Telemedicine in the context of the National Broadband Network

June 2010

Report by NICTA for

Department of Broadband, Communications and the Digital Economy

The research reported in this publication was commissioned by the Australian Government Department of Broadband, Communications and the Digital Economy. The information and opinions contained in it do not necessarily reflect the views or policy of the Department of Broadband, Communications and the Digital Economy.

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Assistant Secretary
Digital Economy and Convergence Strategy Branch
Department of Broadband, Communications and the Digital Economy
GPO 2154
CANBERRA ACT 2601

media@dbcde.gov.au

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The analysis and results of this document are based partly on support and input from key experts in telemedicine. The analysis and results of this document do not necessarily represent the opinions of these experts directly or indirectly.

National ICT Australia Limited
ABN: 62 102 206 173
www.nicta.com.au

Corporate Head Office
Australian Technology Park
Level 5, 13 Garden Street
Eveleigh NSW 2015

T: +61 2 9376 2000
F: +61 2 9376 2300

Report prepared by
Leif Hanlen
Phil Robertson

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1. Executive Summary

1.1. Purpose, approach and context

The purpose of this study was to identify possible opportunities for Australia in telemedicine in the context of emerging high-speed ubiquitous broadband networks, and establish:

- An understanding of successful overseas initiatives in telemedicine and telehealth and why they have been successful;
- A description of Australia's position and progress relative to this work; and
- Identification of key barriers in greater take-up of telemedicine and telehealth in Australia.

We performed this study through a combination of:

- Collection and collation of source materials on telemedicine in Australia and overseas
- Interviews and workshops with external experts for identifying key issues relating to telemedicine experiences and uptake
- Analysis based on a framework that identifies the major functions of telemedicine, key technologies for supporting greater uptake of telemedicine, and the main barriers to uptake that have been experienced in trials or deployments
- Identifying the potential impact of the National Broadband Network (NBN) on the uptake of telemedicine, and the steps that could be taken now to maximise that impact as the NBN is rolled out.

There are several key underlying contextual issues that informed our approach to this study:

- The size and complexity of the health care system, and the degree of public and private sector interdependency in existing supply chains for health-care service delivery
- The genuinely disruptive impact of pervasive broadband connectivity, and its potential to catalyse transformational changes in expectations and services provided in any field.

This tension between constraints on the one hand, and opportunity for radical change on the other, highlights the risk of mismatch when trials are undertaken. It also emphasises the need to involve people from all parts of the health care system, and consider a combination of:

- Integrating new technologies to improve delivery under existing models - essentially capturing the "low-hanging fruit" by taking systematic approaches to identifying and removing barriers. This includes the need to develop or use technology that is clinically appropriate.

- Exploring and trialing scenarios for new delivery models enabled by the disruptive changes – essentially recognising that some of the changes will not be incremental and will not be achieved by incremental approaches.

1.2. Major findings

Our review of Australian and overseas initiatives in telemedicine showed that in general, Australian case studies more often focused on evaluation of off-the-shelf technologies, while international case studies often considered custom e-health information processing applications designed for the case study. In particular the more advanced studies in Europe and the US, appear to have progressed further from testing particular enabling technologies, such as videoconference or data-interchange techniques, and are now focusing on informatics and "higher level" data analysis. In several such studies high bandwidth video conferencing and data transfer are assumed.

The majority of studies reviewed were single-case "proof of efficacy" studies for a specific regional deployment. Very few involved defining pathways to deployment, or systematically moving from single case studies to more global health approaches. Many studies lamented a lack of sustainable business models.

Our analysis was based on reviewing the results of trials and case studies addressing four widely recognised functions of telemedicine as shown in the central **"Functions"** column in Figure 1 below. We identified seven main types of "**Technologies"** that are core to enabling telemedicine, and seven categories of "**Barriers"** that are constraints to its uptake, as also shown in the figure below. Complete descriptions of these technologies and barriers are given in Sections 4 and 5 respectively of this report.

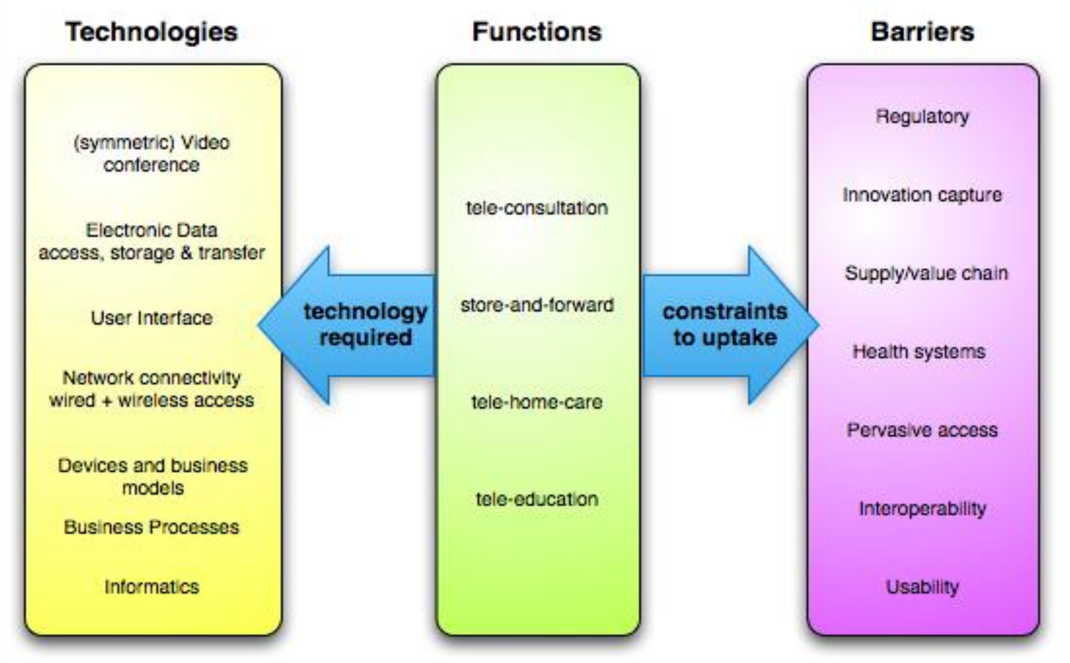

Figure 1 Executive summary: Technologies, Functions and Barriers for telehealth. Technologies listed are those supporting roll out of telehealth services, Functions are from (CITL: Centre for Information Technology Leadership, 2007) health-care functions and Barriers are derived from the literature, interviews and workshop input.

The analysis identified three tiers of barriers:

Our study found that the barriers could be grouped according to three tiers, based on the impact on the trials experienced.

1. First tier barriers were
   - **Regulatory** (ie billing problems, jurisdictional, cost/beneficiary mismatch and other legal or regulatory issues),
   - **Innovation Capture** (ie problems in achieving pathways to deployment of innovative trial results into sustainable programs)
   - **Interoperability** (ie lack of, or conformance problems with, standards and/or interfaces for data, process and other interchanges).
2. Second tier barriers were
   - **Supply/value chain** (ie existing business models, including supply and value chains, posing a barrier to new telemedicine based models)
   - **Pervasive access** (ie lack of ubiquitous patient, care and service provider connectivity, including mobility)
   - **Usabilty** (ie problems with technology solutions not being fit-for-purpose and aligning appropriately with work-practices).
3. The third tier barrier was
   - **Health systems** (ie the lack of systematic processes across health systems to reduce administrative burdens, improve quality and increase efficiencies).

Despite the differences in technologies trialed, we found that the cited impact and occurrence of these seven barriers, in aggregation across the range of studies, was largely consistent between Australian and international studies.

The relationship between the barriers and the technologies is captured in figure 2 below. Our findings showed particularly strong dependencies between **innovation capture** and several of the **technologies**, indicating the challenges in developing effective trials and addressing all the necessary technology issues adequately. Similarly **interoperability** barriers showed a strong link with **data transfer**, **network access** and **informatics** technologies, while **regulatory** barriers aligned strongly with **data transfer**, **network access** and **informatics** technologies.

Our assessment of the expected impact of the NBN on these technologies and barriers is also captured in figure 2 below. We found that the NBN was expected to have:

- A **critical** role in allowing the trials needed for the **innovation capture** barrier, and in overcoming the **pervasive access** and **interoperability** barriers
- A **driver** role in addressing **regulatory** barriers, since a common network infrastructure transcends jurisdictional boundaries.
- A **catalyst** role in developing new **supply/value chains**, gaining quality/cost benefits in **health systems** and addressing **usability** issues through more effective access and competition.

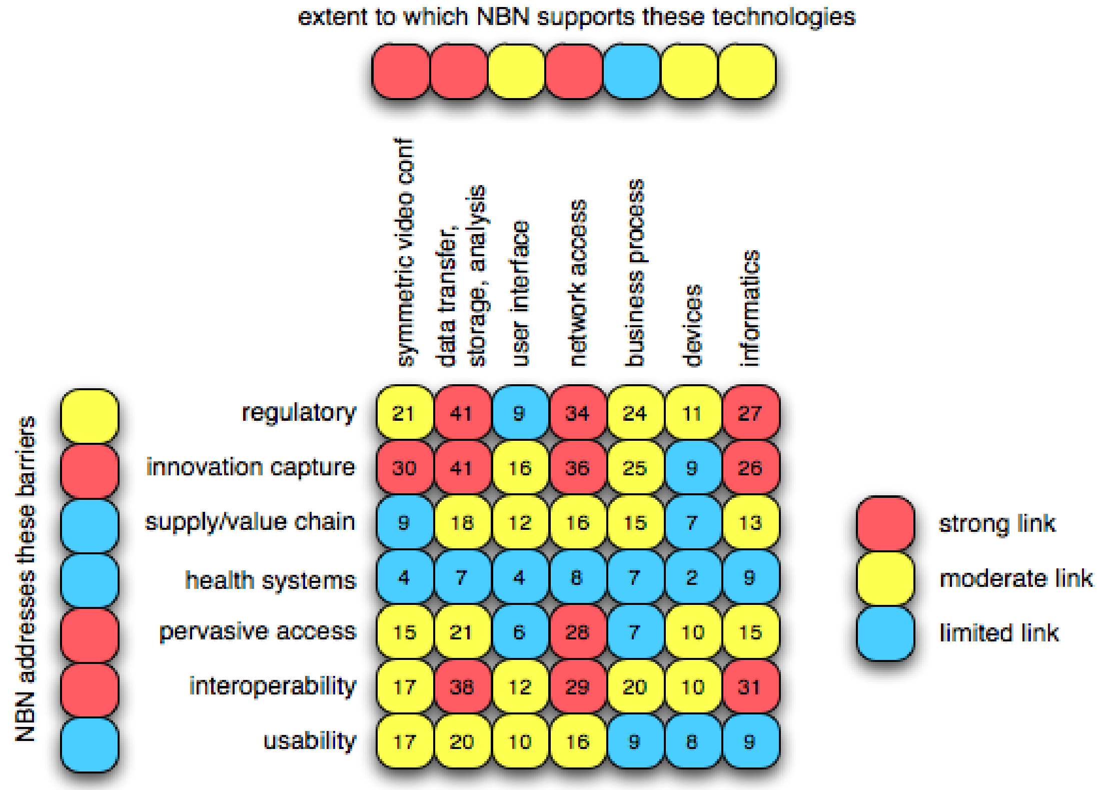

Figure 2 Executive summary: perceived barriers versus technologies. Barriers that are expected to be addressed by the NBN are highlighted red in the bar at the left; those technologies most assisted by NBN are highlighted red.

1.3. Major conclusions

(a) A coordinated strategy should be developed for eHealth trials across the NBN to allow early benefit from its roll-out

An overriding message from our study is the need for greater coordination and planning of a coherent set of trials that have identified paths to sustainable adoption. This involves not just trialing, but also shaping, of future telemedicine services.

Such trials should include consideration of the identified barriers, with specific mechanisms and champions from all stakeholders at each stage to address these barriers. They should also systematically address the technologies required, and ensure that key evaluation criteria are aligned with decision-making for adoption into practice.

(b) A coordinated approach should be taken to developing and testing the technologies needed to underpin effective telemedicine across the NBN

A coordinated approach is needed to address the technology challenges of scalability and interoperability on a heterogeneous broadband network, by developing the technologies that will enable service delivery to required levels of quality, security and reliability.

It is critical to recognise that the core infrastructure alone is not enough to ensure effective service delivery. Requirements for proposed services need to be systematically analysed, and a coherent approach taken to ensuring that the technology challenges are addressed in a scalable way, to ensure the benefits reach end-users.

(c) The NBN will provide a unique opportunity to catalyse change in the way health care is delivered

There is no doubt that health care systems will undergo fundamental transformations over the next several decades. Pervasive broadband access is a genuinely disruptive technology. Australia has the opportunity to use the NBN as a catalyst to jump-start it into a leading position in telehealth-care as an integral part of future healthcare.

This would involve considering a series of challenges: addressing the "systematisation" of health care, developing future supply and value chain scenarios, aligning training and education approaches with these models, planning a migration path from current to future care systems, and exploring how the NBN may improve or catalyse new clinical applications and tools, all in a coordinated way.

(d) Australia needs a coordinated approach to telemedicine innovation support and sharing of information and knowledge

It became evident in our investigations that Australia lacks a coordinated approach to share information and knowledge acquired from trials in a way that could allow progressive and systematic capture of experiences, support innovation, and avoid duplication of effort at regional levels.

A strategic telehealth innovation initiative is needed to support new research, information sharing on trials and technology experiences, and development of new health care scenarios as outlined above, using the NBN to provide open access to the results of such activities.

1.4. Comment on the results and conclusions of this study

The study was undertaken with support and input from many experts in telemedicine, as acknowledged in Appendix 1. We very much appreciate these contributions.

As noted at the front of this report, the analysis and results of this document are based partly on support and input from these contributors. We should point out, however, that the analysis and results of this document do not necessarily represent the opinions of all these experts directly or indirectly.

We would also like to point out that the scope and time-frame of this study did not permit a complete analysis and synthesis of all the material and experiences cited. Our intention, however, was that this material could provide the basis for more focused investigations and development of proposals for maximising the potential of the NBN for telemedicine in Australia. We believe that the conclusions above, and the materials they are based on, form a coherent approach to addressing this opportunity if developed more fully.

Glossary

CSIRO	Commonwealth Scientific and Industrial Research Organisation
DBCDE	Department of Broadband, Communications and the Digital Economy
DIISR	Department of Innovation, Industry, Science and Research
DoHA	Department of Health and Ageing
DSTO	Defence Science and Technology Organisation
ICT	Information and Communications Technologies
NBN	The Australian National Broadband Network
NEHTA	National E-Health Transition Authority
NICTA	National ICT Australia
RPDE	Rapid Prototype Development and Evaluation program

2. Introduction

2.1. Purpose and process of study

The Department of Broadband, Communications and the Digital Economy commissioned this study to identify possible opportunities for Australia in telemedicine in the context of emerging high-speed ubiquitous broadband networks.

The target of the study was to establish:

- An understanding of successful overseas initiatives in telemedicine and telehealth and why they have been successful;
- A description of Australia's position and progress relative to this work; and
- Identification of key barriers in greater take-up of telemedicine and telehealth in Australia.

The deliverable material from this study is a report that addresses these issues, documenting agreement or noting differing views from key external experts and stakeholders.

Interim results have been made available to the Department during the study, in the form of summaries, identified case studies and reports, and workshop notes and presentations.

Representatives from the Department of Health and Ageing, the National E-Health Transition Authority (NEHTA) and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) have been involved in the workshops.

NICTA has carried out a wide range of consultations in the course of undertaking the study and preparing interim results for discussion at the workshops. A list of people and organisations consulted is provided in Appendix 1.

This study has been undertaken using the following process.

Preparation

- Accessing any prior studies identified by the Department as required.
- Invitation to a small number of key external experts in this field to participate in the workshops and related follow-up activity.

Information gathering [2 weeks]

- Collect and collate existing data and reports
- Perform initial investigations

Workshop 1 [1 day]

- Identify and scope major areas of opportunity
- Determine issues and provide guidance for analysis and synthesis

- Elicit insights into key issues for further investigation.

This workshop focused on input from key external experts (clinical, CIO and technical). It also involved representatives from BCDE, DoHA, NEHTA and CSIRO

Synthesis [2 weeks]

- Investigate key issues arising from Workshop 1
- Synthesise results

Workshop 2 [1 day]

1. Present and discuss results of synthesis
2. Formulate major conclusions
3. Develop core recommendations

This workshop examined the synthesis of the results – both from the previous workshop and from the literature review and interviews. The participants included key external experts (clinical, CIO, technical) with approximately 40% from the first workshop and 60% new.

Finalise [1 week]

- Completion of the analysis and synthesis
- Generation of a final report capturing the results of the study and insights or opportunities identified.

2.2. Definitions and assumptions

What is Telemedicine/Tele-Health/E-Health?

Deloitte (2008) outlined a vision for e-Health in Australia, considering this to include telemedicine as a specific case.

> *"E-Health will enable a safer, higher quality, more equitable and sustainable health system for all Australians by transforming the way information is used to plan, manage and deliver health care service*
>
> - *E-Health will empower consumers to better manage their own health*
> - *E-Health will provide care providers with access to decision support tools and up to date consumer information and knowledge sources at the point of care.*
> - *E-Health will support care providers to automatically monitor individual care plans and health status"*

E-Health is the combined use of electronic communication and information technology in the health sector - the use in the health sector of digital data-transmitted, stored and retrieved electronically - for clinical, educational and administrative purposes, both at the local site and at a distance (Mitchell, From telehealth to e-health: the unstoppable rise of e-health, 1999)

Tele-medicine is that subset of e-health that deals with medical diagnostic and treatment services, at a distance. (Mitchell, 1999) Tele-medicine provides health care, decision support services, and information management, with an "anywhere, anytime access" model (HealthInfo, 2010)

Part of the difficulty for Tele-medicine/e-Health is the ambiguity of terms – ultimately e-Health may be considered as any application of information and communications technologies (ICT) to enable improved health outcomes. "Telehealth" is often used interchangeably with "e-health", with "tele" providing emphasis for healthcare "at a distance."

The benefits of telemedicine were reasonably well established by 1999 – see for example (Mitchell, 1999). They typically fall into:

- Equity of access, especially across remote geography and uneven income
- Scalability – increased volume of care without a corresponding increased cost
- Reduced transport (for professional and community) with corresponding greater proportion of time spent on clinician-patient interaction.
- Improved quality of care
- Education – for public, health-care professionals and community awareness.
- Improved and faster diagnosis – quicker treatment leads to improved outcomes

2.3. Framework for analysis

We have developed a framework for this study to help with analysis of case studies and synthesis of results. This should allow subsequent information from case studies to be incorporated in a systematic manner and their impact on the results to be considered.

This framework was based on analysis of case-study results and advice from consultations. It identifies the links between three basic dimensions of telemedicine:

- The **functional** role that telemedicine and telehealth-care provide
- The **technologies** that underpin the provision of telemedicine and telehealth-care, and their underlying requirements
- The **barriers** that have emerged to uptake of telemedicine and telehealth-care services.

We have considered the projected role of the Australian National Broadband Network (NBN) in the context of this study, on the assumptions that:

1. The NBN will connect homes and small businesses, 93% of which don't have this level of access today.
2. The NBN will provide a ubiquitous and common platform.
3. The NBN will offer a much greater upload speed than is currently available to most broadband connected homes in Australia, which will change what is happening in the home and how information becomes available from the home.

