN Co’s Network Termination Devices will have an Analogue Terminal Adapter with a SIP (Session Initiation Protocol) function, which should enable a Retail Service Provider with a compatible softswitch to provide a good quality telephone service with specified parameters.

There is a need for the Government to decide just what services are of significant social importance to need some form of regulation, so that they get translated to the new technology platform.

Policy issues for the medium term include:-

- Management of the transition from Telstra copper to NBN Co fibre or radio access, for individual users;
- Management of the transition for
  - The current USO provider, Telstra; and
  - Other telephony providers

These may well be addressed by the establishment of the Telecommunications Universal Service Management Agency (TUSMA), the subject of a current Discussion Paper. However, the relevant Discussion Paper (DBCDE 2010) does not seem to take into account questions such as:-

- The adequacy of 'near telephony' services (e.g. VoIP);
- The relative role of fixed and mobile services in providing an updated telephone service capability;
• The need for a new Regulated Telephone Service;
• Numbering of these services; and
• Provision of Geographic Information telephone numbering (e.g. for emergency services, legal interception).

In the longer term, as the NBN is established as the predominant fixed access network, the unresolved policy issues include:-

• What are the 'socially important services' required to be available to all Australians:
  • Nothing – let the market, i.e. the service providers, determine them?
  • IP Layer connectivity alone – then who sets these standards?
  • Telephony alone – then what happens to special services?
  • Telephony + new services such as video telephony, which might substitute for TTY (teletypewriting)?
  • A defined bundle of services for a new Universal Service? Then by what process will this Universal Service be agreed, and how will it be regulated?

3. RAISING BROADBAND AWARENESS FOR THE UNINITIATED

The development of a high level of community and individual end users’ confidence in the value and use of broadband services, including the applications delivered to a customer by the NBN, is seen as a very high priority.

According to the ABS’s most recent survey in 2009, some 25% of Australian households in metropolitan areas, and 35% in rural Australia, do not yet use the Internet. The NBN offers the potential for all to move online, but there is little incentive for those who have never used the Internet to do so, unless they are made aware of the advantages for life style and economic position. And more than 30% of those aged over 40 report that a major reason for not using the Internet is that they feel overwhelmed by the apparent complexity of it all.

The Federal Government proposes to improve awareness of the advantages of broadband, in advance of the rollout of the NBN.

To quote Dave Lee of the NSW Farmers Association at this forum: 'Four weeks ago, the National Digital Economy Strategy was announced. Most relevant to the topic of increasing ability is the Digital Communities initiative, with $23.8 million over three years aimed at closing the digital divide'.

'As part of the Digital Communities initiative, 40 Digital Hubs will be established in each of the communities that will first benefit from the NBN. Training will be delivered through a mix of group sessions and on-on-one tutorials on email, accessing government services, very much in line with the Broadband for Seniors program.

'Will 40 Digital Hubs be sufficient? And is this only the beginning, with the program to be extended to cover more areas beyond 2014? Whilst this announcement is a fantastic step forward, hopefully it will later be complimented by further measures.

'[But] will farmers drive hours to attend a lesson on emails? Will they be aware that the 20 minutes at the Hub could save them 30 minutes listening to Government hold music?

'The farming community is diverse, and many farmers are leading the way in improvements to technology. Others aren’t so keen, or haven’t been able to due to inadequate service or relative isolation.'

'The roll-out of the NBN is a crucial event. It is essential that the Government ensures that as many people as possible “opt-in”, and make use of the fantastic opportunity their tax dollars have bought.
'Just as the NBN will provide a fresh approach to education, educating and empowering the rural community will require a new approach.'

A program of public education tailored in content and location to the specific needs of the various segments of the Australian community is needed to ensure members of the community have the confidence and skill to positively participate in the emerging services carried by the NBN.

CONCLUSIONS

The key outcomes of the June 2011 NBN Policy Forums focussed on: the need for further action by Australian federal government agencies on technical regulation of the NBN Quality of Service parameters; specification and regulation of an updated Standard Telephone Service – i.e. a new Regulated Telephone Service; and raising awareness of broadband’s benefits amongst the community. The detailed issues and recommendations are provided in this paper.

At the Melbourne forum, the CEO of Communications Alliance, John Stanton, indicated the willingness of his organization to work with the technical regulator, ACMA, to create any needed technical standards or codes of practice needed to ensure good QoS in future multi-carrier NBN-enabled services. It would be fair to say that the Australian telecommunications industry is looking forward to ACMA providing some leadership in scoping the extent of the standards and codes of practice needed to ensure that the quality of NBN-based services will meet community expectations, and then working with the industry to introduce those new codes and standards.

REFERENCES


AUSTRALIA’S DIGITAL ECONOMY @ 100MBPS AND BEYOND
THE POTENTIAL SOCIAL AND ECONOMIC BENEFITS FROM A NEXT GENERATION NATIONAL BROADBAND NETWORK INFRASTRUCTURE

Nadeen Jayasundara
NBN Co.

Today, over 10 million Australians use the Internet, with the vast majority using broadband technology. While Broadband is often touted as having significant economic and social benefits, the current generation of broadband infrastructure faces constraints in delivering the next generation of applications and services. This report aims to identify the potential economic and social benefits enabled by the implementation and use of a Next Generation Broadband (NGB) Access Network infrastructure in Australia. This follows the announcement by the Australian Government in 2009 that it will construct and run a new high-speed National Broadband Network (NBN). Based on the results of our study of existing literature findings, it is clear that NGB can enable many potential social and economic benefits for Australia, across GDP, productivity, competitiveness & consumer surplus gains, as well as smarter energy resource and transportation supply and use, better Business operations, work / life balance and location, and improvements in Health, Education, Government, Elderly and Regional services.

INTRODUCTION

Today, over 10 million Australians use the Internet, where broadband has quickly become the dominant choice of access (DBCDE 2011). The evolution from narrowband to the current generation broadband (CGB) infrastructure has enabled improved Internet access speeds and experience for users but faces constraints in delivering the next generation or ‘true/ultra’ broadband applications and services. While broadband is often claimed to bring significant benefits to the economy and society, there have been limited studies to date looking at the benefits of ‘Next Generation Broadband’ (NGB), especially for Australia.

The following report aims to identify the potential wider economic and social benefits enabled by the implementation and use of a Next Generation Broadband (NGB) Access Network infrastructure in Australia. This follows the announcement by the Australian Government in 2009 that it will construct and run a new high-speed National Broadband Network (NBN).

A review of available literature has found NGB to be regarded as important social and economic infrastructure. Based on analysis of major issues for Australia and existing literature, frameworks and methodologies, this review identifies major and / or important potential benefits from both a top-down or macro perspective for economic growth and prosperity from national productivity, employment, competitiveness gains, as well as from a bottom-up perspective of innovation in applications and services for smart infrastructure (energy and transportation networks), public services (health care, education and government services) and for businesses (SMEs and Digital Content industry especially)
This topic has emerged from both a personal interest in the major social and economic challenges faced by Australia, and current workplace interest’s at NBN Co Limited to improve knowledge of the potential wider benefits a NBN can bring, outside of direct benefits captured by the network and service provider. This review is also intended to provide an initial breadth of knowledge and potential framework for conducting more in-depth research studies on this topic in future. This is not intended to provide a cost-benefit analysis (CBA) or address barriers and other investment required to realise benefits.

Please note that the views expressed in this report are those of the author and do not necessarily represent those of NBN Co.

LITERATURE REVIEW

NEXT GENERATION BROADBAND AS IMPORTANT SOCIAL AND ECONOMIC INFRASTRUCTURE

The Australian Government (DBCDE 2009) in 2009 announced that it will construct and run a new high-speed National Broadband Network (NBN) that will:

“Connect 90 per cent of all homes, schools and workplaces with optical fibre (fibre-to-the-premises or ‘FTTP’), providing broadband services to Australians with speeds of up to 100 megabits per second in urban and regional towns. The network will connect all other premises with next generation wireless and satellite technologies that will be able to deliver 12 megabits per second or better” (DBCDE 2009, 9).

The Australian Government in announcing its NBN project, promoted the initiative as the biggest single infrastructure project ever in Australia. It was also a major part of the Government’s strategy to develop Australia’s Digital Economy (see Appendix item 1), which was defined as; “The global network of economic and social activities that are enabled by information and communications technologies” (DBCDE 2009, 2). The government described the infrastructure project as providing Australia with the following: affordable access to faster (up to 100 times faster than commonly experienced today) broadband for all persons and businesses, with a combination of FTTP, and Wireless & Satellite technologies; support job growth; enhance innovation, productivity & competitiveness; and meet rapidly growing Internet usage demands (DBCDE 2009).

At the same time in response to the recent ‘Global Financial Crisis’ (‘GFC’) a number of other countries have launched or continued to support major ICT infrastructure stimulus programs, through the economic crisis, focussed on NGB networks (Katz 2009), as shown below in Figure 1.
Note: NBN (2010) more recently forecast $27.5bn total Australian government equity requirement

**Figure 1** - ICT infrastructure stimulus programs (Katz 2009)

The OECD (2009) state that high-speed communications infrastructure investment enables innovation in the economy, drawing the comparison to how electricity and transport infrastructure networks did this in the past. They identify FTTH as the most-forward looking network possible with potential major social and economic spill-over effects on electricity, health, transportation and education, and raise the example of OECD governments committing substantial economic stimulus to such broadband networks. Another report (KPMG 2004) similarly regards CGB in general as critical infrastructure for any modern industrialised economy, comparing it to roads, railways, post, PSTN traditional fixed telephone network, television and mobile phones, but highlights its lack of ubiquitous affordable access as an issue, as shown in Figure 2 below.

**Figure 2** - Comparison of national infrastructure networks

It has also been suggested in various studies that with today’s economy and standard of living increasingly reliant on affordable, ubiquitous broadband being accessible, combined with ever-increasing end-user demands on data speed and usage rates, that broadband will need to continually evolve to the next broadband access system generation (Odling, Magesacher, Host, Borjesson, Berg, & Areizaga, 2009) & (NZInstitute, 2007), as illustrated in Figures 3 to 5 below. These studies identify that based on both historical trends and segmented consumer groups, bandwidth demand will reach levels which can only be met ultimately by fibre-based (FTTH) or Generation 5 system, taking fibre-optic all the way to the home in the ‘last mile’. It stated that access networks need to live up the vision of the future society, and that CGB infrastructure, such as ADSL and ADSL2+, face system bottlenecks in the last mile of access to the home because they still largely use legacy copper based systems (Odling et al 2009) and (NZInstitute 2007b).
Note: ‘Generation 4’ referred above is based on a niche and interim extension of ‘Generation 3’ taking fibre to the 'last' possible DSL / copper distribution point.

Source: (Odling, Magesacher, Host, Borjesson, Berg, & Areizaga, 2009)

Figure 3 - Fixed-line broadband technology evolution path (illustrative only)

Source: NZ Institute 2007b

Figure 4 - Historical speed demand and trend, and fibre (NGB) vs copper (CGB) capability
FRAMEWORK FOR IDENTIFYING MAJOR SOCIAL AND ECONOMIC BENEFITS FOR AUSTRALIA

One way to look at where NGB can most benefit Australia is to understand the future macro or national challenges it faces. The Government in a report on future social and economic challenges faced by Australia over the next 40 years included the following challenges: a growing and ageing population; increasing pressures on the health and transport systems; threats to the environment from climate change & unsustainable energy use; ensuring continued improvements in productivity, education & living standards; and increasing pressures on government services and spending (Treasury 2010). This follows earlier similar comments at a Business Leaders Forum that the four major longer-term trends for the Australian economy and society included:

1. population growth and ageing, reducing employment participation and potential productivity while straining our major cities and public infrastructure;
2. climate change mitigation and adaptation;
3. the information and communications technology (ICT) revolution, as a general purpose technology (GPT), potential for productivity gains, reducing ‘tyranny of distance’, sustainable population settlement, and government service provision; and,
4. the re-emergence of China and India as global economic powers (Henry 2009).