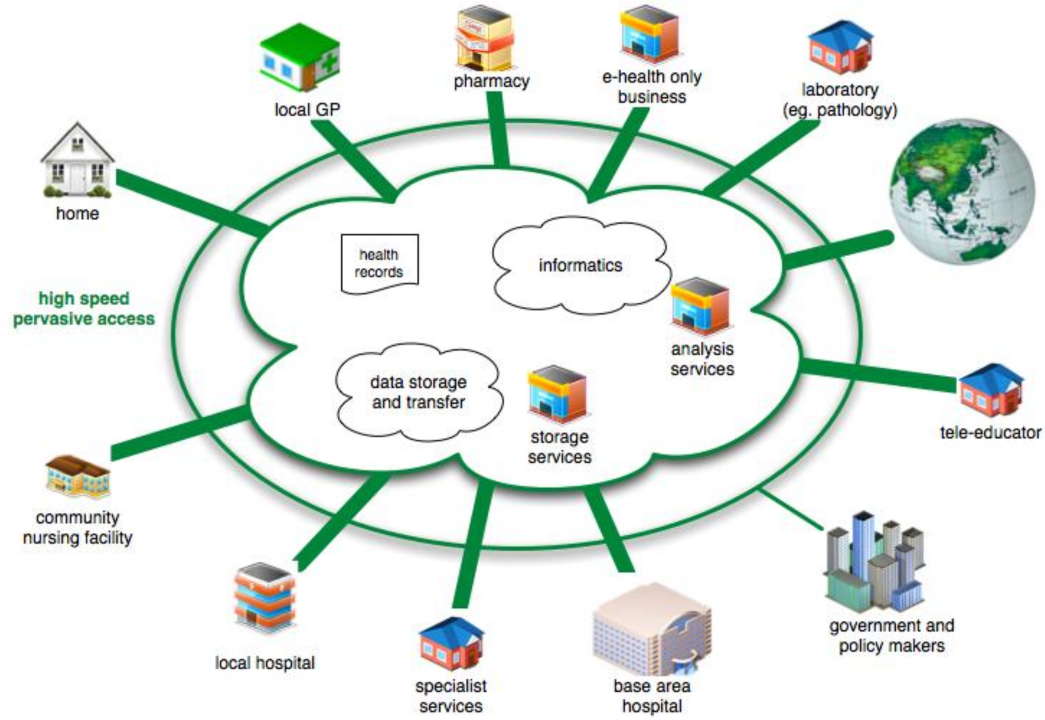

Figure 3 Components of an e-health system in the context of a high-speed broadband network

For the **functional** breakdown we have used standard definitions from the literature.

The **technologies** breakdown is based on the technologies that can largely be addressed independently when delivering a service.

The breakdown into different categories of **barriers** is more difficult to delineate. We have focused on a breakdown into barriers according to the major needs for addressing them, and the likely time frame over which they can be addressed. We have tried to avoid aligning the barriers with the technologies, or with the functional breakdown, to avoid simplistic associations that turn out later to be only part of the challenge for each.

We have used this framework to identify the extent to which the NBN addresses the barriers identified, in being one of:

1. **Critical** to addressing the barriers,
2. A **driver** for overcoming the barriers, or
3. A **catalyst** for tackling the more fundamental underlying issues.

This analysis has been used to identify what steps we should take now to best capture the opportunity offered by the rollout of the NBN for telemedicine and telehealth-care.

2.4. Functional breakdown

We have adopted the functional groupings of CITL (Centre for Information Technology Leadership, 2007) which encompass the aspects of health care associated with telehealth.

2.4.1. Tele-consultation

"Real time (or synchronous) telehealth involves 'live' consultations in a wide range of specialties ranging from dermatology and cardiology to psychiatry. Consultations may occur between medical professionals and patients, or among teams of medical professionals with or without patients - for example, between a GP and a specialist."

2.4.2. Store-and-forward

Store and Forward (or asynchronous) telehealth is the transmission of medical data - such as echocardiograms (E.C.G.s) or photographs of skin lesions, blood glucose levels, and x-rays - for remote diagnosis.

This includes other data-intensive services, such as sending Magnetic Resonance Images (MRI), or Computer Aided Tomography (CAT). In the case of GP-to-specialist teleconsultation, there may be an additional requirement for store-and-forward support for large data files. Such an arrangement might reduce or remove travelling time for specialists and other practitioners. Equally important is after-hours access by practitioners to such data from home, which could significantly change workloads and processes, as it has in many other professional fields.

2.4.3. Tele-homecare

Tele-homecare, or remote monitoring, is the transmission of medical data for disease and injury management and prevention. Examples include monitoring of patients undergoing dialysis, remote fetal monitoring, or support and care to elderly people with chronic conditions living at home.

This includes cases where carers tele-visit to provide social contact and check on health for the elderly in remote or isolated locations.

2.4.4. Tele-education

Tele-education is the transmission of medical information, either for the training of health professionals or to assist members of the public to self-manage their health, including tele-triage.

This includes live video seminars, workshops and coaching.

3. Case studies

A large part of this work involved evaluating international and Australian case studies and trials in telemedicine. The studies were taken from peer-reviewed academic literature, online reports and interviews. Full summaries of the studies are given in the appendices.

The studies have been broken down into functional types (as outlined in section 2.4). Part of the analysis involved extracting the barriers to adoption that were experienced in the studies, and the key technologies that were trialed in support of each study.

The following sub-sections give a summary of the state-of-the-art both internationally and in Australia.

3.1. International case studies

Appendix 2 contains a complete summary of the international case studies reviewed. This also includes the identification of the key challenges and enablers that we used to classify the key technologies and barriers for our analysis.

In considering the international case studies, we also evaluated the underlying care delivery model. Participants in our workshops cited Canada as being a comparable overseas model to Australia. However, we did not restrict our case studies only to those operating in a similar context to Australia.

There is a wide variety of telehealth across the world. The most advanced implementations (e.g. UK National Health, Kaiser Permanente in the US) have operated as the result of government strategy, whole-system payment (ie. alignment of beneficiary and cost-bearer) and either pre-existing or self-deployed network technology. Barriers to telehealth adoption or diffusion have been considered in the academic literature of the United States through the late 1990's, for example (Sanders & Bashshur, 1995) (Tanriverdi & Iacono., 1999)

3.2. Australian case studies

Appendix 3 contains a summary of the Australian case studies we reviewed. This also includes an identification of the major challenges and enablers that we used to classify the key technologies and barriers for our analysis.

There have been several studies in Australia that have addressed "state of the art". The most comprehensive appears to be the work of John Mitchell and Associates, which was prepared for the (then) Department of Communications, Information Technology and the Arts in 1999. More recently, Price-Waterhouse-Coopers have evaluated the state of telemedicine in Australia, with emphasis on Victoria (Victorian Health Service Management, Innovation Council, Telemedicine in Victoria 2007).

There are several hundred telehealth activities across Australia. For example, NSW has 270 facilities and QLD has 656 video conferencing sites. More than 100 telehealth centres currently operate in Western Australia (most of which are in the southern and western regions). Telemedicine in Australia appears to be quickly adopted in the public system where payment is possible, and where the technology is "fit for (clinical) purpose" and supported by existing infrastructure and respective jurisdictions.

> *The use of higher-level telecommunications has become almost a standard part of the functioning of the health system in Australia.*
>
> (National Rural Health Alliance, 2005)

In 2000 there were more than 175 active projects in telehealth in Australia. The Australian component of the conference “Successes and Failures in Telehealth” is becoming a reference point for “state-of-the-art” in telehealth in Australia.

A number of interviewees highlighted the impact of broadband to the home in terms of its attractiveness for a remote or rural health workforce. This factor of “workforce happiness” appears to be quite significant.

> *Good telecommunications — at work and at home — will become as crucial to maintaining the health workforce’s willingness to serve in rural communities as it is to the functioning of rural businesses, large and small, and the essential social support of rural communities.*
>
> (National Rural Health Alliance, 2005)

There is an expectation across (more recent) Australian case studies that the NBN implementation will allow health care providers to focus on their core business, rather than developing ICT (network or device) solutions in-house.

> *A key benefit of the proposed NBN implementation is cheaper and increased communication capability for the health sector to support electronic health, teleheath and eReferral. It is expected that there will be substantial reduction in costs in this area for the health sector.*
>
> (GRHA, 2010)

3.3. Technologies and barriers identified from case studies

Our analysis was based on reviewing the results of trials and case studies addressing four widely recognised functions of telemedicine as shown in the central **"Functions"** column in Figure 4 below. We identified seven main types of "**Technologies"** that are core to enabling telemedicine, and seven categories of "**Barriers"** that are constraints to its uptake, as also shown in the figure below. The following sections give a more complete description of these technologies and barriers, and the extent to which they were critical factors in the cases-studies.

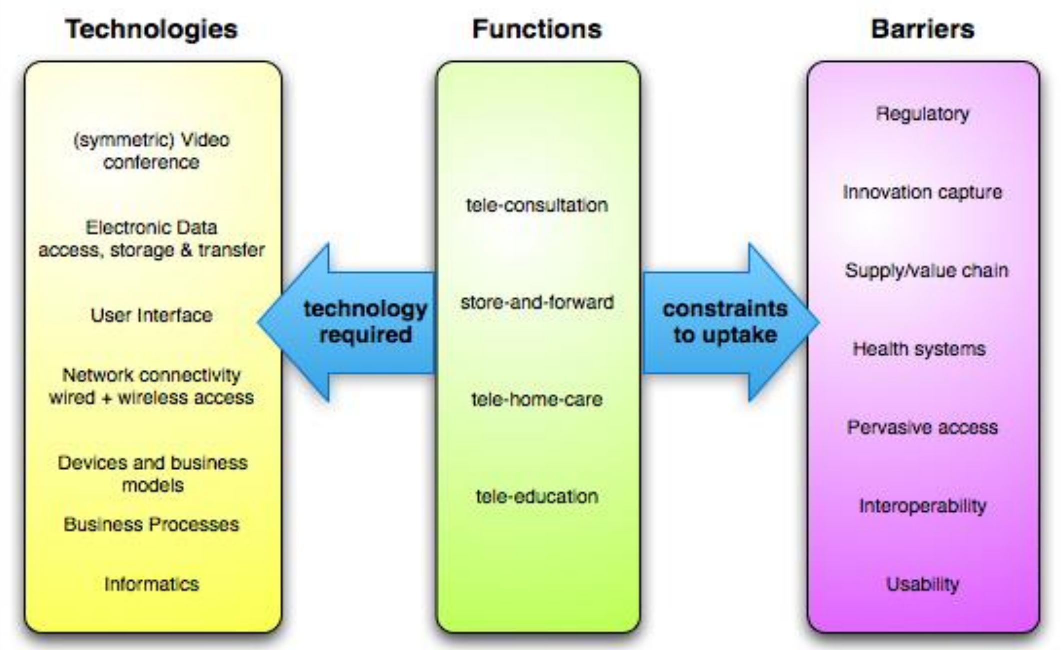

Figure 4 Technologies, Functions and Barriers for telehealth. Technologies listed are those supporting roll out of telehealth services, Functions are from (CITL: Centre for Information Technology Leadership, 2007) health-care functions and Barriers are derived from the literature, interviews and workshop input.

4. Technologies supporting telemedicine

This section summarises the technologies needed to support telemedicine, and expands on the underlying requirements for each technology, the extent to which these requirements have been met in trials, and the potential impact of the NBN for meeting them.

4.1. Technologies used in reported telemedicine case studies

Table 1 Technologies supporting telemedicine

Type of Technology	Description	Underlying technical Requirements
(Symmetrical) Video Conference	Video conference technology, which requires symmetric data links (uplink speed equal to downlink speed). Quality of care is linked with "quality" of video conferencing to varying degrees for different applications.	**Bandwidth** Symmetrical bandwidth is critical for videoconferencing, and supporting the required resolution and framerate for video. The resolution and framerate achievable depends upon the bandwidth and also the coding of the video stream. **Latency** Low latency and minimal variation (jitter).
Electronic data, access, storage and transfer (e.g. eHealth records, PACS)	Stored data, which may be moved and accessed across the network, in similar, though more secure, manner to data traffic across the internet.	**Timeliness** The effectiveness of the data transfer increases with increasing bandwidth, as large files become transferable. **Architecture** Web services, software as service.

User interface (interactions, ser interface (interactions, visualisations, haptic)	The design of how clients and professionals use the technology devices, tools, networks and other system components. For home-based monitoring this is typically focused on simplicity of operation (usability), such as ensuring single functions for buttons and clear indication of what to do next. For professionals the interface supports clinical needs and efficient workflow, and typically involves clear indications of process and status.	**Bandwidth** Remote clinical training requires high bandwidth links, and also in many cases low-and-constant latency. **User Interface Design** Ease of use is critical, particularly for patients. It is important that the interface design accommodates work practices of the professional with minimum changes to work flow and process.
Network connectivity (Wireless and/or wired network access)	This ensures a user has access to data, services and applications of interest independent of place and time, and of where the data, services and applications are located. This includes wireless access to remote or mobile locations both within and outside the clinical setting. This also covers network-to-network connectivity, e.g. from one wide-area-network to the network within a hospital or care facility.	**Bandwidth** Must be adequate for the application and the number of users needing service simultaneously. **Network Management** Seamless access is needed to ensure administrative boundaries are invisible to authorised users. Security and trust support is also needed to maintain privacy while preserving ease of use. Users must trust the system is secure.
Business Processes	Accurate models of the workflows and patient journeys of the health system.	**Architecture** Telehealth systems must integrate into existing supply chain processes and system architectures. **(Business) Process Modeling** Ability to capture essential features in a healthcare environment's business processes.

Devices and associated business models (services, consumables)	Clinical tools relevant to practice, e.g. remote stethoscope for telecardiology, handheld devices and cameras for remote consultation.	**User Interface Design** Simplicity, clinical applicability (in context) and cost. **Device Technologies** Reliability, availability and clinically appropriate.
Informatics (mining, analysis, visualisation of data)	Health informatics is the "smarts" behind e-health. This includes ontologies for describing data, algorithms for mining and analysing data, and visualisation of data for experts and non-experts	**Architecture** Architectures that support access to standardised or aggregated data sets, such as web-based service oriented architectures. **User Interface Design** Ease of use and trust that data is used appropriately.

The table above summarises the underlying technical requirements for each of the technologies identified as critical to telemedicine. It should be noted that most telemedicine functions require combinations of these technologies, and so the overall technical requirements have to be aggregated. It is not sufficient to identify, for example, the highest bandwidth needed for one of the technical requirements and then expect to be able to achieve the telemedicine function with only this highest bandwidth requirement. Similarly the architectures must co-exist and be part of the overall service delivery architecture without impeding any one component. This “systems level” design and engineering is critical to consider in any trial and its planned pathway to deployment.

These explanations and technical requirements are expanded below. These expanded descriptions are not intended to be encompassing or exhaustive, but rather clarify and give examples that illustrate the requirements. The purpose of this is to determine the impact of the NBN on meeting these requirements and hence enabling greater uptake of telemedicine.

4.1.1. Symmetric video conferencing (bandwidth and latency)

Bandwidth

Video streaming systems operate at a variety of rates depending upon bandwidth and quality trade-offs. The fundamental requirements for clinical applications are the fidelity, quality and reliability of the (often multiple) video and audio streams.

For video-conferencing, the perception of telepresence is a key indicator of medical benefit (not simply video conferencing). Further, voice fidelity is an important consideration for telepresence: poor voice quality, especially coupled with high latency can render systems unusable in a clinical setting. Several workshop participants noted the primary use of voice (over video) in many teleconferencing functions – temporary loss of video may be tolerated, but loss of voice is unacceptable.

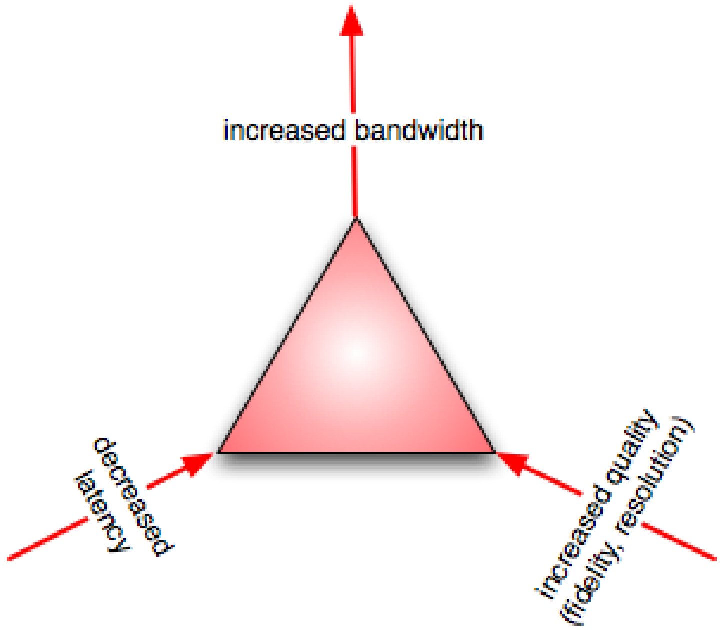

Figure 5 Video-data triangle. For a given video stream, it is possible to trade bandwidth, latency and quality, but not to arbitrarily reduce any one of the factors.

Fidelity is closely related to the bandwidth and also the latency specification of the network, and the video compression used. It is possible to trade latency, quality and bandwidth: one can reduce latency and/or increase quality but only at the cost of increased demands on bandwidth. Conversely, having large amounts of low-cost bandwidth allows very low latency and high quality video interaction. As telemedicine systems are designed to more closely support clinical needs, the NBN will underpin the inevitable increase in aggregate bandwidth needed.

There are very few studies addressing the minimum or maximum clinical requirements for video (although some standards exist for medical imaging). As yet, it is not determined what video specification is necessary for each clinical (or non-clinical) application. It is also not clear at what point "enough bandwidth" provides sufficient fidelity. The following studies provide a range of bandwidth suggestions.

- (Cooeenet@qld, 2009) has suggested bandwidths from 10Mbps to 100Mbps network connectivity will be needed for health applications, such as team-to-team video conferencing with data support.
- (NBN Co, 2010) suggested broadband speeds of up to 100Mbps for telemedicine – with applications such as high definition, 3D video consultation and education.
- (Wilson, 2010) outlined applications of high-bandwidth video conferencing, using a 720x520 pixels, 48kHz CD quality audio, and 70Mbps user initiated video stream[1]. In this experimental setup the video was compressed frame-by-frame

[1] Three simultaneous high-definition video channels were supported

(no inter-frame compression or motion prediction was used). It would be possible to reduce this bandwidth requirement if modern video codecs were used, however, latency may still limit how much compression is possible.

- (Queensland Health, Clinical and Statewide Services) evaluated desktop video conferencing over ISDN, no minimum requirements were given and the context was varied clinical care.
- (Song, Chan, Smith, & Watson, 2002) evaluated ultra-sound video under clinical conditions between the Mater Mothers' Hospital and Kirwan Hospital for Women in Queensland (1,500km). A minimum of 1.52Mbps were needed for fine detail (diagnostics).
- (Cuzzani, 2000) evaluated bandwidth requirements for ophthalmology images and video. They found that a T1 network (1.5Mbps symmetric) operated "well" and network speeds below 0.5T (750kbps) were inadequate.
- High bandwidth for remote viewing is not always essential: (Sharyn Crowie, 2009) demonstrated IP security cameras, operating at 12fps, to provide remote imagery of patients in emergency departments.
- During a 1-day workshop to evaluate the clinical usefulness of videoconferencing, desktop video (700kbps) was typically sufficient, although some clinical comments suggested 10Mbps was necessary. (Steele, 2010)

Cited examples and discussions with workshop participants showed that video communications of widely differing quality, type and bandwidth had been clinically useful. This may be because different fields of clinical practice have different needs[2], but may also be partially explained by advances in technology leading to higher fidelity using less bandwidth, or "ground-up" innovation where many different kinds of technology are being used as needed. It may also be driven by what is possible. For example, in rural settings the cost of even modest bandwidth is prohibitive, so clinicians learn to use what is available.