Another way to look at how NGB can potentially benefit Australia is to look at the services and applications it can deliver and enhance. For the purposes of this report NGB is also defined here from a user-centric perspective, as a purpose-built broadband network capable of supporting the foreseeable next evolution of Voice, Video & Data applications, delivering innovation in Education, Remote Working, Health, Media and Telepresence services (typically a widely-available ubiquitous network capable of delivering a minimum 10-25Mbps+ ‘actual’ symmetrical speeds, high reliability & quality of service, and ‘future-proofed’ upgrade capabilities) (The Allen Consulting Group 2003) (NZInstitute 2007b) (CSMG 2009). This has been referred to as the evolution to ‘True / Ultra Broadband / Next Generation Access (NGA)’ versus ‘Early Broadband / Current Generation Access (CGA)’ capabilities, and pushing through the ‘DSL wall’ as illustrated below in Figures 6 to 8.
### Figure 6 - True / Ultra Broadband capabilities evolution

<table>
<thead>
<tr>
<th>Narrowband</th>
<th>Early Broadband</th>
<th>True/Ultra Broadband</th>
</tr>
</thead>
<tbody>
<tr>
<td>Downstream speeds of up to 56Kbps</td>
<td>Downstream speeds over 200Kbps</td>
<td>Symmetric speeds (downstream and upstream) over 10Mbps</td>
</tr>
<tr>
<td>Single user</td>
<td>Multi-user</td>
<td>Multi-user, multi-appliance/device</td>
</tr>
<tr>
<td>Single service (Internet or phone)</td>
<td>Dual service (Internet plus telephony)</td>
<td>Multi-service (Internet plus Phone plus Video/TV plus other)</td>
</tr>
<tr>
<td>Basic e-mail, Basic web-browser</td>
<td>Media rich email and web-browser</td>
<td>Media rich email and web browser</td>
</tr>
<tr>
<td>Basic information exchange/e-commerce</td>
<td>Rich information exchange/e-commerce</td>
<td>Multi-media applications and Multi-appliances</td>
</tr>
<tr>
<td>Asymmetric (simple consumer) — no interactivity</td>
<td>Asymmetric (sophisticated consumer) — limited interactivity</td>
<td>Multi-node interaction (sophisticated producer/consumer/peer) — full interactivity</td>
</tr>
<tr>
<td>Text capable</td>
<td>Graphics capable</td>
<td>Video capable</td>
</tr>
</tbody>
</table>

Source: The Allen Consulting Group and Ericsson

### Figure 7 - New application categories from 'Crossing the DSL wall'

Source: NZ Institute 2007b
The following literature review has taken a broad-based research approach from both a top-down (traditional economic-based) and bottom-up (service and applications-based) framework, to capture the range of major/important potential benefits from these different but inter-related perspectives. In using this framework and perspectives, the potential value of benefits are not necessarily mutually-exclusive or in addition to each other as bottom-up benefits can be expected to ultimately aggregate to deliver macro / national or regional benefits and outcomes. Also, similar reviews have noted that in any framework it can be difficult to value or create a distinction between social and economic benefits (BSG 2008).

The focus of this report, where possible, is on the incremental benefits of a widely-available NGB (excluding direct benefits captured by the network and service provider), compared to counterfactual development of widely-available existing and inferior CGB. The following findings have been structured around an ‘integrated’ method based on key concepts of benefits most commonly identified and substantiated in existing research found. A mix of ‘classic’ and ‘electronic browsing’ approach to locating literature has been used, although due to the relatively recent emergence of NGB networks, limited journals and studies on this topic could be found. Where relevant this review has been supplanted with excerpts from more widely available studies of CGB.

OVERALL MEASURABLE BENEFITS AND METHODOLOGIES

A review of reasonably recent literature on this topic has identified a number of studies that have attempted to quantify the value of economic and social benefits of various forms of NGB under our definition, as opposed to studies of CGB. Overall these studies show potential measurable positive economic and consumer/public welfare benefits from NGB. Analysis of study results, converted to a comparable basis, indicate a range of 0.04% to ~0.30% annual benefit value in terms of gross domestic product (GDP), as shown in Figure 9 below.
As shown in Figure 10 below, analysis of study methodologies show that higher benefit estimates have applied top-down assumptions of productivity gains and investment multipliers, which show up or deliver economic and social outcomes in terms of increased GDP output and income per capita economic growth and prosperity.

Lower estimates have tended to use a framework by NGB application and perceived consumer value, to determine aggregate consumer welfare and private benefits, which deliver outcomes in terms increased consumer savings, surplus and positive externalities. This would appear to indicate that productivity gains drive the greatest benefit but it can also be argued that measurable consumer benefits may be understated or more difficult to forecast as consumers are yet to widely experience the product or applications that are still to develop.

Most estimates have attempted to include counterfactual or alternative assumptions for CGB, to facilitate estimates of incremental NGB benefits only. It could be argued that all these values are understated as none of these individual approaches provide the complete picture of benefits, which would be the total of productivity, consumer private and surplus benefits (allowing for overlap, double-counting and transfer / substitution of benefits).
### Summary of Recent Quantifiable Benefit Studies, Methodologies and Frameworks

<table>
<thead>
<tr>
<th>NGB Research</th>
<th>Economic Benefit</th>
<th>NGB Network Basis (premises also referred to as homes)</th>
<th>Benefit Research Methodology and Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>US - Singer &amp; West (2010)</td>
<td>US$160bn total output over 4 years</td>
<td>50Mbps+ to 80% of US homes within 4 years by 2015 (using FTTP)</td>
<td>Economic impact on output &amp; employment based on historical investment multiplier for NGB vs. CGB expansion. Prepared for the FTTH Council</td>
</tr>
<tr>
<td>UK – BSG (2008)</td>
<td>UK£2.7bn pa</td>
<td>20Mbps+ to 80% of UK in 10 years (FTTP)</td>
<td>Bottom-up assessment of private value added by NGB vs. counterfactual CGB case. Prepared for the Broadband Stakeholder Group (BSG)</td>
</tr>
<tr>
<td>NZ – NZ Institute (2007)</td>
<td>NZ$2.7-4.4bn annually over 5 years</td>
<td>10Mbps+ to minimum 75% of NZ homes within 10 years by 2018 (FTTP)</td>
<td>Bottom-up assessment of economic value added by NGB applications. Focus on productivity &amp; export growth benefits</td>
</tr>
</tbody>
</table>

Source: Various authors as listed above

**Figure 10 - Summary of recent quantifiable benefit studies, methodologies and frameworks**

Overall these studies provide strong arguments that NGB can and would generate positive incremental benefits and provide indications of the type and magnitude of the benefit value, for the public and economy’s welfare and prosperity. Care should still be taken with the results. This is based on the limited sample of studies currently available, different methodologies and assumptions used, and report sponsors, as shown in Figure 10. Much of this is due to relatively recent emergence and announcements of planned large-scale NGB network roll-outs globally. As such, all the studies found have used forward-looking estimates for both potential NGB benefits and the counterfactual / base case non-NGB comparisons (where used), due to the limited ability and difficulty at this stage to conduct any rigorous historical empirical quantitative studies of actual NGB-only benefits realised.

### Top-Down Economic Perspective

#### Productivity Benefits

The New Zealand Institute (2007b) find on average 63%, or NZ$2.3bn (average of range given) of benefits comes from increased productivity, from remote working, health education and telepresence, although their analysis excluded improved consumer experience, innovation and social benefits. Remote working potential productivity benefits was strongly driven by increased workforce participation of elderly, disabled and chronically ill people, as well as reduced absenteeism from employees only needing partial days-off (rather than whole days) to attend to personal matters (NZInstitute 2007b).
CSMG (2009) in a study focused on consumer benefits still found 23%, or US$2.6bn, of total benefits in 2015 from NGB come from productivity gains. This is driven by tele-working driving greater declines in sick leave absenteeism, and larger increases in the labour force participation for retirees, disabled and parents, than CGB would.

Various studies, as shown in Figure 11 below indicate faster Internet combined with ICT has been shown to improve business productivity.

The Productivity Commission (2009, p. 2) in its submission on the potential fast broadband benefits of NBN in Australia stated the following;

“The internet has dramatically enhanced the efficiency of searching for information and has provided new, more convenient and often cheaper ways of delivering and paying for goods and services. As well as directly boosting productivity the internet has also helped to empower consumers and thereby reinforced the competitive disciplines on suppliers”.

The Productivity Commission (2009, p. 2) go on to further explain that their previous studies found that an acceleration in IT use made an important contribution to the productivity gains made in the 1990’s in many industries, saying that: “well regulated and widely accessible NBN might be expected to facilitate further direct productivity benefits, enabling a greater volume of information and data to be transmitted over a specified time.”

DCITA (2007), highlight various research that ICT added up to 1.2-6% growth in labour productivity (NOIE 2003), and that technology contributed 65-85% of productivity growth in manufacturing industry (NOIE 2004a), and 59-78% in service industries (DCITA 2005b).

The New Zealand Institute’s (2007) research finds that overseas studies indicate that faster broadband speeds (> 2Mbps), and ‘e-business’ focussed firms, had 4-10% productivity improvement.

Katz (2009) finds that broadband can enable improved productivity due to the adoption of more efficient business processes, with a continuing additional but reducing incremental positive economic impact from faster and better quality broadband services, such as would be delivered by a NGB, as they illustrated in Figure 12 below.
Ergas & Robson (2009) while stating that productivity benefits are essentially captured in consumer and business ‘willingness to pay, do present the example of potential productivity improvements of 0.3 to 0.5 for Australia from its NGB NBN implementation.

In summary, existing research indicates a positive productivity effect should occur from NGB, although there is little past empirical research so far confirming the actual impact of broadband on productivity. While the impact has so far been hard to separate from the total ICT effect, the studies above illustrate the potential for improvements in online use & file transfer efficiency, high-quality video communications & collaboration, employment participation, absenteeism reduction and industry productivity gains.

**National Competitiveness**

The New Zealand Institute (2007a) find that establishing a world-class communications infrastructure via NGB is a critical enabler to compete in global markets, providing them with a ‘weightless economy’ that can partially overcome scale and geographic disadvantages that countries like New Zealand faces. They find 37%, or NZ$1.3bn (average of range given) of benefits comes from growth in exports and foreign investment in education, media / entertainment, telepresence and data management sectors and applications (New Zealand Institute 2007b). The New Zealand Institute (2007a) compares the potential economic transformation to what refrigerated shipping provided their primary sector 125 years ago.

The FCC (2010) explain that in an interconnected globalised world that NGB investment in the US will enable their businesses, who originally had a leading position in the global Internet revolution in the 1990’s, to continue to compete in the ICT market in future. Figure 13 below similarly discusses the national advantage benefits broadband can bring under certain conditions.

OECD (2007) in its study of broadband benefits in general, similarly discusses the enabling effects it brings to the globalisation and off-shoring of services, in both highly and lowly-skilled services such as; legal, accounting, marketing and advertising, design, R&D, IT, consulting, human resource management and recruitment services.

PwC (2008) refers to the fundamental driver or benefit of investment in broadband, at a time when other countries are investing, is to maintain or not to lose competitive advantage rather than gain advantage. PWC (2008) state that as one nation invests, other nations will have to follow, and further points to the example of initial NGB infrastructure leader Korea who is now specialising in certain IT products (such as components and materials) to maintain some natural advantages, as it is now being followed by other countries into NGB.

Kenny & Kenny (2010) also refute the need to invest in NGB (via fibre/FTTH) for national competitiveness and international broadband ranking reasons, citing the risk of moving too early, as technology will get cheaper over time and before NGB application demand has developed (although acknowledging the ‘chicken and egg’ situation of needing a high speed network for applications to develop), with little advantage gained in being a leading application developing country.
In summary and despite BSG’s and Kenny & Kenny’s arguments above, it is the author’s opinion that as a high number of large NGB investments are already in-place or are planned to be rolled-out in many countries ahead of Australia (see Figures 1 & 14), then if Australia is looking to diversify or wanting to pursue global opportunities in the digital and service-based economy, it will need NGB to gain the benefit of at least maintaining international competitiveness and risk not being ‘left behind’.

![Figure 14 - FTTH Council ‘Race to Fibre Maturity’ timing of significant NGB penetration](image)

**Figure 14 - FTTH Council ‘Race to Fibre Maturity’ timing of significant NGB penetration**

**Employment and Wages**

*Singer and West (2010)* estimate implementing NGB versus CGB in the US would create an additional annual average of ~210,000 in direct jobs between 2011 and 2015, as the direct effect of the capital expenditure (CAPEX) investment required. This is based on a multiplier of 5.0 additional jobs per every $1m of CAPEX for NGB versus CGB, based on a weighted average employment multiplier for construction and telephone apparatus & fibre cable manufacturing investment. Indirect effects are expected to lead to an additional 660,071 jobs between 2011 and 2015, based on 2.3% increase in broadband take-up and a 2007 study by Robert Crandall, William Lehr and Robert Litan into increases in private, nonfarm jobs. It can be argued that Singer and West take a simplistic approach to predicting employment with no analysis of whether this will create net increase in employment or a temporary transfer from other sectors.

*BSG (2008)*, alternatively, finds that NGB produces no net additional increase in employment, referring to employment impacts as a ‘pseudo externality’ that is often raised as a benefit but should not be included as it produces no net national benefit. *BSG (2008)* state that while jobs are created during the build, these jobs move back to other sectors after the build finishes. It finds that while telecommunications can create jobs, productivity gains can reduce jobs as well.

In conclusion the views are very mixed on employment and wage growth benefits, with *Katz (2009)* in Figure 12, also finding both positives for employment from innovation in the economy and negatives for employment from productivity improvements. Care and / or
further research is advised with assuming significant national net additional employment and wages increases post a NGB construction period.

**Consumer Welfare / Surplus**

OECD (2007) state that high speed broadband provides consumer surplus gains through increased buying knowledge of prices, competition, improved customisation, and greater range of products, enabling greater choice and downward pressure on pricing. They also state that high speed broadband enables a triple-play of services of voice, data & video, as well as new services such as IPTV, video conferencing.

Figure 15 below provides indications consumer surplus benefits identified for broadband in general, for comparison purposes.

Crandall and Jackson (2001) in a direct estimate of consumer surplus identified US$297-460bn p.a. of consumer benefit, from 100% broadband adoption in the US. This was based on assuming broadband changes over time from a ‘luxury’ item to a basic necessity that is relatively inelastic, similar to the basic home fixed-line phone. It is likely that the migration from CGB to NGB will produce a comparably smaller surplus, when compared to their productivity gain findings. Crandall and Jackson (2001) find that that the establishment of internet originally in the 1990’s captured the largest share of benefits of allowing computers to become ‘networked’, pointing to the productivity surge experienced in the US from 1995. Increases in internet speed since then have produced just incremental factor increases in productivity (Crandall & Jackson, 2001).

Greenstein (2007), in a stated ‘ballpark’ simplistic estimate of consumer surplus, calculate a minimum additional US$7.9bn in benefits in 2006, from the migration of an estimated 40m dial-up users to broadband, since the start of broadband services.

Figure 15 - CGB studies of consumer surplus in the US

Dutz, Orszag & Willig (2009) findings appear to contradict Crandall and Jackson, in Figure 15 above, in the magnitude of surplus based on two different approaches, but supports the theory that the relative incremental gains in surplus become smaller compared to the relative incremental gains in Internet speed and technology. Based on actual prices paid and demand elasticity, they find US$20-32bn consumer surplus for broadband (compared to having no Internet) and $12-23bn for broadband (compared to dial-up), between 2005 and 2008. Based on a consumer ‘willingness to pay’ survey, they find a surplus of US$19bn if everyone had 5Mbps speed broadband (compared to having no Internet), and a total of US$25bn for 50Mbps broadband (compared to having no Internet). This indicates an incremental surplus value placed on NGB in this example of $6bn, a 32% increase in surplus versus a 1000% increase in speed.

Ergas & Robson (2009), whilst critical in its overall ‘cost-benefit’ analysis findings for Australia’s NBN investment, does assume incremental increase in the willingness to pay and value from $50 for 10Mbps to between a range of $71 to $120 for 100Mbps NGB based on various scenarios and sensitivities.

Kenny & Kenny (2010) also highlight findings in US and Europe of small incremental willingness and price premium to pay for NGB fibre / FTTH versus CGB, as well as pointing to the limited take-up of NGB services to date.

While these surpluses are much less the Crandall and Jackson estimate above, Dutz, Orszag & Willig (2009) and Greenstein (2007), both explain that their estimates are conservative, largely due to the reason that their ‘willingness to pay’ survey research is based on something respondents have not yet experienced. Dutz, Orszag & Willig (2009) explains that broadband is a classic “experiential good” and that willingness to pay can be expected rise once 50Mbps broadband is actually experienced.
In summary it is expected that this effect would further increase as additional innovations and applications get developed and used (attracted to the higher speeds) and with wider adoption leading to ‘network’ effects, making online use even more valuable. This is illustrated in further analysis of the respondents to the 50Mbps question finding that broadband users were willing to pay 43% more than dial-up users, suggesting that “those who already have higher speeds tend to place a greater value on still-higher speeds” (Dutz, Orszag & Willig (2009, 27).

**BOTTOM-UP INNOVATION PERSPECTIVE**

**Smart Infrastructure applications, systems and networks**

*Energy efficiency, investment, savings and Environmental benefits*

OECD (2009) state that NGB can enable transformation of existing electricity infrastructure into ‘smart grids’, allowing advanced ‘smart metering’ capabilities of two-way distribution, real-time monitoring & management of energy usage, and connection into emerging & regionally dispersed renewable energy sources. This can provide potential benefits of reduced electricity usage, better peak time management and reduced carbon emissions, leading to cost savings for both consumers and producers, and reducing damaging impacts on the environment. Figure 16 below show both the strong growth in home energy use as well as the potential amount of appliances and energy uses that could be better managed through ‘smart metering’. The OECD (2009) point to possible constant widespread demands of 1Mbps for frequent meter readings would strain current broadband networks (especially for uploads).

Source: OECD 2009

**Figure 16** - Average residential electricity consumption. 1950 – 1980, kWh

The FCC (2010) National Broadband Plan sees major benefits from NGB to modernise their electric grid, leading to carbon pollution reductions, increased energy efficiency and lessening their long-term dependence on foreign oil.

Dutz, Orszag & Willig (2009) also identify faster broadband can greatly impact on smart power grid benefits of energy savings, from households getting access to home energy use information and adjustment of appliances in peak demand times, through controlling them remotely through the web.

CSMG (2009) alternatively did not include any benefits from smart grids and only identified relatively smaller savings of US$113m in environmental benefits from CO₂ reduction from
reduced driving miles due to NGB enabled tele-working, medical tele-consultation, HD/3D video conferencing and video streaming.

Also Kenny & Kenny (2010) believe that CGB can deliver ‘smart grid’ benefits due to low meter reading bandwidth requirements and that 1Mbps bandwidth requirement claims are theoretical upper limits for newer smart grids, so NGB should be regarded as unnecessary.

While there are mixed views, it would appear that the ubiquity potential, complimentary electricity grid modernisation, and greater upload capacity and reliability to support growing proliferation devices in the home, that longer-term NGB can still provide some incremental benefits to energy use and the environment. This is shown by energy demands continuing to grow globally, placing significant pressure on energy supply and carbon emissions and global warming, threatening the environment. The International Energy Agency (2009) shows that current trends can be changed but this requires a significant turn-around mainly through energy efficiency measures and renewable energy, as shown in Figure 17 below.

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**Figure 17 - IEA Emission Reduction Scenarios**

Transportation and Flexible work / life benefits

OECD (2009) highlight the NGB benefits ‘Intelligent Transportation Systems (ITS) and ‘Tele-work’ can provide in reducing traffic congestion, driving accidents, fuel usage and costs. This is through the ability of a modern transport system to collate and distribute real-time information to traffic controllers, drivers and people using public transport, as shown in Figure 18 below. This could involve significantly large amounts of data access and broadcasting constantly from vehicles, cameras, traffic lights, road construction, police and accident reports, weather conditions, requiring a NGB network. The OECD (2009) suggests removing just 5% of traffic at peak times could substantially reduce traffic congestion.

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Source: OECD 2009
CSMG (2009) research finds a US$4.8bn consumer benefit from a 0.2% (5.4bn miles) reduction in miles driven. This is through NGB-enabled benefits such Tele-working, HD/3D medical teleconsultation and remote monitoring, video conferencing and video streaming.

The New Zealand Institute (2007b) estimate benefits of NZ$320m p.a. based on reduced travel length & time and congestion, assumed from 5% of the white-collar workers moving to remote working. They find another NZ$95m in net productivity benefits from the use of telepresence technology, based on the assumption of a 20% reduction in domestic & international business trips, partially offset by costs to setup the technology and some losses to the economy from less business trips.

BSG (2008) finds £190 p.a. in reduced business travel benefits from HD video conferencing, assuming 10% of UK business trips are avoided, improving productivity by 3 hours per trip that is regained.

Dutz, Orszag & Willig (2009) identifies faster broadband speeds, via ‘workplace flexibility’, can have a major impact on access to information, enabling more work to be done at home, benefiting both the employee and their employer.

Kenny & Kenny (2010), counters against associating transportation benefits, highlighting evidence of various teleworking measures growing significantly in EU15, UK and US in various time periods between 2000 and 2008 without significant fibre / FTTH use.

It can be argued that this evidence also indicates some relationship with bandwidth growth, as broadband penetration and Internet speeds have grown in those same regions over those time periods (OECD 2008) and with broadband & ICT enabled technology developments essentially facilitating growth in distance work and types of service tasks (OECD 2007), that NGB will allow this relationship and facilitation to continue to grow beyond CGB constraints.

Kenny & Kenny (2010), also raise US survey research identifying that people adopting fibre do teleworking more, questioning not the result but what is driving what, and whether earliest fibre adopters are most likely to do teleworking with the effect dispersing as fibre spreads to the mass market.

While these questions appear valid it can still be found that this survey has found an increase in tele-working in at least a certain segment of the workforce after adopting fibre, which would lead to an overall increase in tele-working levels (holding ‘all other things equal’), regardless of whether it is driven or enabled and / or by fibre use.

Based on the above findings overall, it can be said that NGB can enable Transportation and Tele-working benefits, while it is accepted that realisation of these benefits will be affected by a number of drivers including other investment requirements, industry / work-type and cultural change factors.

Public and Community Services

Improved health care access, service and efficiency benefits

OECD (2009) highlights the potential benefits NGB can bring to more and improved communication between patients, doctors and hospitals. ‘E-health’ (electronic health) services such as high quality remote diagnosis (via tele-consultations) & monitoring (e.g. video camera streams and sensors) and digital transfer of radiological & cardiology images, can vastly improve access to health care, especially for isolated communities and health practitioners, older age or disabled patients with limited mobility, while reducing the strain on the current health care system. Figure 19 below shows some of the potential applications enabled by NGB, which require a combination of high network symmetric speeds, reliability and security, to ensure the quality, safety and trust of remote diagnosis and monitoring.
The FCC (2010) National Broadband Plan states that NGB, “can help improve the quality and lower the cost of health care through health IT and improved data capture and use, which will enable clearer understanding of the most effective treatments and processes”.

CSMG (2009) earlier identified 0.7% (US$2.4bn) of total consumer health care expenditure in the US, could be saved via NGB through delivery of HD/3D medical tele-consultation & remote patient monitoring, and health care information management.

Larger relative benefit have been found by the New Zealand Institute (2007b), which identified percentage of savings of 4.5-7.9% (NZ$620-1,100m) through increased productivity from savings from improved access to medical records, preventative care, in-home supported care and patient monitoring.

Kenny & Kenny (2010) and Ergas & Robson (2009) are critical of claimed healthcare and ‘Telemedicine’ benefits, questioning assumptions used based on hospital medical benefits and basic broadband / Internet connectivity rather than FTTH NGB applications and need. They also raise the barriers to realisation of benefits, from lack of elderly Internet use and required education and support to changes needed in health care system and cultures.

Rising health care demands and costs remains one of Australia’s great challenges. Due to a growing and ageing population, this is expected to place a growing burden on the current health care system to keep up (Treasury 2010). In addition, the health care industry has been found in an IBM study to be the most relatively inefficient sector globally but also with the greatest potential to improve its systems (Ericsson 2010), as shown in Figure 20 below.

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**Figure 19 - NGB Health Applications**

The FCC (2010) National Broadband Plan states that NGB, “can help improve the quality and lower the cost of health care through health IT and improved data capture and use, which will enable clearer understanding of the most effective treatments and processes”.

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While it is clear major challenges to change exist in the health care system, it appears overall that there are ‘e-Health’ or ‘Tele-health’ services enabled or significantly improved by NGB that can deliver many important potential benefits for the health system and care, for remote, chronically ill and elderly patients, as well as small doctor / medical practices through to linking to large hospitals & specialist care, and supporting health care organisations. This is through improvements in the cost and delivery of services and processes such as high quality real-time remote health care, monitoring and rapid transfer of large digital files / images.

**Improved Education, knowledge and skills access and learning benefits**

OECD (2009) point to large potential benefits NGB can provide for education or ‘e-learning’, through improving accessibility, innovation and reducing the cost of learning, especially for tertiary education and remote communities. This is enabled through improved access to the vast amounts of potential digital education resources and materials (such as online learning and research from schools, public libraries, and academic publishing), improved home schooling experience, greater communication and networking between students, teachers and schools, and teacher education and development, and networking information databases. In Figure 21 below, OECD (2009) particularly identify the e-learning opportunity, initially hyped during the Internet bubble, being realised to finally deliver ‘mixed-mode’ and ‘fully online’ courses and options, enabled by high-speed symmetric broadband speeds.
CSMG (2009) identify 0.08%, or US$1bn, benefit to GDP of improved education through NGB. This is through enabling ‘Live Instruction’ applications providing high-quality (HD/3D) and real-time education, assumed to address 1% GDP value of the educational performance gap vs leading developed nations.

The New Zealand Institute (2007b) calculate 2-3%, or NZ$200-300m, in savings from potential productivity benefits from NGB in the Education sector in New Zealand. This includes; improving communications, office efficiency, labour productivity, lower overhead, travel and training costs. It also calculates an additional NZ$150-200m in export benefits from capturing its share of strong growth (estimated at 25% CAGR) in online education in Asia.

In contrast, Kenny & Kenny (2010), claim limited impact has been seen on education, and cite the example of average UK school already having access to high speed broadband at 19.2Mbps, and the examples of NZ and Korea FTTS (Fibre-to-the-School) programs showcasing selective targeting of infrastructure rollout.

Countering this is the broadband-enabled education outcome improvements cited by OECD (2009), while the reported UK bandwidth per school would appear to be very limited for sharing or simultaneous use of even CGB applications amongst students and pupils. This is based on reports of an average 224 students per primary school in 2006 (Curtis 2008), and 1000 students per public secondary schools in 2002 in England (Garrett et al 2004). Also the point above regarding NZ and Korea fails to acknowledge that they have both planned or have built wide-scale NGB rollout to both residential, schools and business users.

Overall there does appear evidence of NGB enabling potential benefits and innovation for Education delivery and experience. The FCC (2010) National Broadband Plan appears to best sum up the benefits for education; in facilitating improved learning opportunities and information, through “more personalised learning opportunities”, and “facilitate the flow of information, helping teachers, parents, schools and other organisations” to make better options available to cater to each student’s needs, location and abilities.

**Improved Government services delivery, processing and engagement benefits**

The FCC (2010) National Broadband Plan identifies opportunities for broadband to improve government operations, service delivery and engagement with the public. The FCC (2010) also states the benefits NGB can bring for public safety, through the use of video for responses to safety and national security incidents, and improving how the public is notified of emergencies.
Dutz, Orszag & Willig (2009) identifies faster broadband speeds, via ‘web 2.0 tools for civic elections’, can have significant impacts on improving online electoral activity, as well as providing greater knowledge for both the public and campaign staff.