Feedback from clinician workshop participants and several other sources, however, has emphasised the close relationship between quality of care decisions and video quality. The ability to extract vital functions from high quality video was given as an example of how new modalities will emerge as the technologies improve. There was a strong consensus from such clinicians that high bandwidth communications is a disruptive technology that will bring about radical changes in health care practice, and that extrapolating from current practices will address only a small part of the potential gains to be made.

It is also becoming increasingly clear that geographic hubs (such as hospitals) may have many (e.g. dozens or hundreds) of simultaneous video consultations. This means that the aggregate bandwidth demanded will be many hundreds of megabits or even gigabits per second. Such rates require fibre infrastructure such as the NBN.

[2] Discussions with surgical clinicians made the point that current video conferencing was useful for discussions among clinicians but was not useful for examining patients. The distinction arises because important clinical evidence that was needed to confirm diagnostic hypotheses relied on the sense of touch. Video was rarely used during surgery, although telephony often was.

Given the variations in video quality used for telemedicine in Australia it would be useful to study this further to obtain more consistent baseline information. This baseline would characterise video requirements against clinical scenarios.

Latency

Latency is a measure of time delay experienced in a system. In packet-switched networks, applications such as video-conferencing or online games have latency requirements around 100ms. Latency and bandwidth combine to produce "quality" scores such as the R-factor (Fluke Networks, 2010). R-factor relates to voice quality over a packet-switched network. Global Services (Global Services, 2006) recommends the following:

Table 2 Latency requirements for videoconferences

Parameter	Value
Packet Loss	< 0.1%
Packet Latency	<= 100 ms
Packet Jitter	< 40 ms

This type of demand highlights an important issue – having a broadband network infrastructure is a necessary but not sufficient condition for achieving high bandwidth and low latency. The layers above the core infrastructure must be developed and trialed with real applications and real traffic to ensure the network management protocols and other components of a ubiquitous and heterogeneous network that likely manage traffic across hybrid fibre, copper and wireless systems support the necessary parameters for the application. This in turn raises the need for early test-beds for such applications.

By addressing both the bandwidth and latency needs, the NBN should enable high quality symmetrical videoconferencing. This is a critical enabler for telemedicine.

4.1.2. Electronic data access, storage and transfer

(CITL: Centre for Information Technology Leadership, 2007) showed that e-health approaches that use store-and-forward (either by itself, or in addition to video conferencing) are beneficial compared to approaches that only used video conferencing.

Data transfer is a critical component of most telehealth case studies. Almost 60% of the Australian references cited data transfer as one of the technologies used. The work of (Bashshur, et al., 2009) shows that a combined telehealth and electronic records approach is essential to achieve the impact and cost savings hoped for in e-health. Discussions with several surgeons indicated that 80% of a diagnosis could rely on the patient history, emphasising the importance of ongoing access to stored records.

Bandwidth

The effectiveness of data access, storage and transfer increases as bandwidth (and therefore the achievable level of image/video fidelity – including resolution, dynamic range and frame-rate) increases. The increasing fidelity supports more accurate diagnoses. Larger bandwidths also accommodate diverse services: high-bandwidth links allow large files to be processed remotely using automatic data analysis (e.g. cloud services) and/or remote backup (storage). High bandwidth provides:

- Faster up/download of individual files
- Removal of barriers to sending and receiving "large" (giga- or tera-byte) files
- Ecosystem of (remote) analysis and storage for large files, without requiring local IT support.

These factors strongly demand a high upload bandwidth (in addition to typical high download bandwidths).

The NBN is a clear requirement for fast and accurate transfer and storage of high-resolution images from the increasing range of imaging technologies being used. Access-on-demand to such images for ongoing diagnosis requires high bandwidths across the network.

It should also be noted that the existence of a high bandwidth NBN upload capacity to small premises could enable the development of specialised e-health service businesses at scales much larger than current practice, with commensurate efficiency improvements. Such businesses could outsource aspects of the analysis of data to external (e.g. cloud service) applications.

Architecture

Appropriately designed network system architecture, data-interface architectures and software-service architectures will allow free flow of information across the network, and also between multiple existing networks. These will also support IT architectures which can adapt to new health business processes. This is crucial to achieve the "anyone, anywhere" access paradigm of telehealth. This access means that professional health knowledge is not constrained by real or virtual barriers within the network – thereby reducing the barrier to applying this knowledge to improved clinical outcomes. The broader requirement of "the right information, in the right place, at the right time" emphasises the need to address the architectural issues on a systematic, network-wide basis.

Without an appropriate architectural approach, a large high-bandwidth physical network becomes fragmented into multiple, disparate (real or virtual) private networks, limiting the scalability of telehealth.

Key aspects of architecture likely to be needed include:

1. Web-based services and Software as a Service:
   Web-based services are likely to become increasingly important for scalable access to data, of private or public nature. *"Software as a Service (SaaS) is a software distribution model in which applications are hosted by a vendor or service provider and made available to customers over a network, typically the Internet"* (Search Cloud Computing). SaaS was implemented in the Australian RPDE case study: Rapid Prototype Development and Evaluation, Electronic Health Records.

2. Data interface/interchange and translation
   "Electronic data interchange (EDI) is the structured transmission of data between organisations by electronic means. It is used to transfer electronic documents from one computer system to another, i.e. from one trading partner to another trading partner." (Wikipedia-EDI, 2010) As an example: NEHEN is a consortium

of regional payers and providers who have designed and implemented a secure and innovative health information exchange for reducing administrative costs and improving the quality, safety, and efficiency of patient care. (NEHEN)

3. Network topology and access
The topology of the network refers to its physical layout – which points are connected to which other points. Network access refers to the allowed use of the network (e.g. whilst an institution may have one or more wide-area-networks, the use of local VPN(s) or similar prevents users moving between those networks or using applications which are relevant and connected physically, but blocked administratively. In the Australian RPDE case study, there were multiple databases, distributed geographically and with intermittent connections. The data needed to be transferred across multiple security portals, and (in future developments) may be sent partially via Internet from overseas. This requires substantial attention to (real and virtual) network topology and access to ensure effective systems.

While the need for the NBN for high bandwidth image and other data transfer is clear and well understood, it is less widely recognised that the NBN also offers an opportunity to take the coherent approach to architecture needed to underpin effective electronic data access, storage and transfer.

4.1.3. User interface

This technology factor relates to the human-computer interface. The design must accommodate the work-practices of the professional user, and the context of the client user. When work practices must be changed to accommodate new technology, the new technology is less likely to be widely adopted.

This technology factor rests on user interface design and bandwidth. The design of user interfaces is critical where there are clinical devices attached to the end of networks – examples include remote monitoring, handheld cameras, and remote stethoscopes. In most cases the aim is for remote devices to change the clinical process as little as possible.

User interface design

“Human-computer interaction (HCI) is the study of how humans interact with computer systems. HCI is a broad term that covers all aspects of the way in which people interact with computers.” (Stone)

Good user interface design aims to make the user's interaction with a given system as simple and efficient as possible, and maintain current work practices as much as possible. One interviewee remarked, “It needs to work at night, when I’ve got gloves on and only use two buttons”. Clinicians do not have the time or resources to operate complex interfaces – the system must be intuitive and designed for the context in which it operates. In short, it must be a dependable tool.

This requires structured task analysis and modeling, supported by user modeling, in the design of interfaces for both the patient and the professional. Typically it also requires monitoring and analysis of users participating in trials according to well-established processes to support user-interface design.

Bandwidth

For remote clinical training – e.g. simulating a surgery from a remote workstation – real time feedback of video streams and haptic[3] or other specialised sensor outputs are required. This kind of application relies on high bandwidth, low latency networks – since the learning experience is more than simply demonstrating examples the user must be convinced that he/she is experiencing a real surgical operation, in order to appropriately absorb the clinical knowledge, (Stevenson, 2010). For haptic devices, both low latency and very low jitter (constant latency) are required for the effect to be convincing.

- (Wilson, 2010) used a 10Mbps link for haptic feedback and corresponding video conferencing to simulate auditory canal operations for clinicians who had some skill at surgical drilling, but no experience on human auditory systems.
- (Hahm, 2007) demonstrated a 60Mbps link which accommodated 4 endoscopic surgeries while simultaneous video conferences shared the link, all with 30fps and delays below 0.3sec.

There is also significant scope for remote education – for example medical education at home – to require large bandwidth, low latency network support. Examples include 3D immersive, virtual environments that provide explanations of medical procedures, or health advice.

4.1.4. Network connectivity

Network connectivity refers to whether (or not) a user has access to the network. It is particularly relevant toward the "tails" of the high-speed network. At the tail, users may require wireless access – for mobility or due to distance from the nearest fibre access point. Due to the variable nature of the tail of the network, and the presence of multiple private networks, both (minimum) bandwidth support and network management are important (Paolini, 2009). An example of what can go wrong would be a physician attempting to consult after-hours from home but not being able to reach the hospital's internal network because there is no VPN access allowed or enabled.

Bandwidth

From the user's perspective it is also important that the network has sufficient bandwidth for clinical needs, and to allow traversing of any intermediate networks and administrative boundaries to reach the service or information required.

Some workshop participants noted that wireless networks that support video have enormous potential for increasing the direct interaction of patients, for example, use for wound care consultations or palliative care consultations. At least one clinician participant was already using wireless video telephony as an integral part of clinical work practices. Overall bandwidth requirements depend on the clinical need, but any reduction in realised bandwidth, due to managing across network protocols, must be characterised and taken into account.

Network Management

Network management comprises systems and tools that include administration, maintenance and provision of the network. For the purpose of this work, it refers to the ability of a given heterogeneous network, one with high-speed fibre-to-premises and

[3] Haptic devices provide tactile interaction.

various wireless access speeds, to appear to be a single network with a common access mechanism, so that the physical connection of the network to the user becomes invisible. For the user, this also means the connection to the desired service (e.g. video conference, file access) is seamless and automatic.

Effective network management requires network access control, Quality of Service (QoS) provisions and the ability to diagnose and respond to network faults.

It also requires support for specified levels of security and trust to protect patient privacy and confidentiality of data, and to allow professional access to required networks according to pre-determined levels of trust or security.

One prospective advantage of the NBN is that in providing close to 100% coverage, through a combination of fibre backbone and wireless and satellite tails, the network performance obligations will be managed by the one wholesale provider. This greatly simplifies the requirements on individual organisation IT departments to manage the complex set of issues associated with managing access over heterogeneous networks within defined performance criteria.

4.1.5. Business processes

Business process modeling "is the activity of representing processes of an enterprise, so that the current process may be analyzed and improved. BPM is typically performed by business analysts and managers who are seeking to improve process efficiency and quality." It incorporates "change management" which is the means by which improved processes are put into practice (Wikipedia-BPM, 2010).

Business process modelling has been a critical part of transformation of many services to electronic practice. Typically it involves modelling the processes for delivery of a service, developing reference architectures based on these models to allow a move to electronically based services, and templates to allow easy uptake of such services. These architectures and templates must provide data and network access under defined security and privacy conditions.

In the healthcare setting the patient journeys and professional work-flows are complex, often highly interrelated, and influenced by jurisdictional boundaries. The supply chains operate with value chains that include private and public sector processes, with funding interventions in both, making change complex and multi-faceted.

4.1.6. Devices and associated business models

The physical devices used by consumers, patients and practitioners of an e-health or telemedicine system are critical for effective care delivery. The devices may be designed for purpose – as is the case for assistive technologies or hand-held cameras -- or generic such as mobile phones used for mobile and remote video-conferencing. The design and cost of the devices play a significant role in the uptake of telehealth, particularly for home care. Typically, due to the rigorous regulatory compliance standards and extreme operating conditions, health specific devices are significantly more expensive than their consumer counterparts and typically have lower functionality

User-interface design

The device is often the primary interface to the user, either patient or health-care professional. This means that the user-interface design is critical to the effective use of the device. Device user-interfaces require task-oriented design, based on understanding how a defined user is expected to, and will, interact with the device.

Device technologies

Device technologies often involve not only the device itself, but also related services and consumables. Devices may need to be able to measure or predict the lifetime of consumables, or detect if they are being used incorrectly. They must also be able to operate reliably over a range of operating conditions, often including water immersion and temperature ranges outside normal consumer device ranges.

4.1.7. Health informatics

Health informatics is the science and practice around information in health that leads to informed and assisted healthcare (Health Informatics Society of Australia, 2010). We consider health informatics to be the "smarts" behind the mining, analysis, visualisation and distribution of health data.

There is huge potential for health informatics to spawn new business processes, and ecosystems of meta-data analysis, as well as enabling improved health outcomes. This is beginning to occur in the US Veterans Affairs system and has been proposed within the Australian RPDE pilot EHR system.

> *"The smart use of data is, and should be, at the very core of a self-improving system. That is the vision. But the current reality is quite different."*

www.yourhealth.gov.au "Smart use of data, information and communication."

In the US Veterans Affairs system electronic data is available for open research (US Dept. Veterans Affairs, 2010), and mining of clinical outcomes is providing proof-of-efficacy for pharmaceutical products.

> *"The bet here is that the thousands (and I do mean thousands) of data sets that HHS [US. Dept Health and Human Services] maintains could actually support some useful applications – applications we can't even imagine yet – in the same vein that the weather data produced by the National Weather Service generates so many services and businesses [...] The difference here is that HHS is planning to make access to the data easy and [...] lend themselves to application development."* Craig Newark, developer of "Craigslist", from (e-patient, 2010).

Similar activity has appeared in Australia in the form of so-called "Mashups" of the Australian Bureau of Statistics (Cornish, 2010). This is a significant trend – one workshop participant was involved in a project which did data-mining on thousands of patients' biochemical lab tests a major Australian Hospital to help predict adverse events automatically. That type of analysis can make enormous differences to patient outcomes, and can be expected to play an increasingly important role in future.

Another trend highlighted by an interviewee is the potential to use automated text-mining tools to access case-study information, to search out cases similar to any particular one being diagnosed. The rate of production of clinical case studies published globally is vastly greater than the ability of clinicians to read them all, but automated methods of capturing a small number of relevant ones to review in more detail could be highly significant.

Architecture

The challenge for effective health informatics is designing architectures for access to data, models and tools that allow different users to access these for different purposes. Such approaches also need to ensure the availability and integrity of tools and models providinig standard functions for analysis and visualisation, and also ways of testing the data to which people are applying such tools to ensure statistical significance, effective calibration, benchmarks and reference data sets. Web-based service oriented architectures are likley to emerge as the standard way of accessing such data, with supporting biostatistical, text-mining and other tools.

User-interface design

A significant part of health informatics is the visualisation of analyses and other derived data in the context of measured data. This requires consideration of the effectiveness and standardisation of the visualisation tools, in terms of avoiding artifacts of the display process and ensuring alignment of perceptual variables with data variables. It also requires that the user-interface within which data are viewed is designed appropriately. This also applies to the user-interface for the access to data, models and tools to support appropriate selections of tools and clarify limitations.

4.2. Analysis of technology use in reported telemedicine case studies

As part of our analysis we examined Australian and international case studies and where possible evaluated which technologies were considered in the case study. We separated the Australian and international cases (the majority of which were from the United States) to determine if there were any significant differences between these groups. For each study, we allocated a value (0,1) as to whether (or not) the study used a particular technology.

Many studies involved multiple technologies. No weighting for choice of technologies or emphasis of the technology within the case study was applied. We did not include a category “other” for technologies. Of the reports reviewed, every one cited at least one of the listed technologies.

Figure 6 shows the results of this analysis, identifying the major differences between Australian and International case studies. The percentages give the number of studies that used a given technology, relative to the total number of studies reviewed.

Overall, Australian studies more often focused on evaluation of off-the-shelf technologies[4]. International studies often considered custom-designed applications focusing on informatics and higher-level data analysis.

Particularly for the EU and US, International studies appear to have “moved on” from testing videoconference requirements or data-interchange techniques, and are now focusing on informatics and “higher level” data analysis. In several EU and US studies, high bandwidth video conferencing is assumed.

[4] There are some notable exceptions such as the ViCCU project described in the appendix which was purpose-built around clinical needs

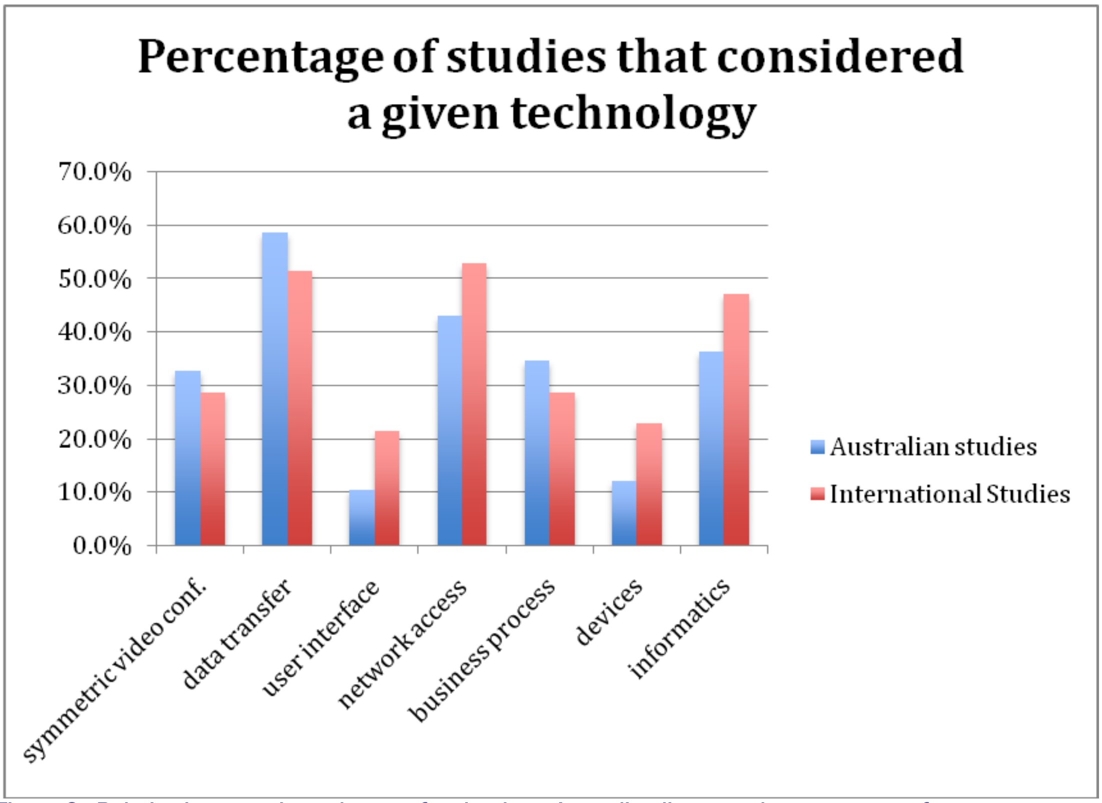

Figure 6: Relative interests in each type of technology. Australian literature has put greater focus on videoconference and data transfer than the international literature. Internationally there is less emphasis on videoconference and data transfer.