DCITA (2007) refers to the shift towards more complex ‘e-government’ services, increasingly needing broadband to be properly used.

BSG (2008) in looking at specific wider social benefits discusses ‘e-voting, virtual deliberation, social networking’ benefits in encouraging an ‘informed democracy’ and reducing participation costs, but that inequalities may occur with early technology adopters having greater ability to voices their views and concerns.

Overall for government services that, for example, could utilise real-time interaction, complex data processing or HD video, that similar to transportation and tele-working, government practises and cultures, often bureaucratic, would need to embrace the beneficial change highlighted above, that NGB could enable.

Business services, operations and growth

Improved SME ICT, market access, productivity and digital content industry benefits

The FCC (2010) National Broadband Plan finds that NGB can benefit Small and Medium Enterprise businesses (SME) by allowing them to more easily overcome lack of scale disadvantages, by expanding potential markets, improving access to customers and suppliers, improving business operations and innovation. An example of an industry that can potentially most benefit is the Digital Content (online video, music, newspaper media and entertainment) sector as shown further below in Figure 23. This is enabled by symmetrical and/or higher QOS applications SME’s can more easily access such as video conferencing, software through cloud-based (online software) services, e-commerce and social & professional networking.

BSG (2008) similarly finds benefits in ‘Network computing and (online) software’ services, that when combined with a fast upload, download and reliable NGB can revolutionise the use of IT for small businesses. BSG (2008) identifies £620m p.a. in total cost savings for small businesses (<50 employees), based on assuming 30% of staff saving £350 p.a. each in avoided support IT costs. Other benefits include reduction in energy and greenhouse gases.

Overall, OECD (2009) research supports all the above findings that ‘scalability’ benefits NGB can enable in ‘cloud computing’, particularly for SME’s, pointing to the evidence of strong demand for Amazon’s Web (cloud computing) Services, as shown in Figure 22 below.

Source: OECD 2009, Adapted from Amazon

Figure 22 - Amazon Web Services bandwidth consumption

Ford and Koutsky (2005) research also found that previous investment in a regional broadband network for businesses and local government organisations in Lake County in Florida led to higher growth in productivity and economic growth than county’s that did not
have the same network. Using their analysis of past retail sales growth from local businesses (used as proxy for economic growth) per capita here, showed that Lake County grew at 0.518% per month from 2002 to 2004, versus a control group of other counties of 0.278%.

OECD (2009) identifies benefits of digital content distribution (e.g. video, music and newspaper content) over a NGB platform to ‘provide greater market reach and capacity to engage in richer interaction with customers and consumers’. It highlights that with video popularity growing already (i.e. YouTube, BBC iPlayer in UK, Hulu in US), non-upgraded broadband networks will face major bandwidth constraints to meet demand and deliver high quality television-like experience. even with improvements in compression technologies.

The New Zealand Institute (2007) find large potential benefits of NZ$680-1030m p.a. from the Digital Media sector from productivity improvements and capturing share of offshore growth. Productivity gains of 15-20% in cost savings are assumed from a bottom-up analysis of faster compression, transfer, back-up, retrieval, and higher quality, of data and images, enabled by NGB. Offshore growth is based on maintaining its 5-8% p.a. growth in digital media exports, assuming New Zealand will miss out without NGB, as competing countries upgrade their broadband speeds.

BSG (2008) finds that NGB can significantly accelerate changes to content distribution through ‘vertical convergence’ of content production and consumption. This would provide benefits of £320m p.a. by lowering content distribution costs (from replacement of physical media), additional value of having on-demand video and a larger choice of video catalogues.

A similar view is found in ‘The Longer Long Tail’ (Anderson C. , 2009), which using examples of large emerging digital catalogues (such a s online video and music), found that advances in the internet networking, search and e-commerce capabilities has allowed an almost never-ending choice of digital entertainment media to meet the demand of collectively large and valuable amount of niche interests.

Cisco (2009) forecast’s support the above growing demand views, as it finds that internet video will account for 91% of global consumer traffic by 2013. which will equate to nearly 700 times the entire US Internet network only 13 years earlier (see appendix item 3). This growth is being enabled by the increasing penetration of high-speed broadband, access devices and consumer multi-tasking (Cisco 2009).

**DISCUSSION AND CONCLUSIONS**

Based on the results of the literature review it is clear that NGB can enable many potential social and economic benefits for Australia. Based on both a top-down economic and bottom-up innovation perspective, and challenges facing Australia, major benefits are in potential GDP, productivity, competitiveness & consumer surplus gains, as well as smarter energy resource and transportation networks and use, better Business operations and services, improvements in Health care, Education & Government services. This will also enable potential benefits for work / life balance and flexibility with the ability for people to virtually work and live from anywhere, live at home longer, and improvements for regional attractiveness, the environment and sustainable growth for Australia. This perspective framework for identifying these benefits and their relationships and drivers has been illustrated in Figure 24 further below.

The difficulty in assessing the Economic and Social Benefits of NGB is in the lack of historical actual empirical evidence to confirm and quantify benefits. This report, while presenting evidence of the potential, is based on literature using forward-looking estimates...
and qualitative judgments. This is both due to the relatively early stage of the technology’s evolution, difficulties in separating broadband benefits, isolating and quantifying social benefits, and challenges in developing counterfactual cases. It is recommended though that attempts still are made to assess historical evidence in future, and the NBN Co’s progressive network roll-out in different geographic locations may present the opportunity for this type of research.

This report has also purposely taken a relatively broad research approach to identify the range of benefits possible. Further research would be recommended to build on this by taking a more-in-depth approach into each of the benefit areas identified. At the same time it is expected challenges and roadblocks will need to be assessed, regarding awareness, education and acceptance of the investment, time, cultural & process changes required to realise the potential benefits.

**Top-down perspective**

![Top-down perspective diagram]

**Bottom-up perspective**

Figure 24 - Overall model framework of findings and conclusion relationships

Acknowledgements

This paper is largely based on updated excerpts from a Master’s Thesis Research Project, originally submitted to UTS in 2010.

Disclaimer

The views expressed in this report are those of the author and not NBN Co.

References


APPENDICES

ITEM 1 - AUSTRALIAN GOVERNMENT MEASURES OF DIGITAL ECONOMY

<table>
<thead>
<tr>
<th>Digital Engagement</th>
<th>Australia</th>
<th>United Kingdom</th>
<th>Canada</th>
<th>France</th>
<th>Korea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Households with home access to the internet (as a percentage of all households)</td>
<td>64% (2007 data)</td>
<td>67% (2007 data)</td>
<td>68% (a) (2006 data)</td>
<td>49% (2007 data)</td>
<td>94% (2007 data)</td>
</tr>
<tr>
<td>Number of broadband subscriptions per 100 inhabitants in 2007</td>
<td>23% (b) (2007 data)</td>
<td>26% (2007 data)</td>
<td>27% (c) (2007 data)</td>
<td>25% (2007 data)</td>
<td>31% (2007 data)</td>
</tr>
<tr>
<td>Individuals who ordered or purchased goods or services on the internet in 2007 (as a percentage of adults)</td>
<td>42% (2007 data)</td>
<td>45% (2007 data)</td>
<td>30% (2007 data)</td>
<td>26% (2007 data)</td>
<td>44% (2007 data)</td>
</tr>
<tr>
<td>Businesses using the internet (as a percentage of businesses with 10 or more employees)</td>
<td>94% (2006 data)</td>
<td>94% (d) (2007 data)</td>
<td>95% (2006 data)</td>
<td>95% (2006 data)</td>
<td>97% (2006 data)</td>
</tr>
<tr>
<td>Businesses with a broadband connection (as a percentage of businesses with 10 or more employees)</td>
<td>90% (2006 data)</td>
<td>78% (e) (2006 data)</td>
<td>92% (2006 data)</td>
<td>87% (2006 data)</td>
<td>96% (2006 data)</td>
</tr>
<tr>
<td>Business with their own website (as a percentage of businesses with 10 or more employees)</td>
<td>56% (f) (2006 data)</td>
<td>75% (g) (2006 data)</td>
<td>68% (2006 data)</td>
<td>61% (2006 data)</td>
<td>58% (2006 data)</td>
</tr>
<tr>
<td>Enterprises’ total turnover from e-commerce (as a percentage of total enterprise turnover)</td>
<td>10% (2005 data)</td>
<td>17% (2006 data)</td>
<td>figure not available</td>
<td>17% (2006 data)</td>
<td>22% (2006 data)</td>
</tr>
</tbody>
</table>

Source: DCBDE (2009)
ITEM 2 - AUSTRALIAN GOVERNMENT STATISTICAL SNAPSHOT

Broadband

As at June 2009, for internet service providers (ISPs) with more than 1000 active subscribers:

<table>
<thead>
<tr>
<th>Category</th>
<th>Subscribers (Million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet subscribers</td>
<td>8.4</td>
</tr>
<tr>
<td>Dial-up subscribers</td>
<td>1.1</td>
</tr>
<tr>
<td>Broadband subscribers</td>
<td>7.3</td>
</tr>
</tbody>
</table>

Download speed:

- 256 kbps to less than 512 kbps: 1.3 million
- 512 kbps to less than 1500 kbps: 1.2 million
- 1.5 Mbps to less than 8 Mbps: 2.5 million
- 8 Mbps to less than 24 Mbps: 1.8 million
- 24 Mbps or greater: 0.4 million

Percentage of broadband subscribers who used DSL connections: 57%

Note: The June 2009 survey included only ISPs with at least 1000 active subscribers, which in December 2008 constituted 99.1 per cent of all internet subscribers.

In 2007-08:

- Households with home computer access: 75%
- Households with internet access: 67%
- Households with broadband access: 52%
- Internet equipped households with broadband access: 78%

Source: ABS 2009, Household Use of Information Technology Australia, 2007-08, Cat. No. 8160.0.

<table>
<thead>
<tr>
<th>Table 1: Internet services June 2006, March 2007, June 2008 and June 2009 for ISPs with at least 1000 active subscribers</th>
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<tbody>
<tr>
<td>Internet subscribers (million)</td>
</tr>
<tr>
<td>Household subscribers (million)</td>
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<tr>
<td>Business and government subscribers (million)</td>
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<tr>
<td>Subscribers less than 256kbps (million)</td>
</tr>
<tr>
<td>Household subscribers (million)</td>
</tr>
<tr>
<td>Business and government subscribers (million)</td>
</tr>
<tr>
<td>Broadband (256kbps or greater) (Million)</td>
</tr>
<tr>
<td>Household subscribers (Million)</td>
</tr>
<tr>
<td>Business and government subscribers (Million)</td>
</tr>
<tr>
<td>DSL subscribers (Million)</td>
</tr>
<tr>
<td>Wireless subscribers (Million)</td>
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<tr>
<td>Broadband subscriber download speed</td>
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<tr>
<td>256kbps to less than 512 kbps (‘000)</td>
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<tr>
<td>512kbps to less than 1500kbps (‘000)</td>
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<tr>
<td>1500kbps or greater (‘000)</td>
</tr>
</tbody>
</table>

Source: DCBDE (2009)
ITEM 3: CISCO GLOBAL CONSUMER INTERNET TRAFFIC FORECAST

Source: Cisco (2009)

The financial advisory firm Greenhill Caliburn identified three key areas of risk with NBN Co’s corporate plan including rollout cost, take up rates and average revenue. Our interpolation between recent trends and indications in these three areas and projections in NBN Co’s corporate plan suggests a significant gap between NBN Co’s likely targets and projections in its corporate plan. Any short fall between actual results and planning targets should be apparent by the 2013 financial year. With an election due soon after that, this would provide an opportunity to revise the corporate plan, most likely by retaining copper based access for longer. Policy issues need to be considered in the context that copper will remain a component of high-speed broadband networks for much longer than envisaged in the current NBN corporate plan.

A SIGNIFICANT GAP IN THE NBN CORPORATE PLAN

The review of the NBN corporate plan by the financial advisory firm Greenhill Caliburn revealed three areas of risk of a substantial shortfall between the business’s financial projections and its likely actual performance: the cost of the rollout; take up rates, including take up rates of higher level services; and average revenue. Our interpolation between recent trends in average access revenue, take-up rates and initial indications on rollout cost and projections in NBN Co’s corporate plan suggests a significant gap between NBN Co’s likely revenue and cost and the projections in its corporate plans. Only the executive summary of the Greenhill Caliburn report has been released, but this suggests it has highlighted similar issues to the government.

The TJA’s May 2011 edition was focused on the policy gaps in the NBN. These covered a range of technical and social issues but did not touch on the commercial and economic gaps, although these have been covered in previous articles published in the TJA and elsewhere. The analyses of the commercial gaps in this article suggest that the NBN will not develop in accordance with its corporate plan.

Possibly the NBN will develop along more commercial lines – that is its corporate plan will evolve to adjust in response to actual costs, take up and average revenue. This may well mean that it will retain copper-based broadband access in some form for a longer period. Alternatively, the NBN may be recast in a wider economic case where those benefits which are not well captured commercially are used specifically to supplement its poor commercial prospects. However, assuming a wider economic case is made for NBN, a non-commercial NBN would become a Federal budget item and so open to ongoing scrutiny of its performance against policy objectives. Again, almost certainly this would delay the long term deployment of ubiquitous fibre to the home in favour of retaining copper based access to high speed broadband for a longer period.
In either case the policy gaps identified in the May edition of TJA need to be considered in the context that copper will remain a component of high-speed broadband networks for much longer than envisaged in the NBN corporate plan.

GREENHILL CALIBURN REVIEW OF NBN’S CORPORATE PLAN: AN AID, NOT AN ENDORSEMENT

Greenhill Caliburn’s review of NBN Co’s corporate plan included: an overview of NBN Co, a preliminary commercial assessment of the corporate plan and a summary of potential ongoing performance management strategies to assist the Commonwealth with its investment in NBN Co. An eight page executive summary of the report was released on 14 February 2011, but the full report is confidential.

The executive summary of the report makes it clear that it does not evaluate the Government’s NBN policy objectives, nor provide a cost benefit analysis nor does it “constitute a recommendation to the Commonwealth with respect to the NBN or NBN Co in any form, including with respect to approval or adoption of the corporate plan.” (Greenhill Caliburn 2011, 1).

Nevertheless, the overview, preliminary commercial assessment and summary of performance management strategies are valuable for the government as investor in the NBN and to aid its management of that investment. Given the substance of the government’s NBN investment, the review is sufficiently worthwhile on that basis without necessarily being an evaluation or analysis.

GREENHILL CALIBURN SAYS NBN’S CORPORATE PLAN, TAKEN AS A WHOLE, IS REASONABLE

Greenhill Caliburn said:

“based on its preliminary review … and subject to the assumptions contained in the corporate plan … taken as a whole, the corporate plan for the development of the NBN is reasonable. In general, key assumptions underlying revenue and cost projections appear to be in line with a range of available domestic and international benchmarks, and are consistent with the stated policy objectives of the Government with respect to the NBN. Accordingly, we believe that the Corporate Plan provides the Government with a reasonable basis upon which to make commercial decisions with respect to NBN Co.” (Greenhill Caliburn, 1).

The Government was sufficiently encouraged by this to state that “(t)he Greenhill Caliburn report confirms NBN Co's key assumptions underlying revenue and cost projections which provide the Government with a reasonable basis on which to make commercial decisions about the NBN” but didn’t mention the preliminary nature of the review or the other qualifications noted including the underlying assumptions (Conroy 2011). In fact the Greenhill Caliburn report goes on to say the corporate plan is based on a number of assumptions and that the NBN’s expected return profile “could vary – potentially materially – if those assumptions are modified” (Greenhill Caliburn, 2).

Overall, the Greenhill Caliburn executive summary makes clear in eight pages three specific areas of significant risk and uncertainty. Two of these are average revenue expectations and take up projections which together are the key drivers of revenue forecasts. It says “(i)n particular long-term revenue forecasts for NBN Co contain inherent uncertainties … (c)hanges to underlying revenue assumptions have the potential to materially affect the return profile for NBN Co.” It’s a point that needs to be made clear because these two drivers of revenue forecasts as laid out in the NBN Co’s corporate plan are at odds with market trends over the past several years.

Greenhill Caliburn appears somewhat less concerned about the third factor, resource costs. It notes that “(a)lthough changes in capital or operating expense forecasts could also have a
material impact, those forecasts mostly relate to nearer-term events and have a lower risk profile given NBN Co’s ability to manage the NBN roll-out.” Nevertheless, given recent experience, there is good reason to be concerned about this factor as well.

**AVERAGE WHOLESALE REVENUE ASSUMPTIONS AT ODDS WITH CURRENT BROADBAND ACCESS REVENUE TRENDS**

Wholesale revenue forecasts in NBN Co’s Corporate Plan 2011 – 2013 are based on two options, Option A (1) and Option A (2), respectively forming upper and lower boundaries of the corporate plan’s scenario range (NBN Co 2010, 109). The two revenue scenario options are not greatly different over the three year corporate planning period, with the first option modelling a blended average revenue per activated line (ARPU) of $34 per month by the end of the three year corporate plan (FY2013) and the lower bound ARPU of $33 per month. These would help generate revenue of $154m to $160m from 566,000 connections in FY13 (or $224-231m annualised).

These ‘prices’ are more than three times higher than the current blended price paid by broadband access seekers for access to copper. Although there are some important differences in the access product offered on copper compared with the proposed fibre access product of NBN Co it highlights the question of ability to pay: that is, does the broadband user community have the capacity to pay such prices given it has grown to a 65% subscriber penetration rate largely due to cheap access? At current average wholesale prices paid for copper access of just over $10 per line per month, 566,000 access lines would only generate around $70m in annual access revenue.

Part of the difference is in the backhaul dimension of the larger footprint of NBN Co’s fibre access network (FAN) compared with the footprint of Telstra’s local exchange service areas (ESAs). In effect this allows access seekers to avoid around half of their backhaul payments and also expands the addressable market given households in some current ESAs can’t be offered effective capacity to support broadband service. Benchmarking backhaul payments by access seekers against their access payments suggests that a 50% saving in backhaul applied to NBN access might add ten percent to the willingness to pay for NBN access. Similarly, a ten percent expansion in service area footprint, other things being equal, might add a similar amount to willingness to pay for fibre access relative to copper access. These two adjustments imply that 566,000 access lines generating $70m, in the relative NBN fibre footprint, might deliver $86m in broadband access revenue.

Two other differences are perhaps more important in assessing the average revenue prospects for NBN Co fibre access service. Access revenue derived from voice service is the most critical of these in the early years of NBN Co’s plan. The broadband market has developed over the past decade on the back of cheap access to a network built for and paid for by voice. In aggregate, broadband lines contribute less than 25% of the annual cost of the copper access network, including Telstra’s own broadband lines at the same average price paid by broadband access seekers, about A$780m per annum in broadband access revenue.

**INITIAL FIBRE ARPU IS SIMILAR TO CURRENT VALUE INCLUDING A COMPONENT FOR VOICE ACCESS**

The bulk of the copper access network is paid for by voice; however, voice revenue is declining rapidly. PSTN revenue has declined by 30% from a peak of A$8.3bn in FY04 to $5.8bn in FY10, or about 5.8% per annum. The retail access share of this (including local call revenue and some inherent retail margin) has declined by 26% from A$4.7bn in FY04 to $3.5bn in FY10, or about 5.0% per annum. The trend indicates a decline in the willingness to pay for fixed voice as valuable voice traffic migrates to mobile and voice access becomes commoditised in a fixed broadband environment.

Initially, the bulk of NBN Co’s revenue is contributed by its access charge for the access virtual circuit (AVC), which is a speed based charge commencing at A$24 per month for a 12
Mbps downstream and 1 Mbps upstream access service (i.e. 12/1 Mbps), rising in small increments to $34 for a 50/20 Mbps access service, $38 for a 100/40 Mbps access service and then rising in larger increments for higher speed access services. At $24 the entry level 12/1 Mbps access service is priced similarly to the current copper access service for voice and shared broadband. In its latest access prices, the ACCC set wholesale line rental (WLR) and line sharing service (LSS) rates of $22.84 and $1.80 respectively, a combined rate of $24.64 for voice and data access service.

Initially also, NBN Co’s product set is similar to that of copper access, with its first product release being high speed broadband and telephony and its second product release being emerging entertainment capability. Although it will offer these at speeds well above that of copper on average, copper can offer these at a sufficiently good speed in many areas. In terms of the AVC component of NBN Co revenue, a substantial value differential arises to the extent people will pay for higher speed access (than is available on copper) to deliver high quality broadband access and entertainment services as well offering access services in areas not well serviced currently by copper.

As well as this potential value differential, NBN Co proposes three further product releases drawing on the high-speed capability of fibre network. These are aimed at business and enterprise, but much of this value will be contested by other networks including privately owned fibre. (NBN Co has a fibre access monopoly only to households and business premises with fewer than 15 people.)

The relationship between demand for voice and broadband access may not work both ways: demand for voice may be relatively inelastic at $22.84 (although this demand elasticity seems to be increasing over time) and given this service is taken up there may then be good demand for broadband access at $1.80. That is to say much of the current demand for broadband access derives from a low access cost given a certain demand for voice. Against that, the demand for broadband as the primary access service with low cost voice provided as a component service looks much more elastic given low subscription prices are a primary driver of retail demand for broadband.

In broadband packages, voice is typically offered as a supplementary service for around $10.00 per month, that is for retail service. If we include voice at $10 per month as an access service, then this would deliver NBN Co additional revenue of about $45m in FY13, or about $130m in total (annualized at $150m and $170m) depending on the previous assumptions. This is an ARPU of about $22.50, close to the current WLR/LSS combined access price but only about two-thirds of NBN Co’s FY13 ARPU target, and essentially with no retail margin on voice service compared with current pricing.

THE KEY TO NBN CO’S LONG TERM ARPU TREND IS ITS ABILITY TO EXTRACT A PREMIUM FOR HIGH SPEED SERVICE QUALITY

The differential may be made up depending on the extent to which people may value and pay for higher speed access service (in more areas than served by copper access) and NBN Co’s ability to extract a premium for service quality at high speed. In our view, this expected uplift in willingness to pay for additional value is a critical factor in NBN Co’s FY13 corporate plan targets.

Extending this beyond FY13, the difference between copper and fibre access on which the NBN Corporate Plan most depends over the long term is its ability to offer higher service quality, in part because its fibre infrastructure allows it great capacity to specify and deliver specific product speed (peak information rate or PIR) and in part because of its provision of backhaul allows it to offer a Connectivity Virtual Circuit (CVC). The CVC is the capacity required for each service area to aggregate access circuits to NBN’s point of interconnection. It is, as NBN Co’s corporate plan says, a “product construct … an aggregation point where the access seekers can choose to contend their traffic to create differentiation. CVCs can be used as proxies for usage charging.” (NBN Co 2010, 103).
The CVC is the ARPU component that is the substantial difference in the value of the fibre access product relative to copper, and ultimately may help justify the economic case for the NBN. It is the potential value in this price component that underlies the case for ubiquitous fibre access, a point made plain in NBN Co’s corporate plan. It says that the CVC products are expected to contribute approximately 30% of revenue by FY2025 and 36% in FY2040. “This reflects a policy to balance NBN Co revenues between speed (AVC) and usage (CVC). The construct of charging for CVC capacity is the principal mechanism by which NBN Co can benefit from the expected future growth in broadband data usage”. (NBN Co 2010, 110).

There are other products that contribute to NBN Co revenue including network interface (NNI) and multicast. These help make up the value differential, but the differential in value between fibre and copper mostly hinges on Retail Service Providers (RSPs) paying more for higher speed access than the basic entry-level service and on the CVC component. The take up of these two components of value needs to drive an increase in access ARPU from (effectively) $24.64 on copper currently to $33.00 on fibre by FY13, a 34% increase over 2 years, or 16% per annum over two years.

The importance of rising ARPU was noted by Greenhill Caliburn, although not quantified in its executive summary.

“Average revenue per user consists of baseline connection fees as well as usage-based rates charged to customers. ARPU is important in driving return increases over time as volume growth (up take) plateaus, shifting revenue growth from new users to increasing returns from each connected customer. The Corporate Plan assumes ARPU will rise over time as usage per customer increases.” (Greenhill Caliburn 2011, 4).

NBN CO’S ASSUMED RISING ARPU TREND COMPARES WITH DECLINE SINCE 2005

The significant value-driven increases in access prices assumed in the corporate plan don’t seem to be realistic against the historic trend in declining access prices. Although the bundled WLR/LSS rate is $24.64 on copper now, it was previously around $28.50. As well, the unconditioned or unbundled local loop (ULL) rate for broadband access on copper is now $16.21 across 90% of copper access lines; that is, roughly comparable with the NBN Co’s proposed fibre footprint. When the ACCC first introduced geographic de-averaging for ULL, the metropolitan rate was $22 per month and the rural price was $40 and across the three bands (city, metro and rural) the rate averaged around $26 per month. The fall to a common rate of A$16.00 is a 38% reduction from that average while the key metropolitan rate has fallen by 27%.

Line sharing rates have fallen even more significantly, from $9.00 to $2.50, and now $1.80. These initial reductions in access prices drove a step down in average monthly retail prices from over $60 in FY05 to around $50 in the following years. Retail ARPU has increased in some years since then to around $55 by FY10 as the broadband market matured, with growth in demand for higher service packages and improvement in ISP margins. However, they fell again in FY11 by about 1.5% as Telstra dropped its broadband prices to rebuild market share. Overall, we contend, there was a sharp drop in regulated broadband access prices mid decade, and further reductions since then. These flowed into lower retail prices and this helped initially drive good growth in broadband subscription for several years before the industry looked to consolidate these gains in better margins and returns in FY09 and FY10. In this context, and with only a gradual and interrupted increase in retail ARPU with maturing subscriber demand, how is it that the NBN expects to turn these trends around to achieve a 34% increase in average access revenue across its fibre product over two years?

Further the step up in access prices over this period is only the start of a long-term trend. On the revenue and connection growth in the NBN Co corporate plan, ARPU is indicated at around $65 per line per month by 2025. This is a 5.7% annual increase sustained for a further
12 years, about twice the rate of inflation, and at odds with access price trends over the past half decade or more.