This analysis also revealed that:

1. Data transfer, network access and informatics are all high scoring: these technologies are found in a large number of the studies.

2. Australian studies tended to be more interested in video conferencing, data transfer and business processes than international studies. International studies tended to be more interested in user interface, network access, devices and informatics. This may be due to the eHealth research field being relatively more mature in the United States and Europe compared to in Australia.

3. In the Australian studies reviewed, the dominant focus was "demonstrating that it worked." Internationally this was also important, but there was an additional component of custom-designed health data analysis that was not as strong in Australia. This may also be due to the (large) volume of freely available health-record data in the US.

4. The US studies that did focus on demonstrating effectiveness of video-conferencing were either from before 2002 (i.e. older) or were literature reviews of many hundreds of case studies.

5. Barriers to adoption

Through the two workshops and our analysis of the literature we have found the following main barriers to adoption of telemedicine:

- Regulatory
- Innovation Capture
- Supply/value chain
- Health systems
- Pervasive access
- Interoperability
- Usability.

In the Australian case studies that we reviewed, there were 136 references to barriers in our test set. Internationally there were 171 references to barriers in our test set. In our workshops and interviews we have found general agreement that:

1. The barriers are often inter-related.
2. Many of the barriers are related to the complex, dynamic and human-centric nature of the health system, and are not unique to telehealth.
3. In addressing the barriers, telehealth should be treated as part of health innovation, and health as a whole, not as a separate component.

5.1. Barriers to adoption in reported telemedicine case studies

Our review of case studies, interviews and workshop discussions led us to identify 7 types of barriers to telemedicine adoption that had been experienced. These barriers are described in Table 3 below, and key issues and factors affecting each are identified in more detail in this section.

Table 3 Descripton of barriers to adoption for telemedicine

Barrier	Description
Regulatory	Barriers due to policy or regulation, including lack of support for billing, inability to charge fee-for-service, difficulties across jurisdictional boundaries, and cost/beneficiary mismatch
Innovation capture	Trials undertaken have lacked defined pathways to deployment of innovative results into sustainable and nation-wide programs or services.
Supply/value chain	Existing business models, including supply and value chains, under which the health care system operates, pose a barrier to new telemedicine based models.

Health systems	The lack of standard processes across health systems to reduce administrative burdens, improve quality and increase efficiencies, resulting in inefficiencies and barriers to the uptake of new practices.
Pervasive Access	The lack of connectivity between patient, care provider, service provider, and major facilities, on a pervasive basis, including mobility and remote and isolated location access.
Interoperability	The inability to interconnect to access or deliver services and data as needed across all networks, systems, and devices, while meeting required standards for reliably, security, etc.
Usability	Problems of devices or technology solutions not being effective (fit-for-purpose and aligning appropriately with work-practices) and efficient (easy to use and learn).

5.1.1. Regulatory

We have considered barriers that relate to policy or regulation, including billing issues, as "regulatory". The grouping was tested at both workshops, and the barrier seemed well understood by all participants. 53% of the references found from Australia, (46% International), suggested regulatory and (within that) billing as a barrier to telehealth.

Billing

Many interviewees and workshop participants highlighted the concern that without resolving billing problems in a uniform way (e.g. MBS item numbers in Australia for services outside the public health system) telehealth uptake will remain limited. Currently in Australia there are MBS item numbers for some telemedicine services, such as psychiatry, and related privacy and other barriers appear to have been overcome. There have also been trials (for example in Western Australia) where special arrangements have been put in place for the trial, suggesting that this might be a viable approach for trials if such changes can have a path to adoption under broader deployment. It appears that resolving this billing issue fully requires evidence of efficacy in a national setting. (Hersh, 2001) (Gosewinckel, 2009), also highlight the need for defining pathways to deployment that include addressing the billing issues. This emphasises the need, discussed later, for all participants in the health system to be involved in planning the pathways to deployment in coordination.

Jurisdictional

Jurisdiction issues and liability issues are untested in Australia (Milstein, 1999) and lead to non-optimal telemedicine practice (CTEL).

In order to scale, the application of telehealth must cross jurisdictional boundaries. The barrier is the cost (time/effort/expense) in developing approaches which address multiple local legal and regulatory requirements.

Mismatch between beneficiary and cost-bearer

When the cost of installing the infrastructure needed for telehealth is borne by a clinic, but that clinic does not derive additional revenue or other benefits from that cost, there is little incentive to invest. There is, however, a clear benefit to the community from improved access to the service. Where the case study is effectively closed with strong alignment of beneficiary and cost-bearer (e.g. Defence, Veterans Affairs and Kaiser-Permanente), telemedicine is becoming sustainably adopted. This is evident from the following case studies:

- US Kaiser Permanente (teleconsultation)
- US Veterans Affairs (teleconsultation)
- Australian Navy (teleconsultation)
- Australian RDPE (store-and-forward)
- Australian Baptist Community Care (telehome-care)

The infrastructure for telehealth is typically an overhead. Given a choice between investing in a long-term ICT project that may result in national benefit, against investing in clinical equipment with known local benefits, the choice is inevitably the latter.

The cost-bearer / beneficiary mismatch also highlights that telemedicine introduces changes in work practice for which the supply chain models are not yet established. For example, telemedicine can increase a clinician's workload without any inrease in remuneration, so why should he or she support it? On the other hand remote imaging lets a specialist provide urgent out-of-hours interpretation from home, avoiding excessive call-out and travel time.

Overall, the regulatory barrier can suffer from a "chicken-and-egg" problem: for example, it may not be possible to develop MBS funding or item numbers without a national proof of efficacy, and it is difficult to encourage large scale proof of efficacy without evidence of funding.

In one workshop, we observed that when a chain of champions was available, this "chicken-and-egg" problem could be partially addressed.

As an example, with representatives from DoHA, DBCDE, clinicians and CIO's from multiple jurisdictions present, the observation that MBS billing was a barrier (clinical observation), was combined with the observation that proof of efficacy on a national scale is needed (DoHA observation) and that network funding potential existed (DBCDE observation) and that appropriate support was available from Chief Information Officers (CIOs) in two regional centres. As a result, a proposal was formed that considers an inter-operable teleconsultation video-conferencing network to operate on a national scale.

This report makes no comment on the merit of the proposal, but rather highlights that with an available group of champions from clinicians, through CIOs through to government, it is possible to build momentum. We include the proposal "Proposal for interoperability for Video Conferencing" as an attachment.

These factors point to a need for government coordination in addressing both these issues. Outside closed systems such as those identified above, public investment in the infrastructure is needed (ie the NBN, including the layers above the basic infrastructure), and also forward planning of the billing systems under emerging supply-chain models for telemedicine.

5.1.2. Innovation capture

This barrier identifies the lack of defined pathways to deployment of telemedicine and telehealth-care more generally. It relates to developing a sustainable path for projects and trials to become on-going systems and programs, thereby capturing the innovation developed in the trial. There is a great deal of literature on the success of technology trials or projects. There is very little material on establishing sustainable business models to move from single projects to whole programs[5].

One challenge is that the health care system is so complex, and crosses so many jurisdictional boundaries, that it can be difficult to establish who has what role, responsibility, or decision making authority along any proposed pathway to deployment.

We found that few trials have demonstrated scalability, which typically requires follow through, transferability, champions among all stakeholders, and sustainability of the trial service.

Many trials also did not identify significant and agreed metrics which directly translate to return-on-investment for policy makers and funders. We also found few cases where the scale of trials allowed broader conclusions to be drawn on a statistically significant basis, as many trials had limited reach and involved limited demographics. This observation was supported by many interviewees.

Few studies have involved a coherent set of trials to address the problem that demonstrating the efficacy of one function alone is seldom sufficient to change established processes. There are also few cases of long-term and large-scale coordination of trials.

One pervasive observation from interviewees and arising from the studies is that innovation capture from trials suffers from the “chicken-and-egg” problem. Genuinely broadband technology trials across more than single point-to-point locations cannot be demonstrated without a broadband network, but broadband investment is difficult to justify without sufficient evidence from real trials. Funding initiatives have allowed trials on experimental or dedicated networks, but that does not allow effective trialing across more widespread high bandwidth networks.

Workshop participants and interviewees highlighted that telehealth does exists across Australia, and expressed the view that the benefits of telehealth are well established. The barrier is not a lack of trialing individual technologies, but leveraging innovation to enhance an existing industry. This appears to be a common plight internationally.

One of the few examples addressing this barrier is from the National Health System, UK:

[5] Several of the references directly observed this fact. Several references also found that many published results could not be tested on the basis of sustainable or effective business models.

> ***The National Innovation Centre (NIC)***
>
> *Funded through the National Health Scheme (NHS) in the UK, the National Innovation Centre works nationally and internationally with innovators in industry, academia and the NHS to speed the development and diffusion of healthcare technology innovations. The NHS-NIC supports innovators, commissioners, and clinicians with a range of free-to-use, secure and confidential tools to help collect clinical needs, rank ideas, surf for help and win competitive (innovation supporting) contracts.*
>
> *NIC also provides an online innovations showcase, providing exemplar innovations across the health system.*
>
> *http://www.nic.nhs.uk/*

This raises the fundamental question of how we expect such innovation to be captured in Australia, and the need for a coordinated and funded mechanism for coherent planning and operating of trials and their pathways to deployment.

53% of the references found from Australia, (51% International), suggested lack of capture of trial output, and lack of movement from projects to programs as a barrier.

5.1.3. Supply/value chain

In any field established supply chains can be a substantial barrier to innovation and disruptive technology because they seldom align with the business models of incumbents. The existing supply chain in health industries may work against the introduction of telemedicine.

For example: many blood glucose monitor suppliers use a “razor and blades” business model[6]. This model sells the glucose monitor (razor) at near cost, and single-use test strips (blades) at a profit. Such an approach means that innovation in monitors (e.g. making the monitors interoperable with wireless/data interfaces) may not be aligned with the current business model of the supplier (which depends on selling more test-strips). It may need several changes before that supply chain can be adapted, such as acceptance of payments for electronic data from monitors, and changes in equipment procurement practices. The challenge is not that there is not an alternative supply-chain model, but rather that existing practices and supply approaches are a barrier to such changes.

Many interviewees emphasised that the health community does not act in a hierarchical deterministic manner. This means that the change process must enable solutions to emerge from the health community, up and down the chain through supportive champions, rather than have solutions imposed from above.

Initial steps toward addressing this barrier will involve identifying existing health processes (e.g. models of care, key patient journeys, typical scenarios, and related

[6] This business model originated from King Gillete, of the Gillete razor company. It operates by selling a master product (the razor) at subsidized price or even at a loss, and then making a profit on consumables (the blades). This business model is widely adopted in disposable razor blades and inkjet printers.

funding mechanisms) and defining what is currently done, and then creating scenarios and the associated payment models for future telehealth systems[7].

Once such scenarios and processes are defined and agreed on, there are then additional challenges of change management and education, and aligning all the industry and government sector players to develop viable overall business models for these scenarios.

A component of this barrier is that telehealth systems often emphasise the benefits to the patient, or society, whereas the value-chain must also address the role of the clinician in achieving these worthwhile aims. An example cited is that of standardised data exchange, for which clinicians "must see the benefit to THEM, Doctors hold their data close", (Overhage, 2008).

26% of the references found from Australia, (30% International), suggested that an unclear value chain, or supply chain, was a barrier to adoption.

5.1.4. Health systems

This barrier relates to the lack of systematisation of many health care services. The challenge is in building scalable, measurable health delivery services that are standardized and interoperable. These "health systems" will exhibit measurable improvements in health care delivery and health outcomes, and should lead to a corresponding reduction in costs. This barrier also encompasses the cultural shift necessary to adopt new innovation.

This reflects the fact that health care systems have largely not yet been "industrialised". This means that the processes have not been defined, standardised, measured, and improved under the kind of quality management systems that have been applied to other sectors. We need to analyse what can and should, what cannot and should not, be industrialised. What can be industrialised should be done with all possible speed, vigour and available resources. Good data is critical to enable the kind of changes needed, for example to support efficient payment and reimbursement models. It should be recognised, however, that existing supply chains may work against these kinds of changes.

Even functions as simple as on-line information about available beds in care facilities, cited by workshop participants as something that takes an inordinate amount of time by telephone presently and results in non-optimal use of existing resources because of the ad-hoc nature of finding the information, would make a significant difference if systematised.

Health innovation occurs within the existing health infrastructure, which is a dynamic and complex system where highly motivated and educated individuals interact as loosely coupled complex groups. Health culture resists "top-down" change – incentive and leadership models for change are needed rather than command-and-control (Grossman, 2008). For example, ubiquitous automation of administrative tasks will likely only occur if driven by doctor and patient demand.

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[7] Several interviewees and workshop participants suggested creating a knowledge base of successful (and unsuccessful) telehealth projects, with a view to what can work, and how those who make local purchasing decisions might transfer existing solutions.

Historically investment in ICT systems to support healthcare has been low (around 3%) compared with investment in other sectors (around 10% typically). This suggests that there is great scope for ICT based productivity improvements.

There are challenges even in the terminology: for example, the concept of "industrialisation" is not constructive in an environment where dedicated care professionals are trying hard not to have health care systems thought of as factories.

This barrier means that the benefits associated with large scale systematic approaches, such as automation of low-value tasks, have largely not been realised in the health care system. It is important to recognise that health care needs "massively scaled individualised outcomes" - that is, recognising the importance of personalised and individual health care, and scaling the appropriate components to improve overall outcomes.

Various groups (particularly in the UK) are beginning to consider this.

> *[T]he process that the dental profession is experiencing. … has all the hallmarks of an industrialisation process. [T]his industrialisation process is not confined to the dental profession in the UK.*
>
> Cottingham J. and Toy, A., "The industrialisation of Dentistry",
> British Dental Journal 2009

> *Since all health services, however organised, face the same problem of resources being insufficient to meet demand for health care, they exhibit an underlying tendency towards solving problems in health care using mechanisms borrowed from other industries.*
>
> Iliffe, S. "From general practice to primary care: the industrialisation of family medicine in Britain",
> Journal Public Health Policy, 2002

> *Radiology, as well as other areas of medical care for patients is undergoing perhaps the most dramatic change in the last several generations… [Understanding this change] requires comparison with the directions that were taken by businesses at the time of the development of means of mass production.*
>
> James T. Rhea, M.D. "The Industrialisation of Medical Care"
> Guest editorial, Emergency Radiology, 1996

Hall (2010) noted that financial incentives are necessary, but not sufficient, to achieve performance improvement. Once performance information on health care practices (or even professionals) becomes accessible (even if only to other clinicians) there is a substantial improvement in quality and efficiency: "Orders to radiology tests fell by 15% in one group, after they compared with colleagues on test use".

Lee (2010) has suggested that a systematic, process-improvement approach to health care will deliver substantial improvements and this would not be captured by incrementally improving status quo.

> *The day will never come when readmission rates are low enough, when heart-attack treatments are fast enough, or all the processes of care delivery are efficient and reliable enough. Thus leaders … need a culture of process improvement and the disciplined use of its methods.*
>
> *In 2001, Virginia Mason Medical Centre (VMMC) was in danger of losing market share and its best physicians to the numerous outstanding hospitals in the region. J. Michael Rona (then center president) had a chance meeting with John Black (then director of lean management at Boeing). Black had sent hundreds of Boeing*

> *Managers to Japan to study the Toyota Product System (TPS). Rona and Gary Kaplan (physician and CEO of VMMC) began taking colleagues on the two-week course and let it be known that leadership roles would most likely be reserved for people (including physicians) who took the training and adopted the lessons. Some of their star physicians left as a result. But Virginia Mason has used its version of the TPS to reduce costs, improve quality and service and strengthen its financial health.*
>
> (Lee, 2010)

10% of the references found from Australia, (14% International), offered the lack of systematic approaches to health as a barrier.

5.1.5. Pervasive access

Pervasive access refers to the lack of connectivity and services to allow “anyone to anyone” and “anyone to everyone” health care access and health care delivery.

A primary challenge is how to establish the provider network to be able to deliver care from any provider to any participant, with access to minimum levels of bandwidth for each function. Support is needed for both structured and flexible collaboration, each with the required levels of security and privacy.

Medical professionals operate in loose collaborations and need to be able to restrict the flow of information between different care-provider networks. Therefore, even if the need for network access is met, there is also a need for structuring virtual private networks to provide the appropriate access for each player in the system.

There is a trade-off between privacy and security of information (from both personal and corporate perspectives) and free-flow of information, and a risk of only supporting the "lowest common denominator" if such issues are not adequately addressed.

Workshop participants emphasised that pervasive access covers the need for connections at all levels of the health care system, including regional communities, access from regional networks to central facilities, access to 24-hr/365-day services for advice or consultation, and access to information on data such as availability of beds in care facilities.

The lack of pervasive access inhibits telehealth uptake in two ways:

1. Limited adoption of telehealth procedures, reducing the impact on health care scaling.
2. Egalitarian approaches to access, which attempt to give all participants a "lowest common denominator" quality of access, result in minimum standards which fail to support the clinical requirements and/or are too costly to allow for equal adoption, and so no participant is given access.

The NBN should provide the basic network connectivity and infrastructure required for pervasive access, and will have the required reach through its fibre backbone and wireless and satellite tails. However the scope and scale of service networks required needs to be identified and a coordinated approach taken to establish these networks. The technology requirements for supporting such access networks, with access control, privacy and security management, need careful investigation, planning, and trialing on suitable test-beds to be in a position to implement them on the NBN as it is rolled out.

Providing pervasive access also offers the potential for new telehealth-only businesses, such as remote consultation or advice, to develop. Such businesses may address current work force shortages by encouraging existing professionals to remain in (or return to) the health community by allowing independence of physical location and choice of scale of effort. As an example, Telehealth Solutions is a telehealth-only business operating in Australia. The business is based in Merrylands, Sydney, NSW. Telehealth Solutions offers "Quality Occupational Health" advice, but not direct teleconsultations.

A lack of pervasive access was offered in 26% of the references found from Australia, (36% International). We believe this difference is predominantly due to the wide variability of network access across the world.

5.1.6. Interoperability

This barrier arises from the inability to interconnect to access and deliver services and data as needed across all networks, systems, and devices.

Telemedicine is only achievable with the exchange of information - between patients, practitioners, suppliers and policy makers. A common basis for data exchange is needed for purposes such as real-time communication, access to health records and other clinical documentation, access to specialized data such as images, and software system interfacing.

This is often referred to as "standardisation", although partial interoperability can be achieved with partial compliance to standard interfaces. In some cases, interoperability is achieved via common interfaces and (possibly hidden) translators for proprietary systems.

Interoperability typically involves meeting common minimum requirements, and aligning with standards (both in terms of minimum quality and interfaces) at all levels of health-care and the health-delivery process. This includes compatibility with Australian and international standards if needed.

One challenge is the acceptance of core standards that might be government mandated, against the pressures of industry group proprietary systems that are central to many of the device and system business models. Open standards may play a key role for Government mandated standards.

Existing approaches to interconnect disparate systems (for example, using web services and Service-Oriented-Architecture (SOA) approaches) are not currently standardised, although major software system vendors often standardise within their own systems.

In practice many systems have emerged as trials and services have been undertaken, resulting in a mixture of compatible and incompatible systems, many without clear standards for interoperability.