It’s an optimistic projection with several clear risks indicated by Greenhill Caliburn: “Consumers of telecommunications services generally have an expectation that prices for services will decline or that consumers will receive higher value services for same price over time. The Corporate Plan assumes that on a per unit basis, the real price of service will decrease over time. This loss is assumed to be more than offset by the increase in consumer spending on broadband services as they purchase higher quality services, measured in usage and potentially targeted or committed speed levels.

“NBN Co’s pricing philosophy maintains low price increments between the different access speed tiers in order to encourage an upward movement through pricing levels. The actual retail prices and services / products offered to consumers are largely outside NBN Co’s control, but in our view NBN Co’s proposed pricebook and approach to pricing are conducive to allowing retail service providers (RSPs) to develop and market applications and services that will meet and encourage the expanding speed and usage requirements of a potentially growing number of internet users.

“Key risks of ARPU assumptions include potential consumer pushback on the usage-based pricing model, the potential need for lower prices to overcome initial low up take, a faster than expected erosion of RSP margins on base-level products (which may affect consumer willingness to buy materially higher priced products) and potentially lower-than-expected growth in attractive internet-based content and “over-the-top” services requiring higher speeds and usage rates.” (Greenhill Caliburn 2011, 4).

OVERALL TAKE UP TARGET OF 70% IS DRIVEN BY THE TELSTRA DEAL

Indeed, the issue is not so much NBN Co’s ability to offer this high service quality but rather to convince enough people to pay for it. The second key factor assessed by Greenhill Caliburn is the extent of take up, especially for the higher level services. NBN Co expects to have 1,268,000 premises passed by fibre by June 2013 (including 249,000 in greenfields sites by third parties) and a further 447,000 to have wireless or satellite available. FY13 is the first full year of substantial growth in rollout. More importantly for its revenue projections it expects to have 511,000 premises connected to the fibre network, a connection rate of 40%.

Perhaps more importantly for long-term value, it expects to have 12,931,000 premises passed by fibre and a further 1 million by satellite and wireless by 2025 when NBN Co expects to be in its established operations phase. Of these it expects to have 9,052,000 premises connected to fibre, a connection rate of 70%. The key assumption behind the 70% connection rate and take-up of basic services is the customer migration agreement recently reached with Telstra.

In the corporate plan’s revenue model, connection and take up of services are taken as the same thing, with connected premises that take no telecommunications services considered with vacant premises and estimated at 12.4% at 2025. The corporate plan considers “the majority of empty/no service premises are structural in nature” (NBN Co p. 116) and doesn’t separately weigh the possibility that people may take a connection when it is offered but not activate a service. A premises is activated, it considers, when a valid service order is received.

Two other key assumptions behind the 70% connection rate target of 2025 are wireless-only premises of 13% (equivalent to 16.3% of households) and third party fibre premises of 4.6%. Clearly, the wireless-only premises assumption is a matter of concern for NBN Co, sufficient for it to require Telstra and Optus to agree not to “promote wireless services as a substitute for fibre based services for 20 years”. (Telstra 2011, 9).
NBN Co’s forecasts of wireless-only households are based on extrapolation of current estimates of 13% growing to 15% by 2015. It argues that this estimate includes 4% of households that subscribe to fixed broadband but not fixed voice, although this group won’t necessarily value the fixed voice broadband bundle intrinsic to NBN Co’s fibre access. In any case it seems an error to limit extrapolation of the current wireless-only household trend which reflects (among other things) the current relative pricing between wireless and fixed broadband, when these relative prices are likely to change significantly through the forecast period. That is, fixed broadband prices are likely to become more expensive relative to wireless, given access pricing in NBN Co’s plan and growth in wireless network capacity. The more likely scenario is further migration of more valuable services from fixed to wireless networks.

Greenhill Caliburn also warned about the “(t)rends towards ‘mobile centric’ broadband networks … to the extent that some consumers may be willing to sacrifice higher speed fibre transmissions for the convenience of mobile platforms.” Despite the guidance of industry experts it said “the prevalence of such homes should be carefully monitored in connection with ongoing performance management efforts”. (Greenhill Caliburn 2011, 3-4).

A related issue for NBN Co’s take up target, but not separately included in its corporate plan, is the growth of wireless femtocells used within buildings or households. NBN Co’s plan envisages these being connected to its fibre network but in many cases they may readily connect to nearby wireless base stations and allow traffic to bypass NBN Co’s access network. The risk was sufficiently important for NBN Co to specifically exclude the option in its subscriber agreement with Telstra.

We would question how workable such restrictions are across the whole industry. Apart from Telstra and Optus there are several other wireless operators capable of developing a workable wireless access strategy in target markets and, given the access price trends outlined, a strong incentive for RSPs to find ways to bypass NBN Co with such technology. If or where this opportunity becomes significant, it is likely to require a commercial response from Telstra and Optus.

**EXPECTATIONS FOR MIGRATION TO FIBRE OF VOICE ONLY HOUSEHOLDS**

A further key issue in NBN Co’s take up projections relates to the 3.5 million households that subscribe to voice-only service on copper, many with monthly telephone bills below $40, or even $30. These make up about a third of all households currently. NBN Co expects 52% of residential end-users initially to be on the basic 12/1Mbps service, including (we assume) these existing voice-only customers, in part a result of the subscriber migration agreement with Telstra. As part of that agreement, these people will by default have their voice service included as part of a broadband service package when they are migrated to NBN Co fibre, although so far they have seen little or no value in broadband services. There is potential for significant ‘leakage’ (as the corporate plans describes it) to wireless among these customers, especially given the impact of changing relative prices between wireless and fixed services. Even to the extent they do migrate to NBN Co’s basic access services there must be significant doubt about their willingness to migrate to higher value plans, which underlies NBN Co’s assumption of rapid increase in ARPU.

**UPSELLING POTENTIAL CONSTRAINED BY STRUCTURAL SEPARATION MODEL**

Compounding these take up and service evolution issues, a key issue only hinted at in the Greenhill Caliburn assessment (at least, only hinted at in the executive summary) is that unlike most other investors in networks, NBN Co is constrained in its ability to up-sell services by its structural separation. It holds the investment risk but the key means of managing this risk – getting enough end users to see the value in higher value access service – is in the hands of third party RSPs. The RSPs have upside revenue incentive to do this, but
this incentive is constrained as margins are squeezed by the CVC price component as they up-
sell. And they don’t have the significant downside incentive; that is, they don’t bear the cost
of failure to develop the high value demand that comes with holding infrastructure
investment. Instead, many have established expertise and differentiation in bargaining down
access prices.

Greenhill Caliburn said the up take of NBN services:

“will be largely driven by consumer assessment of the value proposition … which
will necessarily be measured relative to the value of similar products offered
through other technologies such as copper, wireless broadband or HFC networks.
NBN will be a national wholesaler, so its pricing must allow affordable products to
be offered by its customers, the RSPs. Attractive RSP pricing, robust RSP
competition and the potential for development of innovative prices, services and
applications will be key factors for driving up take.” (Greenhill Caliburn 2011, 3-4).

This is a key risk arising from structural separation, the break in the alignment of incentives
between the body holding the infrastructure investment risk, NBN Co and the groups best
able to manage it by growing high value content, the RSPs. Potentially, structural separation
exacerbates a substantial issue in the industry currently: the volume of traffic levels is
growing at a rate much greater than the value of traffic measured in revenue terms; growth in
traffic volume requires more network capacity but if the revenue is not growing sufficiently
carriers lack the incentive to expand network capacity. Who should pay for increases in
network capacity? In microeconomics, one solution is to vary prices inversely with demand
elasticity, so that usage that is more resilient to price changes pays more. Ideally, where
service quality is a key differentiator such an ‘exchange of values’ is also aided by a good
relationship between buyer and seller to ensure valued service is best delivered. Structural
separation complicates this process; the access network provider can’t readily see the demand
preferences of end users, and so uses a broad proxy such as the CVC charge; and the access
network provider doesn’t have the ‘value’ relationship with the end user and so may not value
the business of the end user sufficiently to provide the appropriate level of service. Such
complications in matching network capacity and service quality with end user needs was not
weighed up in the policy process that led to structural separation and the NBN.

Key risks to NBN Co’s up take assumptions according to Greenhill Caliburn, “relate to
competition from alternative technologies, and the potential for adverse consumer reactions in
one or more markets to service offerings from RSPs to be delivered over the NBN or RSP
pricing options.” Overall, however, Greenhill Caliburn was relatively optimistic about NBN
Co’s pricing being “designed to achieve comparable or better prices”, although this is
probably a reference to higher speed services available on cable currently. The agreement
with Telstra and the relative lack of cable competition, it said, “provide strong support for
NBN Co’s ability to achieve its targeted up take.” (Greenhill Caliburn 2011, 4).

FTTH ROLLOUT COSTS, MORE STRAIGHTFORWARD THAN
DEMAND, BUT STILL HAS RISKS

Of the three key issues raised by Greenhill Caliburn, the cost issues are the most
straightforward. Cost information is relatively well established and resources required for roll
out can be assessed in advance, benchmarked and project managed. As Greenhill Caliburn
puts it, “unlike the drivers of NBN Co revenue, where data availability to support estimates
are limited … the majority of the cost assumptions, including those relating to the impact of
Australia specific elements can be more accurately measured or estimated based on global
precedents or other studies.” (Greenhill Caliburn 2011, 5).

Cost risks are more likely to arise in the capital expenditure associated with rollout given the
substance of this relative to low operating costs. “Given the complexity and large number of
variables, a number of environmental, regulatory and other operational factors could
potentially result in unanticipated costs or delays. For example, the expected real gains in
labour productivity are dependent on delivering consistent productivity improvements throughout the project’s lifetime. However, the impact of such isolated factors is likely to be relatively insignificant on the overall plan.

“Key risks of capital expenditure overruns include changes in government policies and / or local approvals, which could require more expensive underground installation costs, or lack of productivity improvements in materials or labour sourcing over time.” (Greenhill Caliburn 2011, 5).

The risk became more evident in April when NBN Co suspended its network construction tender after 14 construction companies were unable to meet NBN Co’s requirements within budget constraints. NBN Co said at the time that it had benchmarked its project “against similar engineering and civil works projects in Australia and overseas” and did not consider it would receive value for money from those proposals (NBN Co 2011a). However, the view of construction companies was that NBN Co’s RFP required construction companies to carry extensive risks around deployment and mobilisation, including risks that the companies themselves could not necessarily control.

NBN Co thought it could secure better value through an alliance approach. In May it appointed Fujitsu Australia Limited as its prime alliance partner to deliver fibre infrastructure to new developments or ‘greenfields’ sites. In June it appointed Silcar Pty Ltd for the first large-scale deployments of fibre in Queensland, NSW and the ACT. NBN Co says these arrangements are in line with its corporate plan. However, risk sharing is different from the original RFP issued by NBN Co. "In our one-on-one negotiations we agreed NBN Co would assume the risk of other infrastructure providers and Silcar would assume the risk of construction.” (NBN Co 2011b)

NBN Co’s corporate plan targets of 58,000 premises passed by fibre and 35,000 connections by June 2011 were intended to be predominantly met by greenfields build, although under a build, operate and transfer (BOT) model rather than direct construction by NBN contractors. However, delays in finalising arrangements for BOT in greenfields areas mean NBN has likely missed this target. It’s a minor lapse in the early stage of a ten-year construction project, perhaps inevitable given the complexity of the project, but another early indication that unplanned events may undermine a detailed plan.

A further development since Silcar was appointed is the finalisation of definitive agreements with Telstra. The infrastructure services agreement makes Telstra responsible for remediation of that infrastructure as well as ongoing maintenance and repair. However, Telstra has no remediation or service level obligations for lead-in conduits which become the property of NBN Co. These mixed arrangements risk complicating the roll out process, potentially increasing mobilisation of NBN construction crews beyond optimal levels, a key driver of costs.

THREE KEY RISKS POINT TO A SIGNIFICANT GAP IN THE CORPORATE PLAN

“A 10 year, $35.9 billion infrastructure project has many inherent risks”, say Greenhill Caliburn (p. 5). The risks are asymmetric and point the wrong way for NBN Co: ARPU may well be lower, but there is little prospect it will be higher than planned, take up may be lower but is unlikely to be higher or sooner, and at best costs may come out in line with forecasts but there is a good chance they will be higher.

The extent to which NBN Co is achieving or falling short of its corporate plan will be apparent by 2013 when NBN Co should have 1,269,000 premises passed by fibre and a further 448,000 covered by wireless or satellite. Of these it expects 511,000 to be connected to fibre services, in a total of 570,000 active service premises. By then it should be clear whether construction costs are in line or not. The key variable to deliver the corporate plan’s financial target should also be apparent by then: is there enough take up of key services to drive a lift in average revenue to $33 per line per month? This will require nearly half of active service subscriptions to be for a higher than basic level of service.
What will happen in the event that one or more of these three key parameters is missed, causing a gap in achieving the corporate plan? “NBN Co is planning on managing a number of the cost and execution risks of the project by conducting a staged deployment process (using first release sites and second release sites) to refine costings, procurement methodologies, planning, construction processes, operating systems and other related matters. Best practices can be developed from this sequenced rollout.” (Greenhill Caliburn 2011, 5).

However the more substantial risk to achieving the financial targets in NBN Co’s corporate plan is on the revenue side: average revenue and take up targets. If these targets are not met, Greenhill Caliburn suggests “NBN Co has also retained the flexibility to amend the Corporate Plan over time in response to changing circumstances. “The targeted rollout schedule provides … an opportunity to monitor costs and procurement processes, adjust product offerings or pricing levels, identify and adopt best practices and modify other variables prior to the NBN’s introduction nationwide.” (Greenhill Caliburn 2011, 6).

**LIKELY SIGNIFICANT CHANGE IN CORPORATE PLAN IF FY13 TARGETS NOT MET**

This leaves open but unsaid the possibility of a significant change in the plan if NBN Co is running well behind on key variables by FY13. The next federal election is due soon after NBN Co reports FY13 results. Given the Coalition’s broadband policies, a change in Government would certainly lead to a change in broadband plan; in fact a change in focus of rollout to include other technologies and support infrastructure competition in many areas while focusing government support in underserved areas. This may be done most readily by changing the NBN corporate plan to focus on those areas, including expanding copper-based access, although other adjustments would be needed.

However, even if the Labor Government is returned after the next election it too would need to revise NBN Co’s plan if it was not meeting targets. If the outcome of lower revenue and/or higher costs meant that NBN Co’s likely rate of return on invested capital fell below its cost of capital then it would not be counted as a commercial venture and so spending (including capital spending) would become an item on the Federal Budget. The Government has resisted including it as such because such expenditure may delay the planned return to budget surplus. If this remains the policy priority of a Labor Government after the 2013 election and NBN Co is falling well short of its financial targets, that would also likely lead to a significant change in plan. A more budget conscious Labor Government could reduce the rate of rollout; but possibly, if demand for high speed services hasn’t evolved as expected, it may consider retaining copper access in some form for longer, and managing increases in capacity by extending fibre to the node to better match the rate of change in demand.

In support of this possibility, it is notable that the compensation arrangements in favour of Telstra in its services agreement with NBN Co only apply when NBN Co’s fibre deployment reaches 20% of its current coverage target of 93% of premises. By June 2013, if its rollout is on track, NBN will only be at about 12.5% of that target, providing plenty of scope to revise the subscriber agreement without incurring a $500m penalty and still retaining the more important infrastructure agreement.

**CONCLUSION: POLICY GAPS IN THE NBN MAY REQUIRE MORE TIME FOR ADJUSTMENT**

Key policy gaps identified in the TJA’s May edition (TJA 2011) range from interconnection issues (Rocke and Wignall, Hackett), regulatory responsibilities (Eason), points of interconnection (Sinclair), end-to-end service delivery (Rocke and Wignall, Darling), Universal Service Obligations (Darling, Sinclair), the Standard Telephone Service (Darling, Stanton), wholesale competition (Sinclair), end user issues (Sinclair, Darling, Hawkins, Lee), and the need to develop services to use the NBN (Sinclair, Stanton, Budde, Salomon, Pesce).
Our analysis suggests that the resolution of policy and social gaps will not occur in the development context envisaged in the TJA’s May edition articles. However, even assuming a wider economic case for NBN, a non-commercial NBN would become a budget item and so open to ongoing scrutiny of its performance against policy objectives, again, almost certainly delaying the long term deployment of ubiquitous fibre to the home in favour of retaining a copper based or supplemented high speed broadband access network for a longer period. In either case the policy gaps identified in the May edition need to be considered in the context that copper will remain a component of high-speed broadband networks for much longer than envisaged in the current NBN corporate plan.

END NOTES

1. That is for those living sufficiently close to ADSL-equipped exchanges.

REFERENCES


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Janette has a Masters in Health Care Policy and Organisation, and is a Fellow of the Royal Society of Medicine and the Centre for Health Informatics Research and Development. This combination of theory and practice has led to a deep understanding of healthcare delivery, how clinicians and management interact and how to bring about change using IT as a catalyst and enabler.

Janette left the NHS to join BT in 2004 and since then has worked across all BTs major health programmes in the UK and Europe before moving to Asia Pacific to develop a heath practice in 2008. BT has now successfully delivered health programmes in Singapore, Hong Kong and Australia

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Dr Irene Blackberry has a medical background and completed her PhD in Medicine at Monash University in early 2002. Her PhD thesis, “Survival amongst longevity cultures: social, physical activity, and nutritional determinants”, was based on a longitudinal study (Food Habits in Later Life) amongst multicultural older people conducted under the auspices of the World Health Organization (WHO). She found that adherence to a Mediterranean dietary pattern prolonged survival among older people in Greece, Australia, Japan and Sweden.

Irene joined the Health Promotion Division of the National Ageing Research Institute (NARI) in mid 2002 as a Research Fellow where she coordinated a large randomised controlled trial (RCT), “Falls aren’t us” project. She also managed the implementation of falls risk screen in Emergency Department setting.

Beginning in 2006, Irene has a joint appointment as Research Fellow in Primary Care at the Department of General Practice, the University of Melbourne. She coordinates the Patient Engagement And Coaching for Health (PEACH) study, a National Health and Medical Research Council (NHMRC) funded cluster RCT investigating the effectiveness and cost-effectiveness of a patient focused chronic disease self-management program (COACH program) in improving outcomes for people with poorly controlled type 2 diabetes. She is also the coordinator of Chronic Disease Theme within the Primary Care Research Unit at the Department of General Practice. In 2008, she was appointed as the Fellow of the NHMRC Centre Clinical Research Excellence (CCRE) in Clinical Science in Diabetes at the University of Melbourne, Department of Medicine, St Vincent’s Hospital.

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In addition to her clinical roles Maxine is the principal investigator on a number of successful government and non-government grants. These have included telemedicine and ehealth, improving psycho-social support for patients with advanced malignant disease, creating models of palliative care for non-malignant disease and motivational interviewing to improve treatment adherence. She has also been awarded a Solvay Travelling Scholarship.

Maxine has presented at a number of national and international conferences and has publications in the area of end of life care, work ability in chronic illness and cystic fibrosis care. Maxine has recently moved to Perth and is involved in supervising masters and doctoral psychology students. She also provides clinical supervision and staff debriefing to a range of medical disciplines and works in private practice. Maxine has recently conducted a national project involved focus groups across Australia exploring doctors and allied health providers attitudes and their potential use of ehealth.
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Kate is also the General Manager of the Centre for Energy-Efficient Telecommunications at IBES, a joint venture between the University of Melbourne, Victorian State Government and Alcatel-Lucent, including the company’s research arm Bell Labs. The activities in the centre focus on increasing the energy-efficiency of telecommunications.

Previously, she was the Senior Telecommunications Adviser and Deputy Chief of Staff to Senator Stephen Conroy, the Minister for Broadband, Communications and the Digital Economy. Her roles included advising on the National Broadband Network policy, consumer issues and regional telecommunications.

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Dr Elizabeth Cyarto has over 15 years of research and practical experience in Canada and Australia in the area of healthy ageing. Her specific research interest is developing innovative interventions to maintain and improve the health and independence of older people. Elizabeth was awarded her PhD from the School of Human Movement Studies at The University of Queensland where she held an International Postgraduate Research Scholarship. For her doctoral study, she evaluated the impact of a strength and balance training intervention on functional ability, level of physical activity and health-related quality of life of residents of retirement villages. Her thesis was selected for the Dean’s Commendation List for Outstanding PhD in 2007.

Elizabeth joined the National Ageing Research Institute in 2008, where she is the Deputy Director of the Health Promotion Division. She is currently the Project Coordinator on two studies funded by the National Health and Medical Research Council examining the effects of physical activity on cognitive functioning.

In 2009, she was a member of an Australian delegation that travelled to Paris to meet with colleagues from the European Union to discuss Smart Technology for Healthy Ageing. It was hosted in part by the Australian Academy of Technological Sciences and Engineering (ATSE) which is involved in an Australian Research Council initiative to encourage interdisciplinary
LIZ FELL

Liz Fell is a freelance communications journalist, whose coverage of the telecommunications industry began in 1982 with contributions to Communications Australia and weekly broadcasts for ABC Radio Australia and ABC Radio National. She became a contributing editor of International Communications Digest, Communications Update and Hub, and a regular contributor of keynote interviews to Australian Communications and CommsWorld. At an international level, she was Australian correspondent for Television Business International and Cable and Satellite Asia, and contributed a monthly column to Asia Pacific Satellite. Since 1993, she has conducted regular interviews for the Telecommunications Journal of Australia. She has worked as a part-time Lecturer/ Senior Lecturer in a number of Humanities/Arts faculties, including teaching Journalism and coordinating research theses for Master in Journalism students at the University of Technology Sydney. She has also reported for the Federal Government on Journalism Education in Australian Universities.

She has been the recipient of several important awards for her journalism, including the George Munster Award for Freelance Journalism in 1986. She was elected a Distinguished Fellow of the Telecommunications Society of Australia in 2003 for her notable and enduring contributions to Australian telecommunications.
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Peter Gerrand has been a Professoral Fellow in telecommunications at the University of Melbourne since 1996. Before that he was Professor of Telecommunications at RMIT University (1993-96), following 22 years as an industry researcher and executive in Australia and Europe. His career achievements include co-designing the ITU's SDL (Specification and Description Language) (1973-80); leading the development of Australia's current telephone numbering plan (1991-93); and building Australia's first international Internet domain name registrar, Melbourne IT, as founding CEO (1996-2000). His awards include the 1998 ATUG Charles Todd Medal 'for outstanding contributions to the telecommunications industry' and an Australian Centenary Medal in 2003 'for outstanding service to science and technology particularly to public science policy'. His PhD thesis (2008) on 'Minority Languages on the Internet' has been published by VDM Verlag. He is an Adjunct Senior Research Fellow at Monash University's School School of Languages, Cultures and Linguistics, and an Honorary Research Fellow at La Trobe University's School of Historical and European Studies.  
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JOCK GIVEN  
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Jock Given is professor of media and communications at Swinburne University's Institute for Social Research. From 1995 to 2000 he was director of the Communications Law Centre and a member of the ACA's and Telstra's consumer consultative groups. He has been a Policy Advisor at the Australian Film Commission and Director, Legislation and Industry Economics, Department of Transport and Communications. He now researches, writes and teaches about communications law and policy, especially digital broadcasting, media ownership, international trade and the history of the multinational media enterprises.
He is the author of 'Turning off the Television: Broadcasting’s Uncertain Future' and 'America’s Pie: Trade and Culture after 9/11' and is Associate Editor of the International Journal of Digital Television. He holds degrees in Law, Economics, Commerce and Arts from the University of Queensland.

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KATHLEEN GRAY  
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Kathleen Gray holds a joint appointment as a Senior Research Fellow in Health Informatics in the Melbourne Medical School and the Department of Information Systems at the University of Melbourne, and sits on the executive committee of the University’s Institute for a Broadband Enabled Society. Her current research focuses on emerging use of web technologies in healthcare and health literacy, in particular how consumers, carers, clinicians and researchers learn to make effective shared use of new information and communication technologies – for example, social media, augmented reality, internet television and e-collaboration tools. She is a Fellow of the Australasian College of Health Informatics, a founding member of the Victorian eHealth industry Network, and active in promoting clinical informatics and e-health education and training for the health workforce. She has many years’ experience in university teaching, e-learning and academic development.

LOUISE GREENSTOCK  
*Australian Health Workforce Institute, The University of Melbourne*

Dr. Louise Greenstock is a Research Fellow at the Australian Health Workforce Institute, The University of Melbourne. Her multi-disciplinary background has developed from her studies in Psychology, Education and Allied Health Sciences. After completing a degree in
Psychology and Post Graduate Certificate in Social Science, she went on to conduct her PhD research exploring inter-professional working among practitioners from Health and Education services working together in school settings in the UK. Her PhD findings led to the development of a unique theoretical framework depicting inter-professional working which is transferable to a range of professional groups and contexts. Since then Louise has developed her profile as a health workforce researcher with an interest in enabling technologies and facilitating accessible health service provision.

Louise's current research interests are related to inter-professional collaborative practice in health, training, ehealth, telehealth and digital inclusion. She has worked in a number of further and higher educational institutions in the UK and now at the University of Melbourne.

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JENNIFER HEATH  
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Jennifer Heath is an Informatics professional who is currently a member of the Centre for e-Health at the University of Wollongong. Jennifer's industry experience includes more than 15 years in system analysis and design, database, programming and business intelligence roles. In addition, Jennifer has more than a decade of academic and management experience in Australian universities with her research focussing on data mining across health information and more recently on secondary uses of medical data, particularly matters pertaining to consumers and privacy.

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Dr Tim Henwood joined the UQ/Blue Care Research and Practice Development Centre in June of 2008 following the completion of his PhD with the School of Human Movement Studies and the Australasian Centre of Ageing at the University of Queensland. As a gerontologist, Tim is passionate about promoting the benefits of physical activity to the older adult through his research and teaching. Tim has a significant background in exercise prescription for the older adult, having first studied the impact of resistance training on functional well-being as a pilot investigation in commitment to his research honours in 2001. Tim was awarded his PhD for his work investigating the benefits of long-term high-intensity resistance training in independent living adults 65 years and older.