Standards will emerge gradually, but faster progress may be made by taking intermediate approaches. Examples include:

- Developing standards for use of mobile phones, with cameras, by clinicians for data collection and transfer. Mobile phones are used for this purpose in Australia[8] and it is becoming well-established practice in the US. This often occurs in the absence of standardised interfaces.

- Developing middle-ware translation services (e.g. XML to XML converters) for data interchange.

- Developing compliance criteria for data access (for example, in the Australian Department of Defence RPDE case study the “standard” record contains standard e-prescribing data and discharge summaries, and a non-standard scanned "clinical notes". There is no standard storage mechanism of this data, only that extraction of data was guaranteed to comply with the interface specification).

For case studies in which the barrier of interoperability was overcome, one (or both) of two approaches have typically been adopted:

1. Strict compliance to interface specification and strict compliance to quality specification. In one interview a pilot-case developer stated “We did not allow any compromise in our specification to accommodate proprietary systems”.

2. Funding to achieve translation of proprietary system interfaces and/or migration of legacy systems. The funded efforts were devoted to extracting the core material from the existing systems without compromising point 1.

Achieving interoperability is the first step, but the need will evolve to actually achieving interoperation between disparate systems, which will require increasingly sophisticated translators and the ability to understand processes and operate at a semantic level.

Interoperability was cited as a barrier by 47% of the case studies found from Australia, (41% international).

5.1.7. Usability

Usability barriers arise when devices or technology solutions are not effective for their intended purpose, or not efficient in their ease of use. Effectiveness and efficiency are also affected by whether the user has to learn to use the devices or systems, and whether support for that learning process is incorporated.

Poor usability can result from a lack of effort by solutions providers to evaluate the real work practices, and the real user needs, for their systems. Lack of field experience often results in technology solutions that are not fit for purpose, or require changes to work practice, and consequently often fail. Usability can also incorporate measures of user satisfaction, and the degree of change to work practice needed for effective use.

Trials by their nature involve testing propositions made about delivery of a service, so it can be difficult to ensure effective design of devices and user-interfaces for systems from the outset. Problems with usability can then affect the results of trials, so an iterative improvement path is generally needed. Pathways to iterative improvement are

[8] One clinician participant in the first workshop was using a phone in this way as part of his normal work practices.

sometimes treated as part of usability in recognition of this factor, and also of the importance of learning in influencing usability.

Obtaining real clinical buy-in at early stages of a project is critical to success, which usually means a usability process must be planned to allow for both the field experience of technology providers and co-development with clinicians.

Reliability is a key element of usability, but trials often introduce devices that are not yet market-hardened, and may have reliability or other quality control issues independent of their user-interfaces. Simplicity is also a key element of usability, and workshop participants highlighted the need for simplicity and fallback modes of operation (for example, the ability to use voice only at a high quality level was often more important than lower levels of combined voice and video quality on a limited bandwidth teleconference).

During our interviews and workshops, several examples were given of technology that was not fit for purpose

- “Older people need big buttons (on their home care devices) - you can’t read typical technology designed by kids for kids”,
- “The conferencing system used a 40 inch plasma screen which occupied the entire nurse’s workstation”
- “It needs to be usable at night with gloves on and only have two buttons”
- “We had an advantage in designing our system: my brother is a Medic, and my mother is a senior nurse, we have experience in what works.”
- “You can’t call IT support at 3am”

Across the world, it is accepted that usability is critical to the success of any technology innovation in health. Our workshop groups felt strongly that usability is a critical barrier, and suggested that this barrier was a particular challenge in Australia. This emphasis may be an artefact due to the fact that we interviewed users and designers of technology solutions from Australia only. It is possible that similar perceptions would arise in other locations. On the other hand it may also be that Australia has fewer close interactions between technology groups and clinical groups that result in special purpose clinical devices and systems through extended trials.

Usability and ease-of-use were offered as a barrier by 26% of the references found from Australia, (19% international).

5.2. Analysis of barriers to adoption in reported telemedicine case studies

In the following section, we examine Australian and international literature and, where possible, evaluate which barrier(s) constrained the case study. We divided the total literature into those reports from Australian locations and those from international locations (the majority of which were United States). For each study, we allocated a value (0,1) as to whether (or not) the study used a particular technology, and whether the study was constrained by a particular barrier. None of the (more than 150) studies reviewed stated that that the trial could not be completed – i.e. in some sense every study successfully overcame the barriers listed. We also considered whether or not the given study might scale to a larger system, and if so, which of the barriers appeared most likely to constrain such scaling.

Each study could have multiple technologies and multiple barriers. We did not include a category “other”. Of the reports reviewed, only two did not cite one of the listed barriers.

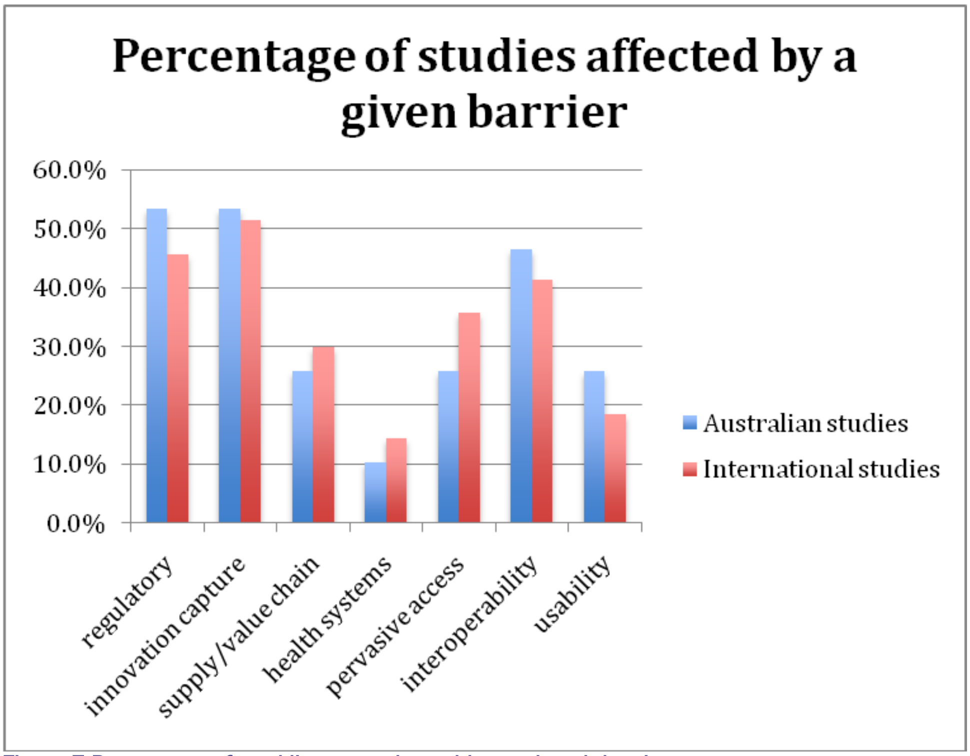

Figure 7 Percentage of total literature that addressed each barrier

The results of the barriers are shown below. The percentages show the number of studies that cited a particular barrier, relative to the total number of studies reviewed.

The impact and occurrence of the 7 barriers is essentially the same for Australian and International studies.

Australia studies cited similar barriers to International studies. For each barrier, the impact (number of studies that cited it) was approximately the same for Australian and International studies.

Systematic approaches to health care delivery were rarely considered in the Australian or International case studies.

The studies reviewed were usually single-case proof of efficacy for a given geography, and were rarely to do with systematically moving from single case studies to global health approaches. Many studies lamented a lack of sustainable business models.

We observed the following:

1. The citing rate of barriers (what percentage of studies were impacted by which barrier) is similar for both Australian and International case studies.

2. Regulatory and Innovation Capture are the two most substantial barriers. Both of these barriers were cited by more than 50% of the reviewed Australian studies.

3. Interoperability barriers were cited by more than 40% of all studies (Australian and International).

4. Usability was addressed in more Australian studies – many Australian studies specifically evaluated usability, or directly cited it as a barrier (reason for failure)[9]. In International case studies (particularly US) usability was often given as a "lesson learnt".

5. Of the review studies, Australian studies were slightly more likely to cite or imply a barrier than International studies, and were more likely to imply multiple barriers.

5.3. Correlation between barrier and technology

From the review of the case studies, we performed a correlation (over all studies) to identify which technologies were impacted by which barrier.

The approach was as follows:

- For every case study, we tested if a barrier or technology was cited or implied
- For each technology, we recorded a 1 if the technology was considered, and 0 otherwise
- For each barrier, we recorded a 1 if the barrier was considered, and 0 otherwise
- For every combination (eg. regulatory-videoconference) the values were added to give a "total correlation score".

	symmetric video conf	data transfer, storage, analysis	user interface	network access	business process	devices	informatics
regulatory	21	41	9	34	24	11	27
innovation capture	30	41	16	36	25	9	26
supply/value chain	9	18	12	16	15	7	13
health systems	4	7	4	8	7	2	9
pervasive access	15	21	6	28	7	10	15
interoperability	17	38	12	29	20	10	31
usability	17	20	10	16	9	8	9

strong link

moderate link

limited link

[9] This matches some observations from workshop participants – "Technology needs to operate perfectly first time, every time" "When it doesn't work, clinicians won't use the next version"

Figure 8 Correlations between perceived barriers (left) and telehealth technology (top) using all case studies. Red implies a barrier is substantial for scaling that technology.

The "total correlation score" gives the number of case studies that addressed a given barrier-technology combination. For example, 21 studies considered both regulatory barriers and videoconferencing. High scores indicate a large number of independent studies observing the same combination of technology-barrier. A low score implies the given combination was relatively rare. The scores ranged from 2 (Health Systems – Devices) to 41 (Innovation Capture and Regulatory for Data Transfer)

The "total correlation score" was rated "strong", "moderate" and "limited" based upon the relative count (upper 25%, middle 50%, lower 25%) of the correlation matrix. The correlation matrix for Australian-only case studies was similar.

Red squares denote a strong correlation between a barrier and a technology. For example, the regulatory barrier strongly impacts on the data transfer technology, and the informatics technology. Yellow squares denote moderate correlation, e.g. Usability has a moderate impact on video conferencing, and network access. Blue squares denote limited correlation.

6. Impact of the National Broadband Network

6.1. Impact of NBN on barriers and technologies

As part of the second workshop, participants were asked to score (high, medium, low) the impact of the NBN on each of the barriers. Participants also scored their opinion on the best barrier to address with a new trial or program. The subjective scores were combined with a weighting 1x for high, 0.6x for medium and 0.2x for low. This technique is well known in areas such as project priority setting (PM-complete).

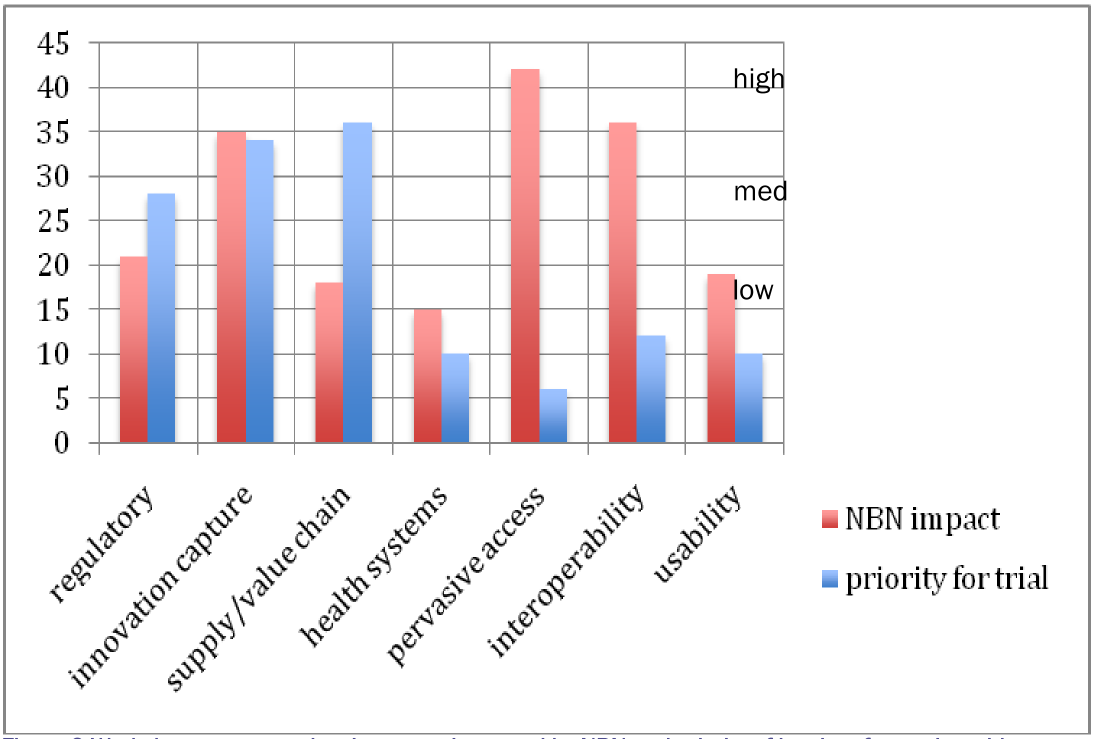

Figure 9 Workshop outcomes: barriers most impacted by NBN and priority of barriers for testing with new program/trial design

Figure 10 shows the perceived impact of the NBN on the barriers, with descriptions of the primary driver for that impact. It should be noted that we performed a separate assessment of this impact before the workshop, and tested our results against the perceptions of the workshop participants.

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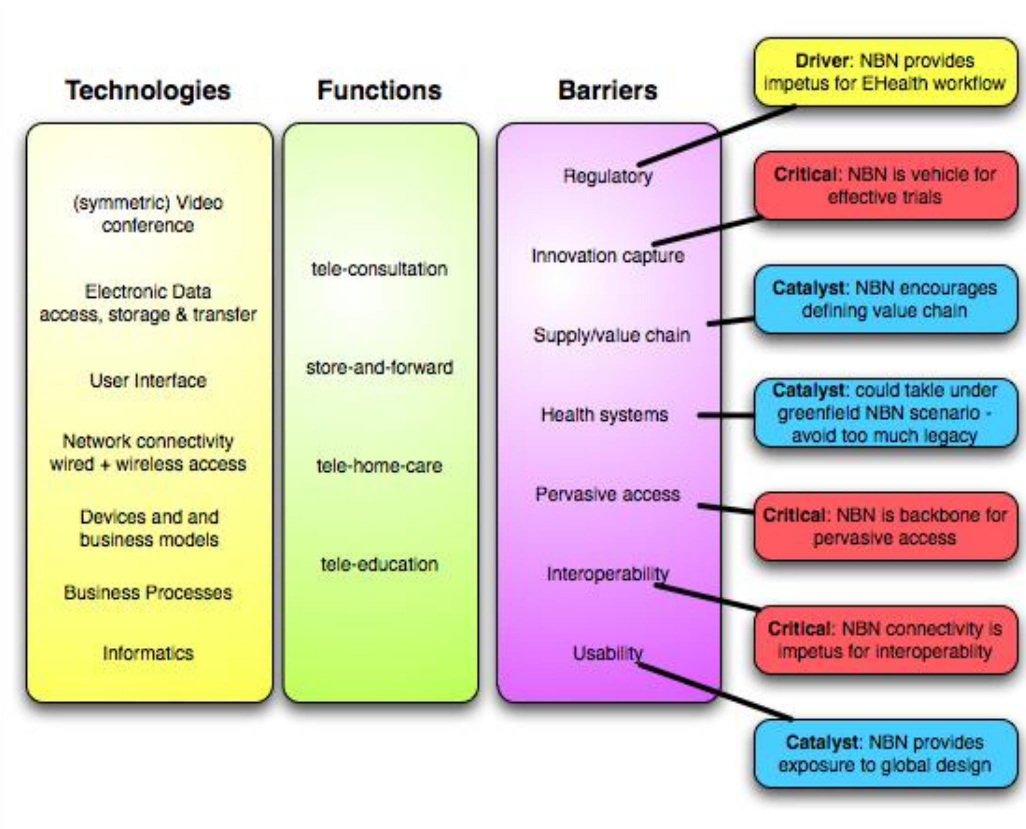

Figure 10 Impact of NBN on barriers (Critical, Driver, Catalyst) Critical impact implies the NBN may directly overcome the barrier. Driver implies the NBN may provide impetus to overcome the barrier. Catalyst implies the NBN may provide an incentive to address the barrier.

We have redrawn the correlation matrix (below) against the perceived impact of the NBN on the barriers, and the expected support from the NBN on the technologies, as shown in figure 11.

The impact of the NBN on technology is related to the extent to which broadband data access addresses the underlying technology. In this case we expect symmetric video, data access and network access to be driven by the NBN, user interfaces and informatics to be moderately impacted and business process and new devices and associated business models to be impacted to a more limited extent.

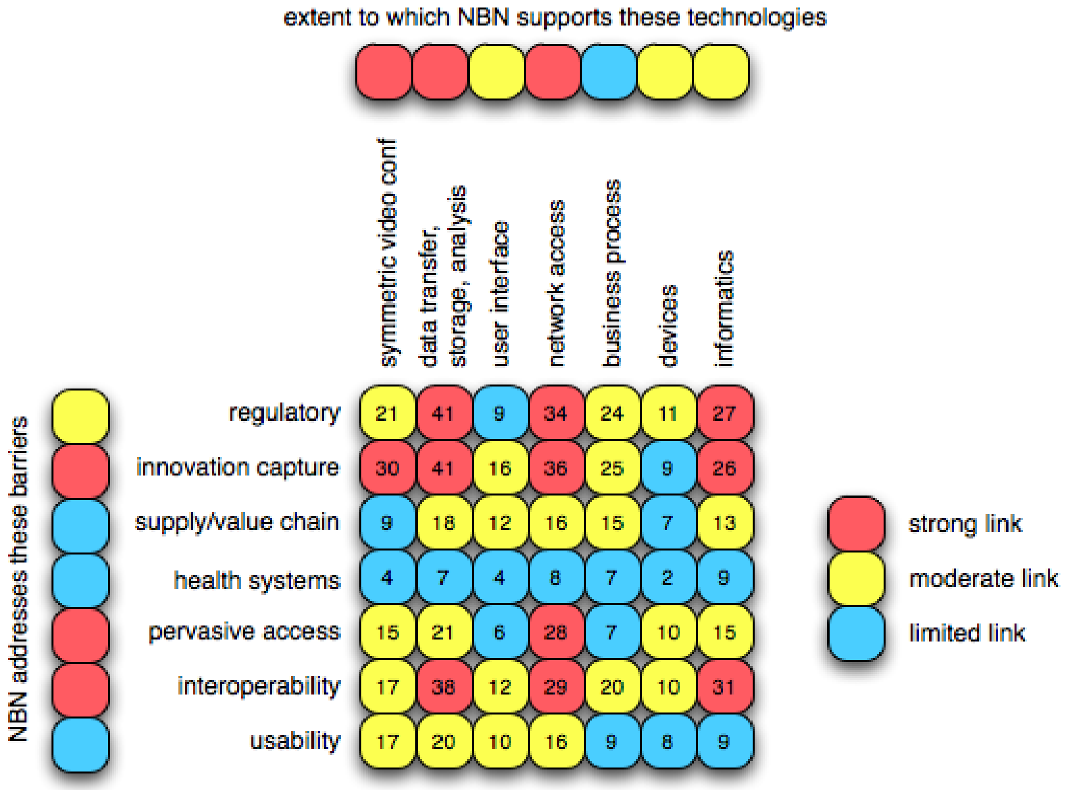

Figure 11 Perceived barriers versus technologies. Barriers that are expected to be addressed by the NBN are highlighted red in the bar at the left; those technologies most assisted by the NBN are highlighted red.

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7. Workshop outcomes: proposed mechanisms for enhanced adoption of telemedicine in the context of the NBN

As part of the second workshop, participants were asked to suggest meaningful technology trials that could lead to sustainable telemedicine programs. The framework for proposing trials was as follows:

1. Identify substantial barriers (across cited references)
2. Identify barriers which had high potential of being impacted by the NBN (see previous section)
3. Identify technologies most supported by the NBN (see previous section)
4. Propose trials that combine this analysis to produce a sustainable program of telemedicine that takes advantage of NBN.

We combined the score of the barrier most impacted by the broadband network, and the score of the barrier most conducive to evaluation with new trial design in the spider diagram below. New designs should address the innovation capture barrier as a priority, also with emphasis on the supply/value chain and regulatory issues. This matches with our own results from the literature survey.

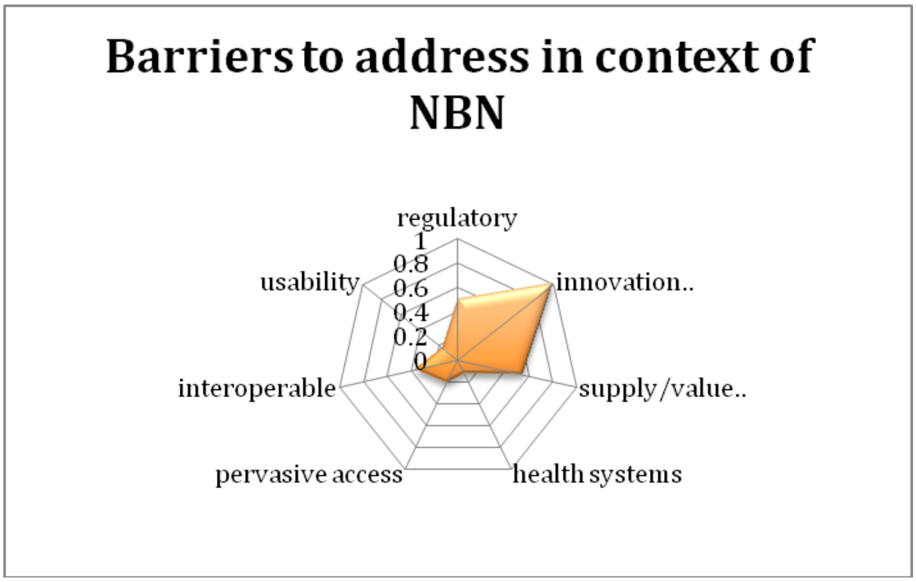

Figure 12 Workshop outcome: barrier(s) most impacted by good trial design, in context of the NBN

Our approach follows (Latifi, et al., 2009): Initiate, Build, Operate, Transfer (IBOT) which includes the "development of a curriculum and education program, the establishment of a nationwide telemedicine network, and the integration of the telemedicine program into the healthcare infrastructure. The endpoint is the transfer of a sustainable telehealth program to the nation."

The proposed trials are outlined in the three proposals below. These proposals indicate the kind of opportunities and the thinking of a mixture of clinicians and technologists indicative of the kind of approach that might lead to a coordinated set of proposals for maximising impact of the NBN in telehealth.

7.1. Trial proposal 1: Clinicians online - Home care, teleconsultations

Description: A national program to deliver and evaluate a system that will enable any health professional (especially clinicians) to consult with any other health professional and/or their patients.

Concept: “Skype 4 Health” but with better quality video, auxiliary data streams, and appointment scheduling.

Outline: The system would be developed with open standards, and open interfaces. It would be trialed in incremental stages – first locally, then across regions and then states and finally nationally.

Early stage patients: first stage patient applications would likely be for:

- Geriatric assessment in the home for wound management
- Stroke assessment in remote Emergency Departments without a specialist present at the remote end
- Multi-disciplinary team meeting or cancer patient care coordination

The system would require

- Interoperability between devices (e.g. Home monitoring devices, videoconferencing technology, mobile devices and handsets).
- Interconnectivity between networks, to allow data to migrate across multiple sub-nets and to allow appointment scheduling with health care providers. An initial example is (Powell, 2009).
- Interoperability for data exchange, to allow augmentation of the teleconsultation with a large-scale remote specialist support and electronic health records.

The NBN would be key in the roll-out of the service, to

- Fill in gaps, and the last mile for existing networks
- Provide bandwidth sufficient to support multiple tele-consultations
- Ensure guaranteed video QoS, from end-to-end, independent of other network activity.

Technical questions we would need to answer

- What defines a standard e-consultation, in order to meet MBS requirements?
- What quality of videoconference technology (bandwidth, latency, QoS, physical setup) is needed for a given clinical care model?
- Given a videoconference, what additional health indicators may be extracted without requiring additional effort for the clinician/patient?

Deployment path questions:

What is the business model (including government support) that will ensure that each stage of the development is sustainable?

7.2. Trial proposal 2: Telelab - remote data access, specialist analysis and data transfer

Description: A national rollout of specialist services under the support of a broadband network.

Concept: Telelab service to enable any clinician to order, and receive laboratory tests and specialist analysis online..

Outline: The service would allow clinicians to access a range of laboratory services on-line. Examples might include ophthalmology, dermatology (wound care), pathology and dentistry. This would roll out in parallel with the teleconsultation program above.

NBN would be key to this service to:

- Allow connectivity to remote regions (e.g. support indigenous care)
- Support (very) large file transfer (e.g. Magnetic Resonance Images) and
- Encourage e-health only specialist businesses – allowing specialists to move beyond hubs such as hospitals.

7.3. Trial proposal 3: National broadband medical training support

Description: An immersive environment for training at any point along the health care work journey, in order to augment existing training services.

Concept: “a 3D, immersive environment for clinical training” with auxiliary data streams and clinical application. Open source modules that can be “dragged and dropped” into a user-friendly immersive training environment.

Outline: The immersive environment would be targeted to service a range of training needs, including:

- Undergraduate, medical assessment training
- Postgraduate upgrading skills in new clinical practice
- Collegiate maintaining contact and skills for isolated clinical practices
- Training of remote and indigenous health professionals and workers – avoid sending people away from their home base.

7.4. Summary of workshop suggestions for trials

A key factor behind these trials scenarios was demonstrating that by taking a systematic approach to analyzing barriers and technologies, and how the NBN will impact on them, we can posit a set of trials through interaction between different players in the health system. This suggests that we can take a systematic approach to tackling these challenges with the full buy-in from all parts of the sector.

The specific trials proposed complement each other, and broadly address the functions of:

1. Teleconsultation and telehome-care (combined)
2. Store-and-forward, and
3. Tele-education.

These are three of the four basic functions of telemedicine identified previously.

8. Summary of key findings

This section captures our key findings from the study, in terms of the status of telemedicine trials in Australia and internationally, the main barriers identified to greater uptake of telemedicine, and the potential impact of the NBN on telemedicine uptake.

8.1. Key findings – Current status

8.1.1. Telemedicine trials

Across the world, many trials have taken place, but very few have had a carefully planned path into adoption. The exceptions are those with a strategic plan, such as Kaiser Permanente, Department of Veteran Affairs in the US, UK Departmentt of Health, and the Danish Government.

Australia's trials have largely lacked the context of a coherent overall telehealth plan. This is common to many other countries, but the difference is that Australia is now rolling out a broadband infrastructure and so has an opportunity to develop a coherent overall strategy and plan. This implies that with the pervasive and high-bandwidth aspects of the NBN implementation, Australia might aspire to deliver eHealth systems beyond those achieved internationally.

The most successful trials/systems in Australia have been evaluated at the level of regional (versus individual hospital or state-wide) health services.

8.1.2. Focus of telemedicine trials

Australian trials have largely focused on evaluation of off-the-shelf technologies such as videoconferencing, whereas major global players have taken for granted that high bandwidth is necessary and will be available, and are focusing more on applications that perform higher-level data analysis. For example, this analysis might provide details such as efficacy of health plans, trends in health care management and effectiveness of GP consultations. A contrast to this has been the ViCCU case study which highlighted the clinical potential of appropriately designed telemedical technology.

Some countries are further down the path of adoption than Australia. They have had broadband, tried it, and discovered and accepted its use. Also they have had much more accessible eHealth data - other countries have taken stronger roles in rolling out eHealth records systems to support healthcare, and by implication produced a more successful telehealth approach. Government enforcement and government interest has played a role in this, as possibly have Australia's concerns about privacy.

Australia has not provided many market opportunities for locally developed telemedicine products, which risks leaving us behind the pace.

8.1.3. Uptake of telemedicine

Australian clinical users have developed an attitude that telemedicine must be completely reliable and always work, or they will not use it. This is not so evident in other countries, and is a usabilty-related barrier that must be addressed.

Successful International systems have a greater focus on funding and enforced training for users (patients and professionals). In Australia training (in general) has not been a core component of trials. Training is fundamentally important for successful results from collaborative systems.

8.2. Key findings – Underlying perceived barriers

Barriers to the uptake of telemedicine were found to fall into three tiers, with similar profiles for barriers in International and Australian studies.

1. Perceived first tier barriers were **Regulatory, Innovation Capture** and **Interoperability**. Resolving these first tier barriers could result in systems comparable with the Kaiser Permanente, the US Veteran Affairs, or the Denmark case studies.
2. Perceived second tier barriers were **Pervasive Access**, **Usability** and **Supply/value chain**. Resolving these second tier barriers would be easier after resolving the first tier barriers, each running under a self-contained value chain, with increasingly pervasive access as the NBN is rolled out, and usability improving through experiences in delivering care, supported by customer/vendor co-development.
3. **Health systems** was perceived as a third tier barrier. Resolving this will be necessary to improve quality and reduce costs in a systematic way, but this does not appear to the major focus of any studies we identified.

It is likely that the challenge of resolving some of the first tier barriers may have over-shadowed the extent to which second or third tier barriers were identified in the case studies reviewed and workshop discussions.

8.3. Key findings – Impact of NBN on barriers to uptake

1. Our analysis suggests that the NBN will have a **critical** role in addressing:

    a. **Innovation Capture**, by creating a national framework for testing of services and technology, and an infrastructure that allows defined pathways for deployment to be planned and implemented.

       The NBN will provide 100Mbit/sec full duplex to 93% of the Australian population. This substantial change in access should encourage Australia to explore higher-end telemedicine applications that are more (video and data) intensive than those currently examined here or overseas.

    b. **Pervasive access**, by achieving widespread connectivity at a network access level through the combination of fibre, wireless and satellite access, and providing a platform for a boundary-less service access and new business opportunities in e-delivery.

    c. **Interoperability**, through connectivity across a common and heterogeneous network that encourages standardisation of interfaces and access to data such as medical records, and equipment. As an example the RPDE trial has driven access to data in multiple hospitals.

2. The NBN should have a **driver** role in addressing:

    a. **Regulatory** barriers, since cross-jurisdictional differences no longer make logical sense once common infrastructure is established - this encourages the differences to be removed.

3. The NBN could be expected to have a **catalyst** role in addressing:

    a. **Supply/value chain**, by providing access to competition, giving rise to market forces in developing evolving supply chains, encouraging cost/benefit pressures to improve the value chains, and allowing innovators to focus on opportunities rather than resolving entrenched situations.

    b. **Usability,** by providing access to competition in device and interface design, opportunities for improved telemedicine equipment benefiting from the higher bandwidths, and easier uptake of improvements through greater visibility of existing best practices.

    c. **Health systems,** by offering an environment under which quality improvements and efficiencies can be trialed and realised, with opportunities to develop next generation systems.

9. Key conclusions

This section captures our conclusions on telemedicine opportunities in the context of the emerging ubiquitous broadband network, or NBN.

These conclusions cover not only factors related to the NBN opportunity, but also some broader issues that should be addressed to best capture the opportunity.

9.1. A coordinated strategy should be developed for eHealth trials across the NBN to allow early benefit from its roll-out

An overriding message from our study is the need for greater coordination and planning of a coherent set of trials that have identified pathways to deployment and sustainable adoption. This involves not just trialing, but also shaping, of future telemedicine services.

Our workshops identified a set of potential trials around:

- Clinicians online: Home care, teleconsultations
- Telelab: remote data access, specialist analysis and data transfer
- National Broadband Medical Training Support

Such trials would include one or more aspects of the identified barriers, with specific mechanisms to address these barriers, and champions from all stakeholder groups involved in ensuring effective pathways to deployment.

They would also systematically address the technologies required, and ensure that key evaluation criteria are aligned with decision-making for adoption into practice.

9.2. A coordinated approach should be taken to developing and testing the technologies needed to underpin effective telemedicine across the NBN

A coordinated approach is needed to address the technology challenges of scalability and interoperability on a heterogeneous broadband network, by developing the layers above the core infrastructure that will enable service delivery to required levels of quality and reliability.

This includes in particular areas such as:

- Architectures to accommodate appropriate balance of Open versus Proprietary systems, device and software system interfaces, and access to e-Health records.
- Reliability, security, trust and privacy requirements to meet clinical requirements.
- Test-bed environments and supporting systems not only for dedicated trials, but also for simulating traffic loads in delivery of services across real networks as they are rolled out.

- Alignment with International standards and emerging tools and systems, to allow progressive upgrading as best-practice evolves.
- Health informatics systems to support increasingly "personalised" health care and the access to, analyzing and visualisation of data to support clinicians' requirements.

These requirements should be systematically analyzed for the proposed trials and services, and a coherent approach taken to ensuring that the technology challenges are addressed in a scalable way.

9.3. The NBN will provide a unique opportunity to catalyse change in the way health care is delivered

There is no doubt that health care systems will undergo fundamental transformations over the next several decades. Pervasive broadband access will be genuinely disruptive. We have the opportunity to use the NBN as a catalyst to advance Australia into a leading position in telehealth-care as an integral part of healthcare more broadly. This would involve addressing a series of challenges in a coordinated way:

- Addressing the "systematisation" of healthcare with appropriate planning and analysis, to improve health care effectiveness and efficiency more broadly.
- Developing future supply chain models and identifying patient journeys, personalised treatments, clinician workflows, value chains, provider environments, drawing on process modeling and re-engineering approaches to develop reference architectures for on-line services and their associated supply-chains.
- Aligning the training and educational models with emerging service models (e.g. systematiccare.net), shifting from "just-in-case" to "just-in-time" clinician training and access to data and expertise through emerging informatics tools.
- Planning a migration path from current care to systematised care models, and ensuring change-management and value-propositions are posed within the wider health context.

These points were not suggested as a high priority by the case studies or from the workshop, but from the evidence discovered we believe this is a one-off opportunity to make major gains if we address these challenges now.

9.4. Australia needs a coordinated approach to telemedicine innovation support and sharing of information and knowledge

It became evident in our investigations that while telemedicine conferences are well established overseas and provide part of what is needed for sharing information, there does not appear to be a coordinated way to share information and knowledge acquired from trials in a way that could allow progressive and systematic capture of experiences in Australia and globally and avoid duplication of effort at regional levels.

We concluded that there is a need for an Australia-wide telemedicine innovation support system for identifying priorities, funding innovation initiatives and identifying pathways to adoption on a national basis.

The NBN rollout provides an ideal opportunity for pervasive and open access to such activities, with its broadband connectivity and associated data access. Such a capability could provide an on-line forum for:

1. Better coordination of stakeholders related to e-health and sharing of information.

2. Opportunities for analysis of existing information to inform trials and early services. More careful analysis of data from trials could better inform the relationship between quality of technologies and quality of care, while analysis of overall outcomes of trials could facilitate broader conclusions.

3. Keeping results of trials live and accessible (e.g. in a common repository), rather than remaining within the realms of the funders (cf. Open Innovation / Access to public info, etc).

4. Developing scenarios of future health care models/supply-chains and incentives for commercial or other players to engage and demonstrate.

5. Development of an innovation support system, including encouragement of "bottom-up" innovation from clinicians and health administrators (e.g. the National Innovation Centre of the UK), identifying "champion chains" for supporting innovation from clinician to administrative and legislative levels, and promulgation of successful innovations more widely.

10. Appendix 1: Participants in this study

A number of external agencies and government departments were contacted as part of this review. We would like to acknowledge in particular, the time and input given by the following people:

Dr. Renu Agarwal	Faculty of Business University of Technology Sydney
Prof. Antony Basten	Garvan Institute and ATSE
Ms. Gayle Boschert	Clever Health Project Manager, Grampians Rural Health Alliance
Prof. Branko Celler	Dean, College of Health & Science, University of Western Sydney
Ms. Margaret Corcoran	Dept. Innovation Industry, Science and Research
Dr. Patrick Cregan	Assoc. Prof. Surgery, University of Western Sydney,
Mr. John Crickmore	Stakeholder, Liaison Office RPDE
Dr. Keith Daniel	Member, ATSE NSW
Dr. Dean Economou	NICTA
Dr. Bob Frater	VP Innovation, ResMed
Dr. Andrew Goodchild	Manager IEHR Design, NEHTA
Ms. Sally Gosewinckel	Assistant Director Medicare Eligibility Section, DoHA
Dr. Tim Gray	Dept. Surgery, University of Melbourne & Royal Melbourne Hospital
Mr. Colin Griffith	Director, Electronic & Network Services, NSW Government CIO
Dr. Chris Gunn	Senior Software Engineer, CSIRO ICT Centre
Dr. David Hansen	e-Health Theme Leader, CSIRO ICT Centre
Prof. Michael Henderson	Chairman: MEDSCI International Healthcare
Dr. Maurice Hennessy	Paediatrics, Royal Children's Hospital International
Dr. June Heinrich	CEO, Baptist Community Care
Mr. Andrew Howard	Head, Architecture and e-Health Strategy, NEHTA
Dr. Yogi Kanagasingam	Research Director, Australian E-Health Research Centre, CSIRO
Prof. Mohammed Khadra	Professor of Surgery, Nepean Clinical School, University of Sydney
Ms. Kathy Kirby	Director E-health Innovation & Bus. Solutions. South. Tas. Area Health Service
Dr. Brendan Lovelock	Health Practice Lead, CISCO Systems
Prof. Anthony Maeder	School Computation & Mathematics University Western Sydney
Mr. Andy Mitchell	Operations Manager, RPDE
Mr. Stephen Moo	CIO, Department of Health and Families, NT Government
Dr. John Parker	CTO Implant Systems, NICTA
Mr. Damien Pentony,	eHealth Strategy Branch, Dept. Health and Ageing
Dr. Kirrily Peters	Dept. Innovation Industry, Science and Research
Ms. Jackie Plunkett	Program Manager, Health eTowns, Northern Territory Government
Mr. David Ryan	CIO, Grampians Rural Health Alliance
Ms. Cathie Steele	Manager, Australian Centre for Health Innovation, Alfred Health
Dr. Duncan Stevenson	Australian National University
Prof. John Wilson	The Alfred Hospital and Monash University
Prof. Laurie Wilson	Post-retirement Fellow CSIRO ICT Centre

11. Appendix 2: Overseas case studies

- (US) (Price-Waterhouse Coopers, 2010) massively-scaled personalized health care is becoming a major focus including health and wellness
- (EU) (Datamonitor, 2005) consumers' demands for personally relevant medical information and services will continue to drive an increase in the quantity and quality of Internet-enabled healthcare applications. Physicians will struggle to balance consumers' demands for online information and services with more practical issues of cost and feasibility
- (Canada) (Jennett, Scott, Hailey, & Ohinmaa, 2003) listed policy implication – including billing, broadband connectivity, and lack of standardized trial metrics to evaluate outcomes as barriers for adoption
- (Canada) (Anvari, 2005) Northbay, a small city in Ontario Province of Canada, runs a remote laparoscopic surgery clinic that enables surgeons in Hamilton (400 km away) to perform laparoscopic surgery;
- (World) (eUser, 2005) Provides a multi-country survey into the relevance of eHealth, eLearning and eGovernment for Europeans, and what barriers exist for adoption. In the countries considered 31% of the population (up from 19%) use the Internet to search for health information. Telephone (eHealth Insider, 2010) with GP's is more common than via email (28% of the population use telephone, 1% use email). The Internet "can become something of an equalizer".
- (World) Telemed (Telemed, 2005) is a repository of links to telemedicine programs throughout the world. It provides a sense of state-of-art across the world as of 2005.
- (eHealth Insider, 2010) observed France, Germany, Italy, Spain and the UK are all principal European e-health market. Further, Europe is seeing a "major shift from secondary usage systems to clinical information systems"
- (Japan/Korea) A number of reports from South Korea and Japan have assumed that high-speed broadband is available (to all) and considered next-stage medical expertise transfer. For example, (Hahm, Lee, Choi, & Shimizu, 2009) state that existing high-speed broadband allows International expertise and conferencing without need for high cost.
- (NZ) The New Zealand Medical Association has a policy statement on the use of telehealth. It describes how to incorporate telehealth where the communication goes beyond simple telephone or email, and recommends telehealth be used as an adjunct to normal practice, and only replace services where is **no reduction** in care[10] (New Zealand Medical Association, 2008)
- (US) Jimison (Jimison, 2009) showed ease-of-use was a strong indicator of uptake for telehealth. Providing e-health with technology that users were already familiar was beneficial. Perceived benefit, system reliability (trust) and fast feedback for clinicians were also important.

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[10] The NZMA does not require the tele-consultation to be *better* than existing services.

- (US) AMD Global Medicine (AMD Global Medicine, 2009) found that "A consistent characteristic of unsuccessful telemedicine programs is that they saw themselves as somehow separate from the overall organization and had independent objectives. Establishing a limited number (perhaps 10 – 20% of the anticipated total) of reasonably capable sites appears to work best. This focuses management attention. It also keeps the audience manageable and focused."
- (Scotland) the NHS of Scotland has released a “toolkit” for advocacy of e-Health.
- (Norway) (Nohr, 2007) demonstrates a business middle process which translates cross-jurisdictional legal issues
- (NZ) (Synergia, for Ministry of Health, 2007) provide a review of ICT support for health care. It found “the information environment has the potential to be a critical underpinning of self-care, supporting the actions of primary health care teams” (Synergia, for Ministry of Health, 2007) also noted that ICT did not stand alone in health, but supported the existing system.
- (US) The speech, by AHRQ CEO, Carolyn Clancy (Clancy, 2006) observed that presidential attention toward telehealth was “a substantial motivator of e-health work” in the United States.
- (US) In 2009 there were more than 193 separate programs focused on eHealth information exchange and analysis (informatics). (eHealth Initiative, 2009)
- Knowledge creation and dissemination is considered to be a valuable activity, in addition to evaluation of outcomes. The Agency for Healthcare Research and Quality provides an annual summary of all IT-related projects in the US. (AHRQ, 2009)

11.1. Teleconsultation case studies

11.1.1. Canada:

The service was established between St. Joseph's Hospital in Hamilton and North Bay General Hospital 400 km north of Hamilton on February 28, 2003. The service uses an IP-VPN (15 Mbps of bandwidth) commercially available [fibre optic] network to connect the robotic console in Hamilton with 3 arms of the Zeus-TS surgical system in North Bay. (Jimison, 2009)

This service includes an active line and a fully redundant (active backup) line enabling the telerobotic surgeon to use the second line immediately if there is failure of the first line. The telerobotic surgeries are performed at the highest priority QoS, which is a function of the network, thus ensuring signal transmission at the most rapid rate possible between the 2 sites. The surgical signals take priority over any other traffic on the network at the time.

The local laparoscopic surgeon as well as the nursing team in North Bay was trained with the use of the robotic arms and instrumentation prior to the start of the service. An experienced technician was also present during each case to ensure smooth setup of the robotic arms.

To date, 21 telerobotic laparoscopic surgeries have taken place between North Bay and Hamilton, including 13 fundoplications, 3 sigmoid resections, 2 right hemicolectomies, 1 anterior resection, and 2 inguinal hernia repairs. The 2 surgeons were able to operate together using the same surgical footprint and interchange roles seamlessly when desired. There have been no serious intra-

operative complications and no cases have had to be converted to open surgeries. The mean hospital stays were equivalent to mean laparoscopic LOS in the tertiary institution.

Telerobotic remote surgery is now in routine use, providing high-quality laparoscopic surgical services to patients in a rural community and providing a superior degree of collaboration between surgeons in teaching hospitals and rural hospitals. Further refinement of the robotic and telecommunication technology should ensure its wider application in the near future.

(Anvari, 2005)

Enablers: existing fibre optic network,
Reduction of risk communications/robot failure

Challenges: bandwidth (15Mbps) (limits further deployment),
Usability

Ontario Telemedicine Network (OTN)

The province of Ontario in Canada has a population of approximately 12 million, most of it concentrated in the large cities of Toronto, Ottawa, and London near the U.S. border. Ontario's northern sector, on the other hand, is often referred to as a province within a province. The area is roughly the size of Texas and California combined; yet it is home to fewer than 1.5 million residents. In such a sparsely populated land, healthcare providers constantly battle shortages of health professionals, distance barriers, isolation, escalating health care costs, and the demands of serving the diverse needs of distinct populations.

Medical telemedicine networks require the utmost performance since the information carried on them can literally mean life or death. Quality is equally important, since medical images or sounds require the highest resolution possible so doctors can quickly discern ailments and make accurate diagnosis. What is needed is a high quality; reliable, compatible, far-reaching network able to serve a remote section of the country 24-hours a day.

Cisco Collaborative Care, running on a Cisco Medical-Grade Network, is a key element of the OTN solution. Collaborative Care uses audio and videoconferencing technologies to interconnect teams or individuals on demand, leading to greater efficiency, better decisions and more effective care. The Collaborative Care solution enables clinicians and first responders to consult with patients and specialists across the province.

One of the mission critical services that OTN delivers over the Cisco Medical-Grade Network is Telestroke. Telestroke brings together videoconferencing and CAT scan Diagnostic Image Sharing over the network. Using this equipment, specialists around the province are on 24-hour call to assist hospitals in rural and remote areas. In the early hours of a stroke, doctors can use a drug to break down the blood clot and reverse the attack, but the same drug can also make a patient bleed to death. So doctors use OTN to reach experts quickly so that they can receive direction on how to properly administer the drug in the few hours that it can make a difference.

To date, more than 800 specialist physicians across more than 200 medical specialties and more than 1500 health professionals (including family physicians, physiotherapists, nutritionists and speech language pathologists) use the network to *provide care to their patients. More than 32,000 consultations are handled each year via OTN. Medical care in Canada is provided by their provincial governments and accounts for 10% of the country's Gross Domestic Product. OTN's use of telemedicine saves the province of Ontario about Canadian $8 million each year in travel costs alone.*

(CISCO, 2007)

Enablers: high bandwidth dedicated network with guaranteed up time
Challenges: pervasive network access to remote communities

11.1.2. United States

Kaiser Permanente

Kaiser Permanente (KP) is a private Health Maintenance Organisation (HMO, or health insurer for Australian terminology), which is commonly given as a "case-study of choice" for telemedicine and electronic health records. Kaiser appears to be well ahead of many health providers, incorporating large scale electronic and personal health records – across its 8million health plan members.

Kaiser Permanente has 8.7 million health-plan members, 165,000 employees, 14,000 physicians (Chow, 2009), 35 medical centres and 431 medical offices (Kaiser 2010).

KP has $1.3 billion in net income on $39 billion in operating revenues and a $2.2billion IT budget. KP created it's own "forward looking technology group" developed in 2007, which has developed simulated environments for home-monitoring system evaluation. Technologies include synchronous (teleconference) and asynchronous (store-and-forward). KP was a founding member of Continua Alliance. (Chow, 2009)

K.P.'s performance has been attributed to three practices:

1. *KP places a strong emphasis on preventive care, reducing costs later on.*
2. *Its doctors are salaried rather than paid per service, which removes the main incentive for doctors to perform unnecessary procedures.*
3. *KP attempts to minimize the time patients spend in high-cost hospitals by carefully planning their stay and by shifting care to outpatient clinics. This practice results in lower costs per member, cost savings for KP and greater doctor attention to patients. A comparison to the UK's National Health Service found that patients spend 2-5 times as much time in NHS hospitals as compared to KP hospitals.*

(Wikipedia, 2010)

Kaiser Permanente set 2015 as the year for the home being the center of care. A key driver to move center of care to the home is to lower capital investments in new facilities.

Kaiser is moving ahead with this program and now has 12 telehealth programs today, all in pilot. One early result is quite impressive: They have seen a 40% reduction in ED visits (i.e., re-admittance) via use of remote care monitoring.

Consumer acceptance and training has not been an issue. In fact, once these systems are installed in a home, consumers actually like them, take personal responsibility being quite diligent in taking their prescribed readings and often do not want to give back the devices when the trial period is over.

The challenges are internal and relate to workflow and data handling specifically, who does the monitoring, how and when should a physician get involved, what data is most important to collect and at what intervals and lastly, where should the data be stored and for how long.

(Chilmark Research, 2007)

Kaiser Permanente allows individuals to have direct access to their health information online and supports their care through patient-to-provider messaging, phone and video-based consultation.

By complementing the health service delivery with online interactions, Kaiser has reduced the number of visits to primary and specialist care clinics by 25% and 22% respectively, whilst not negatively affecting patient satisfaction levels and quality of care outcomes. From a consumer's perspective, the new model of care saved an average of 105 minutes per consultation, as they no longer needed to travel to and from a facility, find parking, wait in waiting rooms, etc.

(Moo, 2010)

Enablers: aligned beneficiary and payer, aligned regulation, clear funding model
Challenges: internal business processes

The Kaiser Permanente, case study suggests that when the people paying for treatment, are also the people who control how treatment is carried out, and control the metrics of the delivery, the result is a rational system focused on adopting technologies that assist health efficiency.

11.2. Store-and-forward case studies

11.2.1. Canada:

Tillsonburg is the first of six Thames Valley community hospitals to connect to a shared digital imaging network that will link six community hospitals with one another and with two teaching hospitals in London, Ont. – London Health Sciences Centre and St. Joseph's Health Care.

Together the hospitals are part of what has come to be called the Thames Valley Hospital Planning Partnership (TVHPP). The five other TVHPP are Alexandra Hospital in Ingersoll, Four Counties Health Services in Newbury, St. Thomas-Elgin General Hospital, Strathroy-Middlesex General Hospital and Woodstock General Hospital.

Their digital linkage with London's two teaching hospitals is expected to transform how patient diagnostic images are recorded, transmitted and reviewed and patient care is delivered. For instance, in a matter of seconds, specialists at London's teaching hospitals will be able to view diagnostic images taken at Tillsonburg hospital, and consult real-time with Tillsonburg physicians.

(Menezes, 2005)

Enablers: local champions, efficiency
Challenges: interoperability of data systems

11.2.2. Bangladesh:

In 2001, a new computerized information system to register; schedule and track immunization of children was introduced by the Department of Public Health in Rajshahi City Corporation, Bangladesh.

On a daily basis, the system uploads new entries from Rajshahi City Corporation's electronic birth registration system (follow this link for further details about this system). For each new-born, a schedule of immunization is created and printed, then given to the parents after registration of their baby's birth, attached to the child's birth registration ticket.

From this immunization schedule, parents can be aware when they need to take their child to the nearest immunization out-reach centre. The barcode on the schedule can be read at the centre, and health records for the child updated.

Even if parents lose the schedule or forget to take their child in, the system provides a safeguard. Every day, it prints out a target list of children whose immunization is due or overdue for a particular centre. That list is delivered to the centre together with the daily vaccine delivery. Centre health workers can use the list for house visits, knowing the child, the address and the vaccination required.

(E-government for developing countries, 2008)

Enablers: High level support,
User-friendly interface,
champions

Challenges: Policy and funding jurisdiction,
Innovation capture

11.2.3. Denmark

The E-Health services being developed are well integrated in the overall service provision and they address some of the current issues in the health system. Particularly well developed are remote consultation services, both via the telephone and online. The level of sophistication is high, with online consultation mediated through an online portal in a secure manner. In addition, a range of practically useful services is available such as online scheduling, prescription renewal and so on.

A national public eHealth portal now serves as the main access point for the health care services, and it provides a quite high service fulfillment. Thus users can interact with their GP (the only condition being that he/she is affiliated to the portal), for both administrative as well a clinical matters.

Denmark also can be seen as a 'diffusion' point for some online health resources - the "netdoktor" interactive portal for the general public has now spread to another 5 EU countries.

(eUser, 2005)

Enabler: strategic roll-out by government; e-health portal stimulates e-health businesses
Challenges: wide range of expectations and quality of service provided

11.2.4. Malaysia

The scale and scope of e-Health in Malaysia indicates significant potential in Internet-based health services. E-Health in Malaysia covers all forms of electronic health care delivered over the internet, from informational, educational and commercial "products" to direct services offered by professionals, non-professionals, businesses or consumers themselves. It also includes a wide variety of clinical activities that have traditionally been characterized as "telehealth", but delivered through the Internet.

Malaysia implemented its national plan for the development of ICT in health in 1995. Two years later, the Malaysian Government made one of the most clearly defined public policy statements on e-Health with its strategy and vision to 2020 of the Multi-Media Super Corridor initiative and the Telemedicine Act 1997. The Multi-Media Super Corridor project was aimed to establish a health-care system which could leverage advanced information and multimedia technologies to deliver previously unattainable health-care services at the individual, family and community levels, with telemedicine and medical informatics as the crucial components. In 2000, when the wider utilization of e-Health had just started, WorldCare, a global player in e-consultation, set up the world's first comprehensive teleconsultation network in Malaysia, connecting forty-one centres of its Ministry of Health across the country. The Government has also allocated funds to expand telehealth and teleconsultation services, to share health records and plans, to set up the National Health Informatics Centres and to implement hospital information systems in selected hospitals and clinics. Further, the introduction of the Health Management Information System has contributed to the increase in the use of ICT in the health sector.

(Fedorov 2009)

The Lifetime Health Plan (LHP) system is a distributed multi-module application for the periodic monitoring and generation of health-care advisories for all Malaysians. [The Lifetime Health Plan project has extended into] LifePlan--that aims to provide life-long, pro-active, personalized, wellness-oriented healthcare services to assist individuals to manage and interpret their health needs. Functionally, LifePlan based healthcare services are delivered over the WWW, packaged as Personalized Lifetime Health Plans that allow individuals to both monitor their health status and to guide them in healthcare planning. [The personal health plan program is continuing as of 2010]

(Association of Private Hospitals of Malaysia, 1999)

Enablers: high-level government support
Challenges: pervasive network access

Malaysia developed a telemedicine plan in 1997, as part of comprehensive government vision on ICT. The strategy "Vision 2020, Multi-media super corridor initiative" includes the 1997 Telemedicine Act, with associated telehealth policies and statements.

The 1997 Act has been cited as "successful for domestic telemedicine" although it may be restrictive for global entrants into the Malaysian e-Health system. (Scott IRDC 2010). We did not find statistics on outcomes.

11.2.5. United States

Beth Israel Deaconess Medical Centre (BIDMC) is currently evaluating a medical records approach that uses mobile phones (iPhones) as the access point for medical records. In addition, a strategy is being developed for 3D bar codes in and around emergency departments and ICU's. In both cases, the bar code and phone form the identification and the access point to the (large) medical databases available. (Halamka, 2010)

11.3. Telehome-care case study

11.3.1. United States

Veterans' Affairs

VHA has trained 5,000 staff to provide [Care Coordination Services, Home Tele Health] CCHT. Routine analysis of data obtained for quality and performance purposes from a cohort of 17,025 CCHT patients shows the benefits of a 25% reduction in numbers of bed days of care, 19% reduction in numbers of hospital admissions, and mean satisfaction score rating of 86% after enrollment into the program. The cost of CCHT is $1,600 per patient per annum, substantially less than other NIC programs and nursing home care. VHA's experience is that an enterprise-wide home telehealth implementation is an appropriate and cost-effective way of managing chronic-care patients in both urban and rural settings.

With VHA's CCHT model, care is actively coordinated across this continuum by a dedicated cadre of care coordinators. Care coordinators are healthcare professionals, usually nurses or social workers. Every CCHT patient is formally assessed by his or her care coordinator upon enrollment in the program […] for NIC, acute care management, or chronic care management services. After a patient is enrolled into the program, his or her care coordinator selects the appropriate home telehealth technology, gives the required training to the patient and caregiver, reviews telehealth monitoring data, and provides active care or case management (including communication with the patient's physician).

Typically, an individual care coordinator manages a panel of between 100 and 150 general medical patients or 90 patients with mental health–related conditions. Dependent upon a patient's underlying chronic condition and guided by the enrollment assessment, their care coordinator selects the appropriate vital signs, other objective parameters (e.g., blood glucose), or disease management data to acquire from the home for ongoing monitoring and disease management purposes. […] The care coordinator then decides which technology is best suited to collect these telehealth-transmitted data. VHA established national contracts for commercial-off-the-shelf (COTS) devices for CCHT

To provide staff with the requisite skills and […] meet VHA's expectation of caring for 50,000 NIC patients within 8 years, VHA created a national CCHT training center in Lake City, Florida.

The training curriculum consists of 12 hours of continuing education online and 2–4 weeks of hands-on training at the local site that a care coordinator must complete in conjunction with other assigned duties. […] The CCHT IT infrastructure is fully secure and protective of patient information. VHA standardized specific data and technical requirements in its technology contracts for the routine exchange of vital signs. VHA's financial decision support system (DSS) captures CCHT workload and provides cost data.

(Darkins, 2008)
(United States Department of Veterans Affairs, 2010)

> **Enablers:** payers-beneficiaries aligned, regulatory barriers overcome, billing mechanism under the control of Veterans Affairs,
> funding to provide system,
> simultaneous development of electronic health records with telehealth provision
> enforce standards compliance ensures interoperable technology
> training for staff mitigates some usability issues
> **Challenges:** current bandwidth limits some "high-end" technologies

Since 2002, VHA continues to collect data on the cost effectiveness, clinical outcomes and organisational impacts of telehome-care. Moreover, these reports are published in peer-reviewed literature. The work of (Kobb, Chumbler, Brennan, & Rebinowitz, 2008) provides a literature review of 10 published references.

In addition to this, VHA has opened its de-identified data, to allow public access. This allows universities and corporations to mine the health data, and means that the VHA clients act as one of the largest test-sets for health research. For example, (Maynard, 2004) provides data resources within the Department of Veterans Affairs that are becoming proxy research tools for the treatment of diabetes in the US.

Telehome-care has been established as part of Veterans Affairs mainstream care since 2002.

Telehome-care is being adopted across many jurisdictions in the US through 2007-2009. The "slow pace of adoption" is partly due to a lack of central data for proof of efficacy, economic benefit and partly a function of innovation speed in the health community: it can take 10 to 20 years for a new practice to go from development to mainstream use (Bohmer, 2010)

11.4. Tele-education case study

11.4.1. United States:

California Telemedicine and eHealth Centre

The California Telemedicine & eHealth Center (CTEC) is a leading source of expertise and comprehensive knowledge in the development and operation of telemedicine and telehealth programs. CTEC is nationally recognized as one of six federally designated Telehealth Resource Centers around the country. CTEC offers extensive hands-on experience in telemedicine development. CTEC understands the larger healthcare delivery system and works with policy makers, corporate, and industry leaders, and community based organizations to develop an environment that will support the optimal use of telemedicine and telehealth.

Over the past 12 years, CTEC has worked with hundreds of programs, providers, universities, government agencies, and equipment developers to identify best program practices, newly emerging technologies and trends, and studies that identify the impact of telemedicine services.

CTEC is housed within the California Health Foundation and Trust, a 501(c) (3) nonprofit corporation affiliated with the California Hospital Association.

CTEC has a long history of leadership in telehealth. In 1996 CTEC produced the first strategic plan for California's telemedicine adoption, and in 2005 CTEC was instrumental in initiating efforts to expand broadband availability throughout rural

California. CTEC funded the development of California's two Telemedicine Learning Centers at UC Davis and UC San Diego.

CTEC aided in the development of new and innovative telemedicine programs for medical specialty services, behavioral health, school dental screenings, diabetic retinopathy screenings, patient education programs, support groups, continuing medical education, provider site development, and on-line telemedicine training. In 2008 CTEC convened a collaborative of programs, payers, and providers to develop reimbursement and other policy incentives to support full optimization of telehealth.

(CTEC, 2008)

Enablers: Legislation,
highly educated and innovative culture,
advocacy

Challenges: fragmented funding structures,
network access costs

1. The legislation cited prevented private and public funders from demanding face-to-face consultation and promoted adoption of telehealth.

2. CTEC acts as a portal to e-health related research and information. CTEC also funds research that is measured against well-developed metrics.

12. Appendix 3: Australian case studies

- (Mitchell, 1998) detailed several case studies of telemedicine, with emphasis on teleradiology, telepathology and call centres. Mitchell addressed video conferencing, observing that videoconferencing was a bottleneck for many telemedicine applications. This was partly due to the lack of affordable broadband at the time.
- (Mitchell, 1999) provided a series of case studies from across Australia and the United States and found that Australian innovation was equal to (and sometimes better than) overseas counterparts.
- (Budde, 2009) examined key trends in networking and digital communication for Governments in Sweden, Norway, Denmark, the Netherlands, United Kingdom, Finland, Korea, Australia, Japan, Taiwan, Singapore, Hong Kong, USA and Canada. Australia is a world leader in the trans-sector approaches towards the use of digital broadband infrastructure.
- (Bahaadinbeigy, 2010) "73% of responding health-care facilities in Western Australia are using telemedicine. Videoconferencing was used for education (76%), wound care (55%) and psychiatry (53%). The most common store-and-forward application was tele-ECG, which was reported by more than half (54%) of respondents. "
- (Horvath & Ross, 2009) has noted eHealth is an important consideration for future graduates
- (Sharyn Crowie, 2009) have successfully trials IP security cameras for remote observation of emergency department patients
- (Song, Chan, Smith, & Watson, 2002) initiated a trail for Fetal tele-ultrasound which is being extended by Queensland Health to multiple hospitals
- (Walker, 2000) “The Telehealth Tasmania Network is a statewide network covering a range of primary care services including Wound Management, Diabetes Education and Support, Specialist Clinics, Mental Health, Palliative Care, and health professional support and education.”
- (Dept Health and Ageing, 2010) HealthConnect implementation aims to leverage existing eHealth projects and infrastructure, and progress towards compliance with National e-Health Transition Authority (NEHTA, 2008) and other nationally agreed standards to improve the availability of information in the health sector.
- (Le, 2009) demonstrated a direct correlation between the National Broadband Network trials in Tasmania and overcoming the barriers of cost-of-access (pervasive access) and showed an expected improved uptake of telehealth services.
- (Powell, 2009) demonstrated an online booking system for coordinated appointments for telehealth patients in Western Australia.

12.1. Teleconsultation case study

- (Lessing, 2001) reviewed 23 of 25 mental health telemedicine programs across Australia. The programs provided both direct clinical and secondary support services.

Few videoconferencing sessions were used for direct clinical care. Videoconferencing was used for professional education, peer support, professional supervision, administration and linking families.

- (National Rural Health Alliance, 2002) cited more than 600 Easyclaim facilities in rural and remote areas that provide easier access to Medicare, as evidence of successful telehealth programs.
- (Celler 2010) Outlined a deployment of a telehome-care system which used low-bandwidth telemedicine capability.

12.1.1. Grampians Rural Health Alliance Victoria

- Operating since 2005, renewed in 2007 and 2009.
- Increased telehealth usage by 40% and improved patient treatment throughout the region.
- Developed a customised Medilink solution to improve telehealth usage. Requirements for mobility and ease of use created a customised solution.
- Improved psychiatric support, patient discharge planning sessions, access to dialysis support nurses and wound care consultants, and more flexible staff training options.

(Bochert & Williams, 2010)

The Grampians Rural Health Alliance (GRHA) situated in western Victoria comprises of 12 hospital-based health services, four bush nursing centres and several stand-alone community health centres. It supports improved regional health outcomes by providing technology, applications and communications solutions to connect the regions health services.

The vendor (iVision) used a consultative approach. Ease of use and mobility, were primary factors for GRHA, iVision oversaw the design and development of the highly customized, integrated and mobile MediLink video conferencing units.

The mobility and simplicity of the 17 MediLink units deployed to date have made them particularly suitable for clinical support, supervision and mentoring. In addition to their installation in emergency departments, acute care nurses are using the units and district nurses to consult with wound care specialists on the needs of individual patients. Ultimately, the MediLink systems will enable health services to provide patients with immediate care using specialists typically not available in remote areas.

(iVision, 2010)

More than 1,200 hours of video conferencing are being notched up on the network each quarter and this figure is growing exponentially. For example, video conferencing usage for the October-December quarter 2009 increased approx 43% over the previous quarter.

Scheduled conferences increased approximately 35% to 699 over the last quarter, while ad-hoc conferences increased by 50%. The increase in the ad hoc videoconference is particularly significant because this service is used more frequently by clinicians for clinical support, supervision and mentoring.

Video conferencing demand was also strong among the regions psychiatric services which are increasingly relying on video conferencing for staff meetings, training, exam preparation and student supervision.

(Techworld, 2009)

Grampians Rural Health Alliance has released a strategic plan for 2010-2015, within which two of the four positioning ICT strategies are:

- *Limit longer term network/communication investments*
- *Short term solutions to meet NHHRC targets especially eReferral and telehealth*

(GRHA, 2010)

Enablers: funding of infrastructure evaluation,
Partnership/consultation with vendor

Challenges: usability, change management (initial clinical resistance),
Developing network/communication investments is not core business

12.1.2. ViCCU (trial in NSW)

Based on several interviews with members of the ViCCU trial and online reports

ViCCU developed as part of the CSIRO funded Centre fo Networking Technologies and Information Economy (CeNTIE).

"High bandwidth, advanced networking technology to make information available in real time so a specialist could decide on patient treatment as if they were in the same room.

The first installation of ViCCU was between Nepean Hospital, on the western outskirts of Sydney, and the Blue Mountains District ANZAC Memorial Hospital, 80 kilometres away in Katoomba. A clinical trial of the system ran for 18 months during which there were 443 documented 'activations'.

This trial was independently evaluated by the Centre for Health Informatics at the University of NSW."

(CSIRO 2009)

ViCCU was modeled on the position and actions of the specialist in the hospital room. The objective was to embed technology within the workflow of the specialist without requiring a change to the work practice or the operation of the team.

"Doctors are patient focused – they don't want to learn new technologies, [we must make] the new technology fit with their work pattern. Not the other way around."

The unit had 3 video streams. The cameras and monitor placement simulated the placement of specialist at foot of the bed in the Intensive Care Unit. There was a side camera, because the specialist would sometimes look at the side, a hand-moveable camera, and a light bench with a video stream - to look at documents and x-rays or other images.

The original system had no substantial video compression. In the original demonstration, a 70Mbps (full duplex) link was required. “One could apply a modern codec and get the 70Mbps requirement down to 10Mbps” [this is really not so, the latency would blow out considerably. Whoever reckoned that was not taking that into account. Suggest we replace this with “alternative codec technology could reduce the 70Mbps requirement substantially, subject to maintaining low enough latency”].

Why did the project between Katoomba and Nepean close?

> *“It required a high-speed broadband link. At the end of the trial, the broadband was not available and so the system couldn’t operate. “ [and today, NBN would fix that part we hope]*
>
> *“There was also the problem of local champions – when the champions moved on, the system did not get used.”[and the schemes we’ve proposed may address this]*

However, many of the lessons learnt from ViCCU have transferred to other projects and demonstrations. ViCCU was the starting point for EchoNet (also from CeNTIE) that enabled real-time remote echocardiography. (CSIRO 2009). ViCCU has also lead to the Loddon Mallee virtual critical care project – Victu – which was supported under the Clever Networks Program.

> **Enablers**: low cost broadband, system designed around clinical requirement
> **Challenges**: sustainable deployment needed on-going broadband access

12.2. Store-and-forward case studies

For studies involving store-and-forward systems, interoperability was typically a significant factor. This was either overcome by

1. Using a Greenfield approach (i.e. Discarding legacy systems) or
2. Substantial modification of interfaces between legacy systems.

Bandwidth was an issue for the use-cases. Sufficiently high bandwidth was often assumed to be present before the case study commenced. In the cases where bandwidth was low, additional digital enhancement techniques were applied.

12.2.1. The Children’s Hospital at Westmead, Sydney, 2007

> *The Children’s hospital at Westmead evaluated wireless hand-held devices for emergency departments.*
>
> *Clinicians will be able to access patient records from anywhere in the Emergency Department, including the patient bedside.*
>
> *The infrastructure consists of 40 Cisco 1200 series wireless networking access points; 40 Vocera hands-free communication badges; 10 Dell notebook computers, which operate on customized, battery-powered trolleys known as COWS (computers on wheels); and six Dell PDAs. IBM designed the installation, upgrade and integration of the Cisco wireless network and the Vocera communications system.*
>
> *The hospital's director of information services, Dr. Ralph Hanson, said his department is not focused on putting in IT for IT's sake and makes sure it assists clinicians in doing their jobs.*

(CISCO, 2007)

Informal discussions with Ralph Hanson and technical staff involved in the trial at the Children's Hospital at Westmead (in 2008) suggested the communication badges were designed as staff identifiers. The badges overcame issues relating to the access privileges for the computers on wheels. Behind the patient records are numerous databases and access systems, which required substantial "plumbing" to ensure all the data was moved from various data stores to the clinician. Finally, smart interfaces are required, to allow a clinician to find the appropriate documents for a given patient easily.

Enablers: low-cost equipment,
Enthusiastic local champions
(Some) experimental IT support for "back-end" interoperability

Challenges: clinician acceptance –enthusiasm difficult to extend to whole staff,
Usability (especially for COWs) work practices changed
Interoperability of legacy systems

12.2.2. Rapid Prototype Development and Evaluation program (2008-9):

The Australian Dept. Defence is developing an electronic health records system. The Rapid Prototype Development and Evaluation (RPDE) program, through the eHealth Task (Task 29), first tested the concept for the system. Limited public details are available

> *The Capability Implementation Plan, delivered by the Task, recommended a staged approach to the implementation of the Defence eHealth System, starting with a Prototype System that establishes the basic electronic health record functionality. Then—through a series of six-monthly cycles over a two-year period—the functionality and geographic reach of the eHealth System would be extended, including integration and connectivity with external health systems and Defence enterprise systems.*
>
> (RPDE, 2009)

The following material is taken from interview notes

What was the scope of the project?
The Task purpose was to examine what solutions were available to address the primary capability deficiency; of the lack of an electronic clinical health informatics application at 'point of care' that allows easy entry of individual clinical information to populate an electronic health record—and the subsequent management of that information. The original problem was that all health records were paper based, and there are two repositories - a central data store (that is fixed) and a unit store that should follow the person.

Major stakeholders were brought together from within Defence and a number of external stakeholders such as Veterans Affairs and Human Services (Department of Health & Ageing). Victoria Prisons were also interested (as they had a similar need) and NEHTA were included as well.

The Task approach was to develop a proof of concept, to evaluate whether an Initial eHealth System could be developed using existing COTS products.

A number of vendors of mature software products were identified in a market study and invited to attend an industry briefing in January 2009. Those vendors were invited to respond to a Request for Proposal, with four vendors providing a number of their products that were integrated to build the Proof-of-Concept system.

The Proof-of-Concept system took 14 days to complete.

The Proof-of-Concept system was based in Canberra, with connections to external systems in Darwin and Brisbane. It was demonstrated to Defence users in Canberra, Melbourne, Brisbane and Darwin

Operated in nodes - nodes could be in or out of contact - which mimicked the central-unit approach. The information was transmitted over a 256-bit encrypted link, with secure messaging. The new system only allowed specified roles to interact with specified parts of the data.

All standards were open, and enforced. The information management component of the system used SnoMed-CT and ICD-10 for terminology. All interfaces were open, and documented. Vendors were informed they could use any back-end system to support the requirements, but the interface compliance and standards compliance were strictly enforced.

The RPDE task engaged practitioners as part of the user requirements phase. How Defence decides to have the practitioners use the system.

The recommendation from the Task was for Defence to engage one or more vendors, to first establish a prototype, then a pilot and finally a production system. This 'spiral development' approach would allow the system to developed gradually and deliver against the user requirements. The Task Sponsor Joint Health Command assessed those recommendations and assigned the role of implementing the Initial eHealth System to its Project Management Office.

Joint Health Command issued a Request for Tender at the start of 2010, and is currently completing its evaluation process.

Enablers: open standards for software and data, single-user point of view,
Constraints: change management

12.3. Telehome-care case studies

The current systems being deployed are low-bandwidth, sometimes with limited bandwidth videoconference capability. The typical use-case is for chronic care at home, in association with early-discharge and/or ageing-in-place.

Network access appears to be a minor barrier in this case since much of the existing telehome-care technology is low bandwidth and may operate over telephone line. There appears to be some scope for improved service – either as better interaction and information delivery - as higher bandwidth uptake occurs.

12.3.1. Baptist Community Services

The following is based on interview notes, June Heinrich, CEO Baptist Community Services.

Baptist Community Services is deploying telehome-care systems for community care of aged persons. There is a consumer demand for people to "age in place" i.e. remain in their home for as long as possible, rather than be moved to nursing care. This also reduced the cost of care – since permanent nursing care is substantially more expensive than for home care.

The cost of home-care is dominated by the cost of transporting a nurse to community patients. Since the care budget is fixed, money that is spent on nurses driving from patient to patient cannot be spent on care. Telemedicine allows the centre to have more ongoing care to more people, without the cost of driving nurses. This then acts as a triage – a nurse goes to a home with information, or based on need, rather than "just in case."

Baptist Community Services trialed several telehome-care solutions, including BL-Healthcare. This service provided video conferencing, reminders for medicine, and used a technology solution which was “a black box that just plugged in to the TV” This provided a health channel, and reminded patients to take their medicine, with a picture of their children on the television which also addressed the isolation of patients. However, the technology company was a startup – they could not provide the level of on-going support required by BCC. The technology was also not well designed for the end-user: “Most of these people don’t live in flashy tech homes, so when there is a new piece of equipment in the room, they get asked by their family to explain why they need it.” There is an expectation this will reduce as the next generation begins to move into aged care.

BCS are now trialing a new pilot with Tunstall equipment, which allows patients to leave hospital care at an earlier discharge than occurred previously. By continuous monitoring, patients can avoid re-admission. The current pilot is progressing and should be completed by the end of 2010.

The economics of telehome-care and the benefits for telehealth are very clear, “much of the problem isn’t technical; it’s about making it work for the user.”

> *The BCS board has invested in a demonstration home featuring what is possible. BCS converted a 1960s home and remodeled it for safe, secure and independent ageing. The design and fit-out also assists people living with dementia or disabilities. [It is] to be a research and development ‘lab' for BCS to trial and apply the latest technologies and also to be a resource to the rest of the industry. The technology includes:*
> *Video display and hands-free phone, CareCall emergency monitoring alarm unit and pendants, Fall detector, Bed occupancy sensor, Chair occupancy sensor, Light sensors, Epileptic seizure alarm, Goodnight switch*
>
> *[BCS] are also going to use the home to trial remote care management using the residents owned television as a personal help channel. We have imported a set-top box device that can monitor vital signs such as blood pressure, weight, breathing, glucose and pulse. It will have specific help functions, plus interactive care messages, health education and video visits. The daughter will be able to record messages on when to take medication and also teleconference.*
>
> *The cost of one set-top box is the equivalent of the cost of one hour of care per week. At the moment, we provide a Medication Round service, which takes a staff member 10 minutes to get in to the home and provide the service before getting back in the car and driving to the next house. We will be able to use our skilled staff more efficiently by using technology to help.*
>
> *The home also has things like a movable sink that can be lowered electronically, and the cook top and kitchen sink have been insulated to ensure there are no burn injuries - all for people in a wheelchair. The carpet has been selected for the roll-ability of a wheelchair. These are simple things but they can make a huge difference to somebody who is ageing and frail.*
>
> (Village interview 2009)

“The truth is, we all want to stay in our own home as long as we can, and we want choice and we want dignity.” (Village interview 2009)

“Older people need big buttons (on their home care devices) you can’t read typical technology designed by kids for kids”, June Heinrich, interview

Enablers: aligned beneficiary and payer, single jurisdiction,
Challenges: usability, design of technology for aged groups.

12.4. Tele-education case study

Med-e-serve was referenced in (Mitchell, From telehealth to e-health: the unstoppable rise of e-health, 1999).

> *Med-e-serve formed in 1994, as a leading Australian Internet community for healthcare professionals. Med-E-Serv supports best practice in the healthcare sector by facilitating the use of innovative Internet technologies for the creation and delivery of continuing education, cost-effective promotion and the development of electronic business processes. By 1998, Med-E-Serv focused on groups of clinicians creating their own content and the groups collaborating online.*
>
> *Med-e-serve was acquired by the University of Queensland in 2007, and now operates as Primed-Medeserv. Primed-Medeserv is Australia's largest provider of online continuing professional development (CPD) for the health care sector. Primed-Medeserv's online learning environments typically contains the following elements ensuring a high level of engagement for learners coupled with Medeserv's differentiated approach of sophisticated education design: facilitators, tutorials, discussion groups, multimedia, case studies, assessment, student progress record keeping. Primed-Medeserv continues to operate as a commercial company. The two co-founders Robert Hendy and Lynn Robinson have professorial positions at University of Queensland.*
>
> *Med-E-Serv has provided a range of continuing professional development programs to tier 1 health organizations and professional colleges some of which include: Australian department on Health and Ageing; Queensland Health; NSW Health; Post Graduate Medical Council of Victoria; The Royal Australian and New Zealand College of Radiologists; Pharmaceutical Society of Australia; The Royal College of Nurses, Australia. [The program is still operational.]*

(PrimEd)

Enablers: consumer demand for professional development
Online access

Challenges: limited market,
Path-to-impact aligned with University higher degree program

Health-Insite

Health-Insite provides an internet-based gateway for health information provided by a wide spectrum of approved information partners. The objective is to provide Australians with easy access to reliable information about health and well-being toward more informed healthcare decisions.

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