Most recently Tim has turned his attention to designing appropriate programs for low functioning older adults at the cusp of losing their independence. He is presently disseminating a program throughout the Blue Care organisation that has proven benefits for function and balance in respite day care clients. His research places emphasis on the importance of exercise to maintain functional well-being and quality of life among older adults. In addition to the impact of exercise, Tim also has research interest in quality of life and was the Project Officer for the Research Network in Ageing Well’s Mentoring Scheme for emerging researchers in ageing. Tim is an active member of the Australian Association of Gerontology and a recognised special population exercise physiologist with Exercise and Sports Science Australia.

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ROBERT HILLARD
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Robert Hillard was an original founder of MIKE2.0 (www.openmethodology.org), which provides a standard approach for Information and Data Management projects, and sits on the Swiss board of its governance body. He has held international consulting leadership roles and provided advice to government and private sector clients around the world. He is a Partner with Deloitte in Australia, leading Technology Consulting nationally, with more than twenty years experience in the discipline of Information and Data Management, focusing on finding and applying standardised approaches to creating, integrating and leveraging information resources. His book, Information-Driven Business (Wiley, 2010), sums up his perspectives on information and how it can be used to revolutionise every aspect of business.

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ALLAN HORSLEY
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Allan Horsley is a Professional Engineer, a Fellow of the Institution of Engineers and has some 45 years of experience in the Australian telecommunications industry.

He has been responsible for designing, building and operating substantial communications networks, with the State Electricity Commission of Victoria in the 70’s and 80’s, and as Managing Director with Vistel Ltd, the Victorian Governments’ telecommunications provider in the 80’s and 90’s. He led the Australian Telecommunications User Group in the 90’s and was a Member and acting Deputy Chair of the Australian Communications Authority, (ACA) during the period 2001 to 2005.

In recent years he has acted as an advisor to both the Australian Communications and Media Authority, (ACMA) and the Department of Communications, Information Technology and the Arts, (DCITA) on telephony services and facilities for Indigenous communities.

He has provided Telecommunications Regulatory training programs to Governments and Regulators in APEC Economies and to the South Pacific Forum telecommunications Regulators.

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NADDEEN JAYASUNDARA  
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Nadeen Jayasundara is a strategy and business planning specialist, with over 15 years experience in Telecommunications, Infrastructure & Construction and Finance industries (currently employed in NBN Co Limited). He has an MBA in Strategic Management, Consulting & Research, and B. Business in Accounting & Finance.

KAY JONES  
*Monash University*

Kay Jones is a Senior Research Fellow in the Department of General Practice, School of Primary Health Care, Monash University. Her research areas include chronic disease management (osteoarthritis, obesity, mental health), and knowledge translation including uptake of guidelines and information technology. In addition, her interests include women’s health, family violence and child protection. She completed her PhD in 2000 studying ‘The emotional effects on custodial and non-custodial parents of being involved with the Child Support Agency in Australia’. Current research and education development include online activities about osteoarthritis, depression and bipolar disorder.

Kay has significant experience in developing research that includes an education component, particularly for general practitioners; she previously worked at the Royal Australian College of General Practitioners (RACGP) in the Quality Assurance and Continuing Professional Development (QA&CPD) program and has strong links with many Divisions of General Practice, particularly in Victoria.
Dr Suzanne Kuys is a Principal Research Fellow with The Prince Charles Hospital and the School of Physiotherapy and Exercise Science, Griffith University. She is part of the Allied Health Research Collaborative for Metro North Health Service District, Queensland Health which fosters allied health research.

Suzanne completed her doctoral studies in 2009 investigating ‘The Effect of Treadmill Walking at High Intensity During Rehabilitation Following Stroke’. Her research interests include rehabilitation following stroke, gait and balance rehabilitation, ageing, outcome measures and cardiorespiratory fitness and physical activity in chronic disease populations.

Suzanne worked as a clinical physiotherapist at Princess Alexandra Hospital, holding a Senior Physiotherapist position from 1999 – 2006; and has been recognised by Queensland Health and the Australian Physiotherapy Association with Advanced Clinician status. She is the Research Advisor for the Queensland Physiotherapy Rehabilitation Network, a group which has now conducted several multicentre trials, and is responsible for more than 10 national and international presentations and 8 publications in peer reviewed journals in the last 5 years. From 2004 - 2008 she coordinated the Neurology program at School of Physiotherapy and Exercise Science, Griffith University. In 2006, Suzanne was awarded Queensland Health Australia Day Achievement Medal for outstanding service to Queensland Health to achieve its mission of ‘Promoting a healthier Queensland’ (1 of 11 awarded). The medals are managed by Queensland Commemorative Events and Celebrations Committee (QCECC) and implemented by National Australia Day Council.

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ADAM LODDERS
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Adam Lodders is Communications Manager at the Institute for a Broadband-Enabled Society. He has over ten years experience in marketing and communications. Adam has degrees in economics and politics and is currently undertaking postgraduate study in public policy focusing on communications policy and the digital economy.

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IAN MARTIN
Royal Bank of Scotland
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Ian Martin has been a telecommunications analyst for 20 years since commencing research in 1988 on the review of Telecom’s USOs. He worked as a research analyst and policy adviser in the Department of Communications on many of the main regulatory and policy issues behind the opening of the sector to competition in the early 1990s.

In 1992 he went on exchange to work with Oftel, the UK regulator, and in 1993 on exchange with the FCC in Washington where he worked on cable regulation. He also undertook a number of telecommunications projects with the OECD in Eastern Europe. On his return to Australia he worked on the Government’s Communications Futures Project.

In 1994 Ian joined BZW as one of the first telecommunications analysts in the Australian capital market. BZW was the lead adviser to the Government on the Telstra IPO in 1997. In 1998 BZW was bought by ABN Amro, which went on to be the lead broker for Telstra 2 in 1999. After contributing to these roles, Ian joined ABN Amro’s global telecoms team in London before returning to work in Australia as senior telecommunications strategist with Macquarie Bank. In 2004 he rejoined ABN Amro as senior telecommunications analyst and
worked on Telstra 3, the sale of the Government’s remaining stake in Telstra. In 2008 ABN Amro was bought by RBS.

Ian now works as a part time telecommunications analyst with RBS, writing investment research across a range of telecommunications matters for Australian and global investors, and as a Senior Research Analyst at Swinburne University’s Institute for Social Research where he works part time on the 2010-12 Australian Research Council funded Discovery Project ‘Imperial Designs’.

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FERNANDO MARTIN SANCHEZ

The University of Melbourne

Fernando Martin Sanchez is Professor and Chair of Health Informatics at The University of Melbourne. He was born in Madrid, Spain, where he studied Molecular Biology and Biochemistry at the Universidad Autonoma. He then received his M.Sc. degree in Knowledge Engineering and a PhD in Informatics from the Polytechnic University. After a postdoctoral stay at the Joint Program in Biomedical Engineering between Emory University Hospital and Georgia Institute of Technology, in Atlanta, USA, he returned to Spain and entered the National Institute of Health Carlos III. From 1993 to 1998 he was the CIO of the Institute and in 1998 became the Founding Director of the Medical Bioinformatics Research Unit. Since 2007 he is Vice-president of IMIA (International Medical Informatics Association). In 2010 he received his PhD in Medicine from the University of La Coruña (Spain).

As of February 2011 he has been appointed Professor and Chair of Health Informatics at the Melbourne Medical School and Head of the IBES Health and Biomedical Informatics Research Laboratory. Prof. Martin-Sanchez is co-author of more than 70 peer-reviewed publications and his research has been funded by some 25 grants from the European Commission and the Spanish Ministries of Health, Science and Defence. His research interests cover a wide range of topics related with the role of informatics in personalized medicine (genomic and nano medicine) and the convergence of Nano, Bio, Info and Cogno (NBIC) technologies for health applications.
Dr. Jennifer Nagao completed her Bachelor of Medicine/Surgery in 2009 and her internship at the Royal Melbourne Hospital. She is currently completing her first year of Basic Physicians’ Training at the Royal Melbourne Hospital and is hoping to be accepted into the Neurology Advanced Training Program in the future. She has an interest in rural and global health inequality.

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Moira Paterson is Associate Professor and Associate Dean (Undergraduate Studies) in the Faculty of Law, Monash University. She is the author of Freedom of Information and Privacy: Government and Information Access in the Modern State (LexisNexis/Butterworths, 2005) and FOI Editor of the Australian Administrative Law Service. She has published widely in the areas of freedom of information, privacy, health records law and intellectual property and received research grants for projects relating to criminal records and employment, the legal implications of e-research developments, the legal implications of shared electronic health records, models for private sector privacy laws and the impact of commercial confidentiality on government accountability.

Her external appointments have included membership of the Advisory Committee to the Australian Law Reform Commission in relation to its reviews of the Privacy Act 1988 (Cth).

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STUART T. SMITH

Neuroscience Research Australia

Stuart Smith completed a PhD in Experimental Psychology at Macquarie University in 2000 followed by a postdoctoral fellowship at NASA’s Ames Research Center (2000-2002). He also has a BSc and MSc from the University of Sydney. Following academic positions at Trinity College Dublin and University College Dublin (2002-2007), Stuart returned to Australia to undertake further research on the development and evaluation of telehealth technologies, with particular emphasis on the issue of postural instability and falls in older people. He is currently a Senior Research Officer at Neuroscience Research Australia and his research is funded by an NHMRC Career Development Award-Industry, NHMRC Project and Partnership grants and an EU FP7 grant. Stuart is regarded a national leader in the development and evaluation of videogames for health

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CRAIG SZUCS  
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Craig recently joined the National E-Health Transition Authority as Change Manager for the Personally Controlled Electronic Health Record. Prior to this Craig spent seven years working within the General Practice Network, holding a number of project management and executive positions in State Based Organisations (SBOs) of the General Practice Network across Victoria and Western Australia before becoming Principal eHealth Adviser for the General Practice Network peak body the AGPN. In this role Craig provided leadership for the eHealth Support Officers Network, a team of eHealth and change management experts distributed across AGPN and the SBOs. Craig has experience in eHealth policy development, project management and a passion for driving eHealth adoption as a means for improving health outcomes in the community. Craig has tertiary qualifications in computer science and private sector experience in IT/IM implementation and administration.

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Rod Tucker is a Laureate Professor at the University of Melbourne and Director of the University of Melbourne’s Institute for a Broadband-Enabled Society (IBES). He is also Director of the Centre for Ultra-Broadband Information Networks (CUBIN). He is a Fellow of the Australian Academy of Science, the Australian Academy of Technological Sciences and Engineering and the IEEE. He was awarded the Australia Prize in 1997 for his contributions to telecommunications and the IEEE LEOS Aron Kressel Award in 2007 for his contributions to semiconductor optoelectronics. Professor Tucker leads a group of staff and
students undertaking research on broadband access technologies and energy efficiency in telecommunications.

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BRENDON WICKHAM
General Practice Victoria

Brendon Wickham is eHealth Program Analyst, General Practice Victoria. He has many years experience as an IT specialist and working in the health sector in his role as an eHealth Support Officer with General Practice Victoria (GPV). At GPV he is part of a team responsible for implementing the e-Health change management strategies of the Department of Health and Ageing for divisions of general practice, while also assisting and facilitating the activities of divisions, GP Liaison Officers, and the state health department. He has worked as an Investigator with the Institute of Health and Workforce Innovation and has published research in the Journal of Assistive Technology. He has a Masters of Health (Informatics) with the University of Tasmania.

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JOHN WILSON
Central Clinical School, Monash University

Professor John Wilson is a respected clinical leader in the Australian health sector and champion for the application of technology to enable effective delivery of health services. He qualified BSc(Hons) with a focus on IT before completing his medical training. John is
currently Head of the Cystic Fibrosis Service at Alfred Health Melbourne, Chair of the Adult Medicine Division Education Committee, Royal Australian College of Physicians (RACP) and an RACP Board member. He is also a member of The Alfred Hospital Ethics Committee and has chaired the Workplace Implementation Group of the Junior Doctors Curriculum (CPMEC).

His research interests include application of electronic health records to medical systems and new pharmacological treatments in chronic disease. John has developed a focus on patient-centred care, examining factors that optimize use of digital solutions while delivering best-quality outcomes.

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BERNARD YAN
Royal Melbourne Hospital

Associate Professor Bernard Yan currently holds dual clinical appointments at the Royal Melbourne Hospital as a Neurointerventionist and Neurologist. He is an associate professor of the University of Melbourne. His key administrative appointments include chairs of the Telestroke service (RMH), Asia Pacific Affairs Committee of Australian and New Zealand Association of Neurology and University of Melbourne Neurology Subspecialty Course in China. He is the principal investigator and on the steering committee of the Interventional Management of Stroke Study 3 (IMS 3). He is also the principal investigator of the Australian branch of the Intra-arterial Plasmin for Ischaemic Stroke Study. In addition, he is the co-investigator of multi-centre stroke studies. His research interests include the development of endovascular devices for the treatment of acute stroke and aneurysms. He is the co-inventor of several endovascular devices. A major focus of his research is in the translation of broadband technology to the delivery of telestroke services to rural areas (Telestroke Service). He is a supervisor to research fellows from the University of Melbourne Department of Medicine and also to overseas neurology research fellows from China.

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ACS-TSA (the Telecommunication Society of Australia, a special interest group within the Australian Computer Society), is grateful to the following sponsors for supporting its journal *TJA* and ACS-TSA’s other activities in support of a well-informed telecommunications industry: