What is Needed for Telehealth to Deliver Sustainable Value to the Routine Operations of Health Care in Australia?

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Thesis Abstract

Telehealth is the delivery of health care services at a distance, using information and communications technology. Telehealth can improve access to health care services through remote consultations, extend care for chronic diseases to the home, make more efficient use of the health workforce, and deliver savings in some aspects of health care. Despite this, telehealth implementation has been slow, fragmented, and frequently short-term. The central research question of this thesis is "What is needed for telehealth to deliver sustainable value to the routine operations of health care in Australia?". This question is answered using a mixed methods approach, combining systematic and narrative reviews, economic analysis and a qualitative interview study of key informants.

The central research question contains four sub-questions:

1. **Can telehealth deliver value to health care?**

A literature review of reviews synthesised the research evidence, concluding that telehealth can contribute positively to health care, although much research was of low quality and not generalisable. Two further pieces of research make an original contribution to this literature:

a) A systematic review of economic analyses of the use of real time video communication in telehealth established that this was cost-effective for home care and on-call specialists, whereas results for rural service delivery were variable.

b) A mixed methods evaluation of a service using home video communication to observe patients with tuberculosis was compared to the traditional in-person home visiting observational service. The telehealth service significantly improved the proportion of medication ingestion episodes that were observed, and the economic analysis showed cost-effectiveness.

2. **What is the status of telehealth services in Australia?**

Data were obtained from the published literature, by searching MedLine, CINAHL and Informit databases post-2000, from 37 telehealth services investigated through the qualitative interview study, and from the Australian Government Medicare statistics. Analysis

showed that Australian telehealth services are small, fragmented and low volume, comprising a very small percentage of total health care activity.

3. **What is needed to increase telehealth implementation?**

Thematic analysis was conducted on data obtained during interviews with 39 clinicians, managers or researchers associated with 37 telehealth services. Analysis revealed that champions were the key factor in initiating telehealth services; these enthusiastic individuals drove the uptake of telehealth by persuading clinicians of the legitimacy of telehealth, and by building relationships between clinicians. As ethico-legal matters were regarded as a barrier to the uptake of telehealth, these were analysed separately, finding that privacy, security and consent were identified as issues, but that they were manageable in practice.

4. **What is needed for telehealth to become routinely sustainable?**

Further qualitative data analysis using grounded theory methods produced an explanatory model proposing that clinician acceptance was the key factor in achieving sustainability. Clinician acceptance could overcome the major barriers of workforce pressure, low demand, limited resourcing and technology problems.

In conclusion, telehealth in Australia remains in an early stage of development. Supporting champions, plus engaging and building relationships between clinicians will enable telehealth to contribute to the overall sustainability of an effective and efficient publicly funded health care system.

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide.

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Manuscripts Contributing to this Thesis

Published

Wade V, Eliott J, Karnon J and Elshaug AG. A qualitative study of sustainability and vulnerability in Australian telehealth services. *Studies in Health Technology and Informatics* 2010; 161: 190-201

Published

Wade VA, Karnon J, Elshaug AG and Hiller JE. A systematic review of economic analyses of telehealth services using real time video communication. *BMC Health Services Research* 2010, 10:233 doi:10.1186/1472-6963-10-233

Published

Wade V, Littleford A and Kralik D. Home medication management by videophone: translation from pilot project to integrated service. *In Handbook of Digital Homecare: Successes and Failures* (Communications in medical and care compunetics) 2011 Bos L, Goldschmidt L, Verhannenman G and Yogesan K (eds) Springer-Verlag Berlin Heidelberg doi:10.1007/978-3-642-19647-8

Published

Wade VA, Eliott JA and Hiller JE. A Qualitative study of ethical, medico-legal and clinical governance matters in Australian telehealth services. *Journal of Telemedicine and Telecare* 2012; 1-6.

Published

Wade VA, Karnon J, Eliott JA and Hiller JE. Home videophones improve direct observation in tuberculosis treatment: a mixed methods evaluation. *PLoS ONE* 2012; 7(11):e50155.

Published

Wade V and Eliott J. The role of the champion in telehealth service development: A qualitative analysis. *Journal of Telemedicine and Telecare* 2012; 18(8):490-492.

Accepted for publication 22nd May 2013, subject to revision

Wade VA, Eliott JA, Hiller JE. Clinician acceptance is the key factor for sustainable telehealth services. *Qualitative Health Research.*

An explanation and justification for the positioning of these publications is as follows:

Studies in Health Technology and Informatics is a book series (2011 impact factor 0.27) and this article, which had originally been accepted through a peer review process to be presented at the Global Telehealth 2010 conference, was subsequently chosen for inclusion in a volume of selected papers from the conference.

BMC Health Services Research (2011 impact factor 1.66) was the preferred option for the systematic review of economic analyses, and was chosen instead of a specialist health economics journal because it was aimed at health providers and administrators who are considering the value of telehealth for their services. This review was marked by the journal as 'Highly Accessed', and has been cited 19 times as recorded in the Web of Knowledge (accessed 8 June 2013)

A book chapter was submitted to the *Handbook of Digital Homecare* (no impact factor) because this format allowed for a detailed description of the development and operations of the home telehealth service which forms the major case study of this thesis.

Two articles, about ethico-legal issues in telehealth, and the role of the champion in telehealth uptake, were published in the *Journal of Telemedicine and Telecare* (2011 impact factor 1.207) as this is one of the two leading specialist journals in telehealth, and these articles would be of interest to those directly engaged in the field.

PLoS ONE (2011 impact factor 4.09) was selected for the mixed methods evaluation of the home telehealth service. There were two reasons for this choice: firstly as the article was about direct observation for tuberculosis and may be of international interest, open access was considered to be important, and secondly, as the article contained three separate studies, it was relatively lengthy.

Finally, *Qualitative Health Research* (2011 impact factor 2.188) was chosen for the article presenting a grounded theory model of telehealth sustainability. Besides being the premier journal for qualitative research in health, this journal takes longer articles with a strong theoretical focus.

Conference Presentations Arising from this Thesis

1. Wade VA Videophone delivery of home medication management; making the transition from a telehealth pilot project to an ongoing service. Health in Transition conference, Adelaide 16-20 August 2009

2. Wade VA Eliott, J, Elshaug A, Karnon J and Hiller J. How does telehealth change healthcare delivery? – a qualitative study. 40th Public Health Association of Australia Annual Conference, Adelaide, 27-29 September 2010

3. Wade VA A qualitative study of sustainability and vulnerability in Australian telehealth services. Global Telehealth 2010, Perth, 10-12 November 2010

4. Wade V, Hiller J, Karnon J, Eliott J and Elshaug A Home telehealth improves the effectiveness of Directly Observed Therapy for tuberculosis. Communicable Disease Control Conference, Canberra, 4-6 April 2011

5. Wade V, Hiller J, Eliott J, Karnon J and Elshaug A The organisational consequences of introducing telehealth – a qualitative study. Successes and Failures in Telehealth, Brisbane, 1-2 December 2011

6. Wade V, Hiller J, Karnon J and Eliott J Home telehealth improves directly observed therapy for tuberculosis. 9th HTAi Annual Meeting, Bilbao, 25-27 June 2012.

7. Wade V The role of the champion in telehealth service development: a qualitative analysis. Global Telehealth 2012, Sydney, 26-28 November 2012.

Acknowledgements

I would like to thank my supervisory panel, who have been models of stability, responsiveness, and intellectual support. Janet Hiller, as primary supervisor, is generous with her time, ruthless with lack of clarity, and has generously concerned herself with my future academic career. I am not a natural born health economist, but Jon Karnon did his best with me, and has greatly advanced my knowledge in this field. Jaklin Eliott joined the panel later to take up the post of qualitative supervisor, and has provided excellent guidance in this area as well as being a very good editor. Adam Elshaug was my most constant support in the early years, and introduced me to many of the nuances of my new role.

I also want to thank Jeremy Hamlyn, who began this journey as my business partner and is now my academic colleague. It is partly his fault that I commenced this PhD in the first place. We also entered The University of Adelaide's entrepreneurs' challenge together, which was a very interesting and major diversion from timely completion.

Thank you Vicki Xafis; we had the kind of relationship that every PhD candidate needs; someone to share your data, talk over the minutiae of the methodology, and have long detailed sessions about one's developing theory.

Thank you Brita Pekarsky; who opened a blank Excel spreadsheet and invited me to free myself from fear when developing an economic model.

Thank you to the Qualitative Methods Discussion Group, who gave me confidence and enabled all of us beginning qualitative researchers to reach the next level.

And finally, thank you also to Belinda, who started a long and arduous period of study at about the same time as I did; our friendship has survived and grown as we have travelled together through long dark tunnels with occasional glimpses of high ground and breathtaking views.

Statement of Conflict of Interest

Throughout much of my PhD candidature, from July 2008 until the 30th June 2012, I had an association with a company that was offering telehealth services to the market on a commercial basis, and my decision to undertake a PhD was related to this association. A conflict of interest is therefore an important part of the context to this thesis, and a detailed discussion of the issue is warranted. The history and background to the conflict of interest is described first, followed by a formal statement.

Background

I am a psychologist and general medical practitioner, and from 2000 to 2007, I was employed by the SA Divisions of General Practice Inc (SADI), an incorporated association which acted as the peak body for the Divisions of General Practice in the state of South Australia. SADI was funded by both the Australian Government and South Australian Government to implement projects and programs aimed at introducing new models of care in general practice which would improve patient health outcomes.

I was the Medical Director and then became the CEO of this organisation. In this role, I judged that e-health development would be a key factor in achieving these aims, which were supported by both levels of government, professional associations and many individual clinicians. The difficulties of implementation were, however, substantial, and in an attempt to overcome these I employed a network design engineer, Mr Jeremy Hamlyn, to implement a managed health network for general practice and primary care in South Australia, which could be used for secure transmission of health data and video communication. Grant applications to set up such a network were unsuccessful, and it further appeared that without ongoing external funding there was no business model that would encourage a diverse group of small health services to become part of such a network, or to continue to fund it once any initial grant was concluded.

From mid-2007, both I and Mr Hamlyn had ceased our employment with SADI, but we still considered there was a place for a managed health network in the private sector. To make such a network sustainable in a private setting, it needed to provide applications that health services might be willing to pay for, and video communication was chosen as the initial product. In this way, Mr Hamlyn and I entered the telehealth arena, using Mr Hamlyn's company, Design Networks Pty Ltd, as the vehicle for a commercial start-up to prove the

value of the concept. Over the next five years, the company conducted several feasibility tests and pilot studies of telehealth services, with myself and Mr Hamlyn working in a medical-technical partnership, whilst searching for a model that would make e-health sustainable.

As part of this undertaking, I canvassed the academic literature and found that the problems we had encountered in e-health implementation were apparent worldwide. Specifically, the same difficulties we had experienced in transitioning pilot studies to ongoing services, in achieving large scale uptake, and in becoming sustainable, had been encountered by many others. Whilst much commentary and some research had been published, I considered that the problem was not well understood, and hence commenced this PhD.

Declaration of Conflict of Interest

Formally, I declare that:

- I was the unpaid Medical Director of Design Networks Pty Ltd for five years, from June 2007 to June 2012.
- I never had any equity in Design Networks, which is 100% owned by Mr Jeremy Hamlyn.
- Over the course of this five year period Design Networks provided me with reimbursement of expenses for conference attendance, a laptop computer, and a videophone with associated connectivity.
- I received reimbursement of expenses for conference attendance on one occasion from Telstra, a large Australian telecommunications company.
- In 2008, I received $2,000 from the Royal District Nursing Service of South Australia (RDNS SA), for conducting an evaluation of a pilot study of using home videophones for medication management(1). Design Networks supplied the technical infrastructure for the study and worked with RDNS SA on the clinical and technical implementation. This pilot project became an ongoing service, and I researched one aspect of this service as part of the PhD.

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List of Abbreviations

ADSL	Asymmetric Digital Services Line
CBT	Cognitive Behaviour Therapy
COPD	Chronic Obstructive Pulmonary Disease
DoH	Department of Health
DSL	Digital Services Line
ED	Emergency Department
EPOC	(Cochrane) Effective Practice and Organisation of Care
HbA1c	Glycosylated Haemoglobin
HTA	Health Technology Assessment
ICT	Information and Communications Technology
ICU	Intensive Care Unit
IP	Internet Protocol
IT	Information Technology
ISDN	Integrated Services Digital Network
MBS	Medicare Benefits Schedule
NBN	National Broadband Network
NTOIP	National Telehealth Outcome Indicators Project
OCD	Obsessive Compulsive Disorder
PTSD	Post-Traumatic Stress Disorder
QoL	Quality of Life
QALY	Quality Adjusted Life Year
RDNS SA	Royal District Nursing Service of South Australia
SADI	SA Divisions of General Practice Inc.
TB	Tuberculosis
TSS	Telehealth Services Study
UK	United Kingdom
US	United States

CHAPTER 1 - Introduction

1.1 Introduction

Telehealth is the delivery of health care services at a distance, using information and communications technology (ICT). Telehealth matters to health care delivery in Australia because it has the potential to assist with three substantive problems currently facing the health care system: increasing demand for services, rising costs, and limits on the capacity of the system to deliver care(2). Increasing demand is largely due to two factors:

1. The aging population, as the burden of chronic illness, particularly conditions such as dementia, increases sharply with age(3).
2. Absolute increases in some chronic conditions, for example diabetes, which are related to increasing inactivity and obesity(4).

Rising costs reflect this increase in demand plus increases in the range and numbers of health services provided, with more diagnostic tests and imaging being conducted, more expensive drugs coming onto the market, and more aggressive treatments being offered throughout the life span.

The ability to meet the demand for health care is limited by the ability of both governments and individuals to pay, and also by the capability of the health workforce, which is aging and has not expanded at the rate of increase in demand. This has led to shortages in some locations and specialist groups(5). Australia has a very large rural area with low population density, and it is simply not possible to have the same levels of service in rural as in urban locations. This, plus the difficulty of recruitment and retention of health care workers in rural areas, has led to inequities in access to services and health outcomes between urban and rural areas(6, 7).

There are both ethical and political imperatives to address these problems, and one of the proposed means of doing this is to use technology to deliver health care services remotely. Telehealth may improve timeliness and accessibility to primary, secondary and tertiary care for rural patients, as well as those living in aged care facilities and other institutions(8). Telehealth also has the capability of extending care for chronic diseases to the home, consequently reducing emergency department visits, hospitalization and overall mortality(9). Economic modelling has predicted substantial savings to health care costs if telehealth was taken up on a broad scale(10).

Despite these proposed and demonstrated benefits, the implementation of telehealth has been slow, uneven, and fragmented, and it has been difficult to achieve routine, sustainable uptake(11, 12). There has been much commentary, together with some theorizing and a limited amount of research into this phenomenon, which will be explored in detail later in this work. This thesis aims to make a contribution to the issue from an Australian perspective; to understand what is needed within Australia for telehealth to deliver on its promise. The relevance of this to telehealth internationally will also be considered.

1.2 About Telehealth

1.2.1 Defining Telehealth and Telemedicine

The terms ‘telehealth’ and ‘telemedicine’ are often used interchangeably, although in the international academic literature ‘telemedicine’ is the more commonly used term(13). In Australia, the *Health On Line* report, produced by the Australian Government’s House of Representatives Standing Committee on Family and Community Affairs, recommended in 1997 that ‘telehealth’ be adopted as the standard term, in order to imply that a broad spectrum of health care was included(14). Mitchell, who carried out a national scoping study for the Australian Government at that time, suggests that the term ‘telemedicine’ lost favour in Australia because it implied services delivered by doctors, whereas ‘telehealth’ included all health professionals, and other health related activities, such as education and administration(15). In this thesis, ‘telehealth’ will be the preferred term except when citing or referring to authors who designate the field as ‘telemedicine’.

The definition of telehealth has changed over time; in the 1970s it was relatively narrow, typically given as “the utilization of interactive or two-way television to provide health care”(16). As the field developed, definitions broadened to include the use of data and automated processes(17), but the narrower concept remained current in Australia for two more decades. In 1997, the *Health On Line* report defined telehealth as “the practice of medicine and delivery of health care between two distant locations by the use of interactive videoconferencing facilities.”(14). Since then, the government has not proffered more definitions of telehealth, rather, the definitions have come from those implementing and researching telehealth services.

Mitchell surveyed a variety of definitions in 1998 and concluded that they contained the common elements of delivery of health services at a distance, by transferring information, using telecommunications, and involving a range of health professionals, patients and other recipients(15). A decade later, Sood collected 104 peer-reviewed definitions of telemedicine, and synthesised these into the following definition:

- Telemedicine being a subset of telehealth, uses communications networks for delivery of health care services and medical education from one geographical location to another, primarily to address challenges like uneven distribution and shortage of infrastructural and human resources(18).

Whereas this definition of telemedicine bears a clear similarity to the definitions of telehealth discussed above, there is some lack of clarity because Sood and colleagues did not define what they meant by telehealth. More succinctly, from 1993 the National Library of Medicine has defined telehealth as "the delivery of health services via remote telecommunications"(19). In considering this variety of approaches, the following definition I have adopted for the purpose of this thesis is broad enough to encompass a variety of types of care and methods of use, but keeps the element of delivery across a physical distance:

- Telehealth is the delivery of health care at a distance using information and communication technology (ICT).

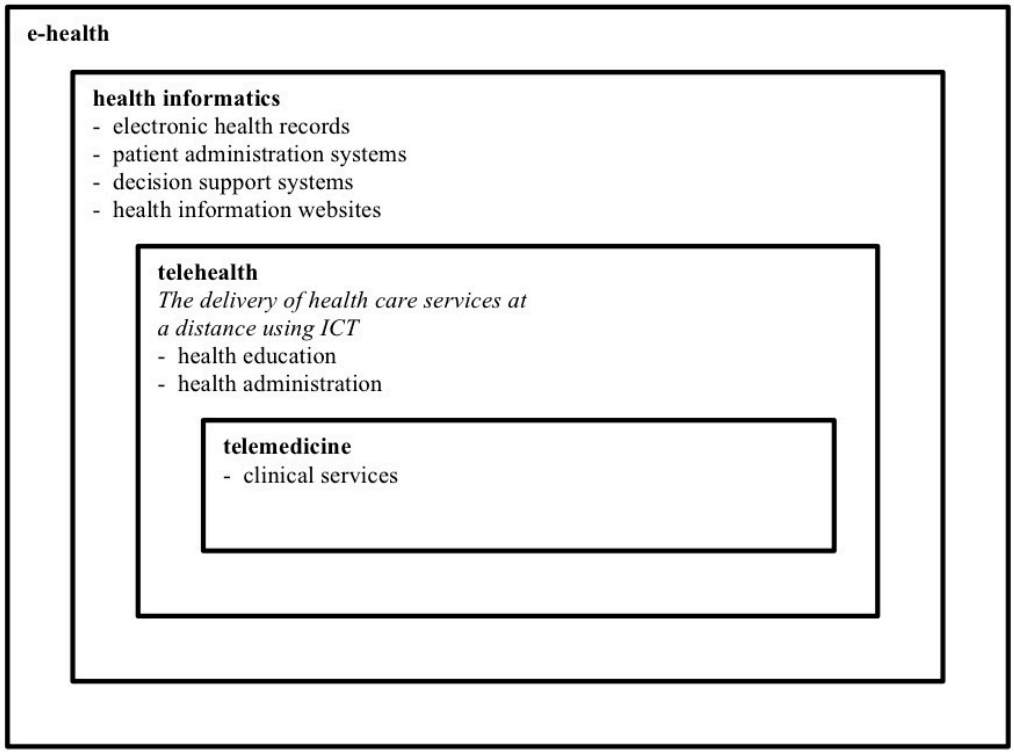
1.2.2 Telehealth in Context

Telehealth has come to be regarded as a subset of the broader field of 'e-health', which encompasses all applications of ICT in health care. The World Health Organization defines e-health as "the transfer of health resources and health care by electronic means"(20). This is closely related to the term 'health informatics', defined as the scientific discipline dealing with the collection, storage, retrieval, communication and optimal use of health related information(21). E-health is the newer term, first appearing in the literature in 1999(13); it originated in the business and marketing sectors, and despite some initial resistance, was rapidly adopted by academia(22). A systematic review of the definitions of e-health concluded that the concept intersected the fields of health, technology and commerce, and was constructed as a tool or a process to expand or enhance health care(23).

As well as telehealth, e-health and health informatics encompass electronic health records, electronic patient administration systems, decision support software, and electronic

health information available via websites. All of these functions support clinical care, but are not the actual direct delivery of care. **Figure 1-1** shows how I have related these concepts to each other, characterising telehealth as a subset of health informatics(24).

Figure 1-1 Telehealth within its Broader Context



This figure also shows how the relationship between telehealth and telemedicine is constructed if telemedicine is restricted to clinical services only, and telehealth includes associated activities, although the question as to whether these terms are synonymous or distinct is still debated in the literature(25). The main focus of this thesis is clinical service delivery, which, as determined above, will be described as telehealth.

1.2.3 The Dimensions of Telehealth

Since telehealth is a means of delivering a broad spectrum of health care services, its manifestations are very diverse. I have taken three previously published classification schemes of telehealth(25-27) and extended these into a system with eight dimensions. This offers a means of describing and comparing telehealth services, which I refer to in the specific research projects within this thesis. The first four dimensions can be applied to any health care activity, and the remaining four specify aspects of the telehealth service being undertaken.

1. **Purpose:** this is sub-categorised into the clinical activities of assessment, diagnosis, treatment, management, and follow up. Associated non-clinical activities such as mentoring, supervision and education are also included here.
2. **Service type:** this refers to the type of health care that is being delivered, and can be subdivided into two groups:
   - *clinical discipline*, for example, psychiatry, radiology, paediatrics, nursing, physiotherapy and so forth.
   - *disease or treatment focused units* such as transplant medicine, palliative care, renal dialysis, or wound care.
3. **Environmental setting:** this specifies the physical location of each participant, for example hospital, remote health centre, general practice, home, or residential aged care facility.
4. **Interaction type:** this refers to the roles of the participants in the telehealth interaction. The first two types are used in standard health care or in telehealth, and the third type is specific to telehealth.
   - *provider-to-patient*; the most common form of health care provision.
   - *provider-to-provider*; this is a clinical interaction without the presence of the patient and includes requests for advice about clinical care, mentoring, and multi-disciplinary case conferences. Most diagnostic services such as clinical biochemistry and radiology also operate in this manner.
   - *provider-to-patient with a second provider*; this means that one health care worker is with the patient and a second health care worker is supplying clinical services at a distance. This is the model that is presently funded for telehealth in Australia.
5. **Technology type:** there are four sub-categories in this dimension:
   - *equipment*; for example, videoconferencing machines, videophones, mobile phones, computers and monitoring devices.
   - *connectivity*; for example, telephone line, broadband, satellite connection, mobile voice, and mobile data services.

- *codec*; this is the means by which the data is coded into a form suitable for transmission, then decoded at the receiving end. There are many types of codecs and those in common use change rapidly.
- *network configuration*; this refers to the way in which the telehealth transmissions are managed and separated from other electronic communications. Examples of configurations include private network, virtual private network, and open internet.

6. **Delivery modality:** there are two modalities:
   - *synchronous*, where the participants communicate interactively in real time.
   - *asynchronous*, where the data is collected then stored for later transmission and receipt; this is also known as store-and-forward telehealth.
7. **Type of data transmitted:** this can be divided into video, still image, audio, text, and non-text data. Examples of this latter category include very simple transmissions such as personal alarms, which can be only on or off, or more complex examples such as remote electrocardiogram monitoring. Specifying the type of data is important because this affects the amount of bandwidth needed for reliable and accurate transmission.
8. **Type of site:** in addition to a geographic description, telehealth sites can be divided into the location nearest to the patient, from which the referral is made or expertise requested, and the distant site where the health care worker providing expertise is located. The Australian New Zealand Telehealth Committee recommended that these be called receiving sites and providing sites, respectively(28).

   In practice, different types of health care are associated with particular forms of telehealth. Three examples illustrate these associations:

   - Psychiatry primarily uses real time video communication, either for direct assessment and management of patients in a provider-to-patient interaction, or for assisting primary care providers with this work, using a consultation-liaison model, which is a provider-to-provider interaction.
   - Dermatology uses mainly store-and-forward transmission of still images and associated text, as provider-to-provider telehealth, whereby the primary care

provider sends the data to a specialist for an opinion. This form of service provision increasingly resembles a diagnostic service.

- Diabetes care to the home may use real time video, but more commonly uses transmission of text from the patient to the provider: typically the patient has a device which records physiologic parameters such as blood pressure or blood sugar readings and these are transmitted asynchronously to a health care provider for later review.

Having presented this classification scheme, some of the common terms that are also found in the telehealth literature can now be placed in context:

Telehomecare (also described as 'telecare'): refers to Dimension 3, the site of delivery. It may also refer to the delivery of social care as well as health services to the home, which relates to Dimension 1, the purpose of the interaction.

Telemonitoring: concerning the transmission of text and non-text data, this is frequently associated with delivery to the home, but can equally be applied to other sites, and is a specification of Dimension 6: type of data transmitted.

M-health: the use of mobile devices such as tablet computers and mobile (cell) telephones in telehealth has been taken up so widely that this term is increasingly regarded as its own field(25); nonetheless, it is arguably a subset of telehealth and a specification of Dimension 5: technology type.

1.2.4 The History of Telehealth

Telehealth is a young field of research and service delivery; although the term was only coined in the 1970s, with hindsight one can see that telehealth activity commenced more than a century ago with the introduction of radio and telephone communication. It has undergone substantial changes in the past 20 years, associated with the development of computer technology, high speed connectivity, and the internet. I have constructed **Table 1-1**, indicating the periods during which the technologies became broadly available, together with a brief summary of the major developments in telehealth. More details are given in Higgins' description of the early developments in telehealth(29), and in Bashur's book(30).

Table 1-1 The History of Telehealth

Time Period	Technology Uptake	Telehealth Activities
1900s – 1950s	Radio Telephone	Radio communication for medical purposes to remote areas and ships at sea. Telephone calls as an adjunct to clinical practice become widespread. Experimental transmission of ECGs and X-rays via facsimile.
1960s	Satellite communication Microwave communication Television: broadcast and closed-circuit	Biomedical telemetry in the space program Feasibility tests of video telehealth in university settings
1970s – 1980s	Digital telephone lines (Integrated Services Digital Network, or ISDN)	Early telehealth services to remote areas and prisons are trialled.
1990s	Internet Personal computers	Video consultation services over ISDN grows, mainly in the government sector. Home telehealth services are trialled.
2000s	Broadband Mobile phones Social media	Home telehealth and chronic disease management services are established. Most services remain small, although Veterans Health in the USA becomes large scale. Video consultations are enabled via software.
2010 to present	Smart phones and tablet computers Fibreoptic networks Fast mobile services (4G) Integrated online platforms for multiple flexible functions (Web 2.0)	Smart phone and tablet health applications proliferate. Bandwidth becomes sufficient to enable home video consultations with affordable technology. Integrated video, data, and still image services are initiated.

1.2.5 The History of Telehealth in Australia

In Australia, the regular use of telehealth began in remote areas from the 1920s, using the pedal radio to contact the Australian Inland Mission Aerial Medical Service, which later became the Royal Flying Doctor Service. There was at least one earlier example of telehealth being conducted using the overland telegraph in 1874(31), although this was *ad hoc* rather than an intentional episode of service.

Video consultation services over digital telephone lines (ISDN) were trialled by State and Territory Health Departments from the late 1980s, and routine services in a limited range of clinical areas were established in the 1990s(32). A few of these, such as the Rural and

Remote Mental Health Services in South Australia, have continued operating to the present day.

In the late 1990s, there was a short period of federal government policy interest in telehealth(33). In 1997, the House of Representatives Standing Committee recommended to the Parliament of the Commonwealth of Australia that telehealth should be developed, and that national bodies to oversee this should be set up(14). The Australian Government commissioned a scoping study(15), established an advisory committee and developed a national plan(32). However, none of the projects or options proposed for financing telehealth were implemented by the government, and national policy interest went into abeyance.

Throughout the 2000s, telehealth in Australia was mainly provided by the State and Territory Health Departments or by academic research centres(34, 35). Reimbursement for video consultations by private psychiatrists was made available through the Medicare Benefits Schedule (MBS) from 2002, but the uptake was very low(36). Although home telehealth and store-and-forward telehealth was prevalent in the USA, United Kingdom, Europe, and Asia(37, 38), in Australia(34, 39) and Canada(40) the majority of activity was real time video consultations to rural areas.

In 2010, the Australian Labor Party promised the delivery of a National Broadband Network (NBN) of fibreoptic cable, that would replace the existing copper landline infrastructure, and that one of the services to be delivered by the NBN would be telehealth(41). To facilitate this, telehealth consultations would be included on the MBS. The type of telehealth that was introduced mirrored the current state of activity in Australia, and from July 1st 2011, private medical specialists were able to receive a rebate for video consulting to patients in outer metropolitan and rural areas. Primary care practitioners could also receive a rebate for assisting the patient with a video consultation(42). From January 1st 2013, this eligibility was restricted to rural areas only(43). Also since 2010, the State and Territory Health Departments have upgraded their old ISDN videoconferencing networks to Internet Protocol (IP) networks, and enlarged the number of endpoints to include more health facilities(44, 45).

1.2.6 The Current Status of Telehealth in Australia

As of June 2013, there is public funding through rebates for item numbers on the Medicare Benefits Schedule for video consultations by medical specialists to patients in rural areas, residential aged care facilities, and Aboriginal health services. There are trials underway of home telehealth and general practice video consultations to residential aged care facilities, and the development of professional standards is underway. The Federal Government has also awarded short term grants to non-government organisations and professional bodies to educate clinicians and promote the uptake of telehealth. Many technology companies have entered the telehealth market, and with this there has been a proliferation of technical options for telehealth service delivery. Multiple forms of delivery have also converged onto single platforms, so for example there are several software applications which claim to be “one stop shops” with the capacity to do synchronous video consulting, electronic record sharing, patient bookings and access to diagnostic tests and imaging. Enabling MBS rebates but leaving the infrastructure and the service development in the hands of individual health care providers and technology companies has left clinicians struggling to make sense of a chaotic market. This is reflected in a proliferation of advice from the professional colleges aiming to assist practitioners with their choices(46, 47). Lack of interoperability, in which the different systems cannot communicate with each other has been a particular issue(48, 49). Data will be drawn together later in this thesis to demonstrate that in Australia, the ability to achieve large scale, sustainable uptake of telehealth remains a problem.

1.3 About this Thesis

1.3.1 Research Question and Logical Structure

The central question of this thesis is:

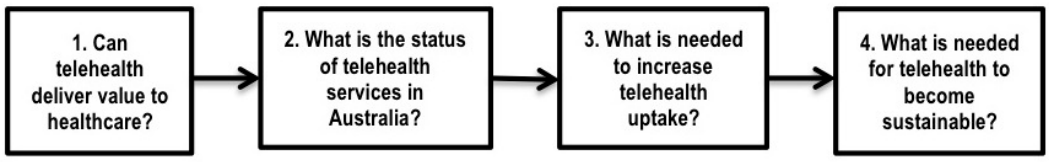
What is needed for telehealth to deliver sustainable value to the routine operations of health care in Australia?

To answer this question four specific research questions are posed:

1. Can telehealth deliver value to health care?
2. What is the status of telehealth services in Australia?
3. What is needed to increase telehealth uptake?
4. What is needed for telehealth to become sustainable?

These questions need to be addressed in this order because it is first necessary to determine whether or not telehealth is capable of delivering value to health care. Second, an assessment of the status of telehealth in Australia will indicate whether or not increased uptake is a feasible goal. If it is then established that efforts should and could be made to increase the use of telehealth in Australia, then one can proceed to asking what is needed to increase uptake and to achieve sustainability (see **Figure 1-2**).

Figure 1-2 Logical Structure of Enquiry



1.3.2 The Research Program

Three distinct research projects were undertaken within this thesis:

1. **A systematic review** of economic analyses of real time video telehealth services. This review fills a gap in the literature and covers a modality of telehealth that is common in Australia, hence is relevant to the central research question.

2. **A mixed methods evaluation** of a telehealth service using home videophones to deliver direct observation for patients with tuberculosis. This service was selected for evaluation because it is both an innovative use of telehealth, and has made the transition from project to sustainable service. The results, therefore, informed the later development of a model of telehealth service sustainability. The evaluation had three components:

3. **A quantitative case note review;**

    a) A qualitative study of patients and staff, and;
    b) An economic analysis and model.

4. **A qualitative interview study** of individuals who have been involved with the initiation and operations of a diverse sample of telehealth services throughout Australia, henceforth called the Telehealth Services Study (TSS). The TSS was the main study that was used to investigate the central research question.

Each of these research projects led to publications, which form the majority of the thesis, plus additional work was done to answer the four research questions above. The specific research questions that guided each publication within this thesis are listed below, under their respective projects:

1. **Systematic Review**

    a) What is known about the cost effectiveness of telehealth services delivery by synchronous video communication?

2. **Mixed Methods Evaluation**

    b) Is videophone delivery of Directly Observed Therapy for tuberculosis a clinically effective and cost-effective method of service delivery, compared to a face-to-face, drive around service?

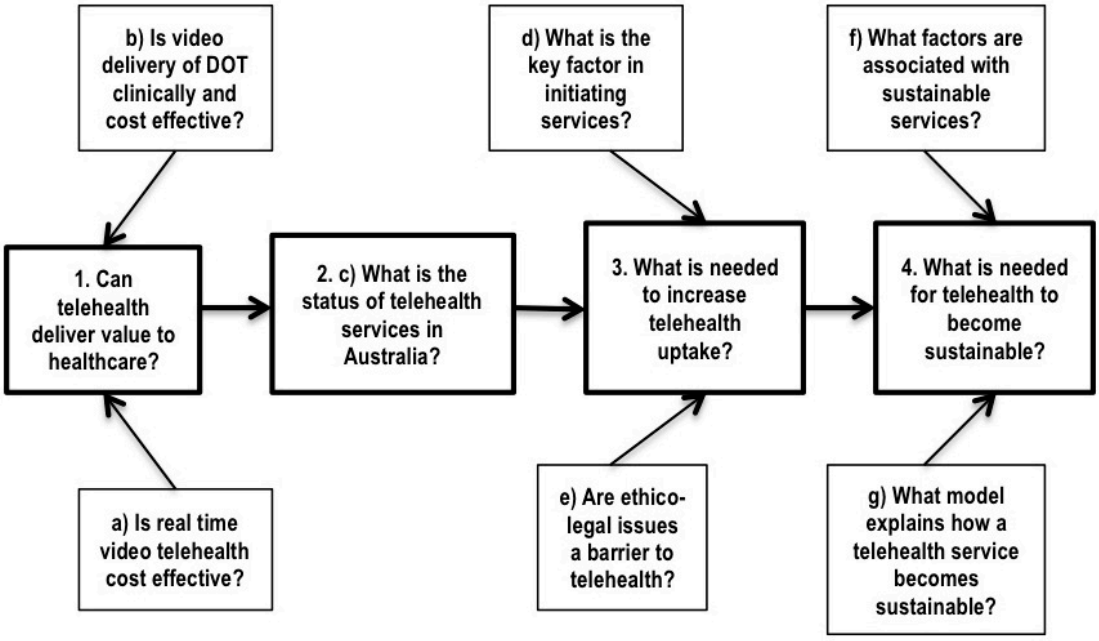
3. **Qualitative Interview Study**

    c) What is the status of telehealth services in Australia?
    d) What is the key factor or factors in the initiation of telehealth services?
    e) Are ethico-legal issues a barrier to implementing telehealth services?
    f) What factors are associated with sustainable telehealth services?

g) What theoretical model explains how a telehealth service becomes sustainable?

Figure 1-3 indicates how the research questions from each publication are related to the four research questions of the entire thesis. This Figure shows how the different components of the thesis hold together. It will be used throughout the thesis when the different sections are introduced, with the corresponding boxes outlined in bold.

Figure 1-3 Logical Structure of Research Questions



Overall, the systematic review and the mixed methods evaluation both contribute to knowledge about the effectiveness of telehealth. The qualitative interview study, together with the qualitative component of the mixed methods evaluation, addresses the issues of the status, uptake and sustainability of telehealth services.

1.3.3 Methodology

The whole thesis, including the case study of the home telehealth service, takes a mixed methods approach, which is a distinctive methodology combining quantitative and qualitative research(50). A succinct definition is “Mixed methods research is a systematic integration of quantitative and qualitative methods in a single study for purposes of obtaining a fuller picture and deeper understanding of a phenomenon”(51). The particular form of

integration used was the convergent parallel design, whereby the quantitative and qualitative data are collected and analysed individually, then brought together when the results are interpreted(52). This form was chosen because the components of the research program were conducted as separate projects, each with their own research questions and methods.

The type of qualitative research also needs to be discussed. I have categorised qualitative health research into two main traditions. One focuses on in-depth exploration of patients' and providers' subjective experiences of illness and health care, to better understand their lived experience(53). The other uses qualitative methods to generate theories, in situations where not enough is known to develop meaningful hypotheses or select the most important variables from a complex environment(54). This latter approach has been particularly applied in the UK to health services research, often as an arm of mixed methods studies, in areas including e-health and telehealth(55, 56), and is the tradition with which this thesis is aligned.

1.3.4 Epistemology

As this work contains a substantial component of qualitative research, epistemology, or the way in which knowledge is obtained and understood, must be considered. The quantitative aspects are conducted with a positivist approach, meaning that the research is intended to add to our understanding of the true state of affairs in the phenomenon being investigated. The quantitative research questions are posed in the usual way, as hypotheses that can be either verified or rejected.

Qualitative research methods, on the other hand, seek to understand social processes by gathering data from the field and analysing the way people make sense of and give meanings to phenomena(57). Qualitative researchers interpret the world to gain increased understanding of the subject matter at hand, accepting that each interpretation may see the world in a different way(58). Such research can be undertaken using a variety of epistemological approaches, and one should be chosen that is suited to:

a) the researcher's own intentions and philosophical stance on the nature of knowledge
b) the type of research question
c) the form of qualitative research being undertaken

My personal philosophy is that I want my work, both theoretically and practically, to be useful. I am a post-positivist, asserting that reality does exist, but can only be apprehended through the perceptions and construction of meaning of individuals(59). The epistemology that fits best with these two stances is pragmatism, which assumes that all knowledge is empirical and perception is interpretive(60). Furthermore, the aim of a pragmatic approach is to produce socially useful knowledge which can be employed as grounds for action; in a nutshell "an idea is as good as the action it produces"(61).

Pragmatism is hence directly aligned with the overarching research question, which asks what is needed to achieve a goal that is intended to improve the health care system.

The form of qualitative research selected is also guided by the research question. As I wished to develop an explanatory model from data obtained in the field, I chose grounded theory, which is a set of methods for inductively generating theory from empirical data(61). Grounded theory can be anchored by many epistemological positions, although it has strong theoretical roots in pragmatism(62).

1.3.5 Outline of Chapters

Chapter Two is a focused literature review on the clinical effectiveness and cost-effectiveness of telehealth. Gaps in the literature are identified, providing the rationale for conducting a systematic review of real time video telehealth.

Chapter Three is a systematic review of the cost-effectiveness of real time video telehealth. Whereas earlier reviews of economic analyses in telehealth had considered all forms of telehealth or had specified a particular clinical discipline or type of application, such as home telemonitoring for heart failure, this is the first systematic review to bring together the economic analyses of delivering telehealth by synchronous video communication. As described in the history of telehealth above, this is the most common form of telehealth used in Australia, and is also relevant to the mixed methods evaluation, as it is the method of delivery employed in the direct observation service.

Publication details: **Wade VA**, Karnon J, Elshaug AG and Hiller JE. A systematic review of economic analyses of telehealth services using real time video communication. *BMC Health Services Research* 2010, 10:233 doi:10.1186/1472-6963-10-233

Chapter Four is a book chapter describing the home videophone medication management service and reviewing the relevant literature. It is a precursor to the mixed methods evaluation. Whereas all the other manuscript-based chapters were externally peer-reviewed, this chapter was reviewed by the book editors.

Publication details: **Wade V**, Littleford A and Kralik D. Home medication management by videophone: translation from pilot project to integrated service. In *Handbook of Digital Homecare: Successes and Failures* (Communications in medical and care compunetics) 2011 Bos L, Goldschmidt L, Verhannenman G and Yogesan K (eds) Springer-Verlag Berlin Heidelberg doi:10.1007/978-3-642-19647-8

Chapter Five is a mixed methods evaluation of the use of home videophones for direct observation of patients with tuberculosis. There has been very little previous research on the use of telehealth in this setting, so this makes a new contribution to the body of evidence on the effectiveness of telehealth.

Publication details: **Wade VA**, Karnon J, Eliott JA and Hiller JE. Home videophones improve direct observation in tuberculosis treatment: a mixed methods evaluation. *PLoS ONE* 2012; 7(11):e50155.

Chapter Six introduces the qualitative interview study by reviewing the previous research and theoretical literature on the uptake and sustainability of telehealth services. Some additional details of the methods of that study, which were not included in the publications due to space limitations, are described.

Chapter Seven answers research question two, concerning the status of telehealth services in Australia, by using findings from the qualitative study, the literature, and Australian government statistics on telehealth activity.

The following two chapters contain four publications which arose from the qualitative study.

Chapter Eight focuses on the uptake of telehealth services. The first publication describes the role of the champion in telehealth service development, proposing that this is the key factor in the initiation of telehealth services.

Publication details: **Wade V** and Eliott J. The role of the champion in telehealth service development: A qualitative analysis. *Journal of Telemedicine and Telecare* 2012; 18(8):490-492.

The second publication addresses the ethical, medico-legal and clinical governance issues in Australian telehealth services. These are often cited in the commentary as barriers to the uptake of telehealth, and this analysis of the data from the qualitative study sought to identify if those actually involved in the development and operations of telehealth services believed that this was the case.

Publication details: **Wade VA**, Eliott JA and Hiller JE. A Qualitative study of ethical, medico-legal and clinical governance matters in Australian telehealth services. *Journal of Telemedicine and Telecare* 2012; 1-6, DOI: 10.1258/jtt.2011.110808

Chapter Nine concerns the sustainability of telehealth services. The first publication explores sustainability and vulnerability in Australian telehealth services. The concept of sustainability is defined and a thematic analysis is conducted of ceased, vulnerable and sustainable telehealth services.

Publication details: **Wade V**, Eliott J, Karnon J and Elshaug AG. A qualitative study of sustainability and vulnerability in Australian telehealth services. *Studies in Health Technology and Informatics* 2010; 161: 190-201

The second publication presents an analysis using grounded theory methods to construct an explanatory model of telehealth service sustainability, together with a rationale for *clinician acceptance* being the most important factor in sustaining telehealth services.

Publication details: **Wade VA**, Eliott JA, Hiller JE. Clinician acceptance is the key factor for sustainable telehealth services.

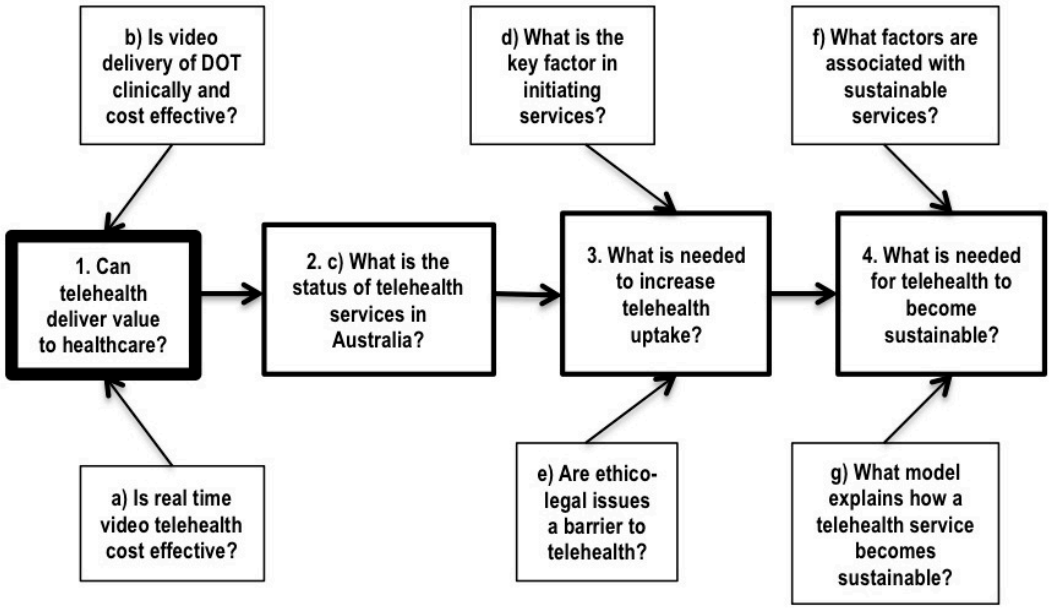
This article has been submitted to *Qualitative Health Research,* and has been accepted for publication subject to revision. Appendix D contains the relevant correspondence.

Chapter Ten summarises and synthesises the research findings, describes the changes in telehealth in Australia over the course of this work, discusses the limitations of this research program, and suggests directions for future research. The chapter and this thesis conclude with advice for policy makers and those implementing telehealth services.

CHAPTER 2 - The value of telehealth: A review of reviews

2.1 Introduction

Figure 2-1 Logical Structure of Research Questions



Chapter 1 defined telehealth and gave an outline of its history, its characteristics, and its potential to deliver value to health care delivery. In the following two chapters I will review the telehealth literature to address Research Question 1: "Can telehealth deliver value to health care?" If answered in the affirmative, then it is reasonable to investigate the means by, and conditions under which, telehealth can be implemented and sustained.

2.1.1 Measuring the Value of Telehealth

When considering if telehealth can deliver value to health care, it is necessary to decide which potentially beneficial outcomes of telehealth should be measured. Several authors have addressed this issue by developing evaluation frameworks for telehealth. These are lists of categories such as technical properties, access to care, safety, efficacy, effectiveness, cost, acceptance, and services utilization(63-65). Existing frameworks from related disciplines have also been adapted to the evaluation of telehealth. Health Technology Assessment (HTA), for example, considers safety, efficacy, effectiveness and economic impact(66), and health services research considers accessibility, cost and quality of care(67). There is, of course, overlap between these disciplinary perspectives.

The most comprehensive effort that has been undertaken to define the value of telehealth was the National Telehealth Outcome Indicators Project (NTOIP) in Canada(68). The authors conducted a systematic literature review and structured consensus process with members of the telehealth community, and recommended that the outcome indicators for telehealth services be categorised into the four dimensions of i) quality (including quality of life, safety, efficacy and effectiveness), ii) access, iii) acceptability and iv) cost. Whilst no one system has achieved general acceptance or prominence, this major work should be considered by those aiming to assess the value of telehealth.

2.1.2 Scope of the Review

Initially, I intended to produce a systematic review of primary studies researching the value of telehealth, and I carried out a MedLine search on 30 November 2009 using search terms set narrowly for specific detection of publications about telehealth (see **Table 2-1**).

Table 2-1 MedLine Search Terms for Proposed Telehealth Effectiveness Review

"Telemedicine"[Mesh:NoExp] OR "Videoconferencing"[Mesh] OR "remote consultation"[Mesh] OR telemedicine[Title/Abstract] OR telehealth[Title/Abstract] OR videoconf*[Title/Abstract]. Filters: Humans and English language, publication dates 1974 to November 2009)

This search gave 8,191 results, and preliminary sorting led to the realization that a systematic review of outcomes across all areas of telehealth could not be accomplished within the program of research planned for the doctoral candidacy. I therefore decided to conduct a review of reviews by synthesising the findings from published reviews of telehealth. The preliminary search located two existing reviews of reviews, and these were used as the starting point for this work.

2.1.3 Aims of the Review

The specific aims of this literature review were:

1. To summarise and critique existing reviews of reviews of telehealth
2. To identify additional reviews not covered by these reviews of reviews, and to update the evidence with recently published reviews

3. To synthesise the review findings by clinical areas, in a manner that is useful for those considering implementation.

2.2 Methods

This chapter is not a formal systematic review of reviews, nonetheless, the following set of criteria were applied to clarify the boundaries of the work and render results from this large field more manageable.

2.2.1 Outcome Measures

2.2.1.1 *Outcome Measures Included*

The outcome measures included are based on an adaptation of the four dimensions of the NTOIP, as described above. Dimension one (quality) is focused on clinical outcomes for patients, and dimension two (access) and three (acceptability) are unchanged. Dimension four (cost), cannot be interpreted alone, and this dimension has been broadened to an assessment of the cost-effectiveness of telehealth. The first three dimensions will be dealt with in this chapter, whilst cost-effectiveness is reviewed in Chapter 3, which contains a systematic review of economic analyses of telehealth services using real time video communication(69).

2.2.1.2 *Clinical Outcomes*

Patient health status is the ultimate indication of the value of a health service or of a particular health intervention. Four different approaches to assessing health status are:

1. Biological measures, for example blood pressure or blood test results.
2. Reported measures, such as quality of life or mental health scales.
3. Diagnostic or therapeutic equivalence, expressed as either concordance between telehealth and in-person outcomes, or accuracy compared to a gold standard. This is used in telehealth research to assess clinical usefulness where telehealth is intended as a direct substitute for in-person care, and should be determined by comparative or non-inferiority studies.
4. Observed health services use, where this is a proxy for clinical outcomes. In these cases the justification needs to be made that decreased admissions or attendances are related to the effectiveness of disease management(70).

2.2.1.3 *Access to Health Care*

This dimension, which includes increasing the absolute level of access to care, as well as increasing relative access across different groups, is a key justification for telehealth(71). Governments and other organisations may be willing to pay more to deliver health services to rural areas, or to disadvantaged populations, either from an obligation to provide universal health care, or for ethical or political motivations. The Australian Institute of Health and Welfare defines access to health care as:

> *"People can obtain health care at the right time and place irrespective of income, physical location and cultural background"*(72).

Measuring access to care, however, is not straightforward. Fortney(73) discriminated five dimensions of access: geographical, temporal, financial, cultural and digital, and notes that each of these can be measured objectively or subjectively; for example physical distance versus reported ease of travel, waiting time versus convenience of available appointments, or availability of the internet versus usability of electronic health applications. These various approaches to defining access will be taken into account in this review of reviews.

2.2.1.4 *Acceptability of Service*

A service may be of potential value, yet this will not be realised if patients or providers regard it as unacceptable and do not take it up. This issue is important to measure when assessing the value of telehealth services, as some have asserted that interposing technology between the provider and patient may be distancing and depersonalizing(74), or have "a generally subtractive communicative effect"(75).

2.2.1.5 *Outcome Measures Excluded*

Feasibility Tests: these are usually conducted at an early stage to determine whether particular types of service delivery are possible, but do not represent the actual value of the service to the patient or health care system.

Cost-effectiveness or Related Economic Outcomes: these are addressed in Chapter 3.

Organisational Outcomes: these concern the way that health care is structured, such as changes to continuity and comprehensiveness of care, the model of care, communities of care and stakeholder engagement. They are potentially important outcome measures but are

excluded because the indicators in this field are very diverse(76), and the chain of logic linking these outcomes to improved patient outcomes is not well established(77).

2.2.1.6 *Types of Telehealth Services Excluded*

Reviews of the following types of telehealth services were excluded:

Telephone-only services: whilst use of this ubiquitous technology is included in the definition of telehealth, research about health call centres, telephone advice, and telephone follow up is sufficiently large and distinct as to comprise a separate field of study.

Diagnostic services: teleradiology and telepathology are excluded because they are not providing direct clinical care, but are limited to a relationship of receiving requests for investigations and providing results. Note that whereas these external diagnostic services are excluded, conducting a diagnostic assessment in the course of a clinical consultation is included.

Self-help services: where a service is offered using ICT, but with no participation from health care providers, such as an automated interactive website.

Reviews with limited scope: reviews about telehealth that were limited to one geographical area or service setting were excluded.

2.2.2 Search Strategy

Literature reviewing the value of telehealth was sought using the following strategies:

1. Reviews were obtained from the two published reviews of reviews(78, 79). The reviews of reviews were identified from the preliminary search in 2009, and from the search strategy shown in **Table 2-1**.
2. To identify subsequent reviews, a MedLine search covered the beginning of 2009 to December 2012, using the following terms: ("Telemedicine"[Mesh] OR “Videoconf*"[Mesh] OR “Telemetry"[Mesh] OR telehealth [Title/Abstract] OR telemedicine[Title/Abstract]) AND ((Humans[Mesh]) AND (English[lang]) AND (Meta-Analysis[ptyp] OR Review[ptyp] OR “systematic review”[Title/Abstract)) This date range was chosen because it was subsequent to the dates of the reviews of reviews.

3. The two main journals in the field, the Journal of Telemedicine and Telecare and the Telemedicine Journal and E-Health were hand-searched from the beginning of 2009 to December 2012.
4. The collection of reviews acquired opportunistically throughout the course of my doctoral studies were examined to ascertain if they contained additional reviews not found by the first three strategies.

2.2.3 Narrative Synthesis

The reviews that met the inclusion criteria were then categorised and tabulated by clinical discipline. Systematic quality assessment, as would be required to convert this work into a systematic review of reviews, was not undertaken due to pragmatic time limitations. All the meta-analyses plus the other reviews in each group that were assessed to be current and of at least reasonable quality were synthesised in narrative form. This involved conducting an informal assessment of the quality of the primary studies within the reviews, and not considering the material from those that had very few or poor quality primary studies.

2.3 Results

2.3.1 Reviews of Reviews

At the time of writing, two existing systematic reviews of reviews in telehealth are:

1. Deshpande A, Khoja S, McKibbon A, Jadad AR. Real-time (synchronous) telehealth in primary care: systematic review of systematic reviews. Ottawa, Canada: 2008. (78) This review was produced as a report for the Canadian Agency for Drugs and Technology in Health.
2. Ekeland AG, Bowes A, Flottorp S. Effectiveness of telemedicine: a systematic review of reviews. *Int J Med Inform*. 2010;79:736-71. (79).

The characteristics and results of these reviews of reviews are compared in **Table 2-2**, followed by a discussion of their limitations.

Table 2-2 Comparison of Reviews of Reviews in Telehealth

Comparators	**Systematic Reviews of Reviews**	
Authors	Deshpande et al 2008 (78)	Ekeland et al 2010 (79)
Databases searched	MedLine, CINAHL, Cochrane, DARE, HealthSTAR	MedLine, CINAHL, Cochrane, DARE, ACM, BNI, HTA, CSA, Embase, TIE, HSTAT, Psychinfo, Web of Science
Sources date range	1999 - 2006	2005 - 2009
Inclusion criteria	- Real time telehealth - Peer reviewed literature in English	- All telehealth interventions - Peer reviewed plus reports - Comparison with another method of care delivery
Exclusion criteria	- Telephone only - Asynchronous telehealth	- Telephone only - Educational interventions - Use of electronic records
Outcome measures	- health outcomes - resource utilization - access to health care - user satisfaction	- health outcomes - cost outcomes - process outcomes - organisational issues
Quality assessment	Grouped into high & low quality with the Oxman & Guyatt index	Reviews with major flaws excluded, using the revised EPOC checklist
Number of reviews	31	80
Results	From 11 high quality reviews: - Home-based telehealth produces better outcomes for chronic conditions, especially heart failure - Real time telehealth is equivalent to in-person for diagnosis and management From all 31 reviews: - weak but persistently positive evidence for high patient satisfaction, and increased access to care	- 20 reviews found telehealth was effective - 19 reviews found telehealth was promising - 22 reviews provided weak or inconsistent results - 13 reviews contained economic analyses; evidence of cost-effectiveness was weak

2.3.1.1 *Coverage*

Although these reviews of reviews were published two years apart, they had just three sources in common, and consequently are complementary rather than overlapping. The Deshpande et al. review of reviews is restricted to real time video telehealth, which the authors point out was the major mode of delivery at the time. This limits their conclusions for home-based telehealth, where asynchronous delivery methods are commonly employed. More generally, the process of constructing a review of reviews leads inevitably to the primary

sources being several years old, with a time delay for the development of new source reviews, and further delay before enough reviews are produced to justify or necessitate a review of reviews.

2.3.1.2 *Quality*

Both publications assessed the quality of their sources using a structured scale. Utilizing the Oxman and Guyatt quality scale(80), Deshpande rated only 11 of the 31 included reviews as being of high quality, with the remaining 20 were regarded as having "major to extensive flaws", defined as a score of 1 to 3 on the Oxman and Guyatt index. This reduces the scope of the conclusions that can be drawn from the entire set of reviews. Ekeland and colleagues stated that reviews with major flaws were excluded, as assessed by a checklist from the Cochrane Effective Practice and Organisation of Care Group (EPOC). Nonetheless, some of the included publications were not actually about the effectiveness of telehealth, but rather about the development of classification systems and methodologies. Additionally, some of their categorization of results is inconsistent; for example, the "promising" group includes both a meta-analysis with a positive effect size that should have been in the "effective" group(81), and a review of very preliminary work in virtual reality where the evidence is better classified as "weak"(82).

2.3.1.3 *Summary*

Together, the two reviews of reviews cover a great diversity of health care, and indicate that there are some areas where the outcomes of telehealth service delivery are effective, but the majority of results were not conclusive. This, plus their lack of currency, means that these publications cannot be taken as sufficient evidence for the value of telehealth. Furthermore, neither work synthesised the evidence by clinical discipline, which is the most useful approach for those considering practical implementation. This provides a justification for sourcing newer reviews, plus additional reviews not captured in these reviews of reviews, and to categorise them by clinical discipline.

2.3.2 Search Results

The Deshpande and Ekeland reviews of reviews together contain 105 articles. The subsequent MedLine search produced 430 results, and screening the abstracts added 73 articles that are not included in either publication. Handsearching the *Journal of Telemedicine*

and Telecare yielded another 4 reviews, with no new results from the *Journal of Telemedicine and E-Health*. Twenty-six additional reviews (12 published before 2009 and 14 from 2009 or later) were added from my own collection of telehealth literature, giving a total of 208 reviews about telehealth. In particular, it should be noted that no further reviews of reviews were found. The results of inspecting these publications in more detail and applying the exclusion criteria are shown in **Table 2-3**.

Table 2-3 Exclusions of Review Articles

Reason for exclusion	Number excluded	Number remaining
Duplicate material published	1	207
Not a systematic review (eg commentary, consensus statements)	8	199
A review of methodology, not outcomes of an intervention	14	185
Outcomes of feasibility tests only	10	175
Cost-effectiveness or other economic outcomes (considered in Chapter 3)	12	163
Organisational outcomes	5	158
Not patient outcomes (eg carer outcomes, ethical outcomes, descriptions of services)	6	152
Limited scope	6	146
Self-help service with no health care provider participation	28	116

The remaining 116 systematic reviews, are tabulated in Appendix A, by clinical area of practice, from most to least recent within each category. Brief narrative summaries of each clinical area, plus the dimensions of access to health care and the acceptability of telehealth, are given below.

2.3.3 Clinical Outcomes of Telehealth

2.3.3.1 *General Reviews*

Reviews covering all forms of telehealth across all populations exist from the early to mid-2000s. The three more recent and higher quality of these reviews, as judged by the two reviews of reviews, conclude that telehealth demonstrates some benefits for home care in patients with chronic conditions, and that video consultations are able to substitute for in-

person consultations in specialties where interpersonal interaction is important, such as neurology and psychiatry(83, 84). Evidence of benefit for delivering services by telehealth to people with low socioeconomic status is found in a high quality HTA report(85).

Concerning the ability to make a diagnosis via telehealth, the authors of a comprehensive review of 160 diagnostic accuracy studies judged that 69% of these studies had results and study designs that demonstrate telehealth to be a viable substitute for conventional practice(84). A recent review of video consultations for medical specialist diagnosis concludes that there is evidence for effectiveness in dermatology, psychiatry, geriatrics, minor injuries, neurology and rheumatology(86). Only one review was found which brought together the evidence for agreement in treatment decisions, showing this could be achieved in dermatology, emergency/trauma care, cardiology, neurosurgery, and intensive care, but the amount and level of evidence is less than that available for diagnosis(84).

When particular modalities of telehealth are singled out, an HTA review of asynchronous (store-and-forward) telehealth concludes there is evidence for lower waiting time, less unnecessary referrals, equivalent diagnostic accuracy and high levels of patient and provider satisfaction(87). A review of the use of mobile phones and text messaging in all types of health care reports statistically significant improvements in medication compliance, self-efficacy and several clinical measures(88).

Having considered general reviews of telehealth, the remaining reviews are classified by clinical discipline or area of health services delivery.

2.3.3.2 *Mental Health*

Whilst this area is often referred to as telepsychiatry, it includes other mental health professionals such as psychologists and psychiatric nurses. Five general reviews published from the early to the mid 2000s indicate that telepsychiatry can accomplish most of the typical work of mental health services, such as assessment, care planning, treatment and review. Overall, the outcomes for patients, as measured by structured clinical assessment, symptom ratings, and quality of life, are equivalent to usual care(89-93). Luxton reviews safety procedures and adverse events in telepsychiatry, concluding that it is safe(163), and Sharp considers the particular concern that psychotic patients might have their symptoms exacerbated by seeing a clinician via video communication and found this is not supported(164). A cautionary note must be sounded about quality of evidence in these

reviews, in that there are few randomised controlled trials, and most research employs satisfaction ratings rather than validated outcome measures(94).

Higher quality evidence about mental health diagnosis is available from a meta-analysis which found no difference between in-person and video consultations(95). A narrative review corroborates these findings(90). For children and adolescents, similar conclusions are drawn, but the research in this area is of lower quality, being primarily from project evaluations and case reports(96).

Turning from diagnosis to treatment, there is one recent meta-analysis which shows that telehealth treatment produces a significant improvement in post-traumatic stress disorder symptoms compared to wait-list controls(97). The remainder of the reviews are narrative, with just two recent reviews being touched upon here. First, a 2012 review concludes that video consulting gives similar outcomes to traditional face-to-face psychotherapy(98), although many studies have weak designs and small sample sizes, plus a substantial minority use non-standard outcome measures, which diminishes their validity. One useful finding, however, from this review is that controlled studies find the therapeutic alliance (a measure of the strength of the relationship between psychotherapist and patient, which is correlated with positive outcomes across different types of therapy) to be equivalent to in-person treatment. Second, a recent review restricted to the child and adolescent population contains three RCTs of delivering treatment by videoconferencing(99); two of these show equivalent outcomes to in-person treatment and one notes more rapid improvement in depression, although sample sizes are small.

In summary, the reviews in mental health indicate a similar outcome for telehealth compared to in-person services. The research quality is uneven, but I judge that the overall evidence is sufficient to say that the use of telehealth can be justified as a means of increasing access to mental health services.

2.3.3.3 *Home Care*

The most common form of telehealth to the home involves regular monitoring of patients with chronic conditions. Information about physiological parameters, such as blood pressure, weight, or blood sugar, are collected from patients. The data may be sent in by the patient manually, such as via a web portal, or a device may collect the data automatically and transmit it to a health service. Usually, the data are monitored by nurses, sometimes with the

help of algorithms which send an alert if there are concerning trends. Most of these telehealth services are asynchronous, although real time video is sometimes used. Where the focus is just one disease or clinical area, these are treated separately in subsequent categories, but many studies combine the management of several chronic conditions, as the model of care is similar and the patients themselves often have more than one chronic illness.

Beginning with the highest quality evidence, meta-analysis identified a statistically significant positive mean weighted effect size of 0.50 for telehealth for all types of chronic diseases(100). Another recent analytic synthesis of home telehealth, which treated the disease categories separately, found a moderately positive mean effect size for chronic lung disease, and weakly positive effects for asthma, diabetes, heart failure and hypertension(101).

Reviews that have used narrative synthesis draw inconsistent conclusions, with reports that the evidence supporting the value of telehealth is inconclusive for most chronic diseases(102), effective only for cardiovascular disease(103), better for asthma but equivocal for heart failure(104), worse for chronic lung disease but effective for heart failure and diabetes(105), and effective for a broad range of chronic conditions(106-108). Two reviews note stronger evidence for process outcomes, such as patient knowledge and self-efficacy, than for clinical outcomes(109, 110). A recent critique of the quality of evidence notes that whilst most of 141 RCTs of home telehealth show positive results, the majority of studies are short term and the overall effect size is small(101).

To summarise, meta-analytic evidence shows that home telehealth as a whole produces small but significant improvements to patient health outcomes, but the picture is much less clear when drilling down to specific conditions. One useful means of clarifying these findings would be to select specific and comparable outcome measures, and then conduct more meta-analyses on the results.

2.3.3.4 *Cardiovascular Conditions*

The most common cardiovascular condition treated via telehealth is chronic heart failure. This is a serious disease with a high mortality rate and frequent exacerbations, which usually require hospital admissions. Early exacerbations can be detected by signs such as shortness of breath and weight gain, hence this condition is a good candidate for telehealth management. Several reviews, including four meta-analyses and a Cochrane review, show that home telemonitoring reduces mortality and hospital admissions(111-116). One dissenting

narrative review claims that there is only a general trend to improvement with inconsistencies between delivery modalities(117), however this review does not include all the studies from the other reviews, and the meta-analyses give a more accurate assessment of the effects of the intervention.

For hypertension, home telemonitoring is a straightforward process since equipment for home blood pressure measurement is readily available. There is consensus among reviews that telehealth is effective(118, 119), and a recent meta-analysis reports pooled results that support telehealth over usual care(120).

A review of telehealth for the diagnosis and management of acute myocardial infarction (heart attack) concludes that all included studies support telehealth, and a meta-analysis of three studies shows reduced mortality(121). Lastly, telehealth has been found to be useful for the secondary prevention of heart disease after an acute event, with improvements in risk factors and a trend towards lower all-causes mortality, compared to usual care(122). Overall, there is high quality evidence that telehealth is a useful addition to care for cardiovascular diseases.

2.3.3.5 *Diabetes*

In diabetes, typically a lifelong condition, patients need to conduct ongoing self-management and lifestyle modification, as well as maintain regular contact with a range of health care providers over a long time period; sustaining motivation and dealing with the burden of disease can be difficult. Telehealth is used for direct monitoring of blood sugar, weight and blood pressure, as well as for encouraging improved self-management. The most commonly used outcome measure is glycosylated haemoglobin (HbA1c), which indicates how good the patient's metabolic control has been over the preceding three months.

To date, one meta-analysis shows that telehealth has a statistically significant positive effect on HbA1c(123), and another reports a non-significant improvement, noting that many of the individual studies from which the data were pooled give negative results(124). The difference in results is likely due to differing search strategies, as the meta-analyses, which contained 19 and 12 studies respectively, have just five studies in common. A more recent meta-analysis confined to the use of mobile phones as the medium for data transmission found a significant improvement in HbA1c(125). A meta-analysis of the total

group of studies would assist, but until that is done, one can only conclude that the strength of evidence for telehealth in diabetes remains equivocal.

Narrative reviews of all forms of diabetes give inconsistent results. Some declare that telehealth is no better than usual care(126, 127), and one concludes that a positive effect on HbA1c was short-term and debatable(128). Siriwardena's review of 27 RCTs in telehealth for diabetes contains two RCTs which indicate worse outcomes than usual care(131). Others report variable results for HbA1c but positive results for processes such as appropriate care, patient education and patient satisfaction(129-131). The variability of these conclusions is due to differing review criteria and patient populations, for example one of the reviews which reports no benefit with telehealth concerned young people with Type 1 diabetes(127), whereas the other reviews are of broader diabetic populations. Two reviews compare video communication with asynchronous types of telehealth care for diabetes and find no differences(124, 131).

In summary, the evidence for diabetes is weaker and less consistent than the evidence for either mental health or cardiovascular disease.

2.3.3.6 *Respiratory Conditions*

Asthma and chronic obstructive pulmonary disease (COPD) are two common respiratory conditions in which treatments have been delivered by telehealth. In both cases home telehealth is conducted by monitoring peak flow and by patient report of symptoms such as cough and shortness of breath. Two reviews conclude that telehealth is effective for asthma, by improving patient knowledge and symptoms(132, 133), and reducing hospital admissions(134).

For COPD, two reviews report telehealth reduces hospital admissions and emergency department visits(135, 136), although an additional review concludes that there was insufficient evidence of benefit due to underpowered studies and heterogeneous outcome measures(137). Tran's meta-analysis of home telehealth contains one RCT of telemonitoring in chronic lung disease that shows higher mortality than usual care, and this study is the major contributor to a non-significant increase in risk for the pooled lung disease subset of studies(105). This finding is not corroborated in the other reviews of telehealth for chronic lung disease(135-137). Jaana's review of all respiratory conditions includes seven studies of

patients after lung transplantation, in which telemonitoring allowed earlier detection of problems, but finds no evidence of improved survival(133).

There are problems with this set of reviews which make it difficult to presume that telehealth is effective for respiratory conditions; the studies on which they are based are small-scale and short-term, the telehealth interventions are often confounded with other programs and the outcome measures are inconsistent.

2.3.3.7 *Acute Stroke*

In the acute treatment of stroke clinical outcomes can be improved if thrombolytic treatment is given to patients within four hours of the onset of symptoms, but the determination of which patients are appropriate for this treatment requires specialised diagnostic services that are only available at larger centres. Telehealth, therefore, has a particular role in enabling the wider and more timely availability of specialist expertise by remote transmission of imaging and video consultations to neurologists or neurosurgeons. Four reviews all conclude that telehealth services improve the rate of thrombolysis (138-141), although the longer-term outcomes have not yet been assessed.

2.3.3.8 *Rehabilitation Services*

This category is limited to physical rehabilitation, as rehabilitation from mental health problems is dealt with in section 2.3.3.2. Two reviews surveyed a broad range of rehabilitation interventions, including cardiac rehabilitation, neurological rehabilitation (stroke, brain injury, spinal cord injury and multiple sclerosis), joint rehabilitation (rheumatological conditions and post-joint replacement), and geriatric rehabilitation for elderly people with weakness, falls or balance issues. One review reports that the clinical outcomes, as measured by physical, functional or psychological capacity, are heterogeneous, but that the well conducted RCTs and quasi-experimental studies show similar or better patient outcomes when compared to usual care(142). The second review judges that the majority of the telerehabilitation applications performed as well as an in-person alternative, and half the applications were rated as having clinical significance. As with the previous review, the higher quality studies show better outcomes than those of lower quality, possibly because the low quality studies have higher drop-out rates and shorter follow up(143). Overall, the research on which these reviews are based is very diverse, small scale and short term hence the evidence for clinical value is limited.

2.3.3.9 *Oncology and Palliative Care*

These two disciplines have been grouped together, as they are both centralised specialties in which the amount and type of care that patients can access is regarded as very important, and rural patients have worse clinical outcomes(144). A review covering all types of tele-oncology finds that the research is formative and fragmented, with some early indications that it is useful for psychosocial and supportive care(145). There is also some evidence that video consultations are as effective as in-person consultations for patient support(146).

In palliative care there is a similar problem of diverse and fragmented evidence, with reviews mainly reporting process outcomes(147, 148). In the few studies which measure patient outcomes such as anxiety levels, or quality of life, numbers are too small to detect significance differences(148).

2.3.3.10 *Dermatology*

Teledermatology is conducted with both real time video consulting and asynchronous telehealth, in which photographs of the skin condition are transmitted. The effectiveness of teledermatology is measured either by concordance, which is the percentage agreement between teledermatology and in-person dermatology, or accuracy, when both modalities are compared to the gold standard of histopathology.

A narrative review of the diagnosis of skin conditions concluded that teledermatology shows the same percentage agreement with in-person dermatology, as differing in-person dermatologists have with each other(149). A second review finds weighted average diagnostic concordance to be in the clinically acceptable range, although better for real time video than still image transmission. This review adds that management concordance, concerning the decision of whether or not to biopsy a skin lesion, was higher than diagnostic concordance(150). A cautionary note is sounded for the particular area of skin malignancies, where both reviews conclude that diagnosis at a distance is not as good as in-person, as measured by comparison with histology, which is the gold standard(149, 150). The close agreement about whether or not to proceed to a biopsy can to some extent compensate for reduced diagnostic accuracy.

2.3.3.11 *Single Area Reviews*

Finally, there are several areas where a single systematic review of clinical outcomes was found, and these are summarised below.

Audiology: Using telehealth for diagnostic procedures such as audiometry, otoscopy and brainstem response has been confirmed as equivalent to in-person diagnosis, and treatments such as hearing aid verification, counselling and treating tinnitus have been found to be reliable and effective compared to conventional methods(151).

Autism Spectrum Disorders: Behavioural assessment, plus supervision of behavioural interventions and early intervention programs could all be carried out effectively by video communication, although the studies reviewed are small and of low quality(152).

Burns Care: In burns care, a review concludes that diagnostic agreement between in-person and telehealth assessment of burns varies greatly between studies, most likely due to technical differences in image capture and lack of standardization of procedures within the discipline. For clinical decision making in acute burns, improved triage and avoidance of medical evacuation is noted, and outpatient follow-up was found to be feasible but study quality is poor as most did not record clinical outcomes(153).

Emergency Medicine: One review of the use of telehealth in emergency departments concludes that it can be clinically successful in providing support to primary care services in remote or isolated areas, both for minor injuries and for giving assistance with acute emergencies and trauma. Most of the studies making up this review are, however, of poor quality with limited or no comparators(154, 155).

Genetic Medicine: Clinical genetics services provided by video consulting are reported to be of similar quality to in-person services, and effective for routine genetic counselling. Studies are limited by small sample sizes and lack of statistical analysis(156).

Geriatric Medicine: A review of telehealth applications in geriatric medicine concludes that geriatric expertise can be provided at a distance to primary care and residential aged care facilities effectively, although much of this work synthesised descriptive, uncontrolled studies (157).

Intensive Care: Off-site intensive care specialists can assist with the treatment of critically ill patients in intensive care units, using a combination of video communication,

telemetry and date transfer. A pooled meta-analysis finds that this form of remote specialist coverage results in a reduction in patient mortality and length of stay in intensive care(158).

Obstetrics: Telehealth has been used for transmitting investigations such as obstetric ultrasound, foetal echocardiography and foetal heart rate monitoring, as well as to provide antenatal and postnatal video consultations. This review concludes that telehealth is useful for managing gestational diabetes, supporting mothers discharged home early after delivery, and managing postpartum depression, however it is largely composed of descriptive studies(159).

Plastic Surgery: Several specific examples were given where transmission of digital images precluded the need for patient transfer, gave accurate assessment of injuries compared to in-person assessment, and was successfully used for post-operative monitoring, although two studies showed discordance between teleconsultations and in-person care. Case examples of adverse events were also described, such as delays in diagnosis and misdiagnosis from photographs. The included studies were very diverse in design with poor methodology(160).

Surgical Mentoring: The outcomes of laparoscopic surgery improve substantially with the experience of the surgeon, but gaining experience is limited by the availability of surgical mentors, so bringing in off-site mentors by telehealth is one solution to this problem. A review indicated that using video communication to provide remote surgical mentoring is safe but further study is needed to prove clinical effectiveness(161).

Paediatric obesity: A review of providing specialised treatment for paediatric obesity found that all studies used video consulting to deliver specialised clinics. The evidence for effectiveness is slight: two studies found telehealth is as effective as face-to-face clinics, one measured satisfaction outcomes only, and another that it reduces treatment attrition for rural families(162).

In summary, nine of these eleven single area reviews are recent, but with the exception of a pooled meta-analysis showing improved patient outcomes for remote specialist coverage to intensive care units, the remainder of these reviews largely synthesise low quality, uncontrolled, descriptive studies. This is most likely due to much of the research being evaluations of clinical service initiatives at an early stage of development.

2.3.4 Access to Health Care

Few reviews explicitly address access to care as an outcome indicator. Of two reviews in the early 2000s, one reports “fair” evidence that telehealth improves access to care for paediatrics, geriatrics, and mental health(165), although the means by which access was measured within each study is not specified. The other indicates that store-and-forward telehealth has modest and variable effects on access to care, and there is low quality evidence that synchronous telehealth provides faster access to definitive care(166). A more recent review devoted specifically to store-and-forward telehealth concludes that it demonstrates shorter waiting times and better access to services in areas that lack health professionals(87).

With specific applications of telehealth, the use of mobile phones is said to lead to faster diagnosis and treatment, plus lower rates of failed appointments(88). With veterans’ access to care, four studies were found showing telehealth improved both perceived and observable measures of accessibility(167). Reduced time to treatment is reported for dermatology(150), and reduced waiting times and less travel to access clinical genetics(156), which is an example of a highly specialised service that is usually located only in larger centres. Also, as mentioned previously, telehealth clearly demonstrates improved access to thrombolysis(138-141).

2.3.5 Acceptability of Telehealth

2.3.5.1 *Patient Acceptance*

Two earlier reviews specifically focus on studies reporting patient satisfaction in telehealth. Both describe high to very high levels of satisfaction, but note methodological difficulties such as superficial questions and lack of comparators(168, 169). A compilation of patient satisfaction outcomes within a general review of telehealth outcomes confirm high acceptance, noting that a substantial majority of patients prefer telehealth to travelling for an in-person consultation(84).

With mental health care, many studies have report high patient satisfaction with telepsychiatry, although there have been isolated examples of patients being anxious or uncomfortable(91, 170). In the vast majority of cases satisfaction is equal to and sometimes greater than in-person care(89, 91, 93). In considering why this might be so, qualitative data suggest that video communication leads to patients feeling less threatened by the consultation

and less inhibited in discussing their problems(93). Sharp hypothesised that psychotic patients find interpersonal interaction overstimulating, and that videoconferencing makes them more comfortable(164).

In other reviews, high patient satisfaction is described in home telehealth for heart failure(171), the elderly with chronic diseases(106), oncology services(145), and rehabilitation services(142). The exception to this level of enthusiasm is store-and-forward dermatology, where one review reported patients had concerns about privacy, anxiety about the unfamiliar process, and disquiet that the consultation was less than complete(172). Details of the way satisfaction was assessed was not available from all reviews, although in many cases satisfaction was assessed with Likert scale ratings, so it is possible that these types of concerns might be underrepresented.

2.3.5.2 *Provider Acceptance*

Telehealth acceptance has been measured less often for health care providers than for patients. In general, results show that whilst clinicians are largely accepting of telehealth, they are distinctly less satisfied than patients(89, 91, 142). When the distinction is drawn between those providers who are actually delivering the care at a distance, and those who are assisting the patient, or referring to telehealth services, two reviews indicate that this second group of clinicians are more satisfied with telehealth. In mental health the nurses and primary care providers have higher satisfaction than the psychiatrists(89), and in aged care, nurses value telehealth for providing closer communication with medical staff(106).

Provider satisfaction has been studied in detail in mental health services, where staff perceive that video communication decreases the ability to detect nonverbal cues(90), interferes with the therapeutic relationship(91), and is more difficult for emotional communication than in-person consultations(170).

In other reviews covering this area, telerehabilitation therapists are positive about telehealth, but more likely than patients to complain about the quality of the technology or the usability of the equipment(142). Intensive care staff were initially ambivalent but moved towards high overall satisfaction(173).

2.3.6 Gap Analysis

In 2010, an analysis of gaps in the systematic reviews of telehealth noted that many telehealth applications did not have up-to-date reviews, and some important areas such as tele-ophthalmology and tele-otorhinolaryngology were missing(174). I did not find any reviews to fill these gaps, and I also note absences in several of the common medical and surgical specialties, such as renal medicine, gastroenterology and orthopaedics. Paediatrics is an especially obvious gap, as there are numerous individual paediatric telehealth services and studies, so this additional MedLine search was conducted; ("Telemedicine"[Mesh] OR "Videoconf*"[Mesh] OR "Telemetry"[Mesh] OR telehealth [Title/Abstract] OR telemedicine[Title/Abstract]) AND (pediatr*), however no additional reviews were found.

In allied health, psychology is well covered, but systematic reviews are lacking for speech pathology, dietetics, occupational therapy or physiotherapy. Finally, there are no reviews devoted specifically to the impact of telehealth on access to care.

2.4 Discussion

The balance of the evidence, as gathered into 114 reviews, indicates that telehealth is capable of delivering value to health care. Furthermore, whilst some studies have found that telehealth is inferior to usual care, most have found that it is equal or better, although few studies have used the correct non-inferiority methodology to establish equivalence. The evidence concerning the safety of telehealth is slight, being limited to a review of adverse events in telepsychiatry which reports that the practice is safe, and some case examples of errors in plastic surgery. The main difficulty with the overall conclusion, however, is that 'telehealth' is not a singular intervention; it is almost as multifaceted and diverse as health care itself. To determine value in specific areas, I have identified two types of telehealth:

1. *substitutive*, where telehealth is intended as a direct replacement for usual care; and
2. *additive*, in which telehealth is an additional intervention aimed at improving health outcomes beyond usual care.

2.4.1 The Value of Telehealth

In substitutive telehealth the comparison needed to prove value is equivalence or non-inferiority to usual care. For psychiatry it is clear that video consultations are able to provide patient assessment, case management and psychotherapy as well as in-person services. Diagnostic equivalence has also been shown for consultations and assessment in audiology, genetic medicine, geriatric medicine, psychology, minor injuries, neurology and rheumatology. The disciplines in which substitutive telehealth is found to be not equivalent but still effective compared to having no access to specialised care, were dermatology and burns care, where still images are used rather than video communication, and plastic surgery, in which telehealth can only provide some components of care.

Additive telehealth encompasses telemonitoring in home care, web-based interventions for mental health, lifestyle and behaviour change, a range of applications for mobile devices, and some specific means for extending the reach of usual care, as in acute stroke management. In these cases the appropriate comparison to prove value is that the additional intervention delivers improved outcomes. The evidence in this area is more variable, but meta-analyses of effects have found significantly better patient outcomes in telemonitoring for all types of chronic disease management pooled together, cardiac failure, hypertension, management of acute myocardial infarction, management of acute stroke, smoking cessation, internet-based treatments for anxiety disorders, and remote monitoring of intensive care units. For telehealth in diabetes home care the results are inconsistent, with one meta-analysis showing significant improvement in glycaemic control, and another not. Systematic reviews without quantitative meta-analysis have concluded that telehealth is effective for the home monitoring of asthma and COPD, and promoting medication adherence. There is inconsistent evidence for treating paediatric obesity, and not enough evidence to draw firm conclusions for surgical mentoring, obstetrics, and physical rehabilitation at home.

Drawing together the highest quality evidence, as provided by quantitative meta-analysis, has found that in psychiatry, patient assessments can be conducted as well by video consultation as in-person, and that telehealth treatment of PTSD is effective. For home care, one meta-analysis and one analytic synthesis found that telehealth had an overall positive effect size for a range of chronic conditions. Other meta-analyses showed significant improvement over usual care in heart failure, hypertension, diabetes, and remote management

of ICU patients. Most of the outcome measures employed were intermediate, such as HbA1c for diabetes, or symptom scales for PTSD, however for heart failure and ICU management patient mortality was reduced.

Although there is no meta-analysis, I would add the management of acute stroke to the high quality group, because four reviews have all shown telehealth produces increased thrombolysis rates, which is a clear-cut intermediate outcome associated with improved longer term outcomes.

Only a small number of reviews address access to health care, with some demonstrating shorter waiting times or higher percentages of patients receiving particular types of services. The absence of research devoted specifically to access to care is a substantial gap because it is such a frequently mentioned benefit of and justification for telehealth.

Drawing a conclusion about the acceptability of telehealth is much clearer. There is a consistent pattern of patients being highly accepting of or satisfied with telehealth, and of providers being positive, but less so. From the patients' perspective, a formal non-inferiority trial has found communication in telehealth consultations to be as satisfactory as in-person consultations(175). Providers, on the other hand, speak of video consulting as placing a barrier between themselves and their patients(91), and yet this sense of distance either does not perturb patients or is seen by them as a positive feature. This has been teased out in the mental health literature; whether it applies to the other specialty areas, to the best of my knowledge, is yet to be investigated. The proposed explanation, that patients feel less anxious and less inhibited, hence are more able to speak freely, also remains to be tested. One study has found that video consultations have a higher rate of turn-taking and that patients appeared more empowered to ask questions of the doctor(176).

2.4.2 The Quality and Scope of the Evidence

Formal assessment of the quality of the individual studies that make up these reviews is beyond the scope of this work. Some general reviews of research quality in telehealth, however, indicated that most service evaluation is descriptive(177), and few made controlled comparisons with usual care(83, 178). Telehealth research is also largely about small scale and highly specific interventions, reflecting the interests of individual researchers, enthusiastic clinicians, and their associated health care services or units. This, plus the great

variability in methodology and outcome measures, has limited the number of quantitative meta-analyses that can be performed.

The majority of the reviews in this synthesis have selected a smaller number of the better quality studies for inclusion, but as most studies are short term evaluations of interventions done under artificial conditions, their effectiveness cannot necessarily be generalised to routine services for people with long term chronic diseases. With the exception of the Whole System Demonstrator Trial in the UK(9), which is too recent to be included in systematic reviews, there has been no purposive attempt to research the outcomes of telehealth on a whole-of-system scale.

An additional methodological shortfall is that almost all studies aimed at demonstrating the equivalence of telehealth to usual care have not been designed to test technical non-inferiority, but have reported findings of no significant difference. This is a less stringent criterion, from which less robust conclusions can be drawn.

The evidence for improved access to care is limited and of low quality. This may be because there is no consistent definition of access to care or consensus about how it should be measured. Another problem is that much telehealth research is done on pilot studies or research trials where patient access is artificially prioritised. Access to care should ideally be measured as part of the normal functioning of the whole system and the processes within it, such as referrals, bookings, and patient eligibility criteria.

One would expect future research to investigate equivalence in more clinical disciplines, and that the evidence for additive telehealth would progress as more intervention studies are conducted and other types of interventions are developed with new technologies and models of care.

2.4.3 Limitations of this Review of Reviews

This review of reviews has a number of limitations as the means for answering the research question:

1. The search strategy was focused rather than exhaustive, being restricted to the studies included in reviews of reviews, a MedLine search, a hand-search of the two specialist telehealth journals, and articles from my existing literature collection. A gauge of how sensitive the MedLine search was can be seen by

conducting the same search terms for the time period covered by the Ekeland review of reviews. Fifty-one of the 80 reviews in this work were not found by the MedLine search, which indicates that a broader search strategy is needed for a comprehensive review.

2. The gap analysis indicated that there are aspects of telehealth service delivery that have not been reviewed, hence it is likely that much original research which could contribute to answering the question has not been covered.
3. The individual sources making up these reviews were not cross-checked, therefore it is possible that some reviews may contain the same source material. If this is the case, then their conclusions are not fully additive, meaning that two reviews on the one topic does not double the strength of the evidence.
4. Systematic quality assessment of each of the reviews has not been done. The basic structure is in place to convert this work into a systematic review of reviews, which could be undertaken if this component plus a broader search strategy were added.
5. New high quality evidence may exist which has not yet been included in reviews. For example, in the use of telehealth to treat heart failure two recent RCTs showed negative results, which casts doubt on the strongly positive conclusions of prior meta-analyses(101).
6. Publication bias is another potential problem, and Wootton suggests that the overwhelmingly positive nature of the evidence for telehealth is indicative of this occurring(101). Whilst publication bias does overstate the positive, to say that it is occurring because the positive evidence is overwhelming is not a convincing argument. Rather, if the results are very positive, removing bias is less likely to render the end result neutral or negative, unless one also posited that there was a reason for bias being particularly large in this field. It should also be noted that some high quality grey literature is included in this synthesis, namely reports from health technology assessment organisations, and their conclusions are similar to the published literature.

2.5 Conclusions

Returning to the first research question of this thesis, "Can telehealth deliver value to health care?" a focused review of reviews and synthesis of the extant literature support an affirmative answer in psychiatry, home care, and management of several chronic conditions, with the proviso that there are many gaps in the research and a much work yet to be done. The evidence for increasing access to care is very limited. Finally, telehealth is very well accepted by patients but less so by health care providers.

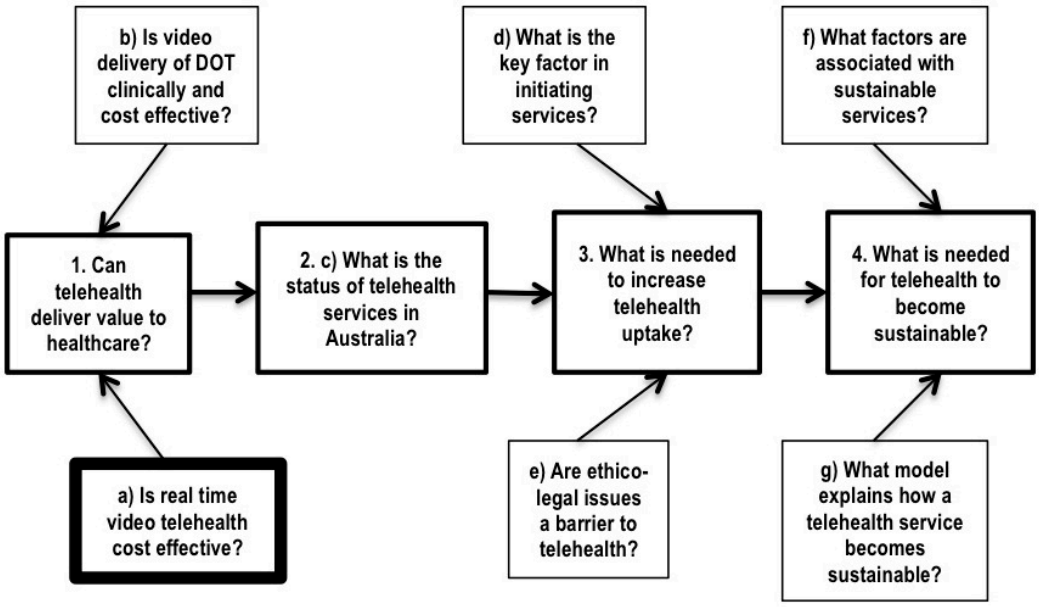
There is, nonetheless, one major problem with the answer to this question: "telehealth" is not a standardised intervention, like a drug or a surgical procedure, it is a method of delivering health care. Concurrently, telehealth research methodology has not been standardised either; hence in this young and fragmented field the ability to quantify benefit through pooled meta-analysis is limited. Telehealth and the research associated with it must be adapted to local health care systems and models of care. Consequently, one must be cautious about generalisations; because telehealth *can* work does not mean that it *will* work in any particular situation.

In regard to future research, this narrative review of reviews could be upgraded to a systematic review of reviews by broadening the search criteria to more databases, adding a strategy for finding high quality grey literature, and conducting quality assessments on each included review. Whilst such a review would be very broad, it could be useful for health services planners or managers who are considering introducing telehealth services and want guidance on which types of telehealth to focus on.

CHAPTER 3 - A systematic review of economic analyses of real time video telehealth

3.1 Preface

Figure 3-1 Logical Structure of Research Questions



This chapter contains a systematic review, which addresses the value of real time video telehealth, and contributes to answering research question 1: "Can telehealth deliver value to health care?": **Wade VA,** Karnon J, Elshaug AG and Hiller JE. A systematic review of economic analyses of telehealth services using real time video communication. *BMC Health Services Research* 2010, 10:233 doi:10.1186/1472-6963-10-233

Economic analysis is an important aspect of proving the value of telehealth, as the ability to deliver health care more cost-effectively has been one of the major justifications for introducing telehealth; not only through direct cost savings by reducing travel, but also by improving coordination and integration of care(8). An economic analysis was included as part of the mixed methods evaluation of the home videophone medication management service, which forms a major part of this thesis.

Prior to conducting this research, I reviewed the health economics literature and noted that previous reviews of economic analyses in telehealth had brought together differing types of telehealth or focused on specific disciplines, but had not covered real time video as a distinct entity. Delivering services by this means has specific requirements for equipment and staffing, with resulting economic implications, therefore I decided to conduct a systematic review of this form of telehealth.

STATEMENT OF AUTHORSHIP

Wade VA, Karnon J, Elshaug AG and Hiller JE. A systematic review of economic analyses of telehealth services using real time video communication. *BMC Health Services Research* 2010, 10:233 doi:10.1186/1472-6963-10-233

Victoria Wade (Candidate)

Conceptualised and initiated the review, conducted the literature searches, analysed the data, wrote the manuscript and acted as corresponding author.

Signed .... Date ...1/7/2013.....

Jonathan Karnon

My contribution to this paper involved advising on the scope of the review and method of quality assessment, reviewing the literature selections, analysing some of the data to achieve consensus on ratings, and manuscript review.
I give consent for Victoria Wade to present this paper for examination towards the Doctor of Philosophy.

Signed Date ...28/6/13.....

Adam Elshaug

My contribution to this paper involved advising on the conduct of a systematic review, and manuscript review.
I give consent for Victoria Wade to present this paper for examination towards the Doctor of Philosophy.

Signed ..... Date ...26/6/2013.....

Janet Hiller

My contribution to this paper involved advising on the conduct of a systematic review, and manuscript review.
I give consent for Victoria Wade to present this paper for examination towards the Doctor of Philosophy.

Signed ... Date ...11/6/13.....

3.2 Publication

Wade et al. BMC Health Services Research 2010, 10:233
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BMC Health Services Research

RESEARCH ARTICLE Open Access

A systematic review of economic analyses of telehealth services using real time video communication

Victoria A Wade[1*], Jonathan Karnon[1], Adam G Elshaug[1,2], Janet E Hiller[1,2]

Abstract

Background: Telehealth is the delivery of health care at a distance, using information and communication technology. The major rationales for its introduction have been to decrease costs, improve efficiency and increase access in health care delivery. This systematic review assesses the economic value of one type of telehealth delivery - synchronous or real time video communication - rather than examining a heterogeneous range of delivery modes as has been the case with previous reviews in this area.

Methods: A systematic search was undertaken for economic analyses of the clinical use of telehealth, ending in June 2009. Studies with patient outcome data and a non-telehealth comparator were included. Cost analyses, non-comparative studies and those where patient satisfaction was the only health outcome were excluded.

Results: 36 articles met the inclusion criteria. 22(61%) of the studies found telehealth to be less costly than the non-telehealth alternative, 11(31%) found greater costs and 3 (9%) gave the same or mixed results. 23 of the studies took the perspective of the health services, 12 were societal, and one was from the patient perspective. In three studies of telehealth to rural areas, the health services paid more for telehealth, but due to savings in patient travel, the societal perspective demonstrated cost savings. In regard to health outcomes, 12 (33%) of studies found improved health outcomes, 21 (58%) found outcomes were not significantly different, 2(6%) found that telehealth was less effective, and 1 (3%) found outcomes differed according to patient group. The organisational model of care was more important in determining the value of the service than the clinical discipline, the type of technology, or the date of the study.

Conclusion: Delivery of health services by real time video communication was cost-effective for home care and access to on-call hospital specialists, showed mixed results for rural service delivery, and was not cost-effective for local delivery of services between hospitals and primary care.

Background

Telehealth is the delivery of health care services at a distance, using information and communication technology (ICT). Telehealth became a separate field of study from the 1970's[1], and innovation increased from the 1990's, due to the development of new technologies such as cellular phones and the internet[2]. The field was originally known as telemedicine, but was later broadened to telehealth[3], although these terms continue to be used interchangeably. It is a subset of e-health, which encompasses all uses of ICT in health, including electronic records and decision support systems, however telehealth is particularly characterised by the geographical separation of patient and provider[4]. Tulu[5] categorises telehealth according to its purpose, such as clinical, educational or administrative; its healthcare discipline area; the environmental setting; the type of communication infrastructure used; and the delivery modality. Telehealth applications are very diverse, ranging from home care for chronic diseases, to remote primary care and subspecialist services such as paediatric cardiology. Telehealth can be delivered synchronously, also known as real-time, where the participants interact with each other simultaneously, and asynchronously,

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also known as store-and-forward, in which information such as X-rays or photographs are collected, transmitted, and then utilised at a later time.

Economic analysis is of central importance to telehealth because the main rationales for its introduction have been to decrease the cost of delivering health care, make more efficient use of the health workforce, and improve timely and equitable access to services. Expansive promises have been made about the potential to achieve these ends. For example Cusack[6]modelled cost savings of $4.3 billion a year if telehealth were implemented to facilitate consultations between healthcare providers in the USA, and this is without considering savings associated with the provision of care direct to the patient. However, the ability to deliver these results needs to be tested in the real world.

Three reviews published in 2000 covered the early economic analyses of telehealth[7-9], and each reported that the studies were methodologically flawed; lacking appropriate outcome measures, consistency and clarity. Thus, no conclusions could be made about the cost-effectiveness of telehealth at that time. In 2001, Roine[10] included economic assessments in a general review of telemedicine, and noted that most were poor quality cost comparisons of short term pilot projects, however there was evidence for cost savings in teleradiology. Whitten's review in 2002 [11] appraised the quality of telehealth articles containing cost data, also finding that most were simple cost comparisons, with no definitive comparison of telemedicine to traditionally organised care. They also noted the difficulty of generalising results of individual economic studies due to the variability of applications and the effect of unique local factors on each telehealth service. Jennet reviewed the broader socio-economic impacts of telehealth in 2003 [12] and combining cost, cost-effectiveness and health system utilisation measures into one category, concluded that there was evidence of benefit of at least fair to good quality in paediatrics, geriatrics, home care, radiology, mental health and rehabilitation. Hailey's review[13] of the benefits of telemedicine in 2004 rated 25 health economic analyses, using Drummond's criteria[14], finding 13 studies met 5 or more criteria and were rated as fair to good. These indicated cost savings in radiology, geriatric care, and intensive care, and conflicting evidence in dermatology.

From 2004, telehealth reviews diverge into specific areas of clinical practice, some of which contained economic outcomes. Two reviews of telepsychiatry concluded that cost-effectiveness could not be demonstrated because the volume of consulting was too low[15,16], while another found conflicting results of both increased and decreased costs[17]. Brebner[18] reviewed telehealth provision of accident and emergency support to primary care, and found seven studies with economic data, all indicating cost-effectiveness, however he concluded that the case was far from proven. A review of the use of telehealth in intensive care units found two clinical trials which showed cost savings[19]. Pare [20] summarised a number of reviews of home care for chronic disease, and reported that very few detailed economic analyses had been done, leading to no confirmation of economic viability. However, in regard to heart failure, Martinez concluded that home monitoring reduced costs of hospital admissions[21], and Seto reported initial costs, but substantial long term cost savings[22]. Recently, Bergmo[23] reviewed the quality of economic evaluations in telemedicine, and echoed the earlier findings of highly diverse evaluations, many of which did not adhere to standard economic evaluation techniques. Specifically, statistical, sensitivity, and marginal analyses, and information on the perspective of the studies were often lacking. Whereas this review pointed out methodological deficiencies, it did not aim to draw conclusions about the cost-effectiveness of telemedicine.

These reviews have covered a broad variety of telehealth applications, from synchronous videoconferencing, to remote monitoring, telephone follow-up, call centre advice lines, email and web-based systems. Each mode of telehealth has requirements for particular technology, staffing, services, and means of organisation, and consequently has different cost components, and can deliver particular types of outcomes. Not surprisingly, it has been difficult to compare results across studies and offer consistent guidance for cost-effective health services development. Therefore this review will focus on one mode of telehealth: real-time or synchronous video communication.

Real-time video can be regarded as the traditional form of telehealth, and despite new developments such as interactive software for chronic disease management, "smart houses" to measure resident's activity levels, and a range of monitoring devices such as scales, glucometers, and peak flow meters now able to send data remotely, real-time video remains in common use across a wide range of disciplines, particularly in mental health, primary care, specialist consulting, and multidisciplinary teamwork. It has particular requirements, and hence associated costs, for video screens, connectivity of sufficient bandwidth and reliability for real time communication, physical space at each location, and health providers' time to deliver the services. Research has been able to directly compare remote consultations with in-person consultations because the health providers' activities are similar to usual care. The intention of this review is to synthesise the economic analyses of this distinct form of telehealth, and determine whether conclusions can be made about its value.

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Methods

Search Strategy

The following electronic databases were searched using these strategies:

- MedLine: ("Telemedicine"[Mesh] OR "Videoconferencing"[Mesh] OR "Telemetry"[Mesh] OR telehealth [Title/Abstract] OR telemedicine[Title/Abstract]) AND (cost[Title/Abstract] OR economic[Title/Abstract]) limited to English language and Humans.
- PsycInfo: (telehealth OR telemedicine OR videoconf* OR telemetry) AND (cost OR economic), limited to humans and peer reviewed journals
- CINAHL: (Telehealth OR telemedicine OR videoconf*) AND (cost OR economic)
- Scopus: (telemedicine OR telehealth OR videoconf*) AND (cost OR economic) for title, abstract or keywords, limited to articles
- Cost Effectiveness Analysis Registry (CEAR), produced by the Center for the Evaluation of Value and Risk in Health (CEVR), at the Institute for Clinical Research and Health Policy Studies at Tufts Medical Center: searched by the individual words telemedicine, telehealth and video
- NHS Economic Evaluations Database (NHS-EED): telehealth OR telemedicine OR videoconf*

The time frame for all searches was from the commencement of the databases until June 2009, or 2009 alone, when the database did not allow months to be specified.

In addition, review articles which were primarily about economic analysis of telehealth services, or included an economic component in the review had their reference lists searched for additional articles.

Inclusion and Exclusion Criteria

Inclusion and exclusion criteria were developed to ensure the review consisted of economic analyses relevant to direct patient care.

Inclusion Criteria

- Economic evaluations of telehealth services which used synchronous video communication as the major mode of delivery
- Telehealth services which directly delivered patient care, either provider to patient or provider to provider, if the latter application was in the context of direct patient care.
- Health economic analyses that included or cited health outcomes data obtained from telehealth services. This data included patient health status and health utilisation measures, but not patient satisfaction measures. Analyses were accepted as cost minimisation if they either produced original data or cited evidence that the outcomes of health care delivery were equivalent or non-inferior for synchronous video compared to usual care. Citations were checked to see that they were of methodologically sound research, and could be validly generalised to the particular telehealth setting, to determine whether a cost-minimisation analysis could be undertaken.

Exclusion Criteria

- Articles that did not contain economic data ie commentary, theory, study design and methodology articles.
- Articles about telehealth services that were not about direct patient care ie education, administration and social uses of the telehealth infrastructure. This included articles about health provider reimbursement and business models for telehealth services.
- Articles about telehealth services with no or very little real time video component ie telemonitoring, store-and-forward of images, telephone, SMS, or email applications.
- Cost analyses with no health outcomes data.
- Economic analyses where the only health outcomes were satisfaction data, or where the health outcomes were not collected equally across comparison groups.

Quality Rating

Articles in the review were assessed according to Chiou's grading system of the quality of health economic analyses[24]. This system contains 16 weighted items developed by an expert committee; some items are applicable to research in general, such as the clarity of the study objective, use of reliable and valid health outcome measures, the methodology for data abstraction, use of statistical analysis, discussion of bias, justified conclusions and disclosure of funding source. Other items apply particularly to economic analysis, such as a statement and justification of the economic perspective, the use of sensitivity or incremental analysis, the length of the time horizon, the use of discounting, the methodology for cost estimates and measurements, and the choice of economic model. The reliability and validity of this method was previously established by testing the scale with a sample of 60 health economists who each rated the same set of economic analyses using the criteria. By contrast, other methods for assessing the quality of economic analyses, such as Drummond's criteria [14], or the checklists used by the Mair[8] and Bergmo [23] reviews have been developed by individual experts. VW and JK graded 3 studies using Chiou's criteria in order to reach consensus on the interpretation of the criteria, and VW graded the remaining papers.

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Results

Results of Search

Using the strategies described above, MedLine produced 1187 search results, PsycInfo 286, CINAHL 393, Scopus, 1887, CEAR 10, and NHS-EED 197.

The reference lists of 24 review articles that were entirely or in part about the economic analysis of telehealth were searched, and did not produce any additional studies that met the criteria. A flow chart of exclusions is shown in Figure 1

Study Characteristics

Table 1 summarises the characteristics of the 36 studies included in the review. The clinical disciplines delivered by the telehealth services were diverse: dermatology (7), mental health (6), paediatric cardiology (4), home nursing (4), intensive care (2), emergency medicine (2), and neurology (2), and single studies in six medical disciplines (infections diseases, internal medicine, general practice, cardiology, oncology, and pain management), and four surgical disciplines (ear nose and throat surgery, orthopaedics, gynaecology, and neurosurgery).

Eighteen of the studies were randomised controlled trials, 6 were studies of diagnostic accuracy, 5 were before and after studies, 2 were prospective case control, 2 were retrospective cohort studies, and there was one each for the categories of non-random trial, prospective cohort and economic modelling.

Health Outcome Measures

When the purpose of the telehealth service was primarily diagnosis and assessment of patients, diagnostic accuracy was used as an outcome, as well as the related measure of the percentage of patients referred for further investigation. However, when patient management was the main intention, a variety of validated instruments were used to assess patient status, including the SF-36, the Global Assessment of Functioning, or the Brief Psychiatric Rating Scale. In some studies measures were chosen for particular settings, such as time taken to achieve self-care, patient adherence to treatment, or quality ratings of medical decisions. In heart failure and intensive care settings, mortality was also used as an outcome. Various healthcare usage rates were reported, such as hospital length of stay, re-admissions, and attendance at emergency departments and outpatient clinics. In tele-dermatology, a measure often used was the percentage of patients requiring further consultations: a proxy for patient outcome, as the dermatological problem is taken as resolved if the patient no longer required specialist care.

Economic Analysis Characteristics

The economic analyses were classified by their health outcome measures, with 18 studies assessed as being cost-consequences, reflecting the diversity of measures described above, 13 cost-minimisation, two cost-

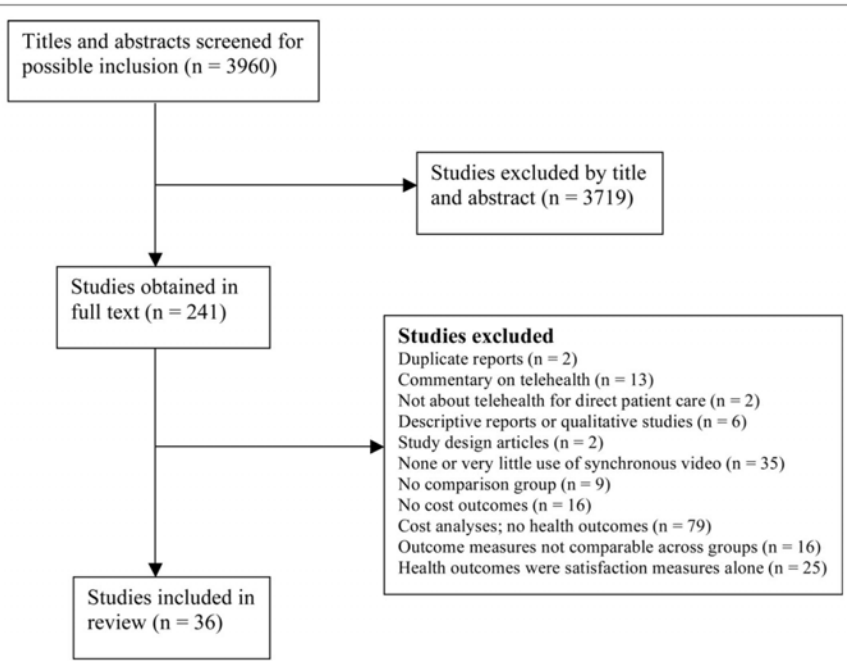

Figure 1 Flow chart of study inclusions.

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Table 1 Summary of Economic Analyses

Article	Service Setting	Clinical Discipline	Study Type	Ec Analysis Type & Quality Score	Technology & Connectivity	Perspective	Cost Outcomes	Telehealth outcome vs usual care
Ruskin 2004 [51]	Rural outpatient	Psychiatry	RCT	CMA 84	Computer, ISDN	Health service	More	Same
Modai 2006 [72]	Rural outpatient	Psychiatry	ProspCC	CCA 45	Not specified, ISDN	Health service	More	Same
O'Reilly 2007 [73]	Rural outpatient	Psychiatry	RCT	CMA 54	VC, ISDN	Health service	Less	Same
Shore 2007 [29]	Rural outpatient	Psychiatry	DiagAcc	CMA 57	VC, ISDN	Health service	Mixed[1]	Same
Crow 2009 [35]	Rural outpatient	Psychology	RCT	CEA 77	Not specified, T1 line	Societal	Less (HS less)	Less[2]
Persaud 2005 [53]	Rural outpatient	Psychiatry & dermatology	RetCoh	CMA 46	Not specified, 384 kbits/sec	Societal	Less (HS more)	Same
Oakley 2000 [74]	Rural outpatient	Dermatology	RCT	CCA 15	Computer, ISDN	Patient	Less	Same
Loane 2001a [32]	Rural outpatient	Dermatology	RCT	CMA 70	Computer, ISDN	Societal	Less (HS more)	Same
Loane 2001b [59]	Rural outpatient	Dermatology	RCT	CMA 40	VC, ISDN	Health service	More	Same
Chua 2001 [36]	Rural outpatient	Neurology	RCT	CCA 25	VC, ISDN	Health service	More	Less
Bergmo 1997 [52]	Rural outpatient	Ear nose & throat	RetCoh	CMA 68	VC, ISDN	Societal	Less (HS less)	Same
Ohinmaa 2002[33]	Rural outpatient	Orthopaedics	RCT	CMA 71	VC, ISDN	Societal	Less (HS more)	Same
Bishai 2003 [62]	Rural outpatient	Gynaecology	DiagAcc	CCA 84	VC, T1 line	Societal	More	More
Pronovost 2009[31]	Rural outpatient	Pain management	RCT	CMA 93	VC, broadband	Societal	Less (HS more)	Same
Johnston 2000[39]	Home care	Nursing	RCT	CCA 19	Not specified Not specified	Health service	Less	Same
Smith 2002 [42]	Home care	Nursing(CPAP)	DiagAcc	CMA 25	Custom, PSTN	Health service	Less	Same
Bohnenkamp 2004[41]	Home care	Nursing	NRT	CCA 35	TV, PSTN	Health service	Same	More
Finkelstein 2006[38]	Home care	Nursing	RCT	CCA 67	TV, PSTN	Health service	Less	More
Chan 2000 [58]	Residential care	Dermatology	DiagAcc	CCA 32	VC, ISDN	Health service	Less	Less[3]
DeMaio 2001 [43]	Home care	Infectious diseases	B&A	CMA 15	Vphone, ISDN	Health service	Less	Same
Jerant 2001 [37]	Home care	Cardiology	RCT	CCA 67	Not specified PSTN	Health service	Less	More
Eron 2006[40]	Home care	Internal medicine	ProspCC	CCA 67	Not specified PSTN	Health service	Less	More
Rendina 1997 [75]	Rural inpatient	Paediatric Cardiol	B&A	CBA 56	VC, T1 line	Health service	Less	Same
Sable 1999 [55]	Rural inpatient	Paediatric Cardiol	DiagAcc	CBA 27	Computer ISDN	Health service	Less	More
Sicotte 2004 [56]	Rural inpatient	Paediatric Cardiol	DiagAcc	CEA 63	VC, ISDN	Health service	More	More
Dowie 2007 [71]	Rural inpatient	Paediatric Cardiol	ProspCoh	CCA 85	VC, ISDN	Societal	Mixed[4] (HS more)	More
Ehlers 2008 [76]	Rural inpatient	Neurology	EcModel	CUA 65	Computer, Not specified	Societal	Less (HS more)	More

Table 1 Summary of Economic Analyses *(Continued)*

Wong 2006 [64]	Rural inpatient	Neurosurgery	RCT	CCA 64	VC, ISDN	Health service	More	Same
Noble 2005 [61]	Rural inpatient	Emerg med	RCT	CCA 60	Not spec, ISDN	Societal	More	Same
Duchesne 2008[57]	Rural inpatient	Emerg med	B&A	CCA 34	VC, T1 line	Health service	Less	More
Kunkler 2007 [60]	Rural inpatient	Oncology	RCT	CMA 64	VC, ISDN	Health service	Less	Same
Loane 2000 [45]	Hosp to PCare	Dermatology	RCT	CMA 54	VC, ISDN	Health service	More	Same
Wootton 2000[46]	Hosp to PCare	Dermatology	RCT	CCA 81	VC, ISDN	Societal	More	Same
Jacklin 2003 [47]	Hosp to PCare	General practice	RCT	CCA 92	Computer, ISDN	Societal	More	Same
Rosenfeld 2000[50]	Specialist on-call	Intensive Care	B&A	CCA 80	Computer, Not specified	Health service	Less	More
Breslow 2004 [49]	Specialist on-call	Intensive Care	B&A	CCA 53	VC, T1 line	Health service	Less	More

B&A = before and after study, DiagAcc = diagnostic accuracy study, EcModel = economic modelling, NRT = non-random trial, ProspCC = prospective case control, ProspCoh = prospective cohort, RCT = randomised controlled trial, RetCoh = retrospective cohort study

ISDN = Integrated Services Digital Network, VC = videoconferencing, Vphone = videophone, Hosp to PCare = Hospital outpatients clinic to local health centre

CMA cost-miminisation analysis, CCA cost-consequences analysis, CBA cost-benefit analysis, CEA cost-effectiveness analysis

1. Cost more in 2003, and less in 2005

2. Less effective, but increased patient access to services

3. Worse diagnostic accuracy, but increased patient access to services

4. Cost less for neonates, more for other patient groups

effectiveness, two cost-benefit and one cost-utility study. Six of the cost-minimisation studies relied on citations of previous work for health outcomes data; in five of these the authors cited their own work in the same clinical settings[25-29], and one study cited a very similar setting[30], therefore these citations were taken as valid evidence of equivalence. 23 studies took the perspective of the health services, 12 were societal, and one was from the patient perspective alone. Using Chiou's criteria for quality assessment, it was apparent that Criterion 4, which states that if the analysis is carried out on a subgroup then the subgroups should be pre-specified at the beginning of the study, was not applicable in 35 of the 36 cases. This criterion was therefore deleted from the grading, leaving the total quality scores out of 99 rather than 100.

Quality varied widely ranging from 15 to 93 points, with four studies rated at 25 or less. The criterion least often fulfilled was having an analytic horizon that allowed time for all relevant and important outcomes to be assessed. This was achieved by only 7 (19%) of studies. Other lower scoring criteria were including a justification for the perspective of the study (36%), and performing an incremental analysis between alternatives for resources and costs (33%). Most studies met the criteria of presenting their objectives in a clear, specific and measurable manner (90%) and provided conclusions that were justified and based on the study results (78%). There were no clear associations between the quality of the studies and the clinical discipline, the organisational model of care, or the year of publication.

Costs and Effects

Overall, 22 (61%) of the studies found telehealth to be less costly than the non-telehealth alternative, 11 (31%) found greater costs, 2 (6%) gave mixed results and in one (3%) the costs were the same. The 8 studies that reported lower costs from the societal perspective were looked at in more detail, and 6 of these showed higher health services costs. Excluding the single study that reported only on the patient perspective, the results from the health service perspective were 17 (49%) found telehealth more costly, 16 (46%) less costly, 1 (3%) found costs changed from more to less over time, and 1 (3%) found costs to be the same. These differences are largely accounted for because in delivering services to rural areas, the health services paid more for telehealth, but the societal perspective demonstrated cost savings due to reductions in patient travel[28,31-34]. In studies where both the societal and the health services perspective showed lower costs, the health services were paying for health care workers to travel[30,35].

Regarding health outcomes, 12 (33%) of studies found improved health outcomes, 21 (58%) found outcomes were not significantly different, 1 (3%) found outcomes differed according to the patient group, and 2 (6%)

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found that telehealth was less effective. Both of the latter studies were of outpatient services to rural areas; one found that more investigations were ordered in a telehealth neurology clinic[36], and the other delivered treatment of bulimia nervosa by videoconferencing, which was clinically effective, but less so than in-person treatment[35]. Neither of these services compromised patient safety. Table 1 sets out the cost and effectiveness results of all studies.

The 18 RCTs showed evenly divided results, with 9 studies reporting telehealth to be more costly and 9 less costly than the non-telehealth comparison, and 15 reported the health outcomes to be the same. The 18 non-RCTs showed results more favourable to telehealth, with 12 reporting telehealth to be less costly, 3 more costly, and 3 giving equal or mixed results. Ten reported improved and 8 similar health outcomes.

There was no indication that the more recent studies were more likely to be cost saving, or to offer improved outcomes, nor were there patterns by clinical discipline. However, when the studies were grouped into five different organisational settings, patterns of costs and effects became apparent:

1. Home care

There were 8 economic analyses of telehealth in this group, 7 delivered to the home, and one to an aged care facility, which was the patients' normal place of residence. All were conducted from the perspective of the health care services, with 7 showing cost savings and one no difference in costs. Three studies were RCTs, and these reported reduced hospital admissions[37], reduced transfer to nursing home care[38], and greater satisfaction, but no other differences in outcomes[39]. Two of the non-random comparisons found the telehealth groups improved their functioning more rapidly [40,41]. The only study on delivery of services to an aged care facility showed a mixed result of increasing accessibility to dermatology services, but reduced diagnostic accuracy. Three of the studies in this group had low quality ratings, of 25 or less, for their economic analysis; two were small scale feasibility projects[42,43]), and the third included an economic analysis as part of a larger study[44].

2. Specialist consultation to primary care

These studies of telehealth from the hospital to local primary care services were all RCTs, two for dermatology services and one for a variety of specialist consultations. In each study, the telehealth intervention involved the patient sitting with a general practitioner whilst consulting with the specialist at a hospital via video link, and the comparison was usual care in which the patient was referred to the hospital for an outpatient consultation. All studies showed similar patient outcomes and increased costs for the health services[45-47]. Two of the economic analysis reported modest time and money savings for patients, but from the societal perspective, telehealth remained more costly. Although two of these studies[45,48] reported that they used both urban and rural settings, the distances concerned were of the order of 10 to 20 kms, so they have been classified as local care.

3. Specialist on-call to hospital

Both of these before and after studies were conducted in intensive care units, where telehealth provided off-site intensivist coverage to hospital wards that had not previously had this service available. Each found lower costs and reductions in patient mortality when the telehealth service was operating; additionally Breslow[49] reported shorter hospital stays, and Rosenfeld reported lower complications[50].

4. Rural outpatient care

This was the largest group, with 14 studies, including all six of the services delivering mental health care, 4 dermatology services, ENT, orthopaedics, gynaecology, and pain management. Nine of the studies were RCTs, and of these, 5 showed telehealth was less costly, and 4 showed increased costs. In regard to patient outcomes, 6 RCTs reported that telehealth was as effective as usual care, and 2 reported reduced effectiveness. Of the 5 non-randomised studies, one showed reduced costs and 4 showed increased costs, and for patient outcomes, one showed better outcomes and 4 found equal outcomes. When sensitivity analyses were done, the cost outcomes depended on the distance between sites, or the frequency of use that was made of the telehealth facilities. Ruskin[51] found that telepsychiatry was more expensive if the psychiatrist needed to travel less than 22 miles to an outlying clinic. Bergmo[52] calculated that ENT teleconsultation became cost-effective if more than 52 patients were seen in a year, Ohinmaa[33] conducted a similar analysis showing that 80 patients a year were needed to break even for orthopaedic outpatient teleconsultations, and Persaud[53] calculated that at present workloads, the telehealth option was more expensive, but would become less expensive at a practically attainable level. One of the studies in this group was a limited analysis from the patient perspective only, and it had a low score (of 15) on the economic analysis quality rating[54].

5. Rural inpatient care

These 9 studies involved specialty clinicians in a central tertiary level hospital consulting with health providers in rural and regional hospitals about patients who were either admitted or were emergency patients, known as the hub-and-spoke model. Four of the studies were in the clinical area of paediatric cardiology. Three studies were RCTs and all showed similar health outcomes to the non-telehealth alternative, with 2 demonstrating

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increased costs and one lower costs than usual care. The 6 non-random comparison studies found results that were more favourable to telehealth, with 5 reporting better and one equal health outcomes, and 5 reporting reduced costs, and one increased costs. The improved health outcomes included reduced numbers of patients transported out of rural areas[55,56], and reduced time to transportation[57].

Technology

Videoconferencing equipment was used most commonly, in 18 studies, followed by computers (7), home televisions (2), videophones (1), a custom-designed unit (1), and unspecified equipment (7). Sicotte[56] noted that equipment was 78% of the total cost of the telehealth modality of delivery and Chan[58] stated that their viewstation was the single largest cost of their service. Persaud[53] and Loane[59] both reported that capital costs were the main reason that telehealth was more costly per consultation, although Loane[59] noted that equipment prices had reduced by the time of publication to the point that if updated costs were used in their analysis, telehealth would have been less costly than conventional care. Kunkler[60] reported that halving the technology cost would reduce their breakeven point from 40 to 20 multidisciplinary meetings per year, although Noble[61] and Ohinmaa[33] found that reducing the annual equipment cost had no impact on the overall cost outcomes.

For connectivity, 22 studies used Integrated Services Digital Network (ISDN) lines, which deliver 128 kilobits/second of data each, and four studies used T1 lines, which are considerably more costly, and can carry 1.5 megabits/second of data. Five studies, all of which were home care, used the PSTN (Public Switched Telephone Network), which is the standard low-bandwidth telephone line supplied to households, and three studies did not specify the connectivity. One study reported using "broadband"[31], and it was assumed that this meant Digital Services Lines (DSL). Connectivity was a significant cost for many telehealth services, with Bishai[62] reporting T1 line charges as their largest single cost, and Chua[36] noting that the hourly cost of ISDN communication was almost identical to the hourly pay of a consultant neurologist. Meilonen[63] commented that differences in telecommunications costs made telehealth cost-saving in some countries and uneconomical in others, and Shore[29] found that telehealth changed from being more costly in 2003 to less costly in 2005, due to reductions in ISDN line charges. However, sensitivity analyses in some studies showed the cost of connectivity to be irrelevant, for example Jacklin found that telehealth remained more expensive even if the cost of telecommunications was reduced to zero, but on the other hand, Crow[35] found that despite using T1 lines, telehealth was always less expensive than usual care.

Three studies reported significant technical problems with their video communication. Persuad[53] said that 29% of their teleconsultations had technical problems, which took an average of 7.2 minutes each to fix, Sable [55] found 8 of the 60 transmitted real time echocardiograms had significant technical problems and 5 could not be transmitted at all, and Wong[64] noted an unacceptably high failure rate of 30.1% for videoconferencing.

Discussion

The literature on telehealth is extensive, however there are a relatively small number of economic analyses that met the review criteria. Identification and review of evidence of equivalence for all economic studies that did not claim or cite equivalence was beyond the capacity of this study, and so a pragmatic approach was taken that excluded economic studies that either did not claim equivalence or provided no direct or indirect (cited) evidence of effectiveness. Cited evidence of equal health outcomes was reviewed to establish that the evidence was relevant to the setting of the economic analysis. This approach resulted in the exclusion of some well-conducted cost analyses[65-68]. Identification of evidence around the effect of the services analysed in these studies would increase the pool of evidence on the cost-effectiveness of telehealth services.

Those studies in which the only health outcomes reported were patient satisfaction ratings were also excluded because telehealth studies report almost uniformly high patient satisfaction, which is likely to be a positive bias due to social desirability and acquiescence [69]. Finally, studies were excluded in which the health outcomes were not comparable, such as where participants receiving telehealth were asked to rate the success or accuracy of the teleconsultation, but this was not done for the usual care comparator.

Quality assessment using Chiou's criteria[24] gave similar results to those of Bergmo's recent review of economic analyses in telehealth[23]. Bergmo reported that studies were most lacking in providing information on the perspective of the study, statistical comparison, sensitivity analyses, and marginal analysis. The criterion least fulfilled in this review, allowing sufficient time to assess all important outcomes, was not used by Bergmo, who developed a new set of criteria based on issues mentioned in the telehealth literature. By comparison, Chiou's criteria were developed and validated by a study of health economists. Also in line with earlier reviews [11,23], there was great variability in methodology and outcome measures. The majority of studies were cost-consequences analyses, utilising outcomes specific to

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each service, and therefore a quantitative meta-analysis could not be attempted.

Overall, nearly two thirds of the studies showed cost savings in utilising telehealth, according to the perspectives adopted by each. In particular, whenever the patient perspective was assessed, telehealth was found to be cost-saving, however when the health services perspective was considered alone, which was possible for 35 of the studies, the proportion reporting cost savings reduced to half. Most studies showed similar health outcomes, about a third showed improved outcomes, and only two indicated that telehealth was less effective. Surprisingly, there was no obvious trend for the more recent studies to indicate more cost savings, which was expected due to the reduction in technology costs over time. When seeking to ascertain the particular circumstances within which telehealth was most cost-effective, the organisational model of care was found to be the most relevant factor.

Organisational Models

The studies that delivered home care via real time video produced cost savings; an interesting finding because reviews of tele-homecare have mainly used telephone and/or telemonitoring[20,22,70]. The videoconferencing units used between health care services have been too expensive for home installation, but this group of studies indicates that various options for home video communication are effective and efficient, allowing for a greater range of telehealth services to be delivered to the home than is possible with audio or data communication alone. If the two short-term feasibility studies are taken out of consideration, one is still left with six studies that show similar results.

Secondly, bringing the expertise of on-call intensive care specialists to hospital wards via telehealth was found to lower costs and improve patient outcomes. This model of care was not a substitution of one form of delivery for another, but an addition to the expertise available to an existing service. However, there were only two studies in this group, and both were in intensive care, so further work is needed before conclusions can be generalised to other areas of hospital care.

When video communication was used between hospitals and local primary care services, there were increased costs due to medical staff time, and additional costs for equipment and connectivity. In each study the patients saved a modest amount of money on travel and reduced time off work, but this was not sufficient to offset the greater costs to the health services. The patient outcomes were similar to usual care, therefore it appears that this model of health service delivery is not economically viable.

Where health care is delivered to rural and remote areas the economic outcomes are variable for both inpatient and outpatient delivery of care. However in these settings cost may not be the only factor that determines implementation, because telehealth is also utilised to improve accessibility or timeliness of service delivery. Policies about equity of access, or local political factors, may contribute to a service that costs more, or is not as effective, being delivered to a rural area. For example, although treating bulimia by videoconferencing was less effective than face to face care, [35], in the real world there is very limited availability of this service in rural areas, so the options are no treatment or treatment that is still genuinely clinically useful. It was notable that four of the telehealth services to rural inpatients were for paediatric cardiology. This discipline may be particularly suited to telehealth because it has a combination of a small number of highly specialised clinicians, only available in tertiary referral hospitals, high costs of transporting infants and children for investigation and consultation, and families that would prefer treatment closer to home.

Technology

The use of technology is one of the defining characteristics of telehealth, and the costs of technology were critical to the outcomes of many of the studies. The standalone videoconferencing equipment used in most studies could be very costly, and although prices have come down over the past decade, expensive tele-presence units with multiple screens and peripheral devices are now being marketed as new generation products. The equipment used in home care was much less expensive, utilising either the patient's own television or smaller video units.

Six of the seven home care studies used the PSTN, ie the patient's own telephone lines, which are a minimal cost to the health service because the patient has already paid for installation and line rental. The PSTN can be used for video communication, however the bandwidth is low, which results in a jerky, reduced quality image, due to low frame rates, however despite the quality of the image, these services were still able to produce improved patient outcomes.

The studies in this review do not reflect the recent advances in connectivity produced by widespread rollout of fast broadband or Digital Services Lines (DSL) with only one recent study utilising DSL[31]. This may be because of quality and reliability issues with DSL. Although both types of lines are digital, ISDN lines provide exclusive bandwidth to the purchaser, whereas with DSL the bandwidth is shared by all the users of the Internet Service Provider (ISP) that is supplying the connectivity. For DSL to provide good quality real time

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video, it needs to have reliable, high upload and download speeds, but if the ISP has over-sold their available bandwidth, and/or the health care service has not purchased enough bandwidth, DSL users will have the experience of poor quality and delays during busy times. New forms of connectivity, such as wireless broadband or fast mobile data services have the potential to make video-based telehealth more flexible and easier to install in a range of settings, including home care.

Facility space

When using synchronous video communication, the patient and provider are, by definition, in two different places at the same time, therefore the cost of each location needs to be taken into account. When one of the locations is a home, for example when a specialist is on-call or working from home, or the service is being delivered to a patient's home, there is no additional cost for office space, but where both locations are health services, each location should be costed. For rural locations, it is often assumed that the patient can attend a local health service to have a telehealth consultation with no additional cost to the remote health service, but this assumes the service has spare rooms, booking, and reception facilities, which may not be the case.

Health Workforce

One of the reasons that telehealth from a hospital to local primary health centre was more expensive than usual care was that a general practitioner was with the patient during the specialist consultation, hence more medical workforce time was used per visit[46,47]. Again, the precise model of care is important, because in serving remote areas this same approach may save costs by reductions in travel time, or improve patient outcomes through more immediate treatment[32,52]. There can also be savings in professional time if transfers are avoided, because health care workers are then not needed to accompany the patient. On the other hand if urban providers are expected to add telehealth onto their current workload for no extra recompense, some resistance would be expected. By contrast, in home care, the patient is usually unaccompanied and therefore only one health professional is consulting with them at a time. However, tele-home care can lead to additional use of health workforce if the telehealth visits are added on to, rather than substituting for, existing services[41].

However, when two health care providers see the patient at the same time, there is the potential for a knowledge transfer effect, leading to reduced specialist referrals, increased and/or improved patient management at the primary care level, and subsequent time and cost savings. This has been reported for primary care management of ENT problems[52], colposcopy [62], and skin conditions[59]. A learning effect leading to 5% less referrals to orthopaedic outpatient clinics was noted by one study [33], however this was estimated by local physicians rather than measured directly. Jacklin[47] hypothesised that joint GP-specialist consultations would lead to downstream savings through improved patient management, but their results did not support this, although the short follow up period of six months and the broad range of specialist disciplines involved may not have allowed enough time for a learning effect to be measurable.

Waiting time

Telehealth can reduce the waiting time to receiving specialist care. For example it has been noted[71] that a visiting paediatric cardiology service was less than monthly, whereas a teleconsultation could be arranged within two days, and that telehealth reduced the time for an ENT consultation from four months to four to six weeks[52]. Researchers have suggested that earlier diagnoses have value in their own right, by providing reassurance, as well as from the health effects of earlier treatment[56]. In addition, long waiting times may lead to additional costs for interim care, or loss of productivity due to untreated conditions[46], however these issues were not assessed in the studies included in this review.

Limitations

There were limitations in the quality of many of the economic analyses that met the criteria for this review, which in turn limits the strength of the conclusions. This is of particular importance because reducing cost and improving efficiency are key arguments for the introduction of telehealth. The validity of these analyses could be improved by:

- Longer term studies to detect potential longer term effects, such as decrease in health services utilisation that may occur if patient outcomes are improved.
- Measuring additional potential outcomes, such as knowledge transfer in provider to provider telehealth.
- Greater homogeneity in study methods and outcome measures, for example, increased use of QALYs.
- Standardising the method for assessing the quality of the economic analyses.

It was also not possible to perform a quantitative meta-analysis of the effects of telehealth because of the heterogeneity of the outcome measures. A higher proportion of the non-random comparisons showed lower costs and better outcomes than did the RCTs,

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suggesting that the studies with a lower level of evidence are biased in favour of telehealth.

Generalisatiblity is a problem for telehealth research as a whole, due to variability in clinical disciplines, environmental settings, workforce and health care financing. This review attempts to deal with this by considering only real time video communication, which has similar infrastructure and ways of clinical practice, and also by grouping the results into similar organisational settings; however this variability means that generalisation should still be considered with caution. Although there are patterns in the results by organisational setting, numbers in these groups are low, and the conclusions would be strengthened by additional research in each area.

Finally, concluding the search at mid-2009, together with the delay between research and publication, has meant that more recent research, which could use higher bandwidth and less costly connectivity, was not yet available for inclusion.

Conclusion

Reviewing 36 economic analyses of the delivery of health services by synchronous video communication indicates that this form of telehealth can offer value to health care, and it suggests that key factors associated with this are the settings and particular models of health service delivery. The health outcomes of the patients were either equal to or better than conventional care, with two minor exceptions that did not compromise quality of care. Therefore the decision as to whether or not to introduce a telehealth service can be made using cost-effectiveness criteria and consideration of the model of care.

It is concluded that synchronous video delivery is cost-effective for home care, and for on-call hospital specialists, and it can be cost-effective for regional and rural health care, depending upon the particular circumstances of the service. However, it is not cost-effective, from the health services perspective, for local delivery of service between hospital specialists and primary care, particularly due to additional health care staffing. Across settings, equipment and connectivity costs have been major factors in setting up telehealth services, but even as these costs reduce, this will not necessarily make telehealth more cost-effective, unless the other factors such as health workforce and facility space are also addressed.

Improvement in the quality of economic analyses is also needed to provide data for more accurate modelling of the effects of widespread introduction of telehealth into the health care system.

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Authors' contributions
VW conducted the searches, analysed the data and wrote the article, JK analysed some of the data, supervised data analysis, and reviewed the article, AE supervised and reviewed the article, and JH supervised and reviewed the article. All authors read and approved the final manuscript.

Competing interests
VW declares that she has a competing interest, being the Medical Director of Design Networks Pty Ltd, a company that supplies telehealth services. This position is not salaried, however VW has received reimbursement of expenses for conference attendance from the company. The company did not initiate or fund this work. The other authors declare that they have no competing interests.

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3.3 Afterword: update and commentary

Since publication in 2010, this systematic review has been cited 19 times, as recorded in the Web of Knowledge (accessed 8 June 2013). Additional systematic reviews in this area were sought in early 2013 to provide an update to the field, and two were located. Mistry reviewed 80 economic evaluations across all areas of telehealth, and concluded that the quality of most remained poor, with no further evidence produced to show that telehealth shows overall cost-effectiveness(179).

The other recent systematic review included nine studies investigating the costs and financial benefits of video communication for home care (180). The authors noted that eight studies did not demonstrate the financial benefits were greater than costs, and one study found that costs for patients were higher for telehealth than usual care. These authors critiqued the review conducted for this thesis, disagreeing with our conclusion that video communication was cost-effective for home care, and stating that the Wade review had based its conclusions on the authors' statements rather than on the data presented. This was not the case, as the individual data from each included study was used as the basis for the results. The differences reflect the way in which benefit was measured; our review assessed health outcomes, hence providing an assessment of cost-effectiveness, whereas the Peeters' review assessed financial benefits.

CHAPTER 4 - Home Medication Management by Videophone: Translation from Pilot Project to Integrated Service

4.1 Preface

This chapter contains an editorially reviewed book chapter:

Wade V, Littleford A and Kralik D. Home medication management by videophone: translation from pilot project to integrated service. In *Handbook of Digital Homecare: Successes and Failures* (Communications in medical and care compunetics) 2011 Bos L, Goldschmidt L, Verhannenman G and Yogesan K (eds) Springer-Verlag Berlin Heidelberg doi:10.1007/978-3-642-19647-8

This publication is a prelude to the mixed-methods evaluation I conducted on the home medication management service, which forms the next chapter of this thesis. I chose to conduct research on this service because it had made the transition from project to sustainable operations, hence it was a relevant case study for the thesis. Also, I was very familiar with the service as I had been closely associated with its set up and initial operations.

The book chapter format provided scope to describe the development and operations of the service in more detail than was possible in a journal article, and includes a literature review on the use of telehealth for medication management. A portion of this publication is devoted to a qualitative evaluation of the service that does not form part of this thesis, as it was conducted solely by the second and third authors.

The following timeline gives further background to my involvement with the service:

- **2007** – I worked with the Royal District Nursing Service of South Australia (RDNS SA) to obtain the funding for the pilot project, then assisted with the practical implementation and conducted an evaluation of the pilot phase of the project(1).
- **2008** – I stepped back from the daily operations of the project. It continued throughout this year at a low level of around 10 patients, whilst RDNS SA considered future implementation.
- **2009** – RDNS SA decided to expand and extend the project into an ongoing service. I was not involved with this decision.
- **2010 to 2011** – I conducted the mixed-methods evaluation of the service.

At the time of writing (mid 2013) the service had been in ongoing operations for over five years, and had plateaued at a level of 80 to 100 patients enrolled at any one time.

STATEMENT OF AUTHORSHIP

Wade V, Littleford A and Kralik D Home medication management by videophone: translation from pilot project to integrated service. In Handbook of Digital Homecare: Successes and Failures (Communications in medical and care compunetics) 2011 Bos L, Goldschmidt L, Verhannenman G and Yogesan K (eds) Springer-Verlag Berlin Heidelberg doi:10.1007/978-3-642-19647-8

Victoria Wade (Candidate)

Responded to a request from the publishers for submission of chapters to this book, and acted as corresponding author. Conceptualised the content and orientation of the manuscript. Conducted a literature review on the topic. Wrote the following sections of the manuscript:
The Abstract
Section 1 Description of the Project
Section 2 Development of the Project
Section 3 Outcome of the Project
Section 5 External Influences on Development and Outcome, sub-sections 5.2 and 5.3
Section 8 Conclusion

Signed .... Date 26/6/2013

Angela Littleford

My contribution to this paper involved conducting a qualitative evaluation of the medication management service, writing the following sections of the manuscript, and reviewing the entire manuscript:
Section 4 Internal Influences on Development and Outcome
Section 5 External Influences on Development and Outcome, sub-section 5.1
Section 6 User Aspects
Section 7 General Aspects
I give consent for Victoria Wade to present this paper for examination towards the Doctor of Philosophy.

Signed .... Date 5.11.12

Debbie Kralik

My contribution to this paper involved conducting a qualitative evaluation of the medication management service, writing the following sections of the manuscript, and reviewing the entire manuscript:
Section 4 Internal Influences on Development and Outcome
Section 5 External Influences on Development and Outcome, sub-section 5.1
Section 6 User Aspects
Section 7 General Aspects
I give consent for Victoria Wade to present this paper for examination towards the Doctor of Philosophy.

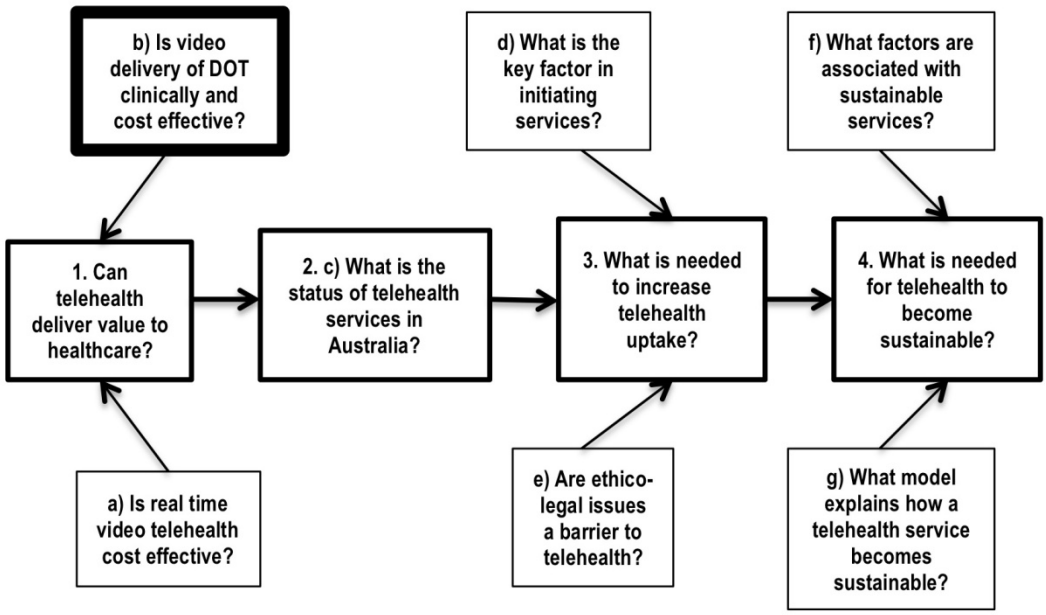
Signed .. .. Date 7.11.12

Wade, V.A., Littleford, A. & Kralik, D. (2011) Home medication management by videophone: translation from pilot project to integrated service.
In Handbook of Digital Homecare: Successes and Failures, Bos, L., Goldschmidt, L., Verhannenman, G. & Yogesan, K, Springer-Verlag, Berlin, *pp. 143-165*

CHAPTER 5 - A Mixed Methods Evaluation of a Sustainable Telehealth Service

5.1 Preface

Figure 5-1 Logical Structure of Research Questions



The publication in this chapter is a mixed-methods evaluation of the use of the home videophone medication management service for patients with tuberculosis (TB):

Wade VA, Karnon J, Eliott JA and Hiller JE. Home videophones improve direct observation in tuberculosis treatment: a mixed methods evaluation. *PLoS ONE* 2012; 7(11):e50155.

As I did not have the resources to evaluate the entire medication management service, I chose to focus on direct observation of medication ingestion for patients with TB. Direct observation is recommended for the successful treatment of TB, but it has been almost exclusively conducted in-person. There is potential for video observation to be useful worldwide, yet very little had been published on the use of telehealth in this area. This publication asks if video delivery of direct observation is clinically and cost effective, and hence contributes to answering research question 1, concerning the ability of telehealth to deliver value to health care.

Details of the ethics approvals, introductory letters to participants, and interview schedules for this study are given in Appendix B.

STATEMENT OF AUTHORSHIP

Wade VA, Karnon J, Eliott JA and Hiller JE. Home videophones improve direct observation in tuberculosis treatment: a mixed methods evaluation. *PLoS ONE* 2012; 7(11):e50155.

Victoria Wade (Candidate)

Conceptualised and designed the research project, conducted the literature review, wrote the manuscript and acted as corresponding author.
For the quantitative section, developed the research protocols, extracted data from the patient case notes, and analysed the outcome comparisons data.
For the economic analysis, constructed the cell-based model, obtained and/or estimated the input parameters, and conducted the scenario and sensitivity analyses.
For the qualitative section, designed the interview protocols, conducted all the interviews, carried out the thematic analysis and developed the sustainability model.

Signed .... Date 26/6/2013

Jonathan Karnon

My contribution to this paper involved conducting the matching of comparison groups with the GenMatch algorithm, setting up the model to generate the convergent parameter sets for the calibration, advising on all aspects of the economic analysis, and manuscript review.
I give consent for Victoria Wade to present this paper for examination towards the Doctor of Philosophy.

Signed Date 28/6/13

Jaklin Eliott

My contribution to this paper involved advising on the qualitative component of the research, including the thematic analysis and sustainability model, and manuscript review.
I give consent for Victoria Wade to present this paper for examination towards the Doctor of Philosophy.

Signed .... Date 1/7/13

Janet Hiller

My contribution to this paper involved assisting with the design of the research project, advising on the quantitative component of the research, and manuscript review.
I give consent for Victoria Wade to present this paper for examination towards the Doctor of Philosophy.

Signed .... Date 4/6/13

5.2 Publication

OPEN ACCESS Freely available online

PLOS ONE

Home Videophones Improve Direct Observation in Tuberculosis Treatment: A Mixed Methods Evaluation

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Abstract

Background: The use of direct observation to monitor tuberculosis treatment is controversial: cost, practical difficulties, and lack of patient acceptability limit effectiveness. Telehealth is a promising alternative delivery method for improving implementation. This study aimed to evaluate the clinical and cost-effectiveness of a telehealth service delivering direct observation, compared to an in-person drive-around service.

Methodology/Principal Findings: The study was conducted within a community nursing service in South Australia. Telehealth patients received daily video calls at home on a desktop videophone provided by the nursing call center. A retrospective cohort study assessed the effectiveness of the telehealth and traditional forms of observation, defined by the proportion of missed observations recorded in case notes. This data was inputted to a model, estimating the incremental cost-effectiveness ratio (ICER) of telehealth. Semi-structured interviews were conducted with current patients, community nursing and Chest Clinic staff, concerning service acceptability, usability and sustainability. The percentage of missed observations for the telehealth service was 12.1 (n = 58), compared to 31.1 for the in-person service (n = 70). Most of the difference of 18.9% (95% CI: 12.2 – 25.4) was due to fewer pre-arranged absences. The economic analysis calculated the ICER to be AUD$1.32 (95% CI: $0.51 – $2.26) per extra day of successful observation. The video service used less staff time, and became dominant if implemented on a larger scale and/or with decreased technology costs. Qualitative analysis found enabling factors of flexible timing, high patient acceptance, staff efficiency, and Chest Clinic support. Substantial technical problems were manageable, and improved liaison between the nursing service and Chest Clinic was an unexpected side-benefit.

Conclusions/Significance: Home video observation is a patient-centered, resource efficient way of delivering direct observation for TB, and is cost-effective when compared with a drive-around service. Future research is recommended to determine applicability and effectiveness in other settings.

Citation: Wade VA, Karnon J, Eliott JA, Hiller JE (2012) Home Videophones Improve Direct Observation in Tuberculosis Treatment: A Mixed Methods Evaluation. PLoS ONE 7(11): e50155. doi:10.1371/journal.pone.0050155

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Competing Interests: Victoria Wade declares that she is the unpaid medical director of Design Networks Pty Ltd, a small Adelaide based company that supplied the videophones and network used by RDNS SA to deliver the home videophone service. VW has received reimbursement for conference attendance from Design Networks and Telstra, an Australian telecommunications company. The other authors declare that they have no conflicting interests in the work. This does not alter the authors' adherence to all the PLOS ONE policies on sharing data and materials.

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Introduction

The treatment of tuberculosis (TB) requires patients to take multiple antibiotics for a minimum of six months; if medication is taken correctly and completely, success rates for both active and latent TB approach 100% [1]. Failure to complete treatment increases the likelihood of recurrence and of developing drug resistant TB, which requires longer, more expensive, and less effective treatment [2,3]. The direct observation of patients with TB taking their medication is intended to improve adherence, and is recommended by the World Health Organization (WHO) as part of standardized short-course chemotherapy [4].

Direct observation is resource-intensive for healthcare services and requires time and effort from patients [5,6]. A Cochrane review containing 11 randomized controlled trials (RCTs) concluded that there was no significant difference in TB cure rates between direct observation and self administration of medication, and recommended that funding spent on direct observation would be better directed to other aspects of TB control [7]. However, only one of these RCTs achieved the WHO treatment target of 85% success rate, indicating poor adherence was an issue in all countries.

The reasons for this low efficacy may lie in the characteristics of each setting. In rural areas of developing countries, patient attendance at a clinic for direct observation takes time and money that the patients often lack, leaving a stark choice between receiving treatment or earning a living [8,9]. In the USA, direct observation can fail because some environments of high crime and drug abuse are too dangerous for outreach workers [10]. A study in Australia deemed home visiting by nurses to be too expensive,

and direct observation by trained family members could only be implemented for 58% of the sample because many patients lived alone [11].

Two systematic reviews of qualitative investigation into the facilitators and barriers to complying with TB treatment found that social, cultural and health system factors such as poverty, stigma, and how treatment and care are organized, reduce the effectiveness of direct observation [12,13]. Regarding service delivery, it has been asserted that TB services are "rarely designed with users' needs in mind and often did not fit readily into the tempo of people's lives" [12].

The case for universal direct observation of all TB patients is that drug resistance is reduced [14], and adherence cannot be predicted by patient characteristics [15]. Economic analyses have found that direct observation is more expensive than standard medical management [16,17], but is cost-effective when the relapse rate and cases averted are accounted for [18,19].

Telehealth, or the delivery of healthcare services at a distance using information and communications technology, has the potential to address several deficiencies in the delivery of direct observation. Using home videophones for real-time direct observation of TB was found to be feasible and acceptable in three pilot studies [20,21] [22], one of which also found cost savings [20]. One feasibility study in an underdeveloped country showed it was possible to use mobile phones to capture video clips of medication ingestion [23]. In general it has been difficult for telehealth services to move beyond a pilot or trial phase into routine operations [24–26].

In 2007, the Royal District Nursing Service of South Australia (RDNS SA), a community nursing service, commenced a telehealth pilot program for medication management [21], installing desktop videophones and broadband data connections in patients' homes. This became a routine service from 2009 [27], operating 24/7 within a larger call center, making daily video calls to patients at mutually agreed times. Previously, direct observation was conducted by daily drive-around home visits, and patients not able to be seen during office hours were usually discharged back to management by TB services.

This paper presents the results of a mixed methods evaluation of the home videophone service, using a convergent parallel approach [28], in which each component of the study was conducted independently, then synthesized at the interpretation phase. The specific objectives were:

- to compare the effectiveness of in-person versus home videophone direct observation as measured by the proportion of missed observations in each group
- to determine the cost-effectiveness of home videophone observations under a range of conditions
- to determine the acceptability, usability and sustainability of the home videophone service by interviewing patients and providers

Methods

Ethics

This study was approved by The University of Adelaide Human Research Ethics Committee, the Royal Adelaide Hospital Research Ethics Committee, and the South Australian Department of Health Human Research Ethics Committee. All participants who were interviewed gave written informed consent. Consent was waived by the above ethics committees for retrospective case note access, provided that no individuals were identified, as allowed by the Australian Government National Statement on Ethical Conduct in Human Research [29], on the grounds that the research was low risk and obtaining consent for this component of the study was impractical.

Quantitative study

Design. A retrospective cohort design was used to compare TB patients who had received direct observation by home videophone with patients who had received this service in person, either by a drive-around service or clinic attendance, because the service model had altered from mainly in-person to mainly home videophone delivery from early 2009.

Participants. Data were sought from the records of the patients who had received direct observation for TB from RDNS SA, from the beginning of 2003 (when records became readily available), to the 15th November 2010.

Data Sources. The uptake of the home videophone service was determined from data provided by the Royal Adelaide Hospital Chest Clinic, showing the total numbers of new TB cases per year commencing treatment, the numbers of patients referred for any form of direct observation, and those specifically referred to RDNS SA.

Within RDNS SA, patients were identified by searching the RDNS SA electronic business system for all patients funded by the Chest Clinic, and all patients with a diagnosis of TB. The paper case notes of these patients were then obtained for data extraction, which was repeated for five percent of cases by the same researcher (VW), after a minimum interval of two weeks, to assess reliability.

Data Collected. Age, sex, country of origin, and English-language capability were collected from admission forms. Length of service was determined as the number of days the patients were enrolled for direct observation, excluding any periods for which patients had their medication suspended.

The denominator for assessing effectiveness was the number of occasions on which the patients were supposed to take their medication. Most had a medication regimen of taking their tablets once a day, but a minority was medically required to take their medication on a different schedule, such as three times a week, or twice daily, which is reflected in the number of intended observations.

The numerator for assessing effectiveness was the number of missed observations, recorded if the visit record and the medication chart record together noted an absence, or if a specific mention of non-observation was made in the progress notes. Partial observation, where only some of the tablets taken were observed, was counted as a successful observation. Reasons for missed observations and discharge from the service were also collected and compared by service type.

Statistical Analysis. Comparison of the video and in-person groups matched each videophone patient with an optimal match from the in-person service, which could be either whole-person or proportionate matches of several individuals, using the GenMatch automated search algorithm. The balance of the observed covariates was maximized by an iterative process, using a generalized Mahalanobis Distance metric, and was continued until there were 199 iterations without improvement [30]. The resulting matched dataset was bootstrapped using the Stata statistical package [31] to generate 95% confidence intervals around the difference in the outcomes between the comparison groups.

Economic Analysis

To jointly estimate the costs and outcomes associated with a traditional drive around service, compared to a mixed video plus drive-around service, a dynamic cell-based cost-effectiveness model was built in Microsoft Office Excel [32]. The workflow processes which fed into this model were informed by the RDNS SA staff interviews, and are shown in Figure 1. Prior to the videophone service, all clients entered the drive-around service, whereby if the patient is not present at the time of the pre-arranged home visit, an attempt is made to telephone the patient and arrange a second time for direct observation that day. In the videophone service, a proportion of patients are deemed unsuitable for the home videophone option and continue to use the drive-around service. For those using the videophone service, if patients do not answer an initial video call, the service tries twice more to make a video call before telephoning patients and attempting to leave a message. Patients can also initiate a video call, providing an additional avenue for achieving successful observation.

The model was populated to estimate the proportion of visits that follow each of the defined pathways, with costs attached to the events along each pathway. The population of patients entering the service is categorized with respect to an underlying measure of adherence to the traditional drive around form of direct observation: compliant (<20% of observations missed), erratic (20 to 50% of observations missed), and non-compliant (>50% observations missed). The percentages of patients in each adherence group were sourced from the matched in-person patient cohort described in the Quantitative study methods section. For the mixed service option, the proportion of patients continuing to use the drive around service was based on the figure in the current operations of the videophone service.

The following section describes the data and assumptions used in the population of the model. Table 1 presents the full range of parameter values and data sources.

Resource Use and costs. Daily resource use was estimated for each model pathway, which were multiplied by the corresponding pathway probabilities and summed to generate an

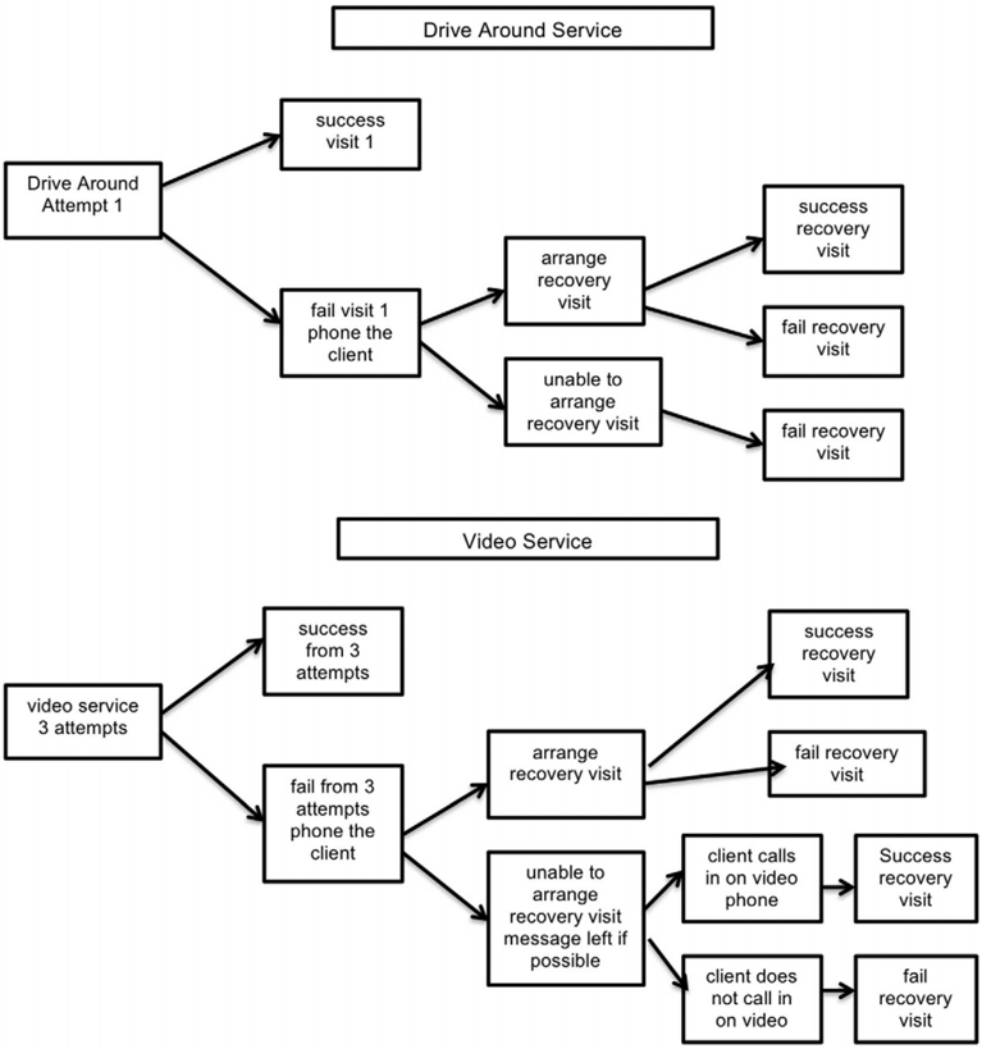

Figure 1. The workflow of delivering direct observation.
doi:10.1371/journal.pone.0050155.g001

Table 1. Economic model input parameter values and sources.

Variable	Values	Source of Data or Estimate
% compliant, erratic and non-compliant patients	36.3, 39.4, 24.3	RDNS SA Case Note Review; matched non-video patients
Number of patients/year on direct observation	47	Royal Adelaide Hospital Chest Clinic
Average trip speed	32 kph	Tranter [43]
Length successful in-person visit	19 mins	RDNS SA business records
Length failed in-person visit	5 mins	Estimate from nurse interviews
Drive time between visits	5 mins	RDNS SA business records
Length successful 1st video visit	8 mins	RDNS SA business records
Length failed 1st video visit	4 mins	Estimate from nurse interviews
Length recovery video visit	7 mins	RDNS SA business records
Length failed recovery video visit	1 min	Estimate from nurse interviews
Supervisor/staff ratio: drive-around	0.071	Estimate from nurse interviews
Supervisor/staff ratio: call centre	0.033	Estimate from nurse interviews
% in-person patients seen on weekends drive-around service	50%	Estimate from case note review
Ratio registered to enrolled nurses drive-around service	0.6	Estimate from nurse interviews
Ratio registered to enrolled nurses video service	0.2	Estimate from nurse interviews
Nurses working hours	38/week	Nurses (South Australia) Award [44]
Nursing salaries	Range: $46K to $85K p.a.*	Nurses (South Australia) Award [44]
Office costs/workstation/yr	$4,800*	Employee cost calculator [45]
Video service costs/unit/month	$200*	Video service provider
Car costs/km	$0.63*	Australian Tax Office [46]

*Currency conversion using purchasing power parity $AUD1 = £UK0.42 [47].
doi:10.1371/journal.pone.0050155.t001

expected cost per patient. Whole of service costs per annum were estimated by multiplying the expected cost per patient by the annual patient prevalence , determined by the number of new cases referred for direct observation per year, and the duration of each case.

The main resource element is nursing time. For the drive around service, nursing time includes the time spent driving between visits. For both service options, alternative times associated with failed and successful observation visits/calls were estimated. Other resources included car running costs (based on estimated average distances between visits), supervisor time, office costs and videophone rental charges. A general assumption is that services are part of larger drive-around and call-centre operations, which allows the allocation of fractional resource units.

Costs were attached to the resources used: salaries for enrolled and registered nurses, additional costs of covering seven days a week, shift work, annual and sick leave, and compulsory on-costs such as superannuation, insurance, and taxes. Proportions of patients seen after-hours, and the proportion of registered versus enrolled nurses were represented. Supervisory staff, office costs, and technology costs were also included in the estimated cost per whole episode of service per patient, and the total cost of the service to the organization per annum. Cost-effectiveness was estimated as the cost per additional day of successful observation of the mixed video with residual drive-around service compared to the drive-around service alone.

Calibration, Scenario and Sensitivity Analysis. Probabilistic calibration was used to generate multiple sets of input parameter values for which there was stochastic uncertainty [33]. The model was calibrated to observed data describing the numbers of observation days in separate cohorts of videophone, and drive-around patients, as measured by the case note review. Sampling values from plausible ranges for relevant input parameters, the effectiveness component of the model was run until 100 convergent parameter sets were found that matched the observed model outputs to two decimal places. The mean outputs and 95% confidence intervals across the 100 convergent parameter sets were reported as the reference case results. The convergent parameter sets represent the joint uncertainty in the input parameters, and so the outputs across the convergent sets were analyzed to estimate the probability that the videophone service is cost-effective at different monetary values per additional day of observation, presented in the form of a cost-effectiveness acceptability curve.

A set of deterministic scenario analyses was also undertaken to model the effects of service variables, which were defined as parameters that could be estimated locally in areas that are considering implementing a videophone DOTS service. Two scenario analyses were also performed to model the outcomes in two plausible settings of a larger city and a service run wholly by a TB clinic.

Qualitative Study

Data Sources. Interviews were requested with clinicians delivering TB services at the Chest Clinic, clinical staff and managers associated with the videophone service at RDNS SA, and current RDNS SA patients who had been receiving direct observation via videophone for at least one month. Text was also collected from case notes when this provided additional perspectives on service delivery issues.

Recruitment. Patients were recruited by RDNS SA staff asking current patients if they would be interested in receiving information about a research project on the service. Willing patients were posted the information sheet and consent form, and the researcher (VW) made telephone contact for recruitment.

Health services staff were recruited by email or direct contact, following permission from service management.

Interview Methods. Interviews were semi-structured, containing open-ended questions asking for a description of the participant's experience of the videophone service, the acceptability, usability and quality of the service, preferences for method of service, problems or difficulties, and advice or suggestions. Staff interviews also addressed the development of the service, its effect on clinical service delivery, liaison with other services, and factors affecting sustainability.

Data Analysis. Interviews were audio-recorded, transcribed and entered into NVivo software [34]. As the healthcare staff worked in small, easily identified units, they were sent their interview transcripts for review, allowing removal of any part which they did not want used.

A thematic analysis was conducted, taking a realist approach to identifying repeating patterns in the data, connecting these to each other and to concepts in the literature [35]. The themes were related to each other to form a diagrammatic model explaining the reasons for the successful uptake of the videophone service.

Results

Quantitative Study

Uptake of Direct Observation. The uptake of direct observation in South Australia is shown in Table 2, which combines the RDNS SA data with the Chest Clinic data from 2006.

The total number of people who commenced treatment for TB was steady over time. Before the videophone service, a minority of patients received direct observation, and of these, less than half were sent to RDNS SA, where they received either a drive-around service or attended a nursing centre. During the period studied, the RDNS SA progressively closed its suburban nursing centres, leaving only the drive-around in-person option by 2010. As only seven patients attended a nursing centre, this group was combined with the drive-around service, to form one in-person group. Following the decision by RDNS SA at the beginning of 2009 to implement telehealth on an ongoing basis, the percentage of patients referred for direct observation has increased, with most being placed into the videophone service.

Selection of Records for Case Note Review. The RDNS SA electronic patient database contained 225 records of patients who were either funded by the Chest Clinic or had a recorded diagnosis of TB, between 1st January 2003 and 15th November 2010. Patients were excluded if they were not treated for TB, were receiving intramuscular or intravenous treatment, or if data were missing from their notes, leaving 128 patients who were seen for 132 episodes of direct observation. Four repeat episodes of care were excluded from subsequent analysis because they were not directly comparable to first episodes.

Table 2. Uptake of direct observation by year and method.

Year	2006	2007	2008	2009	2010*
N total TB patients in SA	74	56	58	54	58
N TB patients on direct observation	26	21	26	39	42
% TB patients on direct observation	35.1%	37.5%	44.8%	72.2%	72.4%
N RDNS SA video patients	0	2*	0	37	30
Video % of total TB patients	0%	3.6%	0%	50.0%	51.7%
N RDNS SA in-person patients	11	9	14	5	3
In-person % of total TB patients	14.9%	16.1%	24.1%	9.3%	5.2%

*to Nov 15 **pilot study patients.

doi:10.1371/journal.pone.0050155.t002

Data Extraction Checking. Six sets of notes were recoded, with four exhibiting minor differences; in each case a single day of service was coded differently, and these were checked a third time to determine the final numbers. All extracted raw data was checked a second time for consistency, and where differences were found, a third time. These changes were minor and did not alter the aggregated results.

Demographic Characteristics of the Patients. Table 3 shows the patient demographics for videophone and non-videophone patients.

With the introduction of the videophone service, the percentage of females increased, the age distribution shifted towards the young adult group, a larger percentage spoke English well, and a higher percentage came from the Southern Asia region.

Video versus In-Person Service Comparisons. Service comparisons between the videophone and in-person groups are shown in Table 4. The different demographic characteristics of the two groups were compensated by matching, which increased the validity of calculating confidence intervals.

The videophone service was more effective than the in-person service, with a significantly reduced percentage of missed observation episodes. The seven patients who attended a nursing center missed 31.2% of observations compared with 31.9% in the 63 patients receiving a drive-around service, therefore these two groups were combined into a single in-person group.

The main reason for the videophone service reducing missed observations was far fewer days lost to pre-arranged absences, such as weekends, attending medical appointments, being on holidays or at work. The videophone service attempted to see all patients

Table 3. Patient characteristics.

	Videophone	%	In Person	%	Total
Gender					
Male	32	55.2%	46	65.7%	78
Female	26	44.8%	24	34.3%	50
Age					
0–19	3	5.2%	8	11.4%	11
20–29	21	36.2%	16	22.9%	37
30–39	19	32.8%	14	20.0%	33
40–49	5	8.6%	13	18.6%	18
50–59	6	10.3%	4	5.7%	10
60+	4	6.9%	15	21.4%	19
Region of Origin					
Africa	7	12.1%	12	17.1%	19
Australia	1	1.7%	11	15.7%	12
Europe	2	3.4%	6	8.6%	8
Eastern Asia	9	15.6%	5	7.1%	14
South East Asia	18	31.0%	22	31.4%	40
Southern Asia	21	36.2%	14	20.0%	35
Proficiency in English					
Good	40	69.0%	39	55.7%	78
Poor/none	18	31.0%	31	44.3%	49

doi:10.1371/journal.pone.0050155.t003

Table 4. Service outcome comparisons.

	Videophone (n = 58)	In Person (n = 70)	Mean Difference (95% Confidence interval)
Average length of service (days)	BM 163.3	133.0	
	AM 163.4	**116.7**	**46.6 (18.2–76.5)**
Average number of service episodes	BM 158.9	124.1	
	AM 158.7	**114.3**	**34.3 (14.1–72.5)**
Average number of non-observations	BM 13.4	40.6	
	AM 13.5	**41.0**	**27.5 (16.6–40.0)**
% Service episodes not observed	BM 12.2	31.8	
	AM 12.1	**31.1**	**18.9 (12.2–25.4)**
Observation days lost: with permission	BM 2.0	30.0	
	AM 2.0	**30.1**	**28.1 (19.3–40.7)**
Observation days lost: non-adherence	BM 5.3	6.4	
	AM 5.3	**3.3**	**2.0 (−5.4–4.8)**
Observation days lost: technical problems	BM 2.0	0	
	AM 2.0	**0**	**2.0 (1.2–3.0)**
Observation days lost: service provider issue	BM 2.1	0.8	
	AM 2.1	**0.7**	**1.4 (1.2–3.0)**
% Patients discharged: treatment complete*	BM 57.7	42.8	
	AM 47.8	**32.8**	**14.9 (−0.2–32.6)**
% Patients discharged: moved out of area*	BM 17.8	14.3	
	AM 15.3	**23.4**	**8.1 (−2.0–5.2)**
% Patients discharged: to Chest Clinic mgmt*	BM 17.8	35.7	
	AM 13.7	**39.4**	**25.7 (9.0–40.1)**

BM = before matching AM = after matching and bootstrapping.
*Comparisons after removing 13 videophone patients who had not yet completed treatment from the sample.
doi:10.1371/journal.pone.0050155.t004

seven days a week, whereas on weekends the nursing centers were closed and the drive-around services were reduced.

Non-adherence, where the patient was absent and could not be contacted, present but refused to take their medication, or claimed they had already taken their medication before the visit, was the same in both types of service. An average of two days was lost from the videophone service due to technical problems, although the variation between patients was large with some having none, and others frequent technical issues. Reasons for technical failure recorded in the case notes included videophone, modem or power failure, poor quality video calls, videophone not responding to rebooting, and connectivity failure, with this latter category subdivided into congestion, internet service provider failure, and landline disconnection. These reasons were not recorded consistently enough to produce reliable subcategories.

The length of service was longer for the videophone group because the service model changed to keep patients on direct observation until the end of their TB treatment. This difference is a conservative estimate because at the time of data extraction, 13 of the videophone patients were still enrolled in the service. This change in approach meant that fewer patients on the videophone service were discharged from direct observation to routine management by the Chest Clinic, and a higher proportion was seen by RDNS SA until their TB treatment was complete.

Economic Analysis and Model

Cost-Effectiveness. Table 5 shows the reference case, in which the model is populated with the RDNS SA data to determine the cost-effectiveness of the two whole-of-service approaches.

The model indicates that operating the video service on this small scale is near to break-even, but is a little more costly than operating a drive-around service, an overall outcome that was confirmed by RDNS SA. Nonetheless the Incremental Cost-Effectiveness Ratio (ICER) is at a level where this additional cost was borne because of the improved effectiveness of the service.

The probabilistic calibration generated a distribution of costs and observation days for both comparators, which are presented in Figure 2 in the form of a cost-effectiveness acceptability curve. This shows that if one is willing to pay an additional $1 to gain an additional day of observation, there is a 30% probability that the videophone service is cost-effective, but if one is willing to pay $2, the probability of cost-effectiveness rises to almost 90%.

Scenario Analysis. *Scenario 1: Larger city.* Adelaide is a small city with a low prevalence of TB. To model a larger city, client numbers were set at 500 a year, the travel time was increased to 10 minutes between visits at an average speed of 20 kph, (allowing for increased traffic congestion), and the cost of the videophone service was reduced to $150 per month per unit. Under these conditions, four video workstations and 4.3 FTE staff are needed in the call center, together with 222 video units. The cost for the whole of the service favors the video option by $545,716per year, and the ICER indicates dominance, that is, both less costly and more effective.

Scenario 2: Stand alone service. To model a TB service with 160 patients a year in a medium-sized city, which is presently conducting its own outreach service, it was assumed that no

Table 5. Reference case - Service comparisons and economic analysis.

Type of Service	Video+Residual In Person	In Person	Difference (95% CI)
Patients/year	47		
Days observed/episode of care	141	92	49
Resource Use/day			
Staff FTE	0.45	1.05	0.61 (0.58–0.63)
Car hours	0.53	6.98	6.46 (6.34–6.59)
Kilometres driven	13.53	60.45	46.92 (44.74–48.89)
Costs ($AUD)			
Whole of service cost/year	$124,753	$121,686	$3,067 (1,184–5276)
Cost/complete patient care episode	$2,654	$2,589	$65.26 (25.20–112.27)
ICER- Cost per additional successful day of observation		$1.32 95% (0.51–2.26)	

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patients were seen in the evenings, travel time was increased to 15 mins between patients at an average speed of 25 kph (as the patients would be more geographically dispersed, with traffic congestion moderately increased) the videophone costs remain at $200 per month per unit, and the percentage of noncompliant patients is greater at 50%. If it is assumed that fractions of staff and cars could be put to effective use by the organization, then two call center workstations, 1.4 FTE call-center staff and 66 videophone units are needed, with the cost difference favoring video by $198,753 per year and the ICER also indicating dominance.

One-Way Deterministic Sensitivity Analyses. Taking the Reference Case as the starting point, the variables that are most relevant to service development were altered one at a time, with the results shown in Table 6.

Number of Patients. Reducing the number to a very small service of 30 patients a year makes it more costly but still worth considering, and increasing the numbers while keeping everything else the same leads to modest savings.

Type of Patients. Changing the percentage of noncompliant patients makes little difference to the outcome; if the proportion is reduced from the reference case of a 25% of patients to 10%, the video service has small increases in both expense and effectiveness, leaving the ICER unchanged. If noncompliant patients are increased to 40% of the total, there is a small difference in favor of the drive-around service, with more patients who are unsuitable for video being entered into the residual drive-around category.

Driving Time. The reference case driving time of 5 minutes between patients was thought to be the minimum possible; as RDNS SA is the major provider of community nursing in Adelaide; each field nurse drives around a geographically compact area. Only an increase was modeled, with any increase in driving time substantially favoring the video service.

Cost of Technology. Decreasing the cost of the technology favors the video service by a moderate amount.

Staff Salaries. Salary estimates in the reference case may be high compared to nursing costs elsewhere; reducing salaries reduces the total costs of both services substantially, with the balance tipping modestly toward the drive-around service.

Weekend Service. The reference case is set at half the drive-around patients receiving a weekend service; reducing this favors the

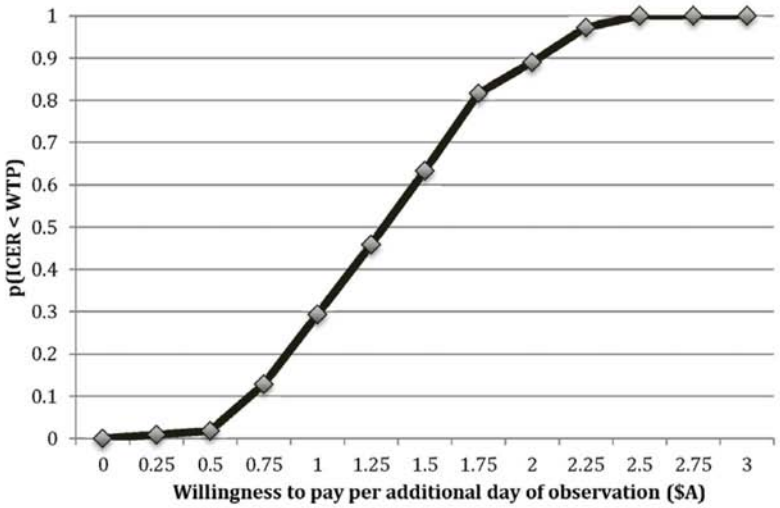

Figure 2. Service comparison cost-effectiveness curve.
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Table 6. One-way deterministic sensitivity analyses.

Variable	Total cost diff/year	Cost diff/patient service episode	Effectiveness difference (days)	ICER
Reference Case	$3,06	$65.2	49	$1.32
Number of patients				
30	$9,348	$311.60	49	$6.30
200	−$30,296	−$151.48	49	dominant
500	−$103,761	−$207.52	49	dominant
% Non-compliant				
10%	$4,305	$91.59	55	$1.63
40%	$5,851	$124.49	43	$2.93
Drive time between patients				
10 mins	−$28,115	−$598.18	49	dominant
20 mins	−$90,478	−$1,925.07	49	dominant
30 mins	−$152,842	−$3,251.96	49	dominant
Cost of technology				
$150/mth/unit	−$11,333	−$241.12	49	dominant
$150/mth/unit	−$25,733	−$547.50	49	dominant
Staff salaries				
↓ by $5,000p.a.	$7,036	$149.71	49	$3.02
↓ by$10,000p.a.	$11,170	$237.66	49	$4.80
↓ by$15,000p.a.	$15,139	$322.11	49	$6.51
Drive-around weekend service				
All patients	−$23,602	−$502.18	35	dominant
No patients	$27,957	$594.83	63	$9.38
Equal length of service	−$20,905	−$444.79	31	dominant

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drive-around service because less staff time is used in the hours when it is more expensive. Conversely, if the drive-around service operates for all patients on the weekends it is more costly than the video service.

Length of Service. If the drive-around service is continued for the same length of time as the video service, for the whole of the treatment episode, then the video service becomes dominant.

Qualitative Study

Interviews. Thirty interviews were conducted with the four staff at the Chest Clinic who had major responsibility for managing TB patients, 14 RDNS SA staff, and 11 current patients. Eight patients spoke English very well and three had English that was adequate but not fluent, which reduced their ability to express themselves at interview. The technical director of the videophone service provider was also interviewed. The staff interviewees reviewed their transcripts and none requested removal of any material.

Thematic Analysis. Analysis of all 30 interviews produced seven themes related to the implementation and effectiveness of the service, shown in Table 7.

Increased convenience and flexibility for patients was a major theme, spoken about by 25 interviewees. Many patients were newly arrived in Australia; nurses noted that the patients had "time management problems, where they've got lots of stress, lots of other difficulties going on" and "are desperate to work, to keep an income going". The videophone service offered more options:

> a lot of them work in jobs where they are out early in the morning, like they start work at seven, so they'll want a call at six in the morning … and the night shift will do that.

The patients could also initiate a video call when they were ready; "after about nine o'clock [pm] we get a lot of them calling in, 'cause they're nurses or taxi drivers finishing their shift", and the service was able to meet cultural needs; "for the Muslims, it's really helpful, because we can do it all before sunrise."

Ten of the 12 patients had a wholly positive attitude to the service, while two expressed mixed feelings. As well as convenience, another factor contributing to acceptability was the good relationship with the nurses. One patient said:

> you sort of develop this friendship with the nurses … there are two nurses that I was first introduced to when I was taking my medication, 'cause when I started mine I was isolated at home, so I was always there for a solid three weeks … they are very caring people.

Most felt that the videophone service improved patients' privacy. For example, a patient said "by videoconferencing I think this is good. Nobody can tell to know, no-one", but two patients mentioned that the videophone service still felt like an intrusion into their homes. One said he would prefer to visit a clinic because he did not want his children to know that he had TB, however, he had accepted the videophone because the alternative was impractical.

Table 7. Thematic analysis of videophone service qualities.

Themes	Categories within each Theme
Convenience and flexibility for patients	• Patients could be observed at a time of their choosing, including early morning or evenings, fitting with lifestyle and cultural needs. • Chosen call time delivered reliably; patients did not need to wait. • Patients could initiate a video observation when they were ready. • Patients could change the time of the observation at the last minute. • Patients could move the videophone to another location whenever they chose.
Acceptability for patients	• Rapport with the nurses developed via video contact. • Patients had a positive regard for the technology. • The technology was regarded as very easy to use. • Staff and some patients thought the videophone service was more private than an in-person service. Two patients expressed privacy concerns.
Efficiency for RDNS SA	• Many more patients could be seen in a shift than with a drive-around service. • The service could be initiated rapidly, without technical support.
Technical problems were manageable	• Substantial and ongoing problems with video call quality were very frustrating. The call centre nurses learned to manage most of these themselves. • Occasional whole of system failures were also managed.
Increased patient adherence	• More convenient scheduling was regarded as improving patient adherence. • Absent patients could be readily called back repeatedly. • Patients who had difficulty taking all their tablets at once could be called in stages. • The potential to cheat over the videophone was noticed and protocols instituted to minimize this.
Improved liaison between RDNS SA and the Chest Clinic	• Increased communication about patients occurred. • The Chest Clinic initiated education of call centre nurses • Joint protocol development was undertaken.
Supported by the Chest Clinic	• More patients were referred to RDNS SA for direct observation. • The Chest Clinic encouraged other hospitals to also refer to the videophone service.

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The technology itself was reported as very easy to use, and was regarded positively by patients:

> all my family think it's lovely. Some of them come here around the time I take it, and they all stand behind here, and the nurse is there.

In regard to increased efficiency for RDNS SA, as well as the obvious saving of travel time, one nurse reported that it was easier to finish videophone visits, as the patients did not try to prolong calls by offering a cup of tea or social interaction.

However there were frequent, substantial, and ongoing technical difficulties which were a source of great frustration to patients and staff, and interfered with the workflow at the call center. The main problem was temporary freezing and drop out of video calls, which the technical service provider explained was due to variable signal strength because one end of the call was connected via a mobile data service. These problems made calling patients with only basic English particularly difficult. The issues could be ameliorated, but not completely resolved, by finding a location in the house with higher signal strength or installing a higher-gain antenna. Over time the nurses learned to troubleshoot these difficulties; many could be improved by asking patients to reboot their videophones. About once a year the entire videophone network went down and the nurses had to make a decision about each patient as to whether they would call them on the telephone that day, or if a field nurse would be asked to make a drive-around visit.

Both the RDNS SA and the Chest Clinic staff thought that the videophone service improved adherence. Some patients found it hard to take their tablets all at once:

> we've had young girls who, it's just a real process; it's a really hard daily struggle for them … sometimes it's the physical struggle of swallowing the tablets. Size and number of tablets; massive amounts.

For these people repeated calls could be made to observe them taking a few at a time. When the service was first initiated, the Chest Clinic raised concerns that patients might find it easier to cheat, and there were a few examples of patients trying to avoid observation recorded in the case notes. One entry read:

> Client did not sit down during the call or show me that she was taking the tablets from the bottles. She rattled the pills in the bottles and told me she was taking 8 tablets. It was not apparent that she had 8 tablets between her finger and thumb and appeared to swallow too quickly.

A protocol was developed of the patients needing to stay onscreen, show each tablet, and swallow one after the other. Keeping the patient talking for a short period after swallowing also allowed the nurses to see if there was any difficulty which could have been caused by concealing tablets in the cheek. One nurse noted that there was no additional ability to check adherence in person, as "in this day and age we do not have the right to be sticking things in someone's mouth". When there were problems with adherence, the Chest Clinic was contacted, and their further discussions with the patients usually resulted in improvement.

As a small number of staff operated the direct observation service, all working in the same call center, there was an unexpected benefit of improved liaison, including joint protocol development, between the RDNS SA and the Chest Clinic. A Chest Clinic staff member said:

> There's a lot more communication between RDNS and myself now, as in the home nurses, I had virtually no communication, unless there was an extreme issue.

Another added "I feel a lot more confident with the service and hence I'm not having to do as many home visits". The Chest Clinic welcomed the increased adherence and better liaison with the nursing service and responded by referring nearly all new TB patients to the videophone service, as well as encouraging other hospitals in Adelaide to do the same. They indicated that this gave them greater control over TB services and made it easier to collect data needed for the national TB control program.

In summary, the advantages and disadvantages of conducting direct observation by home videophone are shown in Table 8.

Explanatory Model of Uptake. Figure 3 shows an explanatory model of these seven themes combining to support ongoing operations, making the videophone service the preferred approach for delivering direct observation. Six the themes were enabling factors, while the major barrier, technical difficulties, could be overcome. The increased uptake produced a positive feedback loop, creating further efficiencies within RDNS SA and more support from the Chest Clinic.

Discussion

Improving the implementation of TB treatment with direct observation has been framed as a choice between a coercive model which includes universal direct observation, or a patient-centered strategy with communities and healthcare services working together [36,37]. There is strong advocacy for both approaches, some arguing that direct observation is necessary to achieve high cure rates and prevent drug resistance [38,39], and others claiming that participatory interventions show greater potential than coercive or inspectorial ones [6,12,37,40], which may drive away those who have most to fear from disclosure [12].

Direct observation has also been difficult to implement; services that are convenient for healthcare staff, such as clinic attendance in office hours, have been impractical, restrictive, and sometimes impossible for patients, whereas outreach services are time-consuming and expensive to operate.

This study suggests that a home videophone approach could offer a means of supplying a high rate of direct observation, although this finding must be tempered by the limitations of the study design, which could not control for all sources of bias. The service was practical to implement in a developed country setting, affordable for the community nursing organization, and was reported by staff and patients to be private, flexible, and convenient. By conducting operations within a 24/7 health call center, it became possible to observe patients after hours, on weekends, or on days when they had other commitments. Staff were readily able to make multiple calls if the patients were absent or unable to take all their tablets at once. Hence many observations which otherwise would have been missed were able to occur.

Nonetheless, the videophone service did not improve the number of observations missed due to patient absence or refusal. The argument could therefore be made that home videophones were simply using a new method to observe people who may have taken their tablets anyway. However the service is intended to be universal, and the qualitative findings indicate how patients, even those who were well-intentioned, well-educated, and living in stable circumstances, struggled with their medications, expressed dislike of taking them, and required considerable support and encouragement to continue treatment. MacIntyre has argued that poor overall compliance rates and inability to predict non-adherence highlights the need for universal direct observation, saying that "interventions to reduce non-compliance are not aimed at patients at the extreme end of the spectrum, but at the majority who are unintentionally non-compliant due to lifestyle factors" [11].

Limitations

The major weakness of this study was the necessity of using a retrospective cohort comparison between the video and drive-around patient groups. Whilst matching was undertaken for the available data on the demographic characteristics of the patients, other confounding factors may have existed, such as disease severity or socioeconomic status, and the effect of these is unknown.

In regard to the known data, the videophone and non-videophone groups had different demographic characteristics, most likely because the referral criteria to enter the service had broadened to include almost all patients with TB, including university students. This may explain the demographic shift towards young adults with good English from the Southern Asian or East Asian areas. Another possible reason is changing patterns of migration to Australia over time. These differences were taken into account during analysis by matching the samples.

Table 8. Videophone service advantages and disadvantages.

Service Issue	Advantages	Disadvantages
Videophone technology	Easy to operate with minimal training	Frequent problems with call quality
	Home installation can be conducted by a non-technician	Occasional whole of system technical failure
Patient acceptance	Positive attitude to videophones	Nil reported
	Patients and nurses developed rapport via video communication	
Patient adherence	Improved by flexible time and place of delivery	A few instances occurred of patients attempting to fake tablet ingestion
	Improved by repeated call backs	
Patient privacy	Staff and most patients reported improved privacy	Two patients reported a feeling of intrusion into the home
Delivery efficiency	Improved by reducing driving time and visit time	Nil reported
Organizational effects	Improved communication and liaison between services	Nil reported

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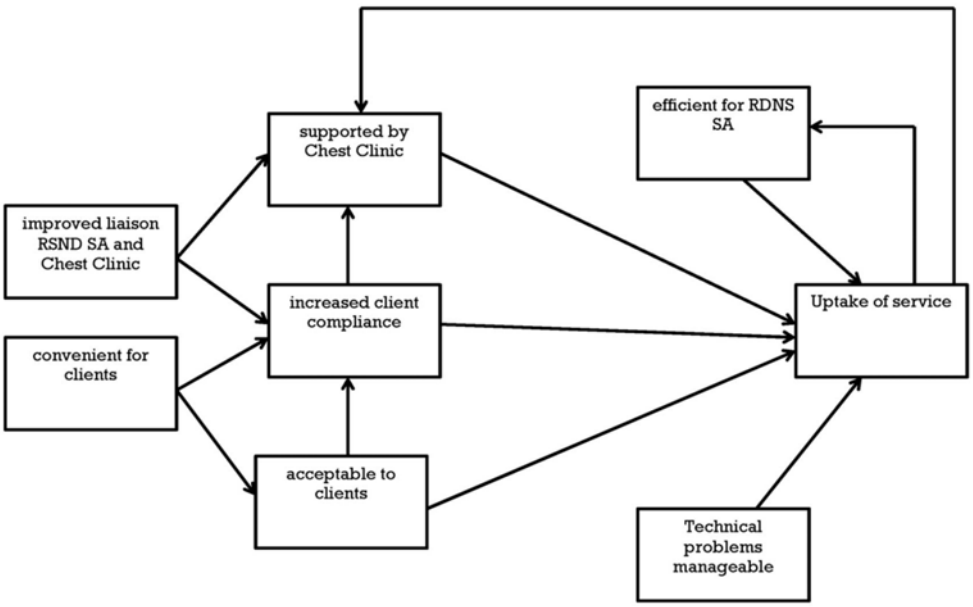

Figure 3. Videophone service uptake model.
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The search for client records within the RDNS SA electronic database may have been incomplete, as the two search methods found different patient lists. However there is no reason to suspect this would have biased the sample. One patient was judged by the nursing service to be unsuitable for the video service, and this exclusion is a potential source of bias in favor of the video service. However as this occurred in only one case, the magnitude of the potential bias would not be sufficient to invalidate the findings.

The study would have been improved by measuring the clinical outcomes of TB, such as cure rate, percentage of relapse, and development of drug resistance, but the study was underpowered to make this comparison; of the 128 cases, only one was an individual who had standard oral treatment for TB and then re-presented with multiple drug resistance; the rate of this outcome is too low to be able to show a significant difference for a sample of this size. Nonetheless, the clinical effectiveness of completion of treatment is well established [1], therefore it is logical that an intervention which improves implementation should also improve outcomes.

Although this study focused on the comparison between the home videophone and a drive-around service, the findings may have broader applicability if a clinic attendance group was added, but the RDNS SA no longer supplied this type of service.

The qualitative study was limited because only videophone patients were interviewed; at the time of this research the single patient receiving a drive-around service was not available for interview. It would have been preferable to arrange interpreters for the three patients whose English was not fluent; their language skills were adequate for basic understanding but some of the nuances of their responses were lost.

The lack of access to confidential internal financial data from RDNS SA is a limitation of the economic analysis, which required staff salaries, office costs, and car costs to be drawn from comparable publicly available data, and some other parameters to be estimated, although the majority of the non-cost aspects were taken from actual service data. The model is a simplification, omitting some of the detailed complexities of daily operations; the aim was to strike a balance between having enough detail to give realistic outcomes, but being broad enough to be usable for services in other settings.

Acceptability

Patients were largely accepting of the home videophone service, describing a high degree of convenience and flexibility as the main positive attributes. The technology itself was well regarded; whilst technological innovation is sometimes seen as difficult or depersonalizing, this was not the case in this instance. The videophones were an enabler for communication with real people rather than a substitute for personal contact, with both staff and patients describing the development of rapport with each other over time. The technology was easy to use, as the videophones looked and functioned like telephones. There were frustrations from fluctuating poor quality of calls, although this had more effect on the staff than the patients, as it affected their ability to complete their set list of calls on each shift.

A few patients reported that an intrusion on their privacy was a difficulty. These issues would apply to both a video and an in-person service, with the video service usually regarded as offering greater privacy. This is of great value to those patients who experience or are concerned about stigma. The one exception to this is when patients might not want to reveal their status to their family or other people with whom they reside.

The issue of patient autonomy has been prominent in the literature on home telehealth [41], and staff reported that the video service made the patients more independent because they did not have to wait at home for a visit during working hours. However this impression was not confirmed by the patients, who had no experience of the drive-around service; their only comparison was of a freer life before they were diagnosed with TB.

Economic Viability

The economic analysis indicates that under all conditions the home videophone service saved resources of nursing time, car hours, and kilometres driven. In its current form, the service is cost-effective but not cost saving, however the sensitivity analysis indicates that the videophone service would become dominant with an increase in the size, decrease in technology costs, or increases in driving time between home visits. Under plausible conditions where the videophone service is not dominant, sensitivity analysis modeled the ICER to be at most $10 per additional day successfully observed, which could be considered for implementation by TB treatment services, depending upon their available budgets.

Although the model predicts that less than one FTE staff member can run the entire direct observation service at the current number of 47 patients per year, this was in the context of a larger video medication management service plus general call center, where economies of scale could be realized with several call center staff sharing these duties.

It could be argued that the service would be less costly if the patients supplied their own broadband or mobile data connection, and their own device, such as a home computer, tablet or mobile phone. However in practice, this has a high likelihood of reducing effectiveness and increasing costs, as the quality of the calls would be reduced and a great deal of time taken up providing technical support to patients.

Sustainability

To the best of our knowledge, this is the first home video direct observation service for TB in the world to have progressed beyond an initial pilot or feasibility test into ongoing, routine operations. The qualitative analysis of the video service indicated that multiple factors contributed to this outcome; particularly demand from the main referrer, efficient use of resources, and acceptability to patients and staff.

It was also important that technical difficulties could be overcome. In the pilot phase the patients had a fixed broadband line installed at home [21]. This was not available in all areas, there was a delay of one to three weeks for activation, and if the patient moved it was difficult to move the connection in a timely manner. The technical development of video calls over the 3G data network drove uptake by enabling the call center nurses to do immediate installations, and although this system was not perfect the technical provider worked with the nurses until they could do most of their own troubleshooting. Hence the call center was able to become reasonably self-sufficient in dealing with the most common technical problems.

Finally, the service proved to be resilient by surviving a number of administrative, structural and governance changes at RDNS SA, although it has remained a small scale operation as numbers of people with TB in South Australia are low. While it provides an example of a sustainable telehealth service, it is a very specific application for a tightly defined purpose, so the results have limited generalizability to the broader uptake and sustainability of telehealth services.

Risk Analysis

As the health system comes to rely more on technological solutions, the risk of consequences from technical failure grows. The videophone service experienced one shutdown that lasted a week, due to failure of the local telecommunications backbone, and there were several other episodes when the whole network was unavailable for a day or less. With larger patient numbers it would be useful to have a protocol to identify those patients for whom a physical visit should be considered when this occurs.

At the home end of the service, there is a risk of poor quality video calls due to increasing traffic on the 3G data network. However, at least in Australia, the development and installation of new mobile telecommunications infrastructure is keeping pace with this growth in use. In theory, the videophones might be lost, damaged, sold or stolen, but this did not actually occur; these risks would be greater if the patients were loaned mobile phones or tablet computers with video-calling capability.

Future Research and Development

Continuing technical innovations are expected into the future. Most new mobile (cell) phones and tablet computers can make video calls, although the quality is poor under mobile conditions; the home videophones required dedicated antennas and other technical developments to bring the signal strength and call quality into the acceptable range.

If identified technical issues are solved, video observation could be expanded to the developing world, where mobile technology is the major way that telecommunications infrastructure is being installed, mobile phone penetration is rising rapidly, and low income earners are paying a substantial percentage of their income on telecommunications [42]. Under these conditions, offering to pay for the patients' mobile phone costs might be a strong inducement to participate in direct observation.

A larger study, preferably designed as a randomized controlled trial, and collecting cure and relapse outcomes, should be the next step in assessing this new approach to direct observation, and would contribute substantially to determining whether or not most services could or should move to this model over time.

Implications for Practice

This method of direct observation can be readily scaled up, especially in larger cities and regions where the telecommunications infrastructure is adequate. Scarce resources can be conserved by seeing larger numbers of TB patients with the same amount of staff. A home video service operated by a specialist TB clinic during office hours would produce some increase in flexibility, but the full benefit would be gained by placing the service within a 24/7 call center.

Additionally, rural patients could be seen, or one call center could serve several cities. The videophones can be posted to patients, who could do their own installation with the aid of an instruction sheet plus a telephone call from the service. There does need to be capability to do hands-on installations for patients with limited English and/or no technical skills at all, but a distant call center could work with local TB treatment services to enable this.

Whether or not this approach is affordable in other jurisdictions will depend upon local health budgets and circumstances. Although the video service was cost-effective compared to a drive-around service, it may still cost more than many TB services can afford; even in a developed country like Australia, a universal drive-around service has not been implemented in all areas because of expense [11]. Finally, the method can be utilized for other clinical conditions where direct observation improves adherence.

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Author Contributions

Conceived and designed the experiments: VW JK JE JH. Performed the experiments: VW JK. Analyzed the data: VW JK JE. Wrote the paper: VW JK JE JH.

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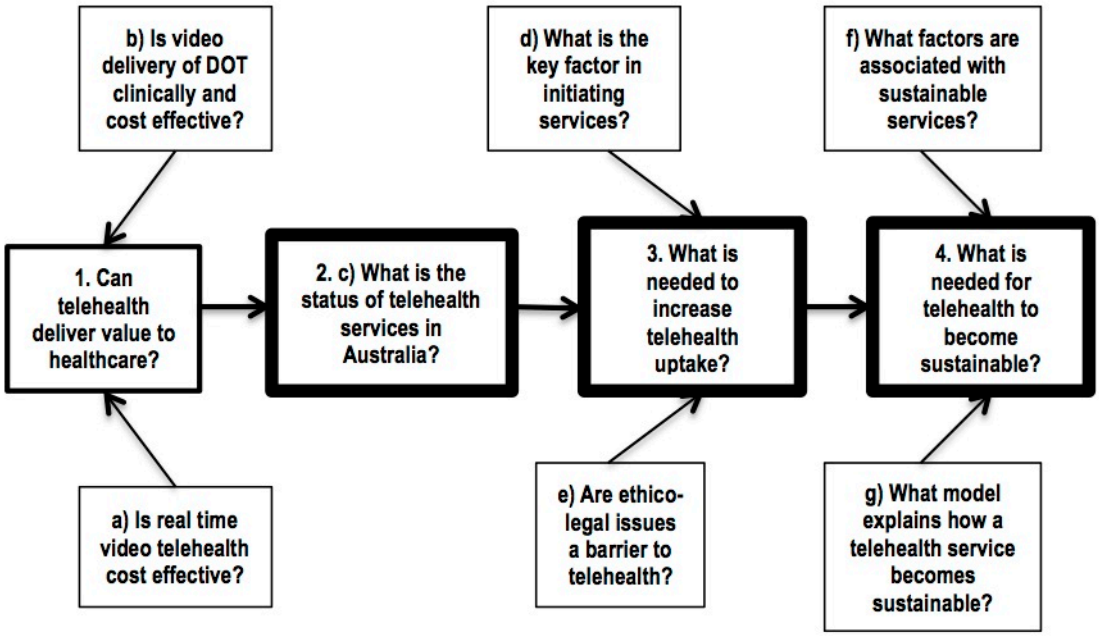
CHAPTER 6 - The Telehealth Services Study: Introduction and Methods

6.1 Introduction

Figure 6-1 Logical Structure of Research Questions



The first research question of this thesis has been addressed by the narrative review in Chapter 2, the systematic review in Chapter 3 and the mixed-methods case study reported in Chapters 4 and 5. The remaining research questions are investigated by the Telehealth Services Study (TSS); a qualitative research project aimed at gaining a better understanding of the uptake and sustainability of telehealth services in Australia. This chapter introduces the TSS, which asks the following three research questions:

1. What is the status of telehealth services in Australia?
2. What is needed to increase telehealth implementation?
3. What is needed for telehealth to become sustainable?

The study was undertaken by conducting semi-structured interviews with individuals who were or had been directly involved in initiating, operating or researching telehealth services. Four journal articles were produced from the study (contained in Chapters 8 and 9 of this thesis) and this chapter provides a literature review, a theoretical discussion and a description of methods that contextualises those publications. The specific aims of this chapter are:

a) To introduce the TSS by reviewing previous research and theory on the uptake and sustainability of telehealth services.
b) To describe the methods of the TSS, giving both an overall outline, and including additional components which were not included in the published articles due to space limitations.

6.2 Literature Review

6.2.1 The Problem of Telehealth

The problem of telehealth is the disparity between the prediction that telehealth would become a major new way to deliver health care, and the actuality, which will be demonstrated in this chapter, of low volume, slow uptake and lack of sustainability. This section begins by summarising the expectations held for telehealth, and then refers to the literature to assess the magnitude and scope of the cited disparity.

6.2.1.1 *The Promise of Telehealth*

In the 1990's, enthusiasm for telehealth was high, with pronouncements that telehealth innovations would be "dazzling in their potential"(181) and "a revolutionary means of providing health care"(182). Through the 2000s, arguments for the adoption of telehealth included increasing equitable access to care(8), solving health care workforce shortages, improving patient safety, and reducing costs(183). The rhetoric that telehealth is "promising" has been prominent for over two decades, and continues until the present day; indeed, in February 2013 The Commonwealth Fund published a set of three case studies in telehealth under the headline "The promise of telehealth"(184).

6.2.1.2 *The Delivery of Telehealth*

The uptake and sustainability of clinical services delivered by telehealth has fallen far short of the levels predicted by enthusiasts, and the international literature demonstrating this will now be reviewed. The Australian literature will be held over until Chapter 7, as this contributes to answering Research Question 2: "What is the status of telehealth services in Australia?".

6.2.1.2.1 *Low Uptake*

Low uptake of telehealth services was reported from the 1990s; research in the US found that the total number of teleconsultations was a tiny fraction of all health care consultations(185), and that only 0.5% of all physicians had participated in telehealth(186). The numbers of patient care episodes per service were also low, with many averaging only eight consultations a month(187). There were similar findings in other countries, with activity of approximately 30 consultations a month described across eight Canadian(188), and 25 Finnish telehealth services(189). This theme continued through the 2000s with reports of underutilisation of telehealth for home hospice visits(190, 191), military applications(192), and telepsychiatry(193).

Over time, however, telehealth activity has gradually increased. Throughout the 1990s, telehealth consultations in the US increased from approximately 2,000 to 70,000 per annum(185), and by 2003, the number of non-radiology telehealth consultations in the US had reached 85,000 per annum. The average number of teleconsultations per network (as defined below in section 6.3.1) per month had increased to 150(194), up from eight a month in 1999(187). The Ontario Telehealth Network, said to be the largest in Canada, conducted more than 32,000 clinical consultations in the 2006-2007 financial year(78), and the Arizona Telemedicine Program amassed a total of more than 50,000 telepsychiatry consultations between 1997 and 2011(195). There is one exceptional example of a large scale, integrated telehealth service operated by the US Veterans Health Administration which had 70,000 patients on its books in 2010 and was predicted to expand to 92,000 patients by the end of 2012(196).

These larger services remain exceptions to the rule with telehealth continuing to be a small fraction of the total amount of health care services delivered; for example Leigh reported that a mental health service using both in-person and telepsychiatry consultations for continuing care conducted 115,149 in-person consultations compared with 7,523 video consultations (6% of the total) over an 18 month period(197). There are also a few small examples in the literature of telehealth replacing in-person care, where video consultations replaced an in-person outreach service for clinical genetics in rural Canada(198), and my study reported in Chapter 5, showing how home videophones replaced drive around visits for direct observation in tuberculosis(199).

Kazley recently reviewed telehealth usage, pointing to continuing slow diffusion, with some networks closing down and others continuing to increase their activity(200). The same general pattern of consolidation was found in a study of teledermatology services across the US(201). The World Health Organisation conducted a global survey of telemedicine in 2009 and found only 13% of responding countries reported an established telepsychiatry service, and 16% an established teledermatology service. As these are the clinical areas which have been operating for the longest time, and for which there is the most evidence (as discussed in Chapter 2), this led them to the conclusion that implementation was still very limited(38).

The main problem with these reports of telehealth uptake is that they usually lack appropriate comparators. Unless one can compare the numbers of telehealth versus in-person consultations for the same types of services, the relative amount of care delivered by telehealth cannot be calculated. Obtaining more accurate information on the proportion of health care provided by telehealth would be a substantial project by itself, although looking at the numbers that are reported, telehealth clearly remains a relatively insignificant mode of service delivery.

6.2.1.2.2 *Lack of Sustainability*

In addition to low levels of operations, it has also become apparent that telehealth services are often not sustainable. The literature contains many evaluations and organisational case studies of telehealth services that either failed to deliver services(202-204), failed to continue functioning(205-208), or at the time of writing looked unlikely to survive due to intractable problems or serious threats(209-213). There have been few longitudinal studies of groups of services, but Lamminen followed up Finnish telehealth services for three years and found that during this time a third had closed down(189).

Some services have been sustained over the longer term(214, 215), although many were reportedly continuing to operate without entering the mainstream(216). A systematic literature search, conducted in 2007, for articles about telemedicine programs that had been successfully integrated into routine care found just 16(217), and a similar international search for descriptions of the routine use of telepsychiatry in 2009 found only nine(218). These numbers are likely to be underestimates because academic publications focus more on trials and developments than on services that are continuing in routine clinical practice, but nonetheless they are still very low.

6.2.2 Explaining the Problem of Telehealth

Given this disparity between predicted and actual uptake in telehealth, a variety of explanations have been offered:

1. Poor fit between the technology available and the clinical service(189, 194, 219).
2. Not enough attention being paid to change management, including consideration of the organisational, work process, and role changes that telehealth requires(189, 220, 221).
3. Lack of reimbursement and business models(222, 223).
4. Lack of high quality research that demonstrates clinical and cost effectiveness(186).
5. Lack of acceptance by physicians and/or patients(219, 224).

Recent commentary continues to wrestle with the problem; in 2012 an editorial in *Telemedicine Journal and E-Health* claimed that failure to adopt has dominated the scientific consideration of telemedicine for 20 years(224). The research investigating this issue will now be reviewed, providing context for the TSS within the broader literature. The larger body of work on the uptake of telehealth will be considered first, followed by the smaller amount on sustainability.

6.2.3 Understanding Uptake

I have categorised the research on understanding the uptake of telehealth into the attitudes of potential and actual participants, the readiness and intention to implement telehealth, and the factors affecting uptake.

6.2.3.1 *Community and Patient Attitudes to Telehealth*

The *satisfaction* literature, which is discussed briefly in Chapter 2, section 2.3.6 on page 39, asks participants to rate or comment on telehealth services they have already received. By contrast, the *attitude* research asks about telehealth in general, and usually includes respondents with no previous direct experience. When the general population is surveyed, only a minority are aware of telehealth, and after it is explained, attitudes are tepid. In Quebec, around 50% said they would use it(225), in rural Denmark 58% of people said they did not like the idea of a video consultation(226), while in Germany 72% were in favour

of use, but this percentage was much lower for older people, who feared loss of contact with their physician(227).

A number of studies have confined their focus to older people, because they are more likely to need health care and less likely to be experienced users of technology. There is a diversity of reports of responses in this population, with some demonstrating that the elderly have a generally positive opinion of telehealth(228-230), while others have found that overall support is tempered by concerns about privacy(231), usability, stigma, accessibility and affordability(232). One study reported that residents of an aged care facility were almost universally negative(204). All of these studies were small scale surveys or qualitative research about elderly people residing in either independent or assisted living facilities, hence they do not necessarily accurately represent the attitudes of the whole of the older population.

To obtain a more nuanced understanding of community attitudes to telehealth, Mort convened a citizens' panel in England, where community members could debate the issues in detail. The panel thought that telehealth should be an addition to existing health care rather than a substitute, and they expressed concerns about safety, effectiveness, erosion of personal relationships, and the use of telehealth to compensate for pressure on resources(233). A very similar set of issues was mentioned by those who declined to participate in a large home care trial of telehealth (234).

People with a health condition who were asked about their attitudes to using telehealth for their personal health care were more receptive: audiology patients were in favour of using telehealth to reduce waiting time and cost(235), and patients with both hypertension(236) and cardiac failure(237) held positive attitudes and expressed a willingness to use technology in managing their chronic conditions. Putting this together with the very high levels of satisfaction patients hold for the actual experience of telehealth, as reviewed in Chapter 2, it appears that the closer people are to telehealth, the more positive their attitudes become.

6.2.3.2 *Provider Attitudes to Telehealth*

Whereas patient and community attitudes to telehealth vary from positive to mixed, health care providers and managers' attitudes range from mixed to negative. Clinicians report the useful possibilities of telehealth for empowering patients and facilitating self-management(238, 239), offering more convenient, accessible and effective support for those

with chronic conditions(238), reducing inappropriate patient transfers(240) and for conferencing with each other(241), but there were several perceived problems and difficulties:

1. Lack of knowledge about the purpose and use of telehealth(242, 243)
2. Fear of using technology(244, 245)
3. Concern about additional workload(240, 245)
4. Potential for the dehumanising or distancing of care(245-248)
5. Patient privacy issues(238, 249)

Those clinicians who used telehealth were more positive than non-users(244, 250). This could be either a selection effect or the impact of experience; in some services clinicians said they became more positive over time(251), although two studies that directly compared clinician's attitudes before and after exposure to telehealth projects found no change(190, 243). Unlike reports from patients, three studies found no relationship between the age of clinicians and their attitudes to or use of telehealth(250, 252, 253).

Overall, provider satisfaction (as reviewed in Chapter 2) is more positive than provider attitudes, which is a similar finding to the patient and community research. Across both attitudes and satisfaction, however, the clinicians are generally less enthusiastic than the patients.

6.2.3.3 *Readiness and Intention to Adopt Telehealth*

Readiness to adopt telehealth should in theory have a close relationship to the success of actual implementation. Researchers have assessed not only individual readiness but also that of organisations and the wider environment, finding much variability across individual health services, with local circumstances being important(254). Two patterns found were that hospitals had greater readiness than primary care services(255), and that synchronised readiness between clients, clinicians and managers was important(256). Readiness assessment tools have been developed(257), but I am not aware of any research which tests their validity in the field.

The intention to adopt telehealth is an even more immediate precursor to action, and when factors affecting clinicians' intention to adopt are investigated, Gagnon found that physicians who perceived higher levels of professional obligation and responsibility had stronger intentions(258). Gagnon then went on to conduct further research indicating that the most significant predictor was the related concept of perceived usefulness(259). Three studies

of patient's intention to adopt found both perceived usefulness and perceived ease-of-use to be important(260-262). Lastly, from an organisational perspective, two studies noted the importance of government support in the decision to adopt telehealth(260, 263).

The difficulty with the research in this area is that all of the studies cited above investigate the factors influencing readiness or intention. Based on the research identified, there are no prospective studies which test the correlation of readiness or intention with the actual uptake or sustained use of telehealth at a later date. Hence it is not known if assessing readiness or intention has any predictive value.

6.2.3.4 *Factors Affecting Uptake*

Whereas the research about attitudes, readiness and intention is intended to be predictive, the most common form of research on telehealth uptake is retrospective, studying the barriers and enablers affecting uptake. In order that this work be manageable, the many hundreds of studies on factors affecting the uptake of individual services will not be included: only reviews or studies that deal with multiple telehealth services will be considered.

There have been three reviews that dealt with this topic; Broens in 2007(264), Jarvis-Selinger in 2008(265), and Kazley in 2012. Each has constructed a set of factors, which are shown in **Table 6-1**, with comparable factors set next to each other.

Table 6-1 Comparison of Factors Affecting Telehealth Uptake

Broens 2007	Jarvis-Selinger 2008	Kazley 2012
Technology – support training usability quality	Technology – support set up compatibility	Technology – availability trained support staff
Financing – provider payments financial structure	Costs and remuneration	Reimbursement of providers
Policy and Legislation – standards security	Protecting privacy	Privacy and security Physician licensure
Organisation – work protocols organisation structures collaborations	Organisational protocols Interprofessional collaboration	
Acceptance – attitudes evidence of effectiveness		
	Quality of Service	
		Lack of common language (international perspective)

The three areas mentioned by all reviews are (1) the technology itself, together with the human infrastructure that supports the technology, (2) the means of funding the service, and (3) governance, that is, whether or not telehealth is allowable by the regulatory and ethical standards set for health services delivery. Two reviews also mentioned work protocols, referring to the concrete details of implementation, such as referral processes, patient eligibility, and how information is handled.

In addition to these reviews, single studies which looked at either a range of distinct telehealth services, or at larger networks with a variety of clinical disciplines, have produced similar results(244, 266-272). Additional enablers found in this group of studies were:

1. Senior executive support(272).
2. Recruiting the right type of patients(269).
3. Forward planning(266, 272).

Additional barriers were:

1. Specialist providers being too busy to provide telehealth(244, 268).

2. Habit or tradition(268, 270).
3. Rural sites being fearful that telehealth would replace on-site services or education(266).

Finally, studies have gauged the importance of the following single factors across multiple services:

- Provider participation: increases uptake at all implementation stages(273).
- Financial factors: initial capital investment supports telehealth, and the typical hospital budgeting approach of short-term survival hinders it(274).
- Policy factors: in the US, telehealth was more likely to be implemented by state governments with greater policy capability and that were less captured by physician interest groups(275).

In summary, technology, funding and governance were the three most commonly mentioned factors that supported the uptake of telehealth, but the literature also found a diversity of other factors were influential.

6.2.4 Understanding Sustainability

As described above, lack of sustainability is a problem for many telehealth services. I will discuss the definition of sustainability and related concepts, then consider the relevant research which examines factors affecting sustainability and compares successful with failed telehealth services. I will conclude with some findings on large scale uptake from two notable case studies.

6.2.4.1 *Defining Sustainability*

When explaining the ability of telehealth services to operate on a long-term basis, the literature refers to three distinct but interrelated concepts:

- Continued functioning: In Chapter 9, I discuss longevity, resilience and ongoing funding as possible definitions of sustainability, and arrive at this definition: *The ability of a service to continue functioning into the future, with no foreseeable threats to operations.*
- Normalisation: May defines normalisation as the routine embedding of a health care innovation into everyday clinical practice(276), and this is generally regarded as synonymous with assimilation and routinisation(277). Integration

can take on the same meaning(278), but may also be used to describe the way in which different services form partnerships with each other(279). Finally, coherence, a term used by Finch(280), describes the way in which different parts of an innovation are focused on the same purpose, and have stable relationships with each other; she regards this as a component of normalisation. I have adopted May's definition of normalisation for this thesis.

- Widespread Uptake: Widespread uptake refers to the phase of innovation where a majority have adopted the new technology or practice(281), or in the case of a single large organisation, when enterprise-wide adoption has occurred.

These concepts overlap, and I regard them as related in this manner, indicating sequentially increasing degrees of sustainability:

- A sustainable service is capable of operating into the future, but need not be normalised or have widespread uptake, although these qualities are helpful for sustainability.
- A normalised service is highly likely to be sustainable, as its sustainability is linked to the broader health care system of which it is a part. It need not have achieved widespread uptake.
- A service with widespread uptake is likely to have achieved both sustainability and normalisation. Widespread uptake could, in theory, indicate merely a passing fad, but this rarely happens in health care.

In the review of the research that follows, the literature that deals with sustainability and normalisation will be treated as a whole, with the few examples of widespread uptake singled out for further discussion.

6.2.4.2 *Factors Affecting Sustainability*

As with factors affecting uptake, I have only considered work covering multiple telehealth services. **Table 6-2** compares three studies which have taken different approaches to this issue. Obstfelder produced a qualitative literature synthesis of telehealth applications which had been successfully introduced into routine service(217); May conducted a qualitative analysis of longitudinal data from three studies of telehealth implementation(276); and Gundim developed a quantitative graphical model from the theoretical literature followed by a validation process with telehealth experts(282).

Table 6-2 Factors Contributing to Successful Sustainability of Telehealth Services

Obstfelder 2007	May 2003	Gundim 2011
telemedicine is seen as a solution to political and medical issues	presence of a policy sponsor	institutional commitment; political and ethico-legal
collaboration between promoters and users	enrolment of cohesive, cooperative groups	partnerships
organizational and technological arrangements have been addressed	integration of professional knowledge and practice; development of new procedures and protocols	functional competence; leadership, training and quality assurance
telemedicine is seen as a benefit		value generation for society
the future operation of the service has been considered		renewal capacity
local service problems clearly stated	structural integration with usual services	
		academic-scientific competence
		economic-financial performance

The table reports the findings from each study using their own terms; I characterise the common concepts in the first three rows of **Table 6-2** as high level organisational and political support, collaborative working, and the development of concrete processes to ensure effective operations. Compared to uptake, the technical issues that were very prominent receive only a minor mention, whereas operational processes and future planning are regarded as more important.

6.2.5 Comparing Success and Failure

Turning from the search for generalizable factors, to examining specific examples, six studies were found that compared successful or continuing telehealth services with failed services, and their results are summarised in **Table 6-3**.

Table 6-3 Comparisons of Successful and Failed Telehealth Services

Study and Setting	Qualities of Successful Services	Qualities of Failed Services
Cook 2001**(283)** Two hospice sites in the US	Senior management support Project coordinators communicate with participants Procedures and protocols developed Nurse champions Patient centred approach	Lack of senior management support High staff turnover
Finch 2007**(284)** Twelve teledermatology services in the UK	Political support Perceived benefits outweigh time and commitment costs Pragmatic approaches to proving efficacy and safety Risks acknowledged and managed Change in professional roles acknowledged and managed Cross-sector & professional support	Lack of high level support Lack of clarity of purpose and benefit Lack of flexibility to adapt to the existing service environment
Guilfoyle 2002**(285)** Video consultations to aged care facilities in Australia	Staff involved in planning and implementation, and had strong sense of ownership All one organisation; reimbursement was covered Connecting service 300 km away	Planned by those who did not conduct it; no ownership by staff Planning disjointed No remuneration for GPs Connecting service 10 km away
Moehr 2006**(286)** Two rural telehealth services in Canada	Using established teams for regular video consultations For chronic conditions which needed visual information High clinical need, specialist input valued	Add hoc consultations Lack of familiarity with equipment Disregard of usual referral patterns Lack of professional acceptance Problematic team dynamics Patchy support of isolated, unrelated functional components
Smith 2002**(287)** Telepaediatrics service to two regional hospitals in Australia	Local champion who screened transport requests and referred for telehealth Connecting service further away	No champion Connecting service closer
Whitten 2003**(288)** Two rural telehealth services in the US	More formal organisational structure More resources and expertise available, including IT Innovative spirit, autonomy encouraged	Lacked technical, administrative and financial resources 100% turnover in project personnel Long delays in technical installation Lack of health care staff at the remote site

These comparative studies confirm the importance to success of high level support, collaboration, and the development of concrete processes, plus they also point to two specific issues not previously mentioned, which are high staff turnover being a factor in failure, and

greater physical distance a factor in success, the latter of which reflects the greater need for service.

6.2.6 Achieving wide-scale uptake

Achieving wide-scale uptake is the least researched aspect of sustainability. I will compare two notable case studies which have taken very different approaches to attaining this goal.

Veterans Health Administration (VHA)

The VHA in the US, as mentioned previously, is an outstanding example of a very large-scale telehealth service; they are, to the best of my knowledge, the largest in the world. Researchers have attributed this success to the following factors:

1. Strong leadership support combined with several small to medium scale RCTs demonstrating improved patient care and reduced service utilization(289).
2. That the VHA is a single funder and provider operating all facets of primary and specialised care for its population(196).
3. That the VHA has normalised telehealth by changing its model of care. Care coordinators now assess each patient for their suitability to receive services via telehealth and then arrange implementation(290).

Whole System Demonstrator (WSD) Trial

The UK Department of Health (DoH) funded a large cluster RCT of home telehealth for patients with chronic conditions, which was intended to be a precursor to broad-scale uptake(55), on the assumption that lack of an evidence base was the main barrier to adoption(291). The trial results showed that patients who received home telehealth had reduced mortality and hospital admissions, but there was no evidence for cost-effectiveness(292) or improvements to quality of life(293). Using these results to support system-wide uptake then became problematic; criticisms were made that the eligibility criteria for the trial were too narrow, excluding the vast majority of patients who might benefit(291), and that the trial design had no flexibility to adapt to local circumstances(294). A decision has not yet been made about implementation into routine practice.

These two telehealth developments used markedly different uptake strategies. The VHA approach was pragmatic; the existing evidence was taken as sufficient, then a flexible

model of telehealth was added to usual services. The UK approach was more rationalist, wanting evidence for the effectiveness of large-scale use. Several years earlier, May pointed out that the danger of conducting large RCTs on health technology implementation is that years after commencement, they tend to produce results that can neither convince decision makers, nor be translated into real world clinical practice(295). Hawe also argued that cluster RCTs of complex interventions with no flexibility are often expensive failures, producing weak or non-significant findings at huge cost(296). It appears that the WSD has fallen into exactly these traps. I would add that once the meaning of the evidence becomes contested, policy makers may well find their easiest and safest course is to avoid making a decision, leading to an innovation languishing in limbo, until enough time passes that all agree it is obsolete or no longer relevant. These examples offer only preliminary understandings of this problem, but give a useful starting point for further investigation.

6.2.7 Summary of the Research

The research on the attitudes of patients and citizens to telehealth has found that greater experience of telehealth leads to more positive attitudes. Health care providers are less positive about telehealth, and there is a small amount of evidence suggesting that their attitudes do not necessarily shift with experience. The readiness to adopt telehealth appears to be related to the perceived usefulness or value of telehealth, and, at least for patients, perceived ease of use.

The research on the most important factors affecting actual implementation indicates that telehealth can make a successful start if the technology is workable, funding is available, and it is not blocked by ethico-legal issues. In order to continue operations, a second key set of factors comes into play: management and/or political support, and the existence of concrete processes that ensure effective operations, both internally and in the relationships with other services. Additional influences that are important for the success of telehealth have been proposed, but there is no consensus yet as to what enables a service to achieve widespread uptake. Comparison of two case studies suggest that a flexible approach to implementation is important.

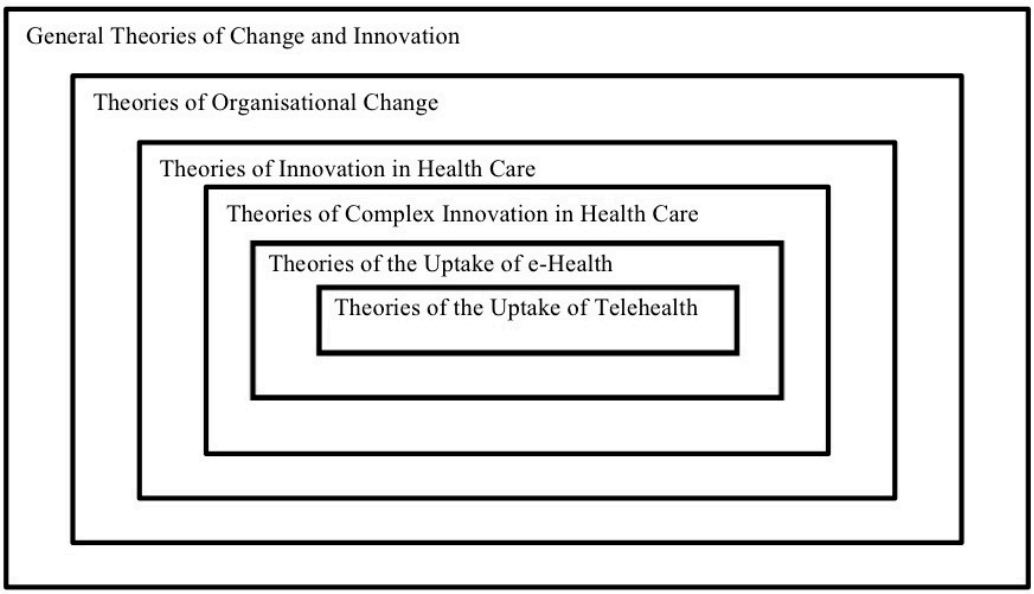
I contend, at this point, that this is as far as one can go down the path of summarising and synthesising the empirical literature. Although others might vary the emphases, create different categories, or include other sources, I suggest that the outcome would still be a list of

factors similar to the above. The next place to look for an understanding of how to make telehealth successful is in the theoretical literature.

6.2.8 Theories of Uptake and Sustainability

Figure 6-2 diagrams the theories relevant to understanding the uptake and sustainability of telehealth. Starting with general theories of change and innovation, there is a progressive narrowing of focus towards the centre.

Figure 6-2 Levels of Theory Relevant to Telehealth Implementation



Chapter 9 deals with the theories which have been directly applied to telehealth. The material that follows outlines the broader theoretical landscape, which will be related back to the explanatory model developed from the TSS in the concluding chapter of the thesis.

6.2.8.1 *General Theories of Change and Innovation*

General systems theory is the broadest theory of all, as described in the classic work of von Bertalanffy, who defined a system as a complex of interacting and inter-dependent elements, which cannot be deduced from the sum of its parts. Systems tend towards equilibrium states which are maintained by feedback(297). Coeira has applied this to health care, suggesting it is difficult to reform because single changes usually do not improve the overall functioning of this complicated system, and hence meet a great deal of inertia(298). When looking particularly at health technology, Schulman considers how new technologies

can produce disruptive innovations, but this rarely occurs in health care because of a tightly woven system of regulations, standards and procedures(299). In a nutshell, health care is an excellent example of the general systems principle that the more complex a system is, the harder it is to change.

6.2.8.2 *Theories of Organisational Change*

Organisational change is a distinct field of theory and research within the sociology, psychology and management disciplines. It began in the 1940's with Kurt Lewin's three stage theory of planned change; unfreezing the existing organisational structure, moving the structure, then refreezing. Many subsequent theories of organisational change are elaborations of this; for example total quality management (TQM), and business process re-engineering (BPR) (300). Todnem conducted a critical analysis of these theories, concluding they are contradictory and lack empirical evidence(301). Moreover, because no one theory has proven effectiveness, many proliferate(302). This has not prevented them from being applied to health services, although from an empirical point of view, Parmelli's review found no effective, generalisable strategies for changing organisational culture in health care(303).

6.2.8.3 *Theories of Innovations in Health Care*

Since many potentially beneficial innovations are not adopted into routine health care, investigating how to promote the uptake of research and evidence-based practice has developed into its own field, known as translational research or implementation science(304). Many theories have been utilised but choosing the best one has proved elusive; for example Robert found no simple and fully predictable model for the adoption of technology innovations(277). Damschroder synthesised 19 theories and models into a consolidated framework with five domains and 37 constructs, offering an "ever more rich understanding of the complexities of implementation"(305). I assert that this is a step in the wrong direction, because the concepts have been taken out of their individual theories and placed on a long list. This process disregards the relationships between the concepts and hence the predictive or explanatory power of each theory is lost.

6.2.8.4 *Theories of Complex Innovations in Health Care*

Plesk has championed the application of *complexity theory* to health care, arguing that changing any aspect of health care delivery is usually a complex problem, the processes

and results of which are inherently non-linear yet self-organising(306). This means that although the precise result of an attempt to change the system cannot be predicted, the system will adapt and evolve through the relationships between its components. Some innovations in health care are simple, such as prescribing one drug instead of another, and others are complex, involving changes to work flow, professional roles and service relationships, as with the introduction of telehealth(307). When the innovation as well as the system is complex, the local structures, processes and relationships need to be taken into account in each situation where the innovation is introduced(296, 308). Complexity theory may therefore be a useful frame for understanding the implementation of telehealth.

Two other theories which have been applied at this level are Greenhalgh's multi-factor theory, which she concluded was helpful for explaining spread and sustainability of complex innovations(309), and May's Normalisation Process Theory, which is described in more detail in Chapter 9(310).

6.2.8.5 *Theories of the Uptake of e-Health*

E-health innovations, which include all applications of ICT to health care, form a subset of complex innovations in health care. Notably, the uptake of ICT in health care has been slower and more difficult than for other sectors such as manufacturing, banking or retail commerce(311). Explanations offered are that data in health care is more complex(220), the processes cannot be easily automated(185), management has less control over labour(185), and that the health care industry is composed of autonomous entities that do not easily interrelate(312).

In terms of theory development, Cornford describes how 20th century technological determinism, which says that new technology is the primary engine of social change, has been replaced by a cluster of theories about the dynamic relationship between individuals and technology. These are collectively called the *social construction of technology approach*(205). Specific example include the FITT framework (Fit between Individuals, Task and Technology)(313), and the socio-technical model(314). Berg describes how these theories can be used to explain issues such as conflicts between fluid, collaborative work practices in health care and the rigid requirements of IT systems(315).

6.2.9 Approach to the Development of a Theoretical Model for the Uptake and Sustainability of Telehealth Services

Returning to the central research question of this thesis, "What is needed for telehealth to deliver sustainable value to the routine operations of health care in Australia?", the relevant empirical and theoretical literature has now been reviewed. The empirical literature has produced a plethora of factors, which I have synthesised to form shorter lists of common factors, but such a synthesis is only a partial explanation of the problem of telehealth. The theoretical literature offers several plausible explanations, and one option would have been to select one of these to inform the design of a study of telehealth in Australia, relating the empirical data to this pre-existing model. Much telehealth research has been conducted in this manner, however there is a risk that this leads to a self-fulfilling prophecy. I wanted to stay open to the possibility of developing a new model from the data I gathered from the field, whilst still allowing for the possibility that an existing model could provide the best explanation.

The next step was to choose what sort of model I intended to develop, and taking the pragmatic approach of aiming to be as useful as possible guided this decision. I first decided to frame the overarching research question positively, to ask what is needed to drive telehealth forward, rather than taking the neutral approach of inquiring into the barriers and enablers. Second, I wanted the findings to be practical and possible to implement. My past experience of being a participant in a planned, high-budget review of an entire health system, called the Generational Health Review(316) led me to be initially hopeful of the outcomes of large-scale intentional change in health care. This review recommended more integrated health care with a strong primary care focus, but in the decade since it was produced in 2003, I have watched this unravel under budgetary pressures, to the point that a recent report concerning the same system recommended pulling out of primary care altogether(317). Today, there is no time nor resourcing for grand change management processes in which every possible factor is addressed, hence I focused on elucidating a small number of enabling factors within a coherent explanatory structure.

6.3 TSS Methods

The articles my colleagues and I produced from the TSS describe the methods relevant to each publication, but these are, of necessity, concise. For clarity and completeness I will now give an outline of the methods, which include some details of procedures that are not contained within the publications, and an overview of the way I undertook the grounded theory development.

6.3.1 Ethics Approval

This study was approved by The University of Adelaide Human Research Ethics Committee in July 2009. An amendment was granted in February 2012 to allow follow up interviews to be conducted. The approval is shown in Appendix C.

6.3.2 Sampling

There were three stages to the sampling process.

1. Australian telehealth services were found by searching for peer reviewed publications in the academic literature. The search terms, plus inclusion and exclusion criteria, are described in the first publication in Chapter 9.
2. From this group of services, a smaller group was chosen for the qualitative study. Two types of qualitative sampling were used: selection by maximum variation, to ensure a diverse sample, and theoretical sampling, in which services were chosen for their potential to test aspects of the developing explanatory model.
3. Follow up interviews were sought from a subset of the original sample, plus one new telehealth service, and this is described in the second publication in Chapter 9.

An aspect of the sampling which is not addressed in the publications is the definition of a *telehealth service*, and how this can be distinguished from a *telehealth network*. My definitions of these two concepts are:

A telehealth service is a distinct entity delivering a particular type of health care for defined conditions, using a specific model of care. For example, an organised group of psychiatrists providing acute assessments to rural areas by video consultation is a service.

A telehealth network is an infrastructure for telehealth that supports more than one service. For example, most of the state and territory Departments of Health in Australia have a video communication network which is used for multiple purposes, including several types of telehealth.

In this study the sampling units were originally intended to be all services, however two networks were included, because they both were implemented as single projects in an integrated fashion. From the point of view of investigating uptake and sustainability they were undergoing the same types of processes as a single service therefore I decided they would be suitable for the qualitative analysis.

6.3.3 Recruitment

The way in which the participants were recruited for interviews is described in Chapter 9, with the introductory letter shown in Appendix C.

6.3.4 Interview Schedule

An interview schedule was developed (see Appendix C). As the interviews were semi-structured, this schedule was indicative rather than prescriptive. I kept reflective notes on each interview, and did not change the range of topics, as they proved to elicit diverse and lengthy replies from participants. After the first seven interviews I decided to be more structured and specifically ask about each topic in the second half of the interview, even if the interviewee had volunteered information in the area earlier. This produced further relevant responses so I maintained that approach for the remainder of the study.

6.3.5 Follow Up

Originally, I intended to interview participants at only one point in time, however a major change to Australian telehealth funding occurred in July 2011. To determine the impact of this on the services in the first round of the study, I contacted each briefly to update their current status, and I initiated a round of follow up interviews, which were conducted between two to three years after the first round (see Appendix C). For pragmatic reasons, the number of follow up interviews was limited.

6.3.6 Timeline of the Study

The interviews for the TSS were conducted over a three year period, and the resultant publications were written at different stages of the study, so **Table 6-4** is provided to summarise which interview data were used in each publication.

Table 6-4 Interview Data Utilised in Each Publication

Date	Interview data collected	Publications using this data
July 2009 to Feb 2009	35 services from the first round of the study	Chapter 9 publication 1 – factors associated with sustainability
July 2009 to Feb 2011	36 services from the first round of the study	Chapter 8 publication 2 – ethico-legal issues and their effect on uptake
July 2009 to May 2012	37 services from the first round of the study	Chapter 8 publication 1 – key factor associated with uptake: champions
July 2009 to June 2012	The 37 first round services plus 7 follow up interviews	Chapter 9 publication 2 – explanatory model of sustainability

6.3.7 Grounded Theory Methods

Developing a grounded theory is different to the usual process of research, in which a comprehensive literature review precedes design, data gathering and analysis. In grounded theory, it is recommended that the literature review be done in two stages; first the field is scoped to identify important concepts and prior research, then study design and data gathering occurs, and finally a detailed literature review commences during data analysis and continues through theory development and interpretation(61, 62). This process is recommended to prevent the researcher being captured by existing ideas too early in the work. It does not mean that a researcher approaches grounded theory as a blank slate, which is neither possible nor

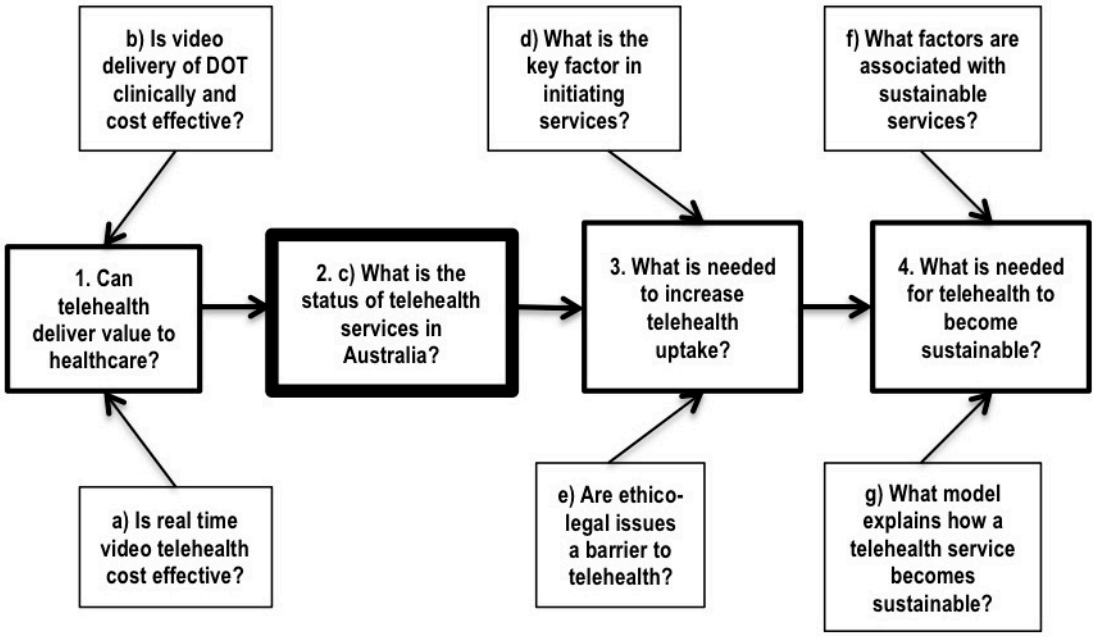
desirable. Rather, the researcher brings pre-existing knowledge, also known as *theoretical sensitivity*, to their work(318). The second stage of the literature review is used to compare existing theories with the new theory, and to contribute to further theory development, in an iterative process.

I followed this approach, using material from the first stage of the literature review to write the research proposal, submit the ethics application, and construct the interview schedule. Then I set the literature aside and conducted the research up to the phase of developing the explanatory model; the details of data coding and stages of analysis are described in Chapter 9. At this point I returned to the literature and read the previous research and relevant theory in detail, comparing the extant theory on telehealth implementation with the model. This comprises much of the discussion section of the grounded theory publication in Chapter 9. Then I conducted the broader review of research and theory which appears in the first section of this chapter, which is revisited in the synthesis and discussion of further theory development in the final chapter.

CHAPTER 7 - The Status of Telehealth Services in Australia

7.1 Introduction

Figure 7-1 Logical Structure of Research Questions



Following on from the conclusion that telehealth is capable of adding value to health care, the second research question of this thesis is: "What is the status of telehealth services in Australia?". This question will be answered with data from three sources:

1. Results from the Telehealth Services Study
2. The published literature
3. The Medicare statistics available from the Australian Government, which are the most recent source of data, and show the effect of the funding changes for telehealth that occurred from July 2011.

7.2 Results from the Telehealth Services Study

7.2.1 Identification of Australian Telehealth Services

The search of the peer reviewed literature between 1998 and 2007 for Australian telehealth services found 409 results in MedLine. A chart detailing the process of exclusions, which is not reported in any of the publications, is shown in **Table 7-1**.

Table 7-1 Identification of Australian Telehealth Services

Number of papers excluded and reason for exclusion	No of articles remaining after exclusions	Comments
	409	Total number in MedLine search result
45 Not telehealth	364	E-health or other related fields
43 Not Australian	321	Either wholly outside Australia, or from Australia to other countries
72 Commentary	249	Includes legal, guidelines, reimbursement, diffusion of innovation
8 Literature reviews	241	
12 General telehealth research	229	9 surveys and 3 miscellaneous
33 Technology	196	9 equipment, 8 imaging, 6 software, 6 systems, and 4 telecommunications
24 Accuracy and usability research	172	21 accuracy of assessment or diagnosis, 3 simulated telehealth services
50 Non-clinical	122	46 education, 3 carer support, 1 staff supervision
12 Case studies	110	11 single case, 1 of two cases
13 Radiology and pathology	97	By themselves, not as part of a broader telehealth application.
14 Telephone services	83	Health telephone call centres, telephone triage, telephone advice and telephone interventions
35 Same services	48	Only one article about each service was included

Searching CINHAL, Informit, and the *Journal of Telemedicine and Telecare* found an additional 12 services, giving an initial sample of 60 services. In some cases the publications by themselves did not provide enough information to determine whether or not the telehealth activity should be included in the sample. When this occurred, the authors were contacted for more information, and six cases were removed from the sample for these reasons:

1. Four were time limited research trials or projects which were not intended to be ongoing services, nor were any efforts made at the end of these projects to turn them into sustained services.
2. One was a teleradiology service.
3. One was a part of an existing service that was already included.

This left a final sample of 54 telehealth services.

7.2.2 Characteristics of Telehealth Services

Of the total of 54 telehealth services, as of December 2009, 16 had ceased operations and 38 were continuing. More detailed information was obtained from the subset of services in the interview sample and this is shown in **Table 7-2**. The interview sample comprised 35 of the 54 services, and was purposively sampled for maximum diversity. Chapter 9 describes how each service was categorised as either ceased, vulnerable or sustainable from the first round interviews. In brief, the services were classified as vulnerable if there was evidence of threats to their sustainability which could result in cessation. The same criteria were applied to the services at follow up, by which time two more services had been added to the sample from the theoretical sampling process.

Table 7-2 Characteristics of Telehealth Services in the Interview Sample

Characteristic	Initial group (n = 35)	%	At follow up (n = 37)	%
Status of Service				
Ceased	8	22.9	10	27.0
Vulnerable	14	40.0	9	24.3
Sustainable	13	37.1	13	35.1
Information not available	0	0.0	5	13.5
Telehealth Mode				
Real time video only	29	82.9	30	81.1
Real time video and other	1	2.9	1	2.7
Store-and-forward only	4	11.4	5	13.5
Email and internet	1	2.9	1	2.7
Activity (clients/month)				
1 or less	5	14.3	5	13.5
1.5 to 5	7	20.0	8	21.6
8 to 10	4	11.4	3	8.1
20 to 80	5	14.3	7	18.9
More than 100	4	11.4	6	16.2
Case conferencing	4	11.4	4	10.8
Information not available	6	17.1	4	10.8

The data in **Table 7-2** is not an indication of the total amount of telehealth activity that was occurring in Australia at the time, because the sample was drawn only from services which had been described in the peer-reviewed literature. Nonetheless, it does show that client

numbers per service were generally low, and that a minority of services were operating sustainably. In regard to activity levels, it should be noted that most participants gave estimates rather than exact figures for the numbers of services provided by their telehealth services, therefore these responses were allocated into categories. Additional results described in Chapter 9 indicate that most telehealth services were delivered from capital city teaching hospitals to health services in rural areas, with very few (14%) to the home. Over the follow up period, there was little change in the status of these services or the amount of activity they were undertaking. These results will now be supplemented with information from the published literature on the position of telehealth in Australia.

7.3 Literature on the Status of Telehealth in Australia

As well as research on individual telehealth services, several surveys and scoping studies collected data on telehealth activity in Australia. In the late 1990s, 73 telehealth projects, trials or services were found to be operating across Australia(15), increasing to 175 in 2000(319). A survey of public and private Australian hospitals conducted in 2002 reported that half had some use of telehealth(34), and by 2008 a survey of Western Australian hospitals found all reported using telehealth(39).

When the types of uses were examined more closely, reports from 2001 and 2005 found that less than half the activity was clinical, with the majority being educational or administrative(319, 320). Even in the 2008 survey, about 40% of hospitals did not have video facilities and the most common application was education(39). Where numbers of clinical service episodes (i.e. not educational or administrative) were reported, the volumes were modest: 816 episodes of service were conducted in a two year period in Western Australia(320), and approximately 7000 uses over several years were reported for a telepaediatric service in Queensland(35). To update the literature, the searches of MedLine, CINAHL and Informit that are described in Chapter 9 were repeated for the time period 2008 to February 2013, but no new activity surveys were found post-2008.

In summary, the picture of telehealth in Australia described by this type of research is of reasonably wide-spread diffusion, but low levels of activity, nearly all within the government sector. There is very little detail given, and the most recent survey is no longer current. The final source of information about telehealth in Australia, the Medicare statistics, contains more recent data.

7.4 Medicare Data

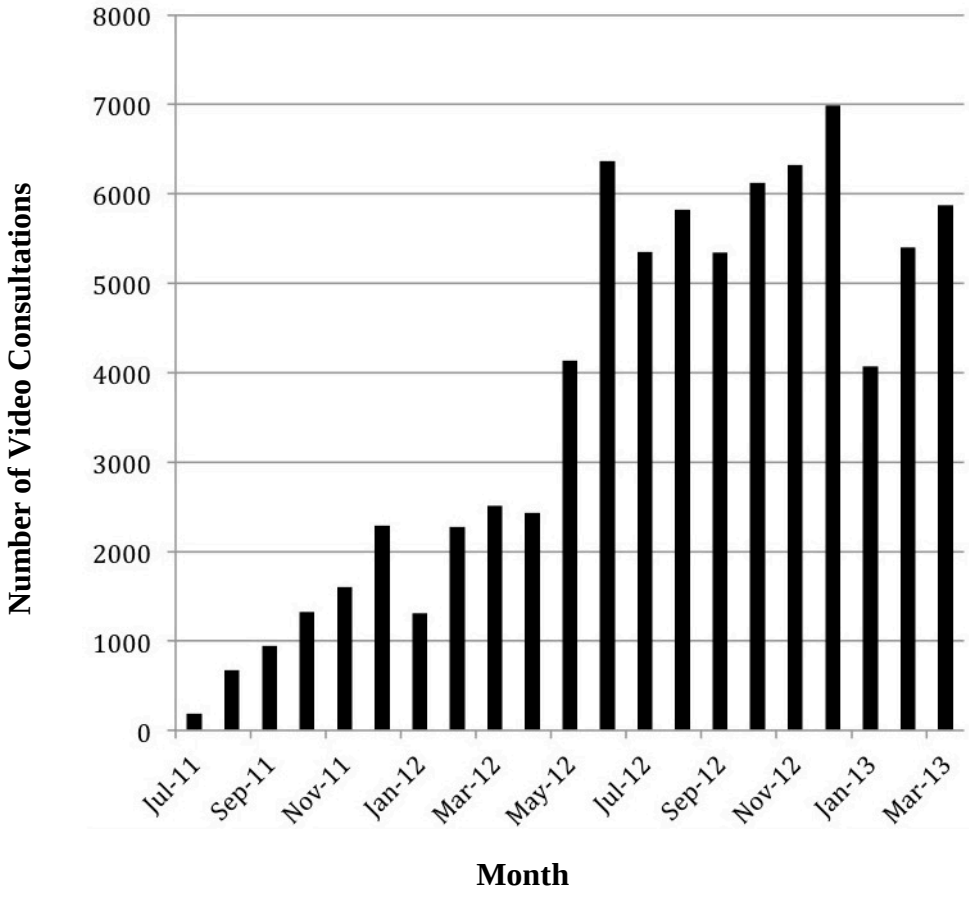
Medicare is Australia's universal health insurance system. It is a fee-for-service system with almost 6000 specified types of medical services ('items') comprising the Medicare Benefits Schedule (MBS). It operates by providing rebates to private health care providers who supply eligible services to patients. Most services are provided by generalist and specialist medical practitioners in ambulatory settings, with limited availability of nursing and allied health services. Public hospital inpatient care is funded differently and will not be considered here.

The individual MBS services rendered are recorded, with summary statistics available from the Medicare website(321). The summary statistics are subject to a minor degree of under-recording, due to administrative errors, failure of practitioners to claim some services, and a small proportion of the population (veterans, temporary visitors, overseas students) that is not included, but on the whole it is a valid and reliable source of information about the level of activity of health services in the private sector.

Medicare has traditionally rebated only in-person consultations. In 2003 a rebate item was added to the MBS for telepsychiatry, although the terms of use were limited to 12 video consultations per patient per year in rural areas(322). Smith reported that the number of MBS telepsychiatry consultations in Australia from 2003 to June 2011 was 8003, or 0.06% of all MBS psychiatric consultations in the same time period(36). He concluded that the uptake of telepsychiatry in Australia was very low.

As described in Chapter 1, on the 1st July 2011, the Australian Government introduced new rebate items for all medical specialists to provide video consultations to patients in outer metropolitan, rural and remote areas, but later amended this to rural and remote areas only. Figure 7.1 shows the month by month uptake of video consultations obtained from the Medicare website from the commencement of the telehealth items.

Figure 7-2 Uptake of Video Consultations in Australia July 2011 to March 2013



An upward trend is evident, although there is a drop in January 2013, concurrent with the removal of outer metropolitan areas from eligibility for telehealth rebates. Some of this reduction may be related to an overall decrease in health services activity during the holiday season, as a reduction also occurred the previous January.

The numbers of telehealth and in-person consultations are compared in **Table 7-3**, categorised into the clinical disciplines as provided by Medicare. *Consultant physician* covers the various subspecialties of internal medicine such as cardiology, gastroenterology, endocrinology and so forth, whereas *Specialist (not otherwise stated)* includes most of the surgical disciplines and any other registered medical specialty not stated on this list.

Table 7-3 does not include video consultations conducted by generalist medical practitioners (GPs) practice nurses, nurse practitioners, Aboriginal health workers and midwives. These health care providers cannot receive a Medicare rebate for initiating a video consultation, but only for being present with the patient whilst a specialist is conducting a

video consultation. This telehealth activity by primary care practitioners has not been included in the measurement of the total amount of telehealth activity funded by Medicare, because each consultation was already recorded when the specialist claimed a rebate. If the primary care items were included the consultations would be double counted, leading to an overestimate of activity. Furthermore, it is not necessary for a primary care practitioner to be present, and a proportion of video consultations occur between the specialist and the patient alone, so the primary care figures cannot be used as validation for the specialist activity.

Table 7-3 Telehealth and In-Person MBS Consultations July 2011 to March 2013

Clinical Area of Consultation	Telehealth	In-Person	% Telehealth
Consultant physician	24,546	18,038,136	0.14%
Psychiatry	13,627	2,900,063	0.47%
Specialist (not otherwise stated)	9,156	18,381,939	0.05%
Anaesthesia	588	3,961,781	0.01%
Neurosurgery	315	349,336	0.09%
Pain medicine	215	86,683	0.02%
Geriatrics	215	38,814	0.55%
Obstetrics	153	2,825, 372	0.01%
Palliative medicine	31	83,342	0.04%
Occupational medicine	10	2073	0.48%
Assisted reproductive medicine	1	123,143	0.00%
Total	48,857	43,965,310	0.10%

Table 7-3 shows that only a small minority of all medical specialist consultations were conducted by telehealth, although in psychiatry the rate has increased sevenfold from 0.06% (under the prior arrangements), to 0.43%. The two other specialties with a higher percentage of video consultations, geriatrics and occupational medicine, are also ‘talking disciplines’, that require a high level of interpersonal interaction. These disciplines might be more suited to video consultations than others and hence more readily taken up, although in the latter two cases the numbers of consultations are low, hence the results may simply reflect random fluctuations.

7.5 Discussion and Conclusions

Analysis of all three sources of information indicates that telehealth in Australia largely consists of small, fragmented services delivering real time video consultations to rural areas. Prior to July 2011 most telehealth activity occurred within the State and Territory Departments of Health. These government entities operate public hospitals which are not funded by the federal Medicare scheme (which principally covers ambulatory care). To the best of my knowledge, no attempts were made to gather a complete picture of activity at this time. Nonetheless, from a combination of the TSS results and survey research, the volume of services was very low, albeit with some modest increase over time. Subsequent to July 2011, all private medical specialists have been able to claim a health insurance rebate for video consultations, and the information on uptake in the private sector also indicates growth, but only to a very small percentage of total activity.

Telehealth activity continues in the public sector, which includes hospital outpatient clinics providing video consultations to rural patients. Many of these clinics have been *privatised*, a process that allows medical specialists to access Medicare rebates for outpatient work, and therefore this activity is now captured by the Medicare data. Unfortunately, there is no readily available way of determining what percentage of the services remain wholly within the State and Territory Health Departments. This activity, plus any nursing and allied health services delivered by telehealth, is not centrally recorded. The type of telehealth found in the TSS, which was largely real time video consultations to rural areas, has been further strengthened by the Medicare rebates, which only support this type of telehealth. Trials of home telehealth for chronic disease management have recently been instigated in Australia(323), but have not yet become a widespread part of health care delivery.

Finally, in regard to fragmentation, it is first worth noting that the Australian health care system is itself fragmented; the private sector is divided into numerous small and medium sized enterprises, and even in the public sector, a large organisation such as a teaching hospital consists of many semi-autonomous units. The TSS results showed a diversity of services with great variability across jurisdictions, and the Australian Government has not mandated or encouraged any particular clinical areas; rather, it has thrown open rebates for video consultations to all medical specialties. It appears that the fragmentation in telehealth mirrors the characteristics of the larger system.

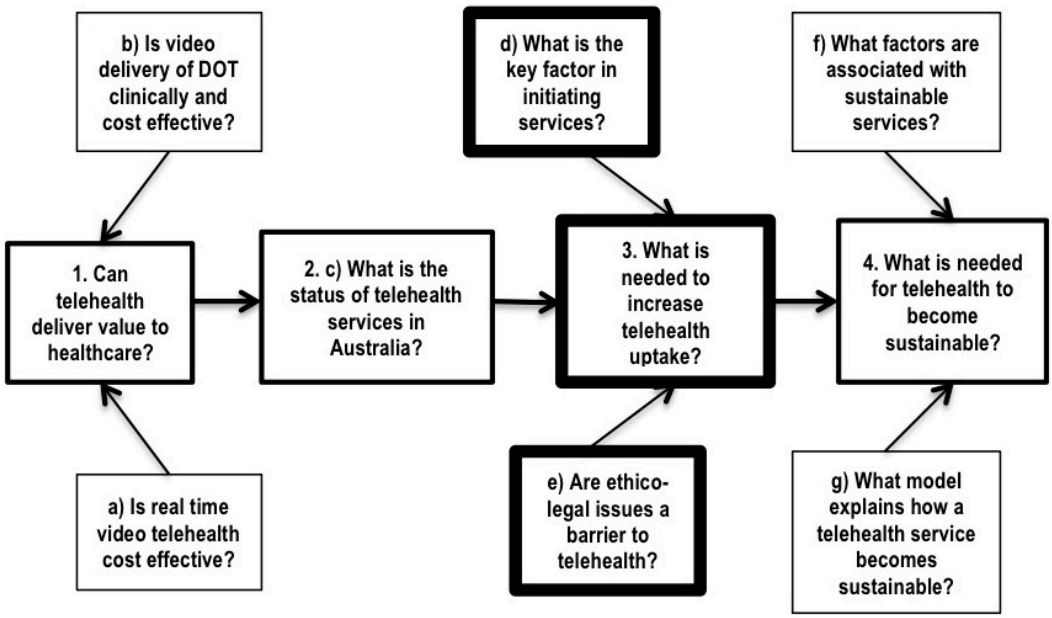
CHAPTER 8 - The Uptake of Telehealth Services in Australia

8.1 Preface

The answer to the first research question of this thesis indicated that telehealth can deliver value to health care, and the answer to the second question showed that there is scope to expand the uptake of telehealth in Australia. The Telehealth Services Study now aims to answer the third and fourth questions by investigating what is needed for telehealth to increase its uptake and to become sustainable. Four publications have been produced from the TSS, and these are now presented in logical order rather than the temporal order of writing. The chronology is described in **Table 6-4**, where the methods of the TSS are described.

This chapter contains the two papers which deal with research question three; "What is needed to increase telehealth uptake?"

Figure 8-1 Logical Structure of Research Questions



The first publication (research question 3d) focuses on the enabling factor of the individual champion, and came out of both the explanatory model constructed in the TSS, and the previous literature on the subject.

Wade V and Eliott J. The role of the champion in telehealth service development: A qualitative analysis. *Journal of Telemedicine and Telecare* 2012; 18(8):490-492.

The second publication addresses the perceived barriers of ethico-legal issues (research question 3e) because these matters were frequently mentioned in the literature as problematic(324, 325) but, as discussed in the article, little work on their actual impact had been published. Also, this article was written at the time of the introduction of the Medicare rebates for video consulting; since I had recent Australian data on the topic, I considered that the results would be of use to private practitioners and others considering taking up telehealth.

Wade VA, Eliott JA and Hiller JE. A Qualitative study of ethical, medico-legal and clinical governance matters in Australian telehealth services. *Journal of Telemedicine and Telecare* 2012; 1-6, DOI: 10.1258/jtt.2011.110808

STATEMENT OF AUTHORSHIP

Wade V and Eliott J. The role of the champion in telehealth service development: A qualitative analysis. Journal of Telemedicine and Telecare 2012; 18(8):490-492.

Victoria Wade (Candidate)

This paper reports a component of the Telehealth Services Study (TSS). In regard to the TSS as a whole, I initiated, conceptualised and designed the study, conducted all the interviews, analysed the data, and wrote the manuscripts arising from the study. In this publication my contribution was:
Conducted the literature review, analysed the data, wrote the manuscript and acted as corresponding author.

Signed .... Date 26/6/2013

Jaklin Eliott

My contribution to this paper involved critiquing the qualitative analysis and reviewing the manuscript.
I give consent for Victoria Wade to present this paper for examination towards the Doctor of Philosophy.

Signed .... Date 1/7/13

STATEMENT OF AUTHORSHIP

Wade VA, Eliott JA and Hiller JE. A Qualitative study of ethical, medico-legal and clinical governance matters in Australian telehealth services. Journal of Telemedicine and Telecare 2012; 1-6, DOI: 10.1258/jtt.2011.110808

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Conducted the literature review, analysed the data, wrote the manuscript and acted as corresponding author.

Signed .... Date 26/6/2013

Jaklin Eliott

My contribution to this paper involved advising on biomedical ethics frameworks and on the qualitative data analysis, plus manuscript review.
I give consent for Victoria Wade to present this paper for examination towards the Doctor of Philosophy.

Signed .... Date 1/7/13

Janet Hiller

My contribution to this paper involved assisting with the design of the research project, and manuscript review.
I give consent for Victoria Wade to present this paper for examination towards the Doctor of Philosophy.

Signed .... Date 11/6/13

8.2 Publication 1:

RESEARCH Original article

The role of the champion in telehealth service development: a qualitative analysis

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Summary

Telehealth 'champions' are enthusiastic individuals who initiate and promote the uptake of telehealth services. Their role and impact was investigated as part of a qualitative study into the uptake and sustainability of telehealth services in Australia. Semi-structured interviews were conducted with 39 individuals who had been involved in the establishment and operations of 37 diverse telehealth services throughout Australia. A grounded theory analysis was carried out. The results indicated that most services were initiated by champions (25 of the 37). The champions appeared to have three main roles: enthusiastic promotion of telehealth, acting as legitimators, and relationship building. Champions were capable of keeping small scale services operating, but the services were vulnerable to cessation when they lost interest or moved on. As long as participation in telehealth remains optional, the role of the champion will be an important factor in continued operations.

Introduction

The problem of translating telehealth services from fragmented short-term pilot projects into sustainable ongoing operations has been widely noted.[1,2] Much initial development has been due to 'champions', i.e. enthusiastic individuals who initiate, promote and drive the uptake of telehealth services.[3] Champions are widely regarded as an essential contributor to the success of telehealth,[4,5] with research into the barriers and enablers of telehealth implementation finding that champions increase participation and uptake.[6–8] Conversely, projects became less active when champions moved on.[9]

Since the implementation of telehealth represents the introduction of a multi-faceted intervention into an already complex system, it is likely that more than enthusiasm is required for champions to be effective. Ellis noted that little had been published on the role of champions and how that role affects the implementation of telehealth.[10] Two studies have pointed out the need for both clinical and managerial champions[11,12] and Garfield & Watson found that a combination of technical and user champions were associated with success.[7] Tanriverdi & Iacono suggested that the main work that champions do is lowering the technical, economic, organizational and behavioural knowledge barriers to implementation.[13]

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However, champions can be problematic: Darkins suggested that champions can try to drive a programme beyond realizable expectations,[14] and Broens *et al.* found that after initial enthusiasm there was a consideration phase where champions were less influential.[15] A longitudinal study found that champions could even be detrimental to the longer term development of a telehealth service, particularly if they had highly identified with the initial phase of development and were unwilling to change to allow the service to expand.[16]

In Australia, many telehealth services are still in the early phases of uptake, with new services being formed following the recent addition of health insurance rebates for video consulting. A qualitative study being conducted on the uptake and sustainability of telehealth services in Australia[17] provided the opportunity to investigate the roles and impact of champions in more detail.

Methods

The study was approved by the appropriate ethics committee. Australian telehealth services were identified through publications,[17] and a sample of services was chosen to ensure diversity of clinical discipline, location of practice and type of telehealth. Potential participants who had direct involvement in the establishment and operations of the telehealth services were approached to request an interview, and informed consent was obtained before commencement.

Journal of Telemedicine and Telecare 2012; **18**: 490–492 DOI: 10.1258/jtt.2012.GTH115

The interview schedule covered the nature of each telehealth service, its development over time, barriers and enablers, and the influence of funding, technical, clinical, organizational, workforce, patient, ethico-legal and research factors on the service. The interviews were audio recorded, transcribed and entered into a standard package (NVivo, QSR International Pty Ltd). A grounded theory analysis was then undertaken.[18]

Results

All of the telehealth services that were approached were willing to supply a person for an interview, and 39 interviews were conducted with about 37 distinct telehealth services over a two year period. The initial interview questions did not ask about champions. However the concept was referred to repeatedly by the participants, so this component of the developing grounded theory was extracted and analysed separately. Interviewees indicated that 25 of the services were initiated by champions; 21 had one champion, three had two champions and one had three champions. Most of the champions were clinical (18), followed by management (5), academic (4) and technical (2). Of the 12 services that did not start with a champion, eight commenced with opportunistic grants, and five of them subsequently ceased operating.

Roles

The champions appeared to have three main roles:

(1) Enthusiastic promotion. As expected, champions maintained enthusiasm, and with sufficient determination a single individual could sustain a service on their own, even in an unfriendly environment. One interviewee said: '*I'm not going away. It's taken a long time to get to where we are now, so the alternative if we don't get it working in [state], is we'll look elsewhere, and try and do studies elsewhere, and raise interest.*' Repeated promotion was often necessary: '*We've had to continually lead the service to be delivered, remind managers, remind nurses, and only last week I sent out a call saying there is capacity, find some more [clients], because they're out there, they just have to be found.*'

(2) Legitimation. Champions disseminated and interpreted the evidence for the effectiveness of telehealth to the broader clinical community. Being an already respected opinion leader was helpful. A senior clinician said: '*I had a degree of reputation with me, so they were prepared to meet with me, and they were prepared to listen to what I had to say.*'

(3) Relationship building. Champions reached out to bring clinicians together. This included in-person visits, conducting educational sessions and building referral pathways. One telehealth coordinator described how she maintained engagement with rural clinicians: '*maybe do some direct work, maybe have a teaching session, usually have lunch, sometimes stay overnight, so create the relationship which is then sustained using the telehealth method.*' However, the high turnover in health services staff, especially in rural areas, made relationship building difficult and affected the continuity of the service: '*everytime somebody quit, you were down for twelve months while they found new people.*'

Motivation

Champions reported being driven by the desire to improve health care services, including the desire to educate other providers, and to advocate improvements to patient care. For example: '*I became a bit of an advocate, because I particularly became concerned over the issues of the residents in the hostel . . . the conditions around their pain, things that could be changed if there was a bit of will.*' A nurse said '*I would like to say that it's the most fantastic thing that ever came into health care in my entire nursing career. It's the best thing that's ever happened, because it's provided a lot of opportunities for clients that would never be able to access any sort of service now or in the future.*'

Loss of champions

However, even very strong motivation cannot be maintained in the face of continuing implementation difficulties. One clinician started out as a champion: '*I was the pusher, the driver, the key person, and I was quite enthusiastic about it, and drove it pretty hard*', but then faced repeated technical and organizational barriers over several years: '*just gradually, you know, there's only so many hours of the day you can spend on beating your head against a brick wall.*'

The phenomenon of decline in usage when champions moved on was also noted, as well as the potential loss of champions being a threat to ongoing operations. Two services had maintained themselves when champions stepped back from an active role, and these had done so by making telehealth a part of normal operations. For example: '*it's working, not because of someone pushing it, but because it's found its place, and it becomes as appropriate as doing a ward round, or any other part of your clinical behaviour.*'

Discussion

The promotion of telehealth appears to be more difficult than is indicated by the standard diffusion models that focus on individual adopters,[19] and the present study suggests that one reason for this is because telehealth requires the development of relationships between clinicians. This was a critical role of service champions, and due to high staff turnover, especially in rural areas, this had to be conducted repeatedly. The lack of pre-existing

telehealth knowledge and skills in the health workforce is a compounding factor. New staff in rural areas usually have a high initial workload, and a great deal to learn about local conditions. Therefore taking up a new mode of delivering services is not their highest priority.

Following the initial uptake phase, the role of the champion needed to change. There were no examples of champions being detrimental to service development as was found by Hendy & Barlow,[16] but there was certainly a vulnerability to continued reliance on champions. May *et al*. have argued that the maintenance of structures to support the continuing provision of telehealth is an organizational rather than an individual task, although the concept of the champion remains powerful in the minds of service providers.[20] However, this depends on what phase of implementation telehealth has arrived at within the broader delivery system. A particular feature of telehealth in Australia is that it remains largely optional. Of all the services in the sample, there were just two examples where telehealth was an expected part of the clinicians' job descriptions. Under these circumstances, the willingness and enthusiasm of clinicians to undertake care by telehealth remains necessary, with champions providing continuing motivational, educational and organizational support.

In the longer term, reliance on the enthusiasm of champions and the choices of individual clinicians means that telehealth services remain vulnerable to environmental changes such as budget cutbacks or restructuring. Although champions have a very important role to play in service development, they are not the whole answer to achieving sustainability.

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RESEARCH Original article

A qualitative study of ethical, medico-legal and clinical governance matters in Australian telehealth services

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Summary

We examined how Australian telehealth service providers perceived and addressed ethical, medico-legal and clinical governance matters arising from service delivery. Thirty-seven telehealth clinicians and managers were interviewed and a qualitative content analysis was conducted. The services covered six Australian jurisdictions and a range of clinical disciplines. There were 11 medical specialities, surgery, mental health, paediatrics, nursing and allied health. Thirty services (83%) used video consulting and 25 (68%) delivered services to rural areas. Telehealth was reported to be beneficial by reducing adverse events, improving health outcomes, offering increased patient choice of service delivery, and improving access to services for rural areas and home care. There were observations of gains or no change in patient-provider rapport compared to face-to-face communication, with some patients reportedly preferring video. Those interviewed reported some problems with privacy and security, and variable informed consent practices. No examples of malpractice were raised, although there was a common misperception that distant providers were not responsible for clinical care. With respect to clinical governance, telehealth was seen as enabling improved quality, integration and implementation of evidence-based care, and to be a major support for the rural health workforce. Although there were potential ethical, medico-legal and governance problems in Australian telehealth services, these had been easily managed in practice.

Introduction

In 2011, the Australian Government offered rebates for medical specialists to provide video consulting to rural areas, outer metropolitan areas, Aboriginal health services, and residential aged care facilities, as well as for nurses and general practitioners to participate in these consultations by being present with the patient.[1] In deciding whether to take up this option, private practitioners need to consider not only the clinical effectiveness of telehealth, but also the question of acceptable professional practice, namely, what are the ethical problems in the use of telehealth? is there an exposure to medicolegal risk? and does telehealth change clinical governance?

Various ethical concerns arising from telehealth have been noted in the literature: about breach of privacy, both in the physical set-up of video communication,[2] and through data transmission and storage.[3] Practices concerning informed consent vary: some jurisdictions require written consent and others regard implied consent as sufficient.[3,4] Patient empowerment may be promoted by home telecare, or it may be reduced by surveillance, compliance and dependence on technology.[5]

Some people say that the patient-provider relationship is affected because the distant provider cannot touch the patient, with debate regarding whether this can be compensated, either by a local provider conducting a physical examination, or by a more thorough history being obtained by the distant provider.[6] Others propose that loss of the caring touch may reduce trust and depersonalize the relationship,[2] although most patients are very positive about rapport via video communication.[7]

Improving equitable access to health care is regarded as a great benefit of telehealth, to the point where it has been suggested that failure to provide telehealth is unethical.[8] A second clinician can provide more comprehensive care,[9] or subspecialist expertise can be brought to patients with rare or complex conditions.[6] However, equity depends on widespread availability; opinions about home telecare suggest that if the costs of equipment and telecommunication are left to the patient, they will be beyond the reach of those most in need.[10]

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Medico-legally, liability for malpractice depends on establishing both a duty of care, and confirming that care has met reasonable standards. Some people assert that existing standards are adequate if the limits of telehealth technology are recognized,[11] and others that new guidelines should be developed.[9] The American Telemedicine Association has developed standards of practice,[12] but there are none in Australia. A free-text search of the databases Legal Online, CaseBase and Intelliconnect using the terms telehealth, telemedicine, telecare, teleconsultation, telemetry, video*, remote consultation and virtual consultation, found no case law relevant to telehealth in Australia; this suggests that it remains untested in the Australian courts. Three of the major Australian medical defence organisations (MDOs) were contacted and confirmed that telehealth was covered by their usual indemnity arrangements.

Clinical governance is a systematic approach to implementing quality and safety in health care, which aims to maximize evidence-based practice and reduce risk.[13] Relevant matters for telehealth include system design, choice of services to be provided by telehealth[14] and how clinical responsibility should be allocated. It is unclear whether responsibility should rest with the primary clinician, or be divided between the local clinician, the distant clinician and the technology provider.[15] These matters have not been resolved in Australia, although with the advent of universal telehealth rebates, standards for practice are under development by the professional colleges.[16]

Although commentary, theory and prescriptive writings are numerous, few studies (none in Australia) have obtained empirical data on these matters from functioning telehealth services. Previous research has been limited to specific settings or projects.[3,17,18] The present study is part of a larger qualitative investigation into the uptake and sustainability of Australian telehealth services.[19] The aim of the present study was to determine how people directly involved in the provision of telehealth services in Australia have perceived and addressed the ethical, legal and governance matters involved in operating the service.

Methods

The study was approved by the appropriate ethics committee. A search in the peer-reviewed literature between January 1998 and December 2007, of the MedLine, CINAHL and Informit databases, identified 54 Australian telehealth services delivering clinical services to patients. From these, a purposive selection of services was made to maximise variation across jurisdiction, type of telehealth, geographical setting and clinical discipline. Clinicians or managers of these services were approached for informed consent to conduct a semi-structured interview.[19] Questions were asked about ethical, medicolegal, organisational and clinical matters arising during service set-up or operation, and interviews were continued until no new matters arose on two consecutive occasions.

Interviews were audio-recorded, transcribed and entered into NVivo software. A content analysis was conducted on the transcripts, using the pre-existing topics from the literature, with additional categories added where necessary to reflect the content. Each category was then further analysed according to whether telehealth was seen as a benefit or a problem. Quotations were selected to demonstrate exemplar cases and unexpected findings.

Results

All services and individuals approached agreed to be interviewed. Thirty-seven interviews concerning 36 telehealth services took place between July 2009 and February 2010. The services covered six Australian jurisdictions and a range of clinical disciplines. There were eleven medical specialities, surgery, mental health, paediatrics, nursing and allied health. Thirty services (83%) used video consulting and 25 (68%) delivered services to rural areas. The services have been described in detail elsewhere.[19]

The matters raised by the participants, together with the benefits, problems and any actions taken, are summarised in Table 1. The numbers of times each matter was mentioned are provided in brackets. Because the interviews were semi-structured, the same questions were not asked in the same way of each interviewee, so these numbers do not represent the importance of each matter. Some problems had none or more than one associated action, and different problems were in some cases associated with the same type of action.

Ethical matters

(1) *Privacy and security.* Three reports of the benefits to privacy were made, including an interviewee from an aged care assessment service who gave the opinion that video consultations increased privacy. Twelve interviewees were concerned about data security, although no actual breaches were identified. Two interviewees reported that patients needed reassurance that their video consultations were not being recorded or broadcast. Actions taken to prevent breaches included encryption and modifying the method of transmission; replacing email with fax, and transmitting the audio and video signals separately. On the other hand, some people regarded the security of an unencrypted video consultation as equivalent to a telephone call and thus acceptable.

Physical privacy was an actual problem rather than merely a concern, with the most serious example being patients in a community dialysis centre who were all in the same room and could overhear teleconsultations

Table 1 Perceived benefits, problems and actions. The numbers of times each matter was mentioned are shown in parentheses

	Benefits	Problems	Actions to address problems
Ethical			
Privacy and security	Health-care delivery less visible (1) Patient notes more secure (1) Patients report telehealth more private than in-person (1)	Concerns expressed about data security; no actual breaches reported (12) Lack of physical privacy (4)	No action: justified as same as usual practice (7) Changed technology (5) Patients informed of potential problem (5) Changed physical set up (3) Changed policy or procedure (2) No action: expressed uncertainty (1)
Consent and choice	More options for service delivery (5) Consent overridden for clinical benefit (1)	Patients and/or carers unhappy with telehealth (4) Health service policy of obtaining written consent ignored (2)	Patients chose to return to in-person care (4)
Empowerment	Patients become more independent (2) Nurses empowered to speak up (1)	Nil	Nil
Access to care	Access to health care provided; previously no care (9) Patients avoided travel (9) Better access to specialist care (6)	Telehealth cost more and needed an extra consultation (1) Concern of not enough health workforce to treat unmet rural need (1)	Patients chose to return to in-person care (1)
Patient-provider relationships	Rapport occurred via video (7) Video communication better than in-person (4)	Concern for loss of rapport via video (4) Not as good for groups or families (2) Reduced choice of clinician (2)	Participants became used to video communication (1)
Medico-legal			
	Reduced liability with increased patient safety (2) Reduced liability by providing a second opinion (1)	Concern re reduced consultation quality (6) Lack of local backup (3) Indemnity coverage problems (3) Lack of risk management policies (3) Video recording seen as a risk (2)	Provider with the patient given responsibility (4) Adapted the type of service offered (3) Indemnity cover negotiated (2) Indemnity withdrawn; service closed (1)
Clinical governance			
Provider-provider relationships	Knowledge transfer, informal training (7) Mentoring and support (6) Rural retention (4) Enabled case conference and audit (3) Led to formal education (2)	Threats to local autonomy perceived (8)	Providers elected not to participate (4) Experience changed attitude (2) Intentional relationship building (1)
Other clinical governance matters	More efficient use of resources (14) Improved quality of care (8) Increased evidence-based practice (3) More integrated health care (3) Improved health-care worker safety (3)	Reduced diagnostic accuracy (5) Lack of confidence in telehealth (4) Policy blocks to telehealth (2) Additional paperwork (1)	Justified as better than standard care (2) Regulatory change enabled telehealth (2) Experience built confidence (1) Explained limitations to patient (1)

with a renal specialist. Providing patients with headsets achieved only partial audio privacy. Again, justifications were made by comparing telehealth with usual care.

(2) *Consent and choice.* Telehealth was seen as providing benefit to patients by offering more choices in five cases. Few patients refused telehealth, even if the choice was difficult. For example, in the dialysis centre mentioned above, the choices on offer were a non-private teleconsultation or a disruptive cessation of dialysis with emergency transfer. In contrast, there was one case with a group of frail, cognitively impaired patients where telehealth was regarded as so much better than physical transportation, that choice and consent were overridden.

In regard to problems, three examples of individuals choosing not to use telehealth came from home telehealth services: two because some patients felt anxious and one because the patients' relatives were unhappy. In a teledermatology service, some patients refused photography, particularly of genital conditions. In each case this was resolved by returning to in-person care. The other problem was a disjunction between policy and practice, whereby two interviewees had ignored organisational attempts to enforce written consent for video consultations: "[State Health] had policies that required patients to provide consent forms … which, to be honest, we never used. Sort of fairly self-evident how the service is going to be delivered and the patients were forewarned in advance".

Overall, few services noted informed consent as a problem to be addressed. Two services, both of which provided treatment at a distance, required written consent before commencement, three spoke of gaining verbal consent, and one about implied consent.

(3) *Empowerment.* Two interviewees, both from home-care services, mentioned that some clients became more self-reliant. In one service, the change to telehealth was seen as empowering nurses.

(4) *Access to care.* Improved access was regarded as a major benefit of telehealth. Interviewees argued that individual and multi-disciplinary expertise could be brought to rural areas, with the alternative often seen as no care, especially for elderly people who could not travel, and very remote patients. Two interviewees said that not providing telehealth to rural people was discriminatory. Enabling an ageing specialist workforce to continue rural consulting was also seen as a benefit.

There were only two examples where problems with access were mentioned. In one service, telehealth provided faster access to specialist care but cost patients more. It proved to be an unpopular choice with most preferring to wait to see a visiting specialist. The other problem mentioned was an in-principle concern that if telehealth became widely available, there would be access problems due to a lack of workforce.

(5) *Patient-provider relationships.* Several respondents said that despite concerns about patient rapport over video communication, this was found to be adequate, and four interviewees said patients regarded video communication as better than face-to-face. The reasons for this were reported as greater equality and a more protected setting. A psychiatrist said: "it's very hard to interrupt when you're on a videoconference, and so people feel very listened to … all those body language things you usually do to tell the patient to stop talking … don't come off as loud in videoconferencing, so the patients just talk and the doctor has to nod until they stop." Four services, however, including two delivering palliative care, were concerned about the reduced quality of the therapeutic relationship, and two noted that rapport over video communication was more difficult for family groups.

Medico-legal matters

(1) *Liability and risk management.* Three interviewees thought that telehealth reduced medico-legal liability; two by avoiding transport and hence increasing patient safety, and one by providing additional expertise through second opinions. Others held that telehealth increased liability because the consultation was of lower quality, due to, for example, lack of physical examination, but that this was mitigated because the provider with the patient retained the duty of care. Other potential medico-legal risks were having no local service to deal with adverse events, making video recordings, which could be subpoenaed in court, and difficulties in obtaining indemnity insurance. Risk mitigation strategies included limiting the type of work done, selecting appropriate patients, and having a lower threshold of concern. No malpractice proceedings were reported.

(2) *Indemnity insurance.* In regard to insurance, six interviewees were confident that telehealth was covered by existing indemnity arrangements, three were uncertain and two discussed decisions by MDOs: one to cover the telehealth activity on a case-by-case basis and one to withdraw indemnity from a service, although this was unrelated to telehealth activities.

(3) *Clinical responsibility.* There were variable perceptions of how clinical responsibility was divided between multiple providers. The most commonly reported arrangement saw both parties agreeing that the local provider retained total responsibility and the telehealth clinician only offered advice. In some services the distant provider took responsibility with selective involvement of local services, ranging from providing a referral or agreeing to be available for backup, to undertaking a substantial proportion of care. Only one interviewee acknowledged shared responsibility.

Clinical governance matters

(1) *Efficient use of resources.* The major perceived benefit of telehealth to the healthcare system as a whole was the ability to make more efficient use of resources, mainly by saving money and time on travel. It was also thought to increase staff safety, by reducing driving and air travel, as well as providing telecare in situations that were unsafe for in-person attendance: "there are some clients that … we can now deliver a service to because the nurse doesn't need to go in the house. It might be around dogs, or it might be around alcohol abuse and violence".

(2) *Provider-provider relationships.* Many clinical benefits to healthcare staff were reported, These included rapid help for emergencies and difficult cases, formal supervision, mentoring, peer review, multi-disciplinary case discussion and informal knowledge transfer. In addition, there was general support to reduce isolation, and together these were seen as assisting rural retention. Reported problems all centred on the rural providers perceiving threats to their autonomy, such as not wanting to lose control of their patients, or be dictated to by city-based specialists. Some rural providers chose not to engage in telehealth, although in three cases the problems were overcome by either deliberate efforts to build a relationship or finding through experience that the threats were baseless.

(3) *Quality of care.* Opinions about the quality of care varied. Some people thought that telehealth improved quality by more rapid diagnosis, increased specialist expertise, a reduction in misadventure, or its use for audit and better health outcomes. Others considered that the quality was similar to usual care, particularly for mental health or geriatric assessment. A third group pointed to reduced diagnostic accuracy, although usage could be justified since it was a lot better to be able to get 80% value than nothing. It was also noted that telehealth services could serve as a vehicle for improved service integration.

(4) *Evidence-based practice.* Finally, three state-wide specialty services had used telehealth to support evidence-based practice. For example, one telehealth coordinator documented all patients requiring care and took a hands-on role in ensuring that images were sent, videoconsultations arranged and local staff up-skilled. Smaller telehealth services reportedly tried to influence local providers to improve care and implement guidelines.

Awareness of problems

Seven interviewees were not aware of any ethical problems arising from their telehealth services, eight were not aware of any medico-legal problems, with a further two noting they had not been previously considered these, but retrospectively acknowledged this as an oversight: "they weren't at the top of our list of things that were important and I think we were very lucky we didn't fall into deep trouble".

Discussion

The present study reports the first data from Australian telehealth services on ethico-legal matters. A diverse sample was obtained, drawing attention to several matters of practical importance, each of which has implications for policy and practice.

Telehealth can offer improvements in physical privacy compared to usual care, and these should be incorporated into service design. Concerns about data security were more anticipatory than actual, but demonstrate the need for national guidelines regarding best practice. Information that is stored and therefore accessible indefinitely, such as electronic records and email, is more vulnerable to being breached than information that is transmitted once, which can only be accessed if the communication is intercepted at the time.

With informed consent, it seems reasonable that where a video consultation is a direct substitute for an in-person consultation, clinicians need not pursue written consent, with a brief verbal explanation being adequate. However, where care is substantively different, seeking formal consent should occur, as well as offering a choice in method of delivery where possible. Medico-legally, it is worrying that many respondents appeared to believe that a clinician supplying expertise from a distance does not have any responsibility for care, whereas there is some degree of shared responsibility.

The present study, in line with other research,[20] found that patients regard video consultation very positively, even sometimes superior to in-person health care. This fact, as well as the benefits to access and quality of care, should be more widely disseminated to clinicians, as it may help overcome reluctance to take up telehealth practice. Major benefits to the rural health workforce were seen, with the proviso that relationships with specialists should be mutually respectful and managed well.

The degree to which telehealth can assist clinical governance and support the uptake of evidence-based care is an important new finding, because it has been difficult to change organisational culture in health-care systems,[21] and previous literature on the organisational effects of telehealth is sparse and focused on details.[22] Telehealth could be a key factor in quality improvement as it produces immediate contact between providers, is based on the management of real patients and promotes trust in interprofessional relationships.[23]

The present study was limited because in most cases only one manager or clinician from each service was interviewed. Conducting organisational case studies would give a deeper understanding of the matters identified, particularly those of governance and system change. Further work could also include the views of patients and external providers using the services.

To conclude, there were potential ethical, medico-legal and governance problems in Australian telehealth services, but these had been easily managed, albeit in an *ad hoc* manner, with no examples of harm to patients. The services that were able to use telehealth to disseminate expertise and support local providers presented useful models for quality improvement and enhanced integration. In addition to improving access for patients, the Australian government's expansion of rebates for remote consulting offers opportunities for substantial system benefits.

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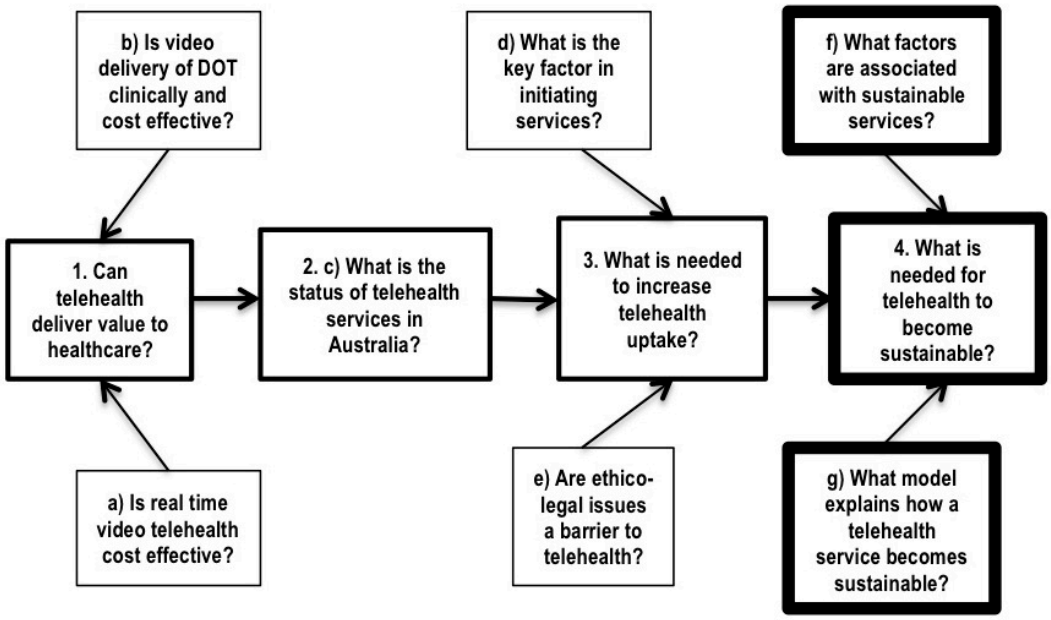
CHAPTER 9 - The Sustainability of Telehealth Services in Australia

9.1 Preface

The last two publications from the Telehealth Services Study address research question four; "What is needed for telehealth to become sustainable?"

Figure 9-1 Logical Structure of Research Questions



The first publication explores the definition of sustainability and proposes that there are different ways of achieving sustainability and factors associated with sustainability (research question 4f)

Wade V, Eliott J, Karnon J and Elshaug AG. A qualitative study of sustainability and vulnerability in Australian telehealth services. *Studies in Health Technology and Informatics* 2010; 161: 190-201

The final publication uses grounded theory methods to further investigate the factors affecting sustainability, and develops these into an explanatory model centred around a key factor (research question 4g).

Wade VA, Eliott JA, Hiller JE. Clinician acceptance is the key factor for sustainable telehealth services. (accepted by *Qualitative Health Research* pending review)

STATEMENT OF AUTHORSHIP

Wade V, Eliott J, Karnon J and Elshaug AG. A qualitative study of sustainability and vulnerability in Australian telehealth services. Studies in Health Technology and Informatics 2010; 161: 190-201

Victoria Wade (Candidate)

This paper reports a component of the Telehealth Services Study (TSS). In regard to the TSS as a whole, I initiated, conceptualised and designed the study, conducted all the interviews, analysed the data, and wrote the manuscripts arising from the study. In this publication my contribution was:
Conducted the literature review, analysed the data, wrote the manuscript and acted as corresponding author.

Signed .... Date 26/6/2013

Jaklin Eliott

My contribution to this paper involved advising on qualitative methodology, reviewing and critiquing the thematic analysis, plus manuscript review.
I give consent for Victoria Wade to present this paper for examination towards the Doctor of Philosophy.

Signed .... Date 1/7/13

Jonathan Karnon

My contribution to this paper involved advising on the design of the study, co-coding some of the interview transcripts, critiquing the thematic analysis, and manuscript review.
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STATEMENT OF AUTHORSHIP

Wade VA, Eliott JA, Hiller JE. Clinician acceptance is the key factor for sustainable telehealth services. *Qualitative Health Research* (accepted for publication subject to revision).

Victoria Wade (Candidate)

This paper reports a component of the Telehealth Services Study (TSS). In regard to the TSS as a whole, I initiated, conceptualised and designed the study, conducted all the interviews, analysed the data, and wrote the manuscripts arising from the study. In this publication my contribution was:
Conducted the literature review, analysed the data, developed the explanatory model, wrote the manuscript and acted as corresponding author.

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My contribution to this paper involved advising on qualitative methodology, reviewing and critiquing several iterations of the explanatory model, plus manuscript review.
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My contribution to this paper involved advising on the design of the study, critiquing the explanatory model, and manuscript review.
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9.2 Publication 1:

A qualitative study of sustainability and vulnerability in Australian telehealth services

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Abstract. The uptake of telehealth into the ongoing and routine operations of healthcare has been slow, uneven and fragmented. Research has focused on the initial adoption and diffusion of telehealth, with much less known about sustainability. This study made a qualitative inquiry into the sustainability of a diverse sample of ceased and continuing telehealth services in Australia, asking why services ceased, and how continuing services were either vulnerable or sustainable.

Fifty four Australian telehealth services were identified in the academic literature over a ten year period between 1998 and 2007. A sample of these was chosen for maximum variation, and 36 semi-structured interviews were conducted concerning 35 telehealth services. Of these services, 8 had ceased, 14 were vulnerable, 10 sustainable, and 3 could not be classified.

The major theme from ceased services was lack of support and insufficient demand from participating sites. Vulnerabilities identified from operating sites were reliance on a single person, low levels of interest, short-term funding, and difficulties making the transition from research to service. Sustainable services had two main models of functioning: to reach a sufficient size and flow of referrals to justify dedicated staffing, coordination and infrastructure; or, to fit a lower level of telehealth activity into an existing clinical setting.

Sustainability of telehealth services can be enhanced by choosing an operating model appropriate to the size of the service, meeting the needs of and developing good relationships with referring services, raising awareness, and succession planning.

Keywords. telehealth, telemedicine, sustainability, qualitative

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1. Introduction

Telehealth, or the use of information and communications technologies (ICT) to deliver healthcare at a distance, was initially expected to rapidly deliver greater cost-effectiveness, increased access to rural and home healthcare, and solutions to workforce shortages[1-3]. However, the uptake of telehealth has failed to match expectations[4-7], being slow and uneven, characterized by trials, niche-market use[6], demonstrations and short-term research, with few examples of large-scale services that have been well integrated into usual care[8].

Research and theorizing about this problem has emerged from diverse fields, including organization and management[9], sociology[10], psychology[11], human factors engineering[12], and diffusion of innovation[13]. The innovation cycle is a generic model used across disciplines, which (with minor variation) outlines stages of adopting, diffusing, sustaining and decommissioning[14]. Research has focused primarily on the earlier part of the cycle, covering readiness for telehealth[15-18], and factors affecting the adoption of telehealth[19-21], with little examining sustainability[14, 22].

In part this may be due to lack of consensus regarding definition. Sustainability is variously defined in the literature: in its simplest form, sustainability could be regarded as the *longevity* of the service[23, 24], however, this definition can only be used retrospectively, and does not capture other associated characteristics. Greenhalgh linked sustainability to *routinisation;* "making an innovation routine until it reaches obsolescence"[22]. Cradduck similarly defined a sustainable telehealth service as one no longer regarded as a special case but has been absorbed into routine healthcare delivery[25]. Routinisation, also known as normalization or mainstreaming, has been closely linked to sustainability, but is not exactly the same concept. May developed a model of the normalization of complex interventions in healthcare, using telehealth as an illustrative example, defining normalization as "the embedding of a technique, technology or organisational change as a routine and taken-for-granted element of clinical practice."[26] Integration is another related term, which Atun has characterized as the assimilation of health interventions into health system functioning[27], being achieved when funding, governance, planning and monitoring of the intervention are conducted by the same means as the general healthcare system[28].

Further definitions of sustainability include *resilience*: the long-term ability of a system to respond and adapt to external forces without detriment to functioning[23]; and *financial* definitions, when funding provides adequate reimbursement for costs[29], or when the telehealth service no longer needs grants or start-up funds[24]. A provisional working definition of sustainability adopted to guide this study was the ability of a service to continue functioning into the future.

Most studies examining sustainability in telehealth have focused on short-term projects and pilot studies, with limited longitudinal investigation. Lamminen followed 36 telehealth programs in Finland over a three-year period: 11 had ceased operations, and the average activity level of the 25 programs still operating was only 88 patients a year, suggesting that telehealth had not been successful in replacing usual methods of care[30]. Finch[31] followed 12 teledermatology services in the UK over eight years, using qualitative methods, comparing those that ceased with those that became routine, and concluded that factors promoting continuation were political support, perceived

benefit, a pragmatic approach to improvement, a perception that risk is manageable, flexible practice, and the ability to re-think professional roles.

Organisational case studies have also explored the sustainability of individual services, finding success factors for ten years or more of operations to be strong collaboration with external partners, local champions, and opportunistic exploitation of options[24], and long-term administrative support with the development of a structured and validated cycle of care[23]. Whilst much larger than a single case study, the Veterans Health Administration should be noted as an exceptional example of a large-scale, sustainable, telehealth implementation[8].

Sustainability is clearly a complex phenomenon, with multiple factors intersecting, including forces specific to each service. What these factors are and how they intersect is poorly understood. In order to redress this, the present study has utilized a qualitative approach to better understand sustainability across a diverse sample of telehealth services.

2. Aims

The specific aims of the research are:

1. to collect a defined sample of telehealth services, document their characteristics, and assess their sustainability.
2. to make a qualitative inquiry (via semistructured interview) into the reasons for these services either succeeding or failing to become sustainable, asking:
   - Why did services fail to become sustainable?
   - Are all continuing services sustainable, or are some vulnerable?
   - How do telehealth services achieve sustainability?
3. to relate the meaning of sustainability evident in this study to the definitions and concepts in the literature.

3. Method

3.1 Identification of Telehealth Services

The University of Adelaide Research Ethics Committee approved this study. Interviews were drawn from a sample of Australian telehealth services delivering clinical services to patients and published in the peer-reviewed literature from January 1998 to December 2007. These dates were chosen to capture the increased academic and political interest in Australian telehealth from the mid-1990s[32], and to allow sufficient time to assess sustainability. The MedLine, CINHAL, and Informit databases were searched, using these strategies:

MedLine

("Telemedicine"[Mesh] OR "Videoconferencing"[Mesh] OR "Telemetry"[Mesh] OR telehealth[Title/Abstract] OR telemedicine[Title/Abstract] OR videoconf*[Title/Abstract]) AND (Australia OR Australian OR Queensland OR Tasmania OR Victoria OR (New South Wales) OR (Northern Territory))

CINHAL

((telehealth OR telemedicine OR telemonitoring OR telemetry OR videoconf*) AND (Australia OR Australian OR Queensland OR Tasmania OR Victoria OR (New South Wales) OR (Northern Territory))

Informit

(telehealth OR telemedicine OR telemonitoring OR telemetry OR videoconf*)

In addition, the *Journal of Telemedicine and Telecar*e was hand-searched.

These searches produced 409 articles; applying the exclusion criteria in Table 1 gave a sample of 54 Australian telehealth services. Projects or trials were included, but only where there was the intention or attempt made to develop the research into a service. Where this was not clear from the publication, the authors were contacted for more information.

Table 1. Exclusion Criteria for Sample Selection

Exclusion Criteria	Comments
Not telehealth	Shareable e-records or other e-health
Not Australian	Includes from Australia to other countries
Commentary	
Literature reviews	
Research about telehealth	Surveys of uptake and attitudes, research on the accuracy and usability of telehealth
Non-clinical service	Education, community and administrative uses
Patient case studies	Only one or two instances of telehealth use reported
Radiology and pathology	When used solely as a diagnostic service
Telephone only	Services combining telephone with other modalities were included
Research project only	Where there was no intention to develop the research into a service

3.2 Qualitative Interview Methods

3.2.1 Sampling

From the sample of 54 services, interviewees were chosen by purposive sampling for maximum variation[33], across jurisdiction, clinical discipline, telehealth setting, telehealth modality, and cessation or continuation of services. Two attempts were made by telephone or email to contact the corresponding authors of the published papers for interview. If unsuccessful, co-authors were approached, and if this was similarly unsuccessful, the organisations responsible for operating the services were asked to ascertain an appropriate candidate for interview. Informed consent was obtained before interviews commenced. Interviews were continued until data saturation was reached, that is, when no substantively new concepts were obtained for two consecutive interviews.

3.2.2 Interview Schedule

The interviews were semi-structured, beginning with broad open-ended questions, asking respondents to describe their telehealth services, and the barriers and enablers that they judged to have been important in the establishment, ongoing operation and sustainability of these services, including potential threats and challenges to sustainability. Information was also sought on levels of activity, number of operating sites, and how this had changed over time. Respondents were then asked how specific

factors had affected the uptake and sustainability of their services. This list of factors was developed by referring to previous literature on telehealth services[19-21]. The interview schedule is available from the corresponding author on request. The order and precise wording of the questions varied in response to the material provided by the respondents, with supplementary questions used for clarification or to seek specific examples of the issues under discussion.

3.2.2 Qualitative data analysis

The interviews were audio-recorded, transcribed into text, entered into NVivo software[34] and analysed for themes; i.e. concepts that organise groups of repeating ideas[35]. Particular attention was paid to talk on the sustainability or cessation of the discussed service, and the threats or challenges to sustainability. Similarities and differences across the services were noted, including those based upon the content and form of each service, and all information gathered was collated to construct categories of sustainability. Accordingly, services were classified as ceased, vulnerable, or sustainable.

4. Results

4.1 Characteristics of the sample

Thirty-six interviews were conducted with 34 individuals, concerning 35 separate telehealth services (two people were interviewed twice, one due to missing data from a technical error, and the other gave separate interviews about two different services). Nine interviews were conducted face-to-face and 27 by telephone. The interviews ranged in length from 23 to 75 minutes (mean: 47 minutes). At the time the interviewees were involved with the telehealth services, 19 were clinicians, 11 were researchers, 4 were managers, and 2 were telehealth coordinators. The clinicians often had multiple roles: 5 of the 19 were also researchers, 4 worked part-time as telehealth coordinators, and 3 had senior management roles.

The characteristics of the 35 services discussed during interview are summarized in Table 2. The largest proportion of services was in the medical specialities, because a wide range of sub-speciality areas were sampled, covering cardiology, respiratory, renal, diabetes, oncology, geriatrics, palliative care, rehabilitation, clinical genetics, pain management, and dermatology.

Twenty-two of the services delivered healthcare directly to patients; eight provided ongoing management or follow-up; seven, assessment or diagnosis; one delivered a time-limited treatment program; and six had multiple clinical purposes. The remaining 13 services were secondary consultations to other healthcare providers, also known as provider-to-provider telehealth. The changes in service activity over time were obtained from the interview material and indicate an approximately even distribution of services that were ceased, declining, maintaining, or expanding activity levels.

Table 2. Characteristics of Telehealth Services in the Interview Sample

Characteristic	Number	Percentage
Jurisdiction		
Queensland	8	22.9
New South Wales	7	20.0
Western Australia	5	14.3
Victoria/Tasmania	6	17.1
South Australia	9	25.7
Clinical Discipline		
Medical specialties*	14	40.0
Mental health	6	17.1
Surgery & Emergency medicine	4	11.4
Paediatrics	4	11.4
Nursing & Allied health	4	11.4
Multiple service network	3	8.6
Location Providing Sites		
Capital city teaching hospital=23)	33	94.3
Rural/regional	2	5.7
Location Receiving Sites		
Rural health services	19	54.3
Rural & urban health services	4	11.4
Urban health services	3	8.6
Patient homes	5	14.3
Residential institutions	2	5.7
Rural other services	2	5.7
Telehealth mode		
Real-time video only	28	80.0
Real-time video & other	1	2.9
Store-and-forward only	4	11.4
Email & internet	1	2.9
Change in Service Activity		
Ceased	8	22.9
Decreasing	8	22.9
Stable	8	22.9
Increasing	11	31.4

* cardiology, respiratory, renal, diabetes, oncology, geriatrics, palliative care, rehabilitation, clinical genetics, pain management, dermatology

Eight of the 35 services had ceased operations, and 14 of the continuing services were categorized as vulnerable because of evidence of threats to their sustainability which could result in cessation. Ten were classified as sustainable, and insufficient information was available to make a judgment in three cases. Table 3 shows the distribution of activity, longevity and funding characteristics for these groups of services. The activity levels of each service varied markedly, from less than one to approximately 1500 client contacts a month, and as most interviewees gave estimates rather than exact numbers, these were placed into frequency-based categories. Four services that conducted case conferencing, and three cases where interviewees were unable to give any activity estimates, were excluded. Notably, many of the telehealth services had considerable longevity, with about two-thirds of the sample operating for six years or more. The funding categories shown in Table 3 simplify often complex arrangements, however, three-quarters of the services were directly funded by government departments.

Table 3. Service Characteristics and Operational Status

	Ceased	Vulnerable	Sustainable	Total
Longevity				
1 year or less	6	0	0	6
2 to 5 years	0	3	2	5
6 to 10 years	1	8	3	12
11 or more years	1	3	5	9
Activity (clients/month)				
1 or less	1	4	0	5
1.5 to 5	3	3	1	7
8 to 10	1	3	0	4
20 to 80	1	2	2	5
More than 100	1	0	3	4
Main source of funding				
Ongoing state health	2	5	7	14
Ongoing other	0	1	0	1
Short-term government	2	5	2	9
Short term research	4	3	1	8

4.2 Thematic Analysis

4.2.1 Why did services fail to become sustainable?

Of the eight telehealth services that ceased, six ran for a year or less. These projects were intended to become ongoing services, but were unable to make the transition. The remaining two services ceased clinical telehealth after operating for several years, although videoconferencing equipment continued to be used for educational or administrative purposes. Several reasons were given regarding their failure to thrive, including lack of support, insufficient demand, issues with technology, and funding.

The major theme (present in 6 interviews), was lack of support from participating sites. Examples included a rural project where the interviewee reported staff to be technophobic, an urban project where clinical and organisational interest rapidly declined in the face of several months delay in sourcing and installing equipment, and a project where the rural interviewee said that the city-based mangers had failed to engage local clinicians.

Insufficient demand for services was also noted. One rural project reported a lack of suitable patients, particularly in remote areas, and another predicted a high demand for telehealth from a preliminary survey, but time, inconvenience, and costs incurred by patients to gain rapid access to specialist expertise, saw most prefer to be wait-listed for a free face-to-face service.

Funding was mentioned as an important factor leading to cessation in two cases. One longstanding case conferencing service became a solely educational service due to changes in the conditions of funding for its part-time coordinator; in another case the interviewee was initially at a loss to explain the failure to continue telehealth, but when prompted to be more specific, said that telehealth came out of the organisation's IT budget, and that IT had other commitments. Technology difficulties were deemed to be substantial in only one instance: the urban project mentioned above.

Was one problem enough to kill a service? Sometimes, but not invariably. For example, one interviewee said that a service attempting videoconferences between patients at home, their usual GPs, a consultant physician, and specialized outreach nurses, was discontinued solely because these groups could not be coordinated. On the

other hand, the longest operating service that nonetheless ultimately failed had been deemed very successful, but was described as having gradually lost its way, due to a combination of problems, including loss of senior management support, loss of the project officer, frustration with technical difficulties, loss of interest of clinicians, over-reliance on a single champion, and a proliferation of nay-sayers.

4.2.2 Are all continuing services sustainable, or are some vulnerable?

Fourteen of the continuing services faced a range of threats to their sustainability:

Lack of succession planning: four of the services relied on a single person without a back-up plan; examples include a telehealth coordinator at a hospital who reported feeling tired and overstressed, and is the only person at that institution who can fill the role, a specialist who established a telehealth service as a study project, and maintained it alongside his other work, and an enthused clinician who did everything from consulting with patients, to organising bookings and installing and maintaining the technology. Although he did not express any difficulty in doing this, it was clear that without him the service could not function.

Low levels of interest: a further four services appeared to have a very low profile and little interest or support from the surrounding healthcare system; for example a service established by a government grant, then left up to private providers to maintain, had halved the number of its operational sites. Two providers in this group were within state health departments, and received very few requests for service.

Short-term funding: one service relying on research grants had a dramatic decline in activity when the grant ended, and increased again when a second grant was secured. In three cases, although continuation was anticipated, the interviewees mentioned short-term grants or service agreements due for renewal as a potential threat.

Transitional phase: two services were assessed as vulnerable because they were in the early stages of transition from research to ongoing operations; one was not accepted by all the clinicians that were intended to use it, and another required a new, and as yet undeveloped, model of service.

Workforce priorities: one service decreased its activity when it lost funding for its telehealth project, but then stabilised by continuing to offer the same services to a smaller number of distant sites; the main threat mentioned was a general increase in workload which might pull the central staff away from telehealth activities in the future, as these were not incorporated into their designated roles.

4.2.3 How do telehealth services achieve sustainability?

Nine of the 10 services categorized as sustainable were provided by the public health system, with clinicians' salaries and the telehealth infrastructure funded by state governments. Funding was an issue, but not the central one, with clinicians in particular saying that money could always be found given demonstrated need and value of the service.

Six services offered patient assessment and/or management advice to large catchment areas; either whole or large portions of a state. This, plus their good relationships with referring individuals and agencies, ensured that they received an

ongoing flow of referrals. Not all of these services were high volume; one service averaged one video assessment a week, but referrals had been stable at this rate over many years.

Each of the sustainable services had developed specific organisational structures to support telehealth as part of their regular operations. In general, all their clinical staff were able to conduct teleconsulting when needed, and the larger volume services had designated coordinators. One service gave a good example of resilience; over a 15-year period it had successfully defended itself against being broken up on at least three occasions, primarily using the good relationships with rural services to leverage political support.

Three services conducted video case conferencing between specialized units. Each had been operating for several years with the same group of clinicians, and were regarded as a small but important part of the weekly routine of providing care. This form of telehealth activity was considered easy to maintain, because no extra staff and very little administrative support was required.

The final example in the sustainable group was quite different to the others, being a home telecare service run by a community organisation using home videophones as an alternative to a drive-around service for selected clients. Because most clients were contacted daily or twice daily, the service was perceived as increasing workforce efficiencies. Indeed, this service had the largest volume of the sample, at over 1500 client contacts a month.

5. Discussion

This is the first qualitative study to explore the sustainability of a sizable, diverse sample of telehealth services in Australia. Encouragingly, over two-thirds of the 54 services had achieved ongoing (albeit to varying degrees) operational status, countering claims that most services fail, and claims that "sustainable telehealth has almost become an oxymoron"[25].

In the interview sample, 36 interviews were required to reach data saturation. This produced a comprehensive and credible sample with a good spread of characteristics such as client activity levels and years of operation. The services were classified into three groups of ceased, vulnerable, and sustainable, and each group included several services, enabling meaningful comparisons. The sample was dominated by synchronous video communication and services from capital cities to rural areas, operated by the state public health systems. This may in part be explained by the fact that Australia has a universal health insurance system that does not rebate telehealth (apart from a very limited use of tele-psychiatry), so there is little incentive for widespread implementation in the private sector.

5.1 Lessons from failed and vulnerable services

Most failed and many vulnerable services lacked adequate support from the organisations and clinicians who were intended to use the service, producing low levels of uptake and lack of demand. These two problems can combine to prevent a service from becoming sustainable, or produce a downward spiral in a longstanding service. Another issue was over-reliance on a single person: in the telehealth field, 'clinical champions' have often been essential for initial adoption and implementation[36, 37],

and many of the interviews were conducted with enthusiasts who would fit that description. There was nonetheless, a clear vulnerability for services that continue to rely solely on these individuals. Finally, technical and funding problems were mentioned but as one of a range of minor issues. It was rare for a single issue to be identified as causing the demise of a service; the exception was an example where all parties appeared theoretically willing to participate, but it proved practically impossible to bring busy clinicians together at the same time.

5.2 Lessons from sustainable services

Two unique ways to achieve sustainability were found: one was to reach a sufficient size, or critical mass, where the numbers of referrals and tele-consultations justified dedicated staffing, coordination and infrastructure. Distant sites will support central providing site/s if they are seen as meeting ongoing needs and having value, hence the vital importance of good relationships between provider and receiver.

The other route to sustainability involved adding a low level of telehealth activity into an existing clinical setting. Case conferencing fitted this pattern, but it was also an option for distant consulting services. Once routines were established and staff had acquired telehealth skills, these applications were able to continue because they were regarded as valuable, but made few demands on the time or capacity of the operators.

Whilst the vast majority of sustainable services were publicly funded, this by itself did not guarantee sustainability as there were publicly funded services in the ceased and vulnerable groups as well.

5.3 Limitations of the study

The main limitation was identifying the sample through academic publications; projects or services that produced only internal reports, or published in the grey literature were not included. Furthermore, recently established services were excluded, because the search was limited to two years before the present to allow time for the telehealth activities to succeed or fail at becoming sustainable. Also, the study largely relied on one interviewee per service, so could not utilize the multiple sources of data that can be achieved by conducting organisational case studies. Nonetheless, the aim of obtaining a diverse sample was accomplished, and the services investigated covered a broad range of disciplines, locations, sizes and outcomes.

5.4 The concept of sustainability

Echoing the variation in definitions of sustainability within the academic literature, sustainability, as characterized within this sample, appears to be more than an all-or-nothing concept; there are degrees of sustainability, and different ways to be sustainable. Sustainability was not synonymous with routinisation or integration, as some of the sustainable services were still separate from the usual operations of healthcare, and some of the vulnerable services were integrated into usual procedures. Nevertheless, routinisation and integration were very important associated features of sustainability, particularly for telehealth activities that fitted within an existing clinical unit.

A purely financial model of sustainability was not supported by this study, with financial factors being less prominent than expected. It must be acknowledged,

however, that the majority of services were run by state governments, and most of the others were funded by research or other grant arrangements, therefore did not have to operate from a commercial business model. A budget is, of course, one of the essential requirements for running any health service, but within the public sector it appeared that if the need and the support could be demonstrated, the budget would follow. Resilience was also mentioned, but not across the dataset, suggesting that this may not be an essential part of sustainability.

6. Conclusions

This investigation into the sustainability of telehealth services has found that, although the majority of Australian telehealth services reported in the academic literature have continued to operate, less than half of these have achieved solid sustainability. Qualitative analysis of interview data offers the following suggestions for policy and practice:

- More than one organisational model can be sustainable, and should be selected depending upon the likely volume of the service.
- Particular vulnerabilities include relying on individual champions, a low level of awareness and interest, short-term funding, and making the transition from research to service.
- The sustainability of telehealth services can be encouraged by paying specific and detailed attention to referring services, both by meeting their clinical needs and by maintaining good relationships.
- Other strategies for improving sustainability are marketing to raise the levels of awareness of the services, and succession planning.

Additional research into the different levels and types of sustainability, and the factors that influence transitions between these would be useful. The data from the present set of interviews will be further analysed to elucidate this, and to develop a grounded theory of the uptake, integration and sustainability of telehealth services.

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Competing interests VW declares that she has a competing interest, being the Medical Director of Design Networks Pty Ltd, a company that supplies telehealth services. This position is not salaried, although VW has received reimbursement of expenses for conference attendance from the company. The company did not initiate or fund this work. The other authors declare that they have no competing interests.

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9.3 Publication 2: Clinician Acceptance is the Key Factor for Sustainable Telehealth Services

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Declaration of conflicting interests

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Abstract

Telehealth, the delivery of health care services at a distance using information and communications technology, has been slow to be adopted and difficult to sustain. Theories of the introduction of complex change into health care usually take a multi-factorial approach; we intentionally sought a single point of intervention that would have maximum impact on implementation. We conducted a qualitative interview study of 36 Australian telehealth services, sampling for maximum variation, and used grounded theory methods to develop an explanatory model to determine the most important factor affecting the success of telehealth. We propose that *clinician acceptance* explains much of the variation in the uptake, expansion, and sustainability of Australian telehealth services, and that clinician acceptance could, in most circumstances, overcome low demand, technology problems, workforce pressure, and lack of resourcing. We conclude that our model offers practical advice to those seeking to implement change with limited resources.

Keywords

grounded theory; health care administration; interviews, semistructured; research, qualitative; technology

Introduction

Telehealth encompasses the delivery of health care services at a distance, using information and communications technology. There are numerous definitions (Sood et al., 2007), but here we regard telehealth as the delivery of clinical services to patients by providers who are physically located at a distance. In this respect, telehealth is synonymous with telemedicine, and is a distinct subset of e-health, which encompasses all the uses of information and communications technology supporting health care (Al-Shorbaji & Geissbuhler, 2012). Telehealth contains several modalities for delivering health care services, which are divided into synchronous or real time applications, such as video consultations and asynchronous or store-and-forward applications, such as transmitting still images or physiological data (Tulu, Chatterjee, & Maheshware, 2007).

Clinical video consultations began in the 1970s, followed by an explosion of interest in telehealth from the mid-1990s (Bashshur, Reardon, & Shannon, 2000). Enthusiastic commentary and theoretical modelling promised huge gains in the context of a technological imperative for adoption (Bangert, Doktor, & Warren, 1999; Cusack et al., 2008; Simpson, 2005). Telehealth is an engaging concept because it has been proposed as an all-in-one solution for several difficult problems in health care delivery, namely lack of access to care for rural and disadvantaged groups, maldistribution of specialist services, the rising costs of health services, and the need to deliver more care direct to the home for the aging population with chronic diseases (Bashshur & Shannon, 2009; DeVany, Alverson, D'Iorio, & Simmons, 2008; Tracy, Rheuban, Waters, DeVany, & Whitten, 2008).

Yet even as the interest in telehealth accelerated, the evidence regarding utilization did not match predictions. Studies noting the failure of telehealth to be adopted at the expected rate emerged from the late 1990s, with low uptake (Paul, Pearlson, & McDaniel, 1999; Tanriverdi & Iacono, 1999), uneven diffusion (B. Grigsby et al., 2002), and failure of pilot projects to translate into ongoing services (Barlow, Bayer, & Curry, 2003; Kerr & Norris, 2004; C. May et al., 2003; Zanaboni & Wootton, 2012). Reports of underutilization appeared across a range of clinical areas, including psychiatry (Grealish, Hunter, Glaze, & Potter, 2005; Hailey, Ohinmaa, & Roine, 2009), rural health (Gagnon, Duplantie, Fortin, & Landry, 2006; Robinson, 2002), military medicine (Lam & Mackenzie, 2005), pathology (Dennis, Start, & Cross, 2005) and palliative care (Whitten, Holtz, Meyer, & Nazione, 2009). When the numbers of teleconsultations conducted by individual services were measured, they

typically ranged between a few hundred to few thousand episodes a year (Dillon, Loermans, Davis, & Xu, 2005; Hailey et al., 2009; Lamminen, Semberg, Ruohonen, & Roine, 2001). Numbers of sites and services increased over time, but continued to be a very small fraction of total health care activity (B. Grigsby et al., 2007). Zanaboni characterizes telemedicine as an "immature technology" that has stalled (Zanaboni & Wootton, 2012).

This disjunction between expectation and reality prompted much commentary and numerous policy recommendations (Jennett et al., 2004). Researchers began to investigate why the implementation of telehealth has been so difficult, and what is needed for successful uptake, typically constructing lists of barriers and enablers. Three reviews of such research collectively indicate that the enablers were well-functioning technology, user training, planned change with provider participation, development of protocols, acceptance by health care providers, support for provider collaboration, use of a business model, and supporting policy and legislation. Barriers cited were technical problems, lack of technical support, lack of usability, provider concerns about quality and ethico-legal matters, absence of protocols, lack of a business model, and regulatory barriers in licensing and standards (Broens et al., 2007; Jarvis-Selinger, Chan, Payne, Plohman, & Ho, 2008; Obstfelder, Engeseth, & Wynn, 2007).

Although this approach to understanding how innovative practice is adopted in health care delivery is commonly used, it lacks an explicit theoretical framework, as does the majority of research in telehealth (Gammon, Johannessen, Sorensen, Wynn, & Whitten, 2008). The implicit assumption is that each factor has some degree of impact and that the use of telehealth can be encouraged by increasing the enablers and reducing the barriers. Mair's (Mair et al., 2012) recent meta-review of the uptake of e-health concluded that, despite the proliferation of reviews of barriers and enablers, the underlying mechanisms have not been well characterized or explained. Robert's systematic review of assimilation of technologies into health care also noted that the vast majority of adoption research was atheoretical and that no simple, fully predictive model had been developed (Robert, Greenhalgh, MacFarlane, & Peacock, 2010).

There has been some use of extant theories in researching the implementation of telehealth. Roger's diffusion of innovation theory (Rogers, 2003), which is best known for a typography of adopters ranging from innovators to laggards, has been the dominant paradigm across the entire field of knowledge translation (Estabrooks et al., 2008), as well as being

specifically applied to telehealth (Al-Qirim, 2003; Menachemi, Burke, & Ayers, 2004). Other approaches to explaining the uptake of telehealth have included structuration theory (Lehoux, Sicotte, Denis, Berg, & Lacroix, 2002), human factors research (Kaufman et al., 2003), the unified theory of acceptance and use of technology (Whitten, Holtz, & Nguyen, 2010), and the technology-organization-environment framework (Liu, 2011).

Researchers in telehealth have also created new theories. Most have had little impact, with the exception of Normalization Process Theory (NPT). This began from ethnographic studies of telehealth services, (T. Finch, May, Mair, Mort, & Gask, 2003; C. May, Gask, et al., 2001) and has subsequently been generalized to explain and address the observed problem of achieving the routine adoption of complex interventions in health care (C. May, 2006) It has become a formal meso-level theory with 16 major concepts, covering the mechanisms people use to generate and operationalize new work practices, how these work practices become routinely embedded in health care services, and what investments are needed to ensure the work practices are maintained (C. R. May et al., 2009). NPT has developed a set of hypotheses, and a quantitative assessment tool (T. L. Finch, Mair, O'Donnell, Murray, & May, 2012; C. R. May et al., 2011), and is being used prospectively as a framework for telehealth research (MacFarlane & O'Reilly-de Brun, 2012). Any new theory, therefore, about the implementation of telehealth should detail its relationship with NPT.

As NPT is intended to be a comprehensive model, it is multifaceted; there is no single narrative or explanation that enables an implementer to focus their attention on a particular action, actor or process. The successful introduction of telehealth is acknowledged as a complex and multi-dimensional issue (Wootton & Hebert, 2001), and it is possible that the environment is so complex that no single pathway or key factor exists. Nonetheless, qualitative research techniques have the capacity to examine a chaotic, multivariate environment and construct a unifying concept, potentially facilitating understanding and informing actions to promote the use of telehealth.

Our previous research within the Australian context focused on sustainability, because most telehealth services begin as trials, feasibility tests or pilot studies, which then face the difficulty of transition to a sustainable service (C. May, Mort, Mair, & Williams, 2001). We characterized sustainable services as having no foreseeable threats to their ongoing operations, and investigated factors affecting the sustainability and vulnerability of services (Author, 2010). We directed the scope of our work at the level of individual telehealth

services, as they succeed or fail within the broader health care system. It would be possible to treat the entire health care system as the unit of analysis but throughout the duration of this research, telehealth in Australia was a patchwork of distinct services, each with a defined clinical area and model of care. From mid-2011, Australia's universal health insurance scheme has facilitated telehealth by providing payments for video consultations between medical specialists, patients, and primary care services in outer metropolitan and rural areas, and the impact of which will be considered as part of this study.

We selected grounded theory as the overall framework for this research because it fitted best with our intention to investigate a particular phenomenon across diverse circumstances and produce an explanatory model (Starks & Trinidad, 2007). Other work utilizing grounded theory methods to explain telehealth implementation comprises one field study (Moffatt & Eley, 2011), and a literature review (Obstfelder et al., 2007), both of which produced thematic analyses containing lists of factors. A third study commenced with grounded theory but concluded by adopting diffusion of innovation theory (Helitzer, Heath, Maltrud, Sullivan, & Alverson, 2003). None of these articles carried the grounded theory method through to the final stage of producing an integrated model, and therefore we assert the value of further investigation of this phenomenon with new data.

Our specific aim was to use grounded theory methods to build a model which identifies the most important point of intervention for promoting the successful uptake and sustainable operations of telehealth services. This approach has practical value for change management, because there are limits to the amount of time and resources that can be put into supporting change, and such a model also offers a means of prioritizing where to place one's efforts.

Methods

Sampling

We located Australian telehealth services by searching the academic literature published between 1998 and 2007, selecting this latter date as a cut-off point to allow at least two years since the commencement of the telehealth activity and our assessment of its sustainability. We excluded telehealth activities that were one off trials, but because many telehealth services begin as projects (C. May, Mort, et al., 2001), we included those still in project phase provided they were intended to become ongoing services. Where the intention was not stated in the publication, we contacted the authors of the article for clarification. Nonconsulting types of telehealth such as teleradiology and telepathology were excluded, as were telephone-only services such as health call centers, because these are sufficiently distinct as to constitute their own fields of investigation. Applying these criteria, we found 54 services, which covered medical, surgical, nursing, and allied health services across both rural and urban areas. The majority used real time video communication, but some used store-and-forward of images and data. Additional details of the search strategy and results are described elsewhere (Author, 2010). From the identified services, we chose an initial sample for maximum diversity, across the dimensions of clinical discipline, type of telehealth, geographical setting, and the current operational status of the service. We ceased this sampling when we reached saturation, which we defined as no new categories arising from two consecutive interviews. Additionally, we undertook theoretical sampling during the grounded theory analysis, and longitudinal sampling to assess changes over time.

Study Procedures

The University of Adelaide Human Research Ethics Committee approved this study. We approached the corresponding authors of the articles in our initial sample to request an interview, or, where they could not be contacted, the organizations which were or had been operating the services. The study participants had direct involvement in the establishment, management, clinical operations or evaluation of the services. All participants were sent written information about the study and gave informed consent before they were interviewed. Where possible, the interviews were conducted in person, but otherwise by telephone.

The first author constructed a semi-structured interview guide, based on the concepts previously described in the literature. This began with general questions about the initiation, characteristics, operations and sustainability of the telehealth service, then moved to a set of specific questions about the effects of funding, technology, management, policy, politics, patient, clinical, workforce, ethical, legal and research issues on the functioning of the service. Interviews were audio-recorded, transcribed and entered into NVivo software (QSR, 2009), which was used to facilitate categorization and analysis.

Epistemology

The study data comprises text, re-presenting the interviewee's perceptions and constructions of their worlds, first filtered through their own histories and contexts, then actively interpreted by ourselves. Hence, we acknowledge that our explanation is one of many potential constructed interpretive portrayals (Charmez, 2006). We took a post-positivist approach to analysis (Annells, 1996), because our intention is that this explanatory model clarifies what is important for telehealth services to be successful, and what elements within the process could be influenced to increase uptake. We assumed that our understanding does relate to processes in the external world, and that these processes can be explored, although not fully apprehended, through the application of grounded theory methods.

Grounded Theory Methodology

Glaser and Strauss first presented Grounded Theory as a post-positivist inductive approach to developing new theories about social phenomena, in distinction to and in reaction against the then-prevailing ethos of testing a priori theories by the hypothetico-deductive method (Glaser & Strauss, 1967). Grounded theory methods diverged into two streams, employing either Glaser's theoretical coding families (Glaser, 2002) or Strauss and Corbin's set of techniques such as the coding paradigm and conditional matrix (Corbin & Strauss, 2008). Although some assert fundamental incompatibilities between these approaches, (Boychuck & Morgan, 2004; Walker & Myrick, 2006), others claim they exhibit more similarities than differences (Kelle, 2005). We conclude that grounded theory is a broad field with no set canon; rather, there is the flexibility and the necessity for each researcher to select and adapt its methods to their own research aims and data. We used the basic techniques of constant comparison and memoing throughout the process, and conducted three distinct phases of theory development: a first phase of line-by-line open coding, an intermediate phase

of selection and combination of these codes into concepts; and a final phase of theory construction.

Context and Reflexivity

The first author is a medical practitioner with a history of working in health system reform, who had tried to create a successful telehealth service. She became an enthusiast for telehealth and, noting the lack of a business model as one substantive problem, became the medical director of a small telehealth company. Following first-hand experience of the implementation problems described above, and dissatisfied with the current explanations in the literature, she designed and initiated the present research program. At the time of writing, the first author had ceased commercial involvement with the telehealth company, and is managing a telehealth project in a clinical academic setting.

This background means that the first author approached the research as an experienced insider with a conflict of interest, not as a novice or outsider. This has the advantages of pre-existing theoretical sensitivity and ease of engaging with potential interviewees, but also meant that the conflict of interest needed to be managed in a transparent and ethical way. To achieve this, the first author kept reflexive and relational memos (Hall & Callery, 2001), and worked closely with her coauthors and a colleague who did not have a conflict of interest and were able to provide continuing oversight and critique.

Results

Results of Sampling

Initial interviews: We commenced sampling in July 2009, accessing the first service opportunistically and conducting an initial interview to test the schedule and process. Between August 2009 and February 2010 we selected 30 services by maximum diversity and five services theoretically, the latter to pursue the potential impact of services being part of a larger network. Open coding and initial categorization proceeded throughout this period. We included one additional service in May 2012, to test an aspect of the developing theory.

Each individual we approached either granted an interview or referred us to another appropriate person who agreed to participate. The first author conducted all the interviews, with the intention of interviewing one person per service; however, one interviewee was interviewed twice because of data loss from a technical problem, and one service requested we interview two people. We concluded with 39 interviews about 37 distinct services.

Thirty-one interviews were conducted by telephone and eight in person (seven were at the interviewees' workplaces; one person came to the first author's office). Interview length ranged between 23 and 75 minutes, with most being about 45 minutes.

Follow up interviews: To investigate the impact of increased funding for telehealth from July 2011, through the introduction of health insurance rebates for video consultations, we conducted seven follow-up interviews in May and June 2012, which was the maximum number we could undertake because of pragmatic reasons. We selected services to include some likely and some unlikely to be affected by the change, and interviewed six of our original interviewees plus an individual who had taken up the role of the previous interviewee. One interview was face-to-face, six by telephone, and their length ranged between 8 and 34 minutes.

Description of services: Of the 37 telehealth services in the sample, ten had ceased operations. The remainder continued to operate, with varying levels of activity, ranging from less than one service event a month, to more than 1,500 a month. The most common form of service delivery was real-time video, and the most frequent setting was the supply of specialist services from a city to a health service in a rural or remote area. The sample also

contained a minority of inter-urban services, home care services, and store-and-forward telehealth.

Grounded Theory Analysis

The first author commenced the analysis with detailed open coding of the interview transcriptions. The other authors and one other colleague coded an interview each and reviewed data periodically. This initial stage resulted in hundreds of diverse and fragmented codes; to provide an integrative point of comparison, the first author wrote concise narrative summaries of each service, together with a preliminary formulation of the likely explanation for their present status. These narratives treated each service as a single entity, not yet attempting to bring them together under one model. In stage two we used focused coding according to Charmaz (Charmaz, 2006), and added axial coding (Corbin & Strauss, 2008) when a category was difficult to characterize.

After many iterations of constant comparison, we identified three dimensions of coding to be the foundation for the development of the explanatory model:

Service outcomes: This substantive code describes the status of the telehealth service at the time of the interview. In addition to the categories of ceased, vulnerable and sustainable, previously identified (Author, 2010) we added the concepts of normalized and integrated. We note, however, that the apparently straightforward classification of services into ceased and continuing to operate was problematic, as, for example, where the service had gone into abeyance, and could possibly be resurrected.

Perceived causal influences: Our focused coding of the factors perceived to affect the outcome of the services formed the second set of substantive codes. These broadly resembled the characteristics of services found in prior thematic analyses and raised in our interview schedule as described in the methods. We added one major new category, *systemic or inter-organizational issues*, and expanded the political category to include a more general consideration of power.

Operational trajectories: Finally, we created a set of process codes about the trajectory of service operations over time, covering initiation, the change from project to service, expansion, and contraction.

Our integration phase of theory development involved comparisons across these three dimensions, bringing the earlier narrative summaries into the operational trajectory analysis, and making extensive use of diagrams to trace the interviewees' perceptions of influence. From this, we chose a key factor that was both essential to the success of the services and densely related to the other substantive codes.

The Key Factor

We propose that *clinician acceptance* is the key factor or most important influence on the successful operation of telehealth services. By clinician acceptance, we mean the willingness of clinicians to use telehealth as an option for service delivery, either by taking up a telehealth innovation or working within an existing telehealth service. This is different from the concept of the *clinical champion*, who promotes telehealth to others (Hendy & Barlow, 2012).

We did not come to this position lightly. Indeed, we initially considered that the organizational or structural domain was the most likely area to contain the key factor. As a clinician, the first author was aware that she was attuned to the opinions of other clinicians, and was wary of attributing too much power to clinical opinion. However, based on our construction of the theoretical elements of the model, as well as from the strength of opinions of our informants, we argue that clinician acceptance is the key factor.

Beginning with the theoretical aspect, we mapped the relationships between the concepts supporting telehealth services, as shown in Figure 1. We propose that three of these concepts are necessary and immediate precursors to a successful telehealth service: (a) actors providing health services (workforce availability), (b) actors demanding telehealth services and (c) technology connecting 1 and 2. If these components are sustainable, then the service itself will be sustainable. Our model then shows how these elements, plus the intermediate component of resourcing, are all related to clinician acceptance, which occupies the central position in the model. We describe these relationships below.

Workforce Availability

Shortages of all types of health workforce are a significant problem in Australia, and could have been the major factor preventing telehealth services from functioning. No services were reported to have ceased because of a lack of workforce, although there was a single

example where lack of workforce threatened the existence of a highly specialized service to rural areas:

- *we had a shortage of specialists two years ago and there were issues about whether we could sustain a telemedicine service with such few numbers, however we pushed on and survived . . . but particularly it limited any chance of expansion.*

Typically, our informants said that if clinicians wanted to use telehealth they would make themselves available. The most frequently mentioned reason for doing this was a willingness to put in extra effort to benefit patients; "[*It] was just, annoying, to see that these kids could be seen a certain way if we started this [telehealth] program up, so I kind of started it up, in my own time after work, staying back*" and "*when it gets hard we can just think about the people who've benefited from the project, and everyone goes yeah, it's worth keeping going*." We therefore propose that clinical acceptance influences workforce availability.

Clinician demand for service

As well as an available workforce, sustainable telehealth must also have an ongoing demand for services, manifested by patient referrals, requests for specialist assistance or attendance at case conferences. The issue here is whether the clinicians supplying telehealth services simply respond to demand from other health care providers, or if they make active efforts to shape the demand. There were three services where low or absent demand was reported to be a major factor in cessation, but a further group of services continued to operate for several years at a low level with minimal resources, primarily because the clinicians maintained their willingness to supply telehealth consultations. In these cases the clinicians made time for telehealth in between their other activities, for example: "*one of our doctors has to stop seeing one of the patients here, and take the telemedicine call, so they fit it into their work day*."

At higher levels of demand, clinicians tried to manage demand by matching the number of referrals with the clinical time available. Methods included not publicizing a service, or limiting service provision to a geographical area. For example, one tele-mental health service provider said "*we don't deliberately advertise our services, particularly for [type of patient], 'cause we can't deal with the numbers that come through.*" Another service,

which lost its telehealth funding, continued running the service but reduced demand by working with a smaller number of sites. Managing demand was also reportedly used to ensure expansion was smooth:

- *If all of a sudden [the government] say you need to offer this service to every single hospital in [State], and provide telemedicine services for every specialty, I'd be disinclined because I'd be worried about trying to do too much too quickly.*

In short, although demand is necessary for a service to run, clinicians intentionally adjusted it to suit their own context and circumstances.

Adequate technology

Adequate technology is the third essential component of a functioning telehealth service. If the technology never attains or persistently falls below a minimum necessary standard, the entire telehealth service cannot operate. There was only one example where inadequate technology led to service cessation: a service that had intractable problems in achieving sufficient bandwidth to patients' home.

Clinicians usually had little influence on the type and quality of the technology used for telehealth, although they could accept or reject what was available. In practice, provided that the clinicians accepted telehealth, a substantial number of technical difficulties were tolerated, defying commonly held beliefs that clinicians will only use technology if it is excellent. For example, a mental health worker who had conducted video consultations for more than a decade said: "*invariably on this old machine, I've hit the thing, and done all the stuff, and nothing's happened, or something's gone wrong."* Another interviewee said, of technical issues in a home care service, "*Normally you just sort of wait it out, you dance around it; you might ring [the patient] on their landline and get them to reboot and that sort of thing, but you just take it in your stride.*" By contrast, very high quality technology could be a problem; a hospital which invested heavily in ensuring that their video connection was as near as possible to physical presence eventually closed their telehealth service because management decided the technology was too expensive.

Resourcing

Each telehealth service had a resourcing or business model, whether this was an allocated budget, payment by episode of service, or addition of the service to existing activity. Some might argue that change is primarily driven by allocation of resources, but our informants opined that the influence operated in the opposite direction. A typical comment was "*if clinicians are supportive then you've got more chance of getting a budget*." Another interviewee gave an example of how this works in practice; after a telehealth service lost grant funding, the hospital management originally was unwilling to, but then decided that it could, financially support telehealth. When the interviewer probed further, asking why their response had changed, it came down to the clinicians' willingness to provide the service "*I think that the consultants involved felt like they were providing a good service, and they were very keen to do that."*

Participant opinions about the key factor

Our participants repeatedly stated that clinician acceptance (willingness to use deliver services using telehealth) was either a very important, or the most important, factor in service success. The concept was variously named, including "*clinician interest*," "*consultant support*," and "*staff commitment*" and was mentioned as critical across a variety of services types including multi-disciplinary case conferencing, rural patient assessments, and specialist patient management. A typical statement was "*the interest and motivation of those regional pediatricians was one of the key factors, having someone who honestly wants to do the work*."

The interviewees also said that lack of clinician acceptance led to failure. A researcher who reported only modest success in introducing a telehealth service said that "*if you don't have clinicians on-side then you won't have an activity either*." A specialist physician noted, of a service he provided to rural areas "*It's very hard if there's not the [clinician] interest at both ends, for the service to work in a sustainable way, so I think that's one of the key things that remains the case and why utilization is poor*." Furthermore, interviewees argued that lack of clinician acceptance could not be overcome with other incentives. A clinician said "*money's not the savior of everything and so it means that the players do need to have an interest and think that it's worthwhile. If you don't have that, it won't get up anyway*." A manager concurred "*If [clinicians are] not interested, and they don't*

want to do things that way, then they're not going to be supportive of it, even if you coax them, give them money and other types of incentives."

Alternative explanations

Finally, other candidates for the key factor were not supported by the data. We specifically asked about patient demand, because this can be a potent influence on physician behavior, but there were no reports of uptake being driven by patient demand. In an environment where there was little public awareness of telehealth, patient acceptance followed clinicians recommending telehealth. A specialist physician did suggest that, if it existed, patient demand would be important: "I think if we were being asked to deliver our service [by telehealth] then we would. It's as pure and simple as that, so lack of education amongst the consumers".

We further considered a cluster of political, policy and management support that influenced the initiation of services and allocation of resources, but deemed these to be a step removed from sustainable operations. To illustrate the basis for this judgment, in discussing a sustainable telehealth service between hospitals, one clinician said "I don't think [management] would know whether it's happening or not, I would suggest. But then, that's the way it should be . . . the framework ought to be there, and then it either flies or it sinks."

Achieving Clinician Acceptance

Having proposed that clinician acceptance is the key factor in sustaining a telehealth service, we next address how this is achieved over time. In analyzing the trajectory of telehealth services, we found that all but two of the 37 services in our sample started as small-scale projects with short-term funding, and have previously reported that most of these were initiated by champions (Author, in press). Further analysis indicated that champions also played a critical role in the subsequent conversion of a project to an ongoing service. During this transition it was often necessary to rely on a series of short-term grants or funding from various sources, with the champions possessing the motivation and making the time to shepherd the telehealth activity through this process.

Once a service moved beyond the project phase, broader clinician acceptance became the key factor in determining the degree to which it was able to grow and become sustainable: "It's nudging up because, see, I think the thing is now that everyone throughout

our service, whether it's the allied health staff, or whether it's the nursing staff, or whatever, are telehealth doing something, they're enthusiastic about use." We therefore argue that champions are important for initiation, but clinician acceptance is necessary for continuation.

We have previously argued that champions are effective because they *legitimized* telehealth and *built relationships* between providers (Author, in press), and we now propose that these strategies (detailed below) work by supporting clinician acceptance, as shown in Figure 1.

Legitimation. We characterize legitimation as the process of promoting a set of beliefs about telehealth to clinicians that enhance clinician acceptance. The three types of beliefs and the associated actions taken by champions are: 1. Telehealth is effective; involving interpretation and dissemination of research findings about the accuracy and clinical outcomes of telehealth. 2. Telehealth is safe; giving examples of how clinical and medico-legal risk can be managed. 3. Telehealth is normal; involving the presentation of telehealth as usual care or routine practice. One of the means by which this was achieved was the development of protocols and standards. This presentation of telehealth, however, did not necessarily mean that it had actually become standard or routine practice.

Relationship building. The second function of champions, to build relationships between providers, had the dual result of feeding demand for services as well promoting clinician acceptance. For example, an academic who had set up a telehealth assessment service said: "I think the most important is the relationship that you have with the people at the remote site, and that it's an integral part of their system, that they make referrals." Conversely, relationship problems reportedly impacted negatively on services: a clinician operating a service to rural areas mentioned that: "one of the consistent problems in making the service work is maintaining the cohesion of relationships in the network."

Impact of New Funding Model

All services in the sample had been initiated before July 2011, the date when video consultations in private practice attracted a health insurance rebate in Australia, and following up services after the change offered an additional opportunity to gather data about the relationship between resourcing and clinician acceptance. Seven services were followed up: three of which were not eligible to access the new health insurance rebate were operating under the same constraints as two years previously, and levels of activity remained

unchanged. Considering the other four services, in one a senior clinician reported that a modest increase in activity was related to greater funding:

- *before it was more the altruism I suppose, you felt as though it was a good thing to do, but now you actually get paid quite well for it . . . so add that on top of the feeling as though you're doing some good, and so it's certain, that's the reason why my numbers have built up a bit.*

He also noted that his personal willingness to provide telehealth continued to be important for the sustainability of the service, claiming "if this hospital employs a new staff specialist, it's expected [they are] going to manage the inpatients, and [they are] expected to do outpatients, but there isn't an expectation that 30% of [the] outpatients will be provided by telehealth." He further argued that lack of clinician acceptance remained a limiting factor to expansion: "some clinicians are just straightforward resistant to it, you know, that's not how you practice medicine type thing".

Another service also had a small increase in telehealth activity, and in this case management had changed the job descriptions of their clinicians to make video consultations a compulsory part of their work. This was the only example in the study where this had occurred, and it could be argued that adopting telehealth as a policy or organizational requirement should be a key factor driving uptake, but the interviewee reported that this did not, on its own, increase the uptake from referring sites.

Finally two services had not changed despite the new funding arrangements. In one the clinicians had a very positive attitude to telehealth, and had been claiming insurance rebates for video consultations. They had not increased their activity however, because they saw that the clinical need had not altered. The last service was using store-and-forward telehealth, and staff were considering video consultations, but had not yet commenced.

The overall finding from the follow-up sample was that the increase in resourcing approximately a year prior to the second interviews had not produced a large increase in telehealth activity, and that the presence or absence of clinician acceptance remained an important factor.

Discussion

We propose that the key factor explaining variation in the successful uptake, expansion, and sustainability of telehealth services is clinician acceptance.. It is not the only factor affecting the outcome, with demand, workforce pressure, and availability of resources also influential. We found, however, that clinicians who accepted telehealth would continue to supply it even if demand was very low, the technology was problematic, or there was pressure on clinical workforce, and that they would find resources to operate the service. In a very small minority of cases, characterized by the total absence of demand, or by technology that was below a minimum functional standard, cessation occurred regardless of clinician acceptance.

Within the telehealth literature, clinician acceptance has been identified as problematic. For example, a recent editorial declared that the greatest challenge to the integration of telemedicine into delivery of health care is lack of acceptance by patients and practitioners, noting that the reasons for this phenomenon remain unclear (Merrell & Doarn, 2012). The literature on user acceptance includes a framework proposing conceptual, contextual, utilization and legitimation dimensions (Whitten & Richardson, 2002), a commentary suggesting that nine cognitive-emotional factors contribute to acceptance (Buck, 2009), and one thematic analysis of provider acceptance, which reported themes of turf, ownership, efficacy, practice concept, apprehension and learning time (Campbell, Harris, & Hodge, 2001). None of these publications specifically addressed how clinician acceptance is related to the uptake of telehealth.

Through developing an explanatory model based on grounded theory, we have demonstrated the ways in which clinician acceptance promotes telehealth, and justified its degree of influence. Our model is an intentional simplification of a complex environment, because we aimed to construct an explanation of what element in this complex environment has most influence, rather than to build a comprehensive, multi-factor theory of innovation in health care services. Many such theories exist already, but few address the relative importance of each of their components. In considering how extant theories relate to our findings, we exclude those that outline and describe which dimensions should be included in a theory, rather than explicating the relationships between these dimensions to produce a coherent narrative. Thus we do not discuss theoretical frameworks, such as the technology, organization and environment framework (Liu, 2011), the framework for designing user-

centered teleconsulting systems (Esser & Goossens, 2009), and frameworks for evaluating telehealth (Bashshur, 2005; J. Grigsby, Brega, & Devore, 2005)..

Robert's review of research into the adoption and assimilation of new technologies into health care categorized the theoretical perspectives used in these studies as either *individualist*, *structuralist* or *processual*, where the individualist theories focused on the agency of champions or entrepreneurs, the structuralist on the characteristics of the organization, and processual on the interaction of individuals and structures (Robert et al., 2010). We extend this typology and group the theories into four categories, on a continuum from relatively straightforward to more complex, focusing on 1) individual agents, 2) the individual/technology relationship, 3) the processes, and 4) the whole system, additionally considering how clinician acceptance relates to each of these.

The most commonly used individualistic theory is *diffusion of innovation* (Estabrooks et al., 2008); it encompasses qualities of the innovation and the environmental context, although the individuals who chose whether or not to adopt an innovation remain central (Rogers, 2003). Other individualistic theories which have been applied to telehealth are the *knowledge barrier perspective* (Tanriverdi & Iacono, 1999), in which the lack of technical, economic, organizational and behavioral knowledge is said to be the main inhibitor of uptake, and the *Technology Acceptance Model* (Orruno, Gagnon, Asua, & Abdeljelil, 2011) in which the expectations and attitudes of potential users are regarded as predictors of behavior. Robert et al. (Robert et al., 2010) noted that individualistic theories have a greater focus on early adoption of innovation, and less on later routinization. Our model is individualist, and we add to these theories by showing that individual clinician acceptance is additionally important for the expansion and sustainability of telehealth services.

Theories about the relationship between individuals and technology regard usability as the critical success factor in health technology implementation (Kay, 2005). For example, the *human factors approach* (Salvemini, 1999) and the *sociotechnical model* (Sittig & Ash, 2011) both deal with the user-technology interface, and recommend involving users in system design and testing. By contrast, our work does not support usability as the key factor, showing that sub-optimal technology will be used by clinicians for long periods of time, provided they accept this method of delivery.

Several types of theories focus on processes. For example, life cycle theories suggest that different processes are important at different stages of technology implementation.

Broens' *layered implementation model of telehealth* proposes that technology is most important in the prototype phase; acceptance in the pilot phase; and, organization, finance, policy and legislation in the later phases (Broens et al., 2007). Chiu also developed a *lifecycle model of e-health uptake* with acceptance being most important at the initiation stage, progressing to perceived burden of use at the later outcome stage (Chiu & Eysenbach, 2010). Our model emphasizes the continuing importance of clinician acceptance in the later stages of the life cycles.

A further process theory, *disruptive innovation,* focuses on innovations that produce fundamental changes in the market, and are therefore resisted more strenuously than incremental innovations (Schulman, Vidal, & Ackerly, 2009). Malik (Malik, 2003) showed how telehealth is a disruptive innovation which alters organizational structure and dynamics, states that key users, particularly physicians, are wary of adoption.

Normalization Process Theory (NPT) specifically addresses how innovations become routine operations (C. May, 2006). The theory identifies four generative mechanisms for creating normalization, of which three (coherence, cognitive participation and reflexive monitoring) are actions undertaken by clinicians and are directly related to the legitimation of telehealth which we suggest promotes acceptance. The fourth generative mechanism of collective action (concerned with organizing and enacting processes) was considered within our analysis, yet did not emerge as a key factor. This might be because NPT was derived within the British health system in which collective action informs whole of system structure, whereas in Australia there is no single national system but rather a mixed public/private set of systems, with the new payment for telehealth assigned to the individual clinician. Additionally, most telehealth services in our sample had not yet achieved normalization, even those that had become sustainable. Therefore, although our model is compatible with NPT, we take a different approach, in part because of the different environment within which the models were developed.

Finally, whole-of-system theories are concerned with multiple types and levels of concepts as well as the relationships between these. *Complexity theory* (Plsek, 2003) and the *general systems approach* (Coiera, 2011) have been used to explain why change in health systems has been so difficult. Lehoux (Lehoux et al., 2002) applied Gidden's *structuration theory* to telehealth suggesting that the theory of use behind telehealth requires but cannot sustain a full restructuring of work practices, nor can it resolve issues of clinical need, trust,

and relationships. We suggest that these issues can be regarded as components of clinician acceptance in that clinicians moderate need, establishing or building upon trust and relationships in their telehealth practice. Bareiss (Bareiss, 2001) utilized *critical theory* in a case study of telehealth, across social, industrial and ideological contexts, and concluded that telehealth maintained unequal distribution of power by centralizing expertise and moving resources from rural to urban areas. The threat of this occurring was important to some rural providers in our sample, but as a relatively minor theme, it did not earn its way into our final model.

Generalizability

Telehealth in Australia is dominated by real time video consultations to rural areas, and until recently most telehealth activity occurred in government-run services (Author, in press). There are many telehealth services in similar settings in the USA and Canada to which this model could apply. We suggest that clinician acceptance might also be central in other attempts to introduce technological innovations into health care. For example, mixed-methods research on the large scale implementation of summary electronic care records in the United Kingdom found that the main determinant of whether or not these were used was the preference of the individual clinician (Greenhalgh et al., 2010).

Study Limitations and Future Research

A deeper understanding of each service would have been achieved by interviewing more than one person per service, and by including other data such as documents and reports. Substantial changes to telehealth services resourcing occurred midway through the study and although we did some follow up interviews, this was limited as data gathering ceased for pragmatic reasons. The relationship between resourcing and clinician acceptance could have also been explored by sampling new services that had commenced after the changes to insurance rebates, but we did not include these because none had been operating long enough to assess their uptake or sustainability.

Given the changes to Australian funding arrangements for telehealth, further research including a longitudinal study of a larger number of services will provide an opportunity to see if our model has continued relevance in this new environment. If telehealth becomes

ubiquitous it is possible that health care services could require that clinicians include telehealth in their practice, thus reducing the importance of clinician acceptance.

Conclusions

We have developed a model of the uptake and sustainability of telehealth services in which clinician acceptance is the concept with the greatest amount of influence; we conclude that this provides practical guidance for those implementing telehealth in settings where service delivery by telehealth is optional. This model could be superseded if the health care system makes a total transition to telehealth delivery, but despite predictions for more than 20 years this has not yet occurred, and there is very limited guidance on what works to promote the adoption of ICT in health care (Gagnon et al., 2009). Other theories in this area include multiple factors that are not weighted and we argue that these approaches may discourage innovation because they convey the impression that change is too large and difficult a job to undertake. In times of financial restriction, change management budgets are typically small or even absent, with health services often expected to produce changes in delivery ‘within existing resources’. Our model provides innovators with guidance on where to focus their energies to achieve this task.

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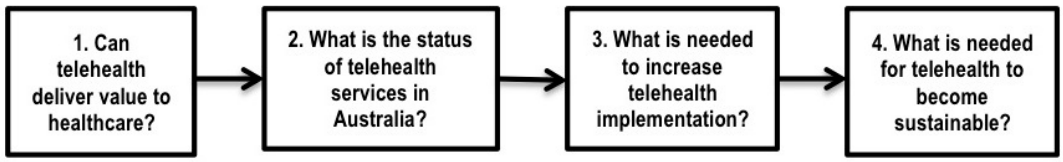
CHAPTER 10 – Discussion and Conclusions

10.1 Introduction

In this final chapter I begin by answering the four specific research questions which form the spine of the work.

Figure 10-1 Logical Structure of Research Questions



I then return to the central research question, in a discussion which summarises the theory development and suggests possibilities for its extension:

- "What is needed for telehealth to deliver sustainable value to the routine operations of health care in Australia?"

This will lead into describing the limitations of the research program, the future developments of telehealth, and the implications of this research for further research and for telehealth practice.

10.2 The Four Specific Research Questions

10.2.1 Can telehealth deliver value to health care?

This question was addressed by selecting four ways to measure the value of telehealth services: patient outcomes, economic outcomes, access to health care and the acceptability of telehealth services. With regards to the first, a focused review of reviews showed that telehealth is able to substitute for in-person care in certain areas, and can add new models of care that deliver improved patient outcomes, such as telemonitoring for chronic disease management. For the remaining three outcomes, cost-effectiveness is also variable and situation-specific, there is a small amount of research indicating increased access to care, patient acceptability is very high, and provider acceptability is moderate. Because telehealth is a complex intervention, the results vary across particular circumstances and the intervention needs to be tailored to local conditions.

Several caveats lurk behind these broad conclusions. For patient outcomes there is much poorly designed research with small numbers of patients, and few high quality RCTs and meta-analyses. The process of conducting a systematic review of economic analyses in Chapter 3 revealed many inadequate cost-comparison studies and incomplete economic analyses. The sheer diversity of telehealth is challenging for researchers; as a method of delivery rather than a standardised intervention, it has been designed or adapted for multiple health and societal circumstances. This makes it difficult to generalise across environments. Indeed, my systematic review of economic analyses concluded that cost-effectiveness varied according to the organisational model of care. Such variability means that each aspect of health care that is changed by telehealth needs to have its own research or evaluation done to determine its effects. Furthermore, looking for comparisons between telehealth and usual care often reveals that the relevant research and evaluation has not been done on the associated traditional aspects of health services delivery.

I then turn from the broad to the particular, making an original contribution to the telehealth body of knowledge by researching one telehealth service. The specific area, home video observation of patients receiving medication for tuberculosis, was chosen because of my close association with the development of that service and because there was little research in the area; I have declared my conflict of interest in the preface, and reflected on potential bias in the grounded theory article in Chapter 9. The publication of my mixed-methods evaluation of the direct observation service is contained in Chapter 5, and shows that the use of home videophones reduced missed observations and was cost-effective. I then constructed an economic model to enable the findings to be applied to other health service environments, which showed that scaling up such a service would lead to increased cost-effectiveness.

10.2.2 What is the status of telehealth services in Australia?

The second research question is answered in Chapter 7 with examination of data from the Telehealth Services Study (TSS), the literature, and Australian government data on health services activity. This revealed that Australian telehealth services were small, narrowly focused, and fragmented.

Unexpectedly, there was a major change to the telehealth environment in July 2011, at the mid-point of my PhD candidature, when Medicare, Australia's universal health

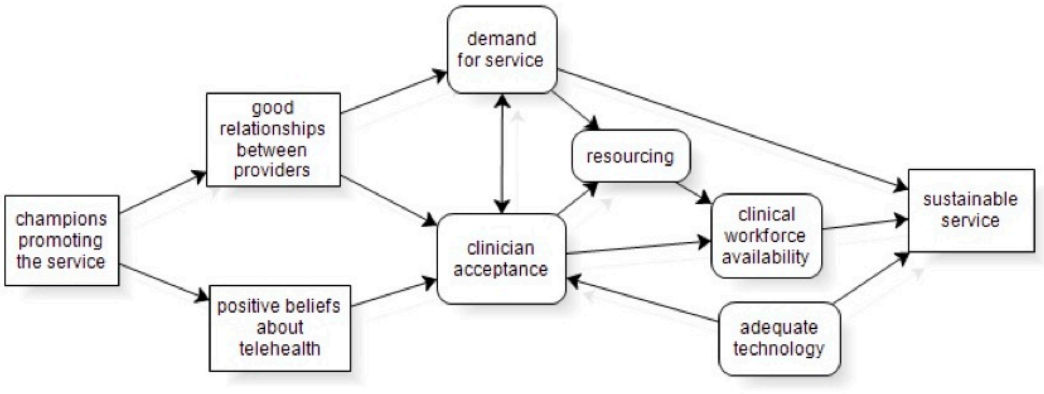
insurance system, introduced rebates for specialist medical practitioners to provide video consultations to patients in rural areas(43). Health professionals and organisations had been lobbying the federal government for telehealth rebates since the 1990s(32), with very limited success. The change occurred suddenly, arguably for reasons of political expediency(41), and provided a natural experiment on the effect of changing funding models on the implementation of telehealth.

Whilst I did not have the time and resources to make the most of this natural experiment, I was able to gather some follow up data, which showed little change to the telehealth services in the TSS sample in the short term. Most of these services, however, were operating within state government Departments of Health, whereas the new financial arrangements supported video consulting by private medical specialists. It is obvious that Medicare rebates have increased uptake; as described in Chapter 7, in 21 months nearly 50,000 video consultations have been conducted in the private sector, and many individual medical practitioners have tried telehealth. Yet, as of March 2013, the numbers of consultations on a national scale were very low, being 0.1% of total comparable services. It was not possible to include these new services in the study, but industry commentators have noted they are low volume and limited scope (326).

10.2.3 What is needed to increase telehealth uptake?

The main intention of the TSS was to conduct a qualitative interview study to develop a model of how telehealth is sustainably implemented in Australia. This model, described in detail in Chapter 9, is reproduced here:

Figure 10-2 Model of Sustainability in Telehealth Services



Beginning with the initiation and uptake of the services, in the first publication in Chapter 8 I describe how the key factor is individual champions. Most of the services in the TSS were commenced by champions, rather than through broader policy, needs assessment, nor service development activities. This is one explanation for the fragmentation of telehealth, because individuals have harnessed their own experience and expertise to set up services which reflect their particular interests. Therefore the type of telehealth currently offered in each area varies according to these historical factors; for example if one looks at long lasting and highly developed services, South Australia has a telepsychiatry service(327), Queensland a telepaediatrics service(35) and Western Australia a tele-ophthalmology service(328), each of which was pioneered by enthusiastic individuals.

The model also shows how champions drive uptake, by the two main methods of a) building relationships and b) promoting positive beliefs about telehealth, namely, that telehealth is an effective, safe and normal means of providing health care. Effectiveness is promoted by disseminating the research evidence in telehealth, whereas the beliefs about safety and normality concern the ethico-legal dimensions of service delivery. These are explored in the second publication of Chapter 8, which shows that the TSS interviewees did perceive issues of privacy, security, informed consent, and quality of care, but that they had been readily addressed in practice.

10.2.4 What is needed for telehealth to become sustainable?

The first publication in Chapter 9 is based on a thematic analysis of the data from the TSS, with the aim to find out how telehealth services could operate sustainably. I identified two operating models: a) fitting a low level of telehealth activity into existing service delivery, and b) reaching sufficient size to justify dedicated staffing and infrastructure. From the thematic analysis in this first piece of work, the factors associated with sustainability were meeting clinical needs, good relationships with referring services, raising awareness of telehealth and succession planning.

The thematic analysis also explored factors associated with vulnerability, noting a group of small scale services that had been initiated and maintained by champions, sometimes for several years. This indicates that champions can enable the longevity of a service, but that this does not equate with my definition of sustainability (as defined on page 119), which is the

ability to continue functioning into the future with no foreseeable threats. Rather, services that are operated solely by a champion and have no succession plan remain vulnerable.

The second publication continued the qualitative analysis using grounded theory methods to build the explanatory model shown in Figure 10.1. This model proposes that whilst champions are the main driver for uptake, clinician acceptance is the key factor in telehealth sustainability. Once clinician acceptance has been built by champions, this acceptance enables the major barriers of workforce pressure, low demand, limited resourcing and technology problems to be overcome. Further research is needed to determine whether or not this model applies to the sustainability of the new telehealth services supported by Medicare rebates. There are early reports that sustainability in this sector is likely to be a problem, with some private medical practitioners conducting a small number of video consultations then ceasing(329).

10.3 Discussion of the Theoretical Model

The central research question, "What is needed for telehealth to deliver sustainable value to the routine operations of health care in Australia?", is answered by the development of the model setting out the key enabling factors, as shown in **Figure 10-1.** This model is a *substantive grounded theory*, that is, it concerns a particular phenomenon in its time and place(330). I will now discuss how the model relates to the broader literature, reflect on the findings, and propose further developments to the theory. This iterative approach is pivotal to theory development in grounded theory practice.

In the grounded theory article, I show how the model is compatible with most other theories, such as diffusion of innovation, normalisation process theory, and systems theories, but does not support the sociotechnical theories which concern the relationship between people and technology. These latter theories give a high priority to usability and ease of use, but my analysis indicated that if there was clinician acceptance, substantial technology problems could be overcome. This is evident from both the Telehealth Services Study, and the qualitative component of the home telehealth study in Chapter 5.

By constructing a model which highlights the key factors, I have taken a different approach from the usual method of investigation. Had I addressed the typical question in this field of research, namely "What are the barriers and enablers to the implementation of

telehealth?", I would likely have produced a list of factors resembling those assembled in Chapter 6. To recap, these were workable technology, funding, ethico-legal issues, management and political support, organisational processes and organisational relationships. These factors have face validity; they appear plausible, yet during my professional activities I had observed that the apparently default approach to health system change management, of committing large amounts of time and money to managing several identifiable factors simultaneously, was not necessarily effective at producing change. Notable examples of this phenomenon in the literature are the Whole System Demonstrator trial of home telehealth(294), and the Summary Care Record project to introduce shareable electronic health records(331). In both these cases the National Health Service in the UK mounted large-scale change management projects which faced very substantial delays and difficulties in achieving their objectives. From considering these issues, I conclude that a model of the key enabling factors is a useful addition to the field, particularly as it could assist innovators in deciding where to focus their change management efforts. Reflecting on this explanatory model, I had not anticipated that the key factor was clinician acceptance. My previous experience in large scale health system development had predisposed me to think that organisational factors would be most important. There is much in the existing theoretical literature to support this view, and many interview participants also spoke about organisational factors at length. At this point I was left with an apparent paradox: that in such a large and complex entity as the health care system, one so demonstrably difficult to change, I found the key enablers to come from individual effort. This was both in the actions of champions to create new services, and in clinician acceptance driving sustainability. To grapple with this paradox, I revisited the empirical and theoretical literature, as set out in Chapter 6.

Returning briefly to the barriers and enablers approach, enabling factors are usually constructed as opposites to the barriers, or represented as the same concepts on continua. Accordingly, if senior management support is an enabler, lack of senior management support is a barrier, if usable technology is an enabler, then technical problems are a barrier, and so forth. By taking a different direction of identifying the key enabling factors, and seeking to place these within an explanatory model, the possibility then arises that the key barriers and key enablers may be quite different entities within different models.

After considering the other theories relevant to the area, namely, general systems theory, organisational change theories, complexity theory, and normalisation process theory, I now hypothesise that the key barriers might be organisational and systemic. If this is the case, then the agency of particular individuals creates new structures and processes, whereas organisational factors function to resist change.

There is some support for this in the literature. Coeira has suggested that system inertia is the primary reason for the difficulties in implementing e-health to improve care(298), further observing that the current health care system was not actually planned or constructed in a top-down, managerial sense, such that introducing e-health is "trying to re-engineer a system that was never consciously engineered in the first place"(332). Institutional inertia is a well developed topic in the organisational literature(333), but has been little applied to health care.

Additional avenues to pursue include Dopson's work on the role of context in understanding change and innovation in health care services, which argued that identifying a list of factors does not enable one to predict change. Instead, Dopson demonstrated how these factors may form into different combinations and be of different influence in particular contexts(334).

Having now both a theory of the key enabling factors and a hypothesis about the key resisting factor, the next stage in grounded theory methodology would be to return to the field using theoretical sampling to gather more data. The ways in which this could be accomplished will now be considered.

10.4 Future Research on the Theoretical Model

The immediate and specific next steps I could undertake to further develop the grounded theory are:

First, reanalyse the TSS interview data by asking the negative question "What are the main barriers to the uptake and sustainability of telehealth services?". This would look at the sample of failed and vulnerable services in more detail, with the intention of developing a companion model to the key enablers.

Second, seek more data from additional telehealth services chosen using theoretical sampling. In particular, I would select a variety of services that failed to become sustainable,

and also seek examples which might contradict the developing theory, such as where organisational factors appeared to be enabling.

Third, at the time of writing, my current employment involves leading a project which aims to build a telehealth service, create and deliver education about telehealth, and promote the uptake of telehealth. This plus my other previous telehealth research and practice has been in the background throughout this thesis, and has informed my thinking, but not been incorporated systematically into the research. It would be possible to bring these experiences into an ongoing research program using an action research framework. This would enable researcher insights to contribute to theory development.

Fourth, follow up the current or expanded sample of telehealth services over time to produce a set of longitudinal case studies, in which the influences on the change of status of these services might be seen more clearly. One of the issues to be explored would be whether or not the key factor continues to be clinician acceptance, or if other factors come into play should telehealth gain a firmer foothold in health services delivery.

Taking a broader view, this work could be expanded with the aim of developing a more extensive theory that is applicable to the whole set of complex innovations in health care, of which telehealth is just one example. This would begin the development of a *formal grounded theory* which is more abstract and generalizable than a substantive theory. To achieve this, one might begin by investigating the implementation of telehealth in health care systems outside Australia. Most value would be gained by seeking an intentionally diverse sample; for example by including a planned system where telehealth is more fully developed, such as Canada, Norway or Finland, and also an unplanned system in a developing country, such as India. One could then add three wider comparisons, each of which would contribute to theory development:

a) between telehealth and other forms of e-health implementation, such as electronic health records or decision support systems
b) between telehealth and other complex innovations in health care, such as care planning or coordinated care systems
c) between telehealth and the implementation of IT in fields outside health.

10.5 Limitations of the Research Program

The research program consisted of three distinct projects:

1. A systematic review
2. A mixed-methods evaluation
3. A qualitative interview study of telehealth services (the TSS)

Each project had its own limitations which are addressed in the published chapters. This section comments on the limitations of the research program and thesis as a whole. The main issues are:

i) Scope of the Thesis

Telehealth is applicable to so many aspects of health care delivery that any individual attempting a research program on the question "What is needed for telehealth to deliver value to the routine operations of health care in Australia?" can only investigate a small part of the field. I began, however, with a broad approach to the evidence in Chapter 2, which gives an assessment of the overall value of telehealth. Following a middle section that contains a focused systematic review and a detailed evaluation of a functioning service, I then returned to telehealth services throughout Australia. It was not possible to cover all services, nonetheless, I selected my interview sample for maximum diversity and continued to data saturation, which I defined as the point when two consecutive interviews produced no new concepts in the initial open coding analysis. I acknowledge that further interviews may have produced new concepts, although conducting a second round of interviews two years later did not do so. I would contend, therefore, that the field was well covered by my sampling, and that the theory was developed from source materials of adequate size and diversity. Ways in which the scope of the work can be broadened to construct a more generalisable theory have been discussed above.

ii) Timeliness of the Thesis

This thesis was commenced at a time when telehealth in Australia had been essentially in stasis for over a decade. Between the late 1990s and 2008, the model of delivery had changed very little: almost all services were provided by State governments, and there was a small but steady flow of projects, some of which survived to become ongoing services. A few long lived telehealth services had existed in the same form for many years, undergoing

a slow increase in activity, and a group of hopeful champions still believed that the expansion of telehealth was just around the corner. During the five years of my doctoral candidacy, the field changed rapidly on several fronts:

- New technologies appeared in quick succession, such as social media, mobile health applications, and inexpensive compact devices for home monitoring.
- Telecommunications improved for both fixed-line and mobile connectivity. Simultaneously, the cost of bandwidth and data transfer dropped, enabling many types of telehealth that were previously impractical to flourish.
- Government policy changed dramatically, and funding for telehealth increased halfway through this research, with the introduction of the Medicare rebates for video consultations in the private sector. This then changed again as these rebates were restricted to rural areas only, just before completion of the research.

Clearly the timelines inherent in any doctoral thesis dictate that data collection must eventually cease. Although I was able to conduct follow-up interviews with seven services, which revealed little alteration pre and post the changes in the Medicare rebates, a specific focus on new services that commenced since July 2011, plus longer term follow up would be a very useful addition to the data.

iii) Integration of the Thesis

Having not set limits in the initial phase of this work, I gathered a large and diverse amount of data, and it was then challenging to bring this together. Theory development in health services research is a complicated and multifactorial undertaking. The process of induction, in which the area to be studied is not totally defined before research commences, means that the investigator should cast a broad net, and not narrow the scope prematurely, in order to avoid being restricted to a limited set of ideas in theory construction. The means I used to achieve an integration was by linking all the different aspects of the thesis to the four sequential research questions.

10.6 Future Directions

10.6.1 Current Trends and the Future of Telehealth in Australia

In 1998, Mitchell commented that telehealth in Australia was fragmented and immature, but that it was on the cusp of large scale expansion(15). Arguably, 15 years later, little has changed, prompting the question: is the long, slow struggle to introduce telehealth finally about to coalesce into a major method of delivery which is part of normal health care? Certainly, recent policy and reimbursement changes have supported video consulting to rural areas, and enabled multiple small telehealth services to commence in the private sector. There is a difference, however, between individual telehealth services and a telehealth system; continuing fragmentation and lack of a national plan have been noted(326).

I suggest that there are two main reasons for this lack of integration. First, each telehealth service has needed to develop its own infrastructure, both technical and administrative, and therefore there are limited opportunities to achieve economies of scale. As a point of analogy, it is as if we had never developed the Public Switched Telephone Network, but kept using independent telephone exchanges and lines for different purposes. Will the implementation of the fibreoptic National Broadband Network in Australia solve the problem? At the time of writing, in mid-2013, this has made little practical impact on telehealth, first because the areas of actual installation are small and scattered, and second because implementing a high quality communications network is a very different task to initiating a telehealth service.

Second, as I have discussed previously, the fragmentation of telehealth services is a reflection of the fragmentation of most other forms of health service delivery. I consider that as long as we are unable to construct an agreed way for a patient to receive integrated care from many different health services, implementing telehealth will continue to be difficult. Where telehealth services have been set up, however, they can contribute to service integration by improving communication between services; this phenomenon occurred, for example, in the mixed methods case study presented in Chapter 5. In regard to the theoretical model, one of the important functions of champions is to encourage clinician acceptance by building relationships between clinicians.

I have demonstrated in this thesis that we are not currently at the stage of large scale integrated telehealth services in Australia. Worldwide, there is still only one example of a

very large scale, multi-purpose, integrated telehealth system, operated by the Veterans Health Administration in the United States(196). In Australia, trials of telehealth to the home are underway(323), which have the potential to reach a much larger scale than video consultations to rural areas, but as yet these remain as isolated projects. For the future, commentators predict that the concept of telehealth as a separate field will disappear when service delivery by telehealth becomes commonplace and ubiquitous(335). This has already happened in radiology, where the use of picture archiving and communication systems used to be called teleradiology, but now constitutes business as usual. For the rest of health care, telehealth remains a distinct area of endeavour, and the findings presented here indicate that in Australia we still have a distance to travel before telehealth is fully absorbed into routine service delivery.

10.6.2 Recommendations for Telehealth Research

Many have said that more and better research in telehealth is required(178, 186, 336). As well as the steps discussed in section 10.4 to continue the development of the grounded theory, some additional areas for further research that build on this thesis are as follows:

Two further literature reviews could be prepared for publication. The narrative review of the value of telehealth in Chapter 2 could be converted into a systematic review of reviews, and the literature review in Chapter 6 on the uptake and sustainability of telehealth covers an area that, as far as I am aware, has not been published as a review article, and should therefore be revised with a view to publication.

An important area that is under-researched is the impact of telehealth on the whole health system. Current research in telehealth is limited because it almost exclusively studies small scale and highly specific interventions, and claims that telehealth will produce profound changes to the total system of health care have not yet been substantiated. For example, in most health care systems, we lack information about how many telehealth services exist or the types of activities being undertaken. We also do not know the optimal proportion of health care services that could or should be delivered by telehealth, or in other words, how telehealth best fits within the whole health care system. Even as large a study as the Whole System Demonstrator trial of home telehealth for chronic conditions was conducted without any substantial integration with existing health care services(294). Hence the very important

question – what effect would the wide-scale and integrated uptake of telehealth have on the overall patient outcomes, costs, structure and function of the health system? – has not been addressed.

In regard to the methodology of future research, the distinction made in the discussion section of Chapter 2 between substitutive and additive telehealth could be expanded and used as the basis for a paper about choosing comparators and outcome measures in the evaluation of telehealth services. This may be helpful for those investigating the value of individual services but methodological issues remain when investigating organisational and system impacts. Greenhalgh commented that experimental science is ill-suited to the evaluation of e-health programs where there are multiple interacting variables that change over time(337), and hence it may be difficult to adhere to the usual hierarchy of evidence. Jones cautions that the health care system has not yet been properly re-engineered to use e-health, and that conducting research on rudimentary or inadequately developed systems will not give us the answers we are seeking(311).

As do others (24), I suggest that in this unstable, rapidly changing and unpredictable environment there will continue to be a need for high quality research, both quantitative and qualitative. Quantitative health systems research could usefully investigate the important but under-researched issues of measuring the impact of telehealth on access to care, health workforce distribution, and organisational outcomes. In the qualitative arena, research should be focused on further exploration of how complex interventions are implemented and interact with existing services, to improve our ability to select and introduce innovations that will actually deliver value to health care(338).

10.6.3 Recommendations for Practice

The telehealth literature contains many lists of recommendations and discussions of implications for practice, often based on a list of barriers and enablers, or an evaluation framework. Some have suggested that the main issue is improving the evidence base for telehealth(186, 336), whilst others have collectively recommended that telehealth implementation would be promoted by conducting needs analyses, developing strategic and business plans, developing policies and standards, broadening funding and provider

reimbursement, creating user acceptance, training health care professionals in telehealth, and building robust and interoperable technical systems(183, 185, 264, 291, 339, 340).

Few would disagree with this list of recommendations, but I argue for a more parsimonious set. Based on the analyses presented and discussed above, I recommend that, in the current Australian environment, those responsible for health services policy or decision making could optimally encourage the implementation of telehealth in the following ways:

i) Identifying and supporting individual champions – or at the least, standing out of their way. Champions are often resilient but can be crushed by years of blocking and obfuscation. Sometimes their individual enthusiasms will not be compatible with the broader organisational and systemic requirements. In such cases, I recommend working with the champions to tailor their intentions to fit with the larger system, in the spirit of wanting to make the innovations work.

ii) Cultivating acceptance from the majority of clinicians. This involves two main actions; first, providing information about ethical and medico-legal concerns with practical methods for addressing these matters, and second, disseminating evidence that new forms of telehealth practice are safe and effective.

iii) Building relationships among services and among clinicians. This is especially important in telehealth because new services cannot be implemented in isolation; they can only exist in the context of relationships among services and clinicians. Efficiencies in change management can be achieved by recruiting the same champions that are relied on for initiating innovation to act as opinion leaders for steps ii) and iii).

iv) Allowing flexibility and situational responsiveness in implementation. For wide scale uptake one should not expect all areas of the system to develop at the same rate or to adopt the innovation in the same way. Setting guiding principles and supporting steps i), ii), and iii) is likely to be more effective and less painful than attempting to micro-manage every step of the change in advance.

10.7 Conclusions

In conclusion, this thesis has demonstrated the following points:

i) Telehealth is capable of delivering value to health care. Previous research showed clinical benefit in selected areas of patient care, such as mental health services and heart

failure. Much telehealth research, however, is of low quality and substantial gaps in the literature remain. Moreover, telehealth is a complex intervention which must be adapted to local circumstances. The findings from my systematic review of economic analyses confirm this point by indicating that the economic value of telehealth depends upon the model of care within which telehealth is implemented.

ii) In one particular clinical area, I have shown that telehealth can deliver clinical and economic value to the treatment of tuberculosis, by enabling direct observation of medication ingestion with home videophones.

iii) Telehealth in Australia is small scale and fragmented, and the introduction, two years ago, of national health insurance funding for video consultations in the private sector has led to some increase in activity, but has not yet altered the fundamentals of this situation.

iv) I have developed a theoretical model of the uptake and sustainability of telehealth services which, very briefly summarised, establishes that champions initiate telehealth services, and wider clinician acceptance is the key factor enabling these services to achieve sustainability. I have built on this model by proposing that organisational factors are the main source of resistance to change, and gone on to suggest a future research program to investigate this hypothesis.

v) To enable telehealth to make an increased contribution to an effective and efficient publicly funded health care system, telehealth champions should be supported to fulfil their roles of engaging and building relationships between clinicians.

Applying the above theoretical model and set of recommendations will, I suggest, be the most successful means of enabling telehealth to finally deliver its potential value to health care. This approach, of taking a complex environment and extracting the key factors needed for change, is based soundly on theory and practice, as well as being realistic to conduct. Whilst designed for the implementation of telehealth services, the model is also relevant and broadly applicable to the introduction of other complex innovations in health care. There is a continuing need for the health care system to change and adapt, and this thesis sets out a clear direction for advancing this process.

APPENDIX A - Reviews meeting the inclusion criteria for the review of reviews

APPENDIX A: Reviews meeting the inclusion criteria.

Note: each study is tabulated once only, in the category within which it is first mentioned in the text.

Author	Scope of Review	Measures	Summary of Results	Source
Section 3.3.1 General reviews of telehealth				
Martin-Khan 2011(86)	video consultations for medical specialist diagnosis	clinical	diagnosis reliable dermatology, psychiatry, geriatrics, minor injuries, neurology, rheumatology	MedLine
Hill 2010(289)	all types telehealth for veterans	clinical, organisational	effective for chronic disease management, increased access to care	MedLine
Krishna 2009(88)	mobile phones all types health care	clinical, utilisation	improvements in several areas, better attendance, increased access to care	MedLine
Deshpande 2008(87)	asynchronous telehealth all conditions	clinical, economic, social	diagnostic accuracy, better access, but study quality was low, and small scale	Ekeland
Hersh 2006(166)	all types of telehealth and all conditions	clinical, access	diagnosis and management similar to in-person, routine care for psychiatry and home care for chronic disease was effective	Deshpande
Hersh 2006(85)	all types telehealth for people with low socio-economic status	clinical, organisational	benefits of home care in chronic conditions, better communication with providers.	Ekeland
Heinzelmann 2005(84)	all types of telehealth and all conditions	clinical, economic, organisational	great variability, dermatology, ECG and psychiatry were supported	self
Glueckauf 2004(341)	all types telehealth for chronic conditions	clinical	video consulting was equivalent to in-person, internet and automated phone services were effective	self
Hailey 2004(83)	all types of telehealth and all conditions	clinical, economic	benefit from geriatric care and home care, some cost saving	Deshpande
Hailey 2002(342)	all types of telehealth and all conditions	clinical, economic	benefit from home care, mental health, echocardiography, dermatology	Deshpande
Hersh 2002(343)	all types telehealth for diagnosis and management decisions	clinical	most evidence for psychiatry and dermatology	Deshpande
Roine 2001(344)	all types of telehealth and all conditions	clinical, economic	effective for radiology, neurosurgery, psychiatry, echocardiography, and video consultations from primary to secondary care	Deshpande
Hersh 2001(345)	home and hospital, all conditions	clinical	benefits for home care in chronic disease (except diabetes), hospital benefit ER, surgical & neonatal ICU	Deshpande
Currell 2000(346)	all types of telehealth and all conditions	clinical	Cochrane review: feasible, little evidence of benefit	Deshpande
Section 3.3.2 Mental Health				
Backhaus 2012(98)	video consulting psychotherapy, almost all CBT	clinical	similar outcomes to in-person care	MedLine
Slone 2012(99)	telepsychology, child and adolescent	clinical	encouraging for video, internet and telephone	self
Young 2012(347)	interventions for substance misuse	clinical	most studies supported the interventions, challenges in sustaining participation	MedLine
Sharp 2011(164)	video consulting psychotic patients	clinical	equivalent to in-person, well accepted by psychotic patients	self
Sloan 2011(97)	telehealth treatment of PTSD symptoms	clinical, meta-analysis	significant improvement in on symptoms compared to wait list controls	self
Steel 2011(348)	video consulting rehabilitation for chronic conditions	clinical	similar outcomes to in-person care	MedLine
Diamond	behavioural assessment,	clinical	poor quality research, approach seems	MedLine

2010(96)	children and adolescents		feasible	
Garcia-Lizana 2010(349)	telehealth treatment of depression	clinical	video consulting is equivalent to in-person care and internet programs can improve symptoms, more research needed	MedLine
Luxton 2010(163)	telehealth mental health safety	safety	descriptive of incidents and safety plans	MedLine
Richardson 2009(94)	video consulting mental health	clinical	equivalent to in-person but research limited	self
Bee 2008(81)	remote psychotherapy for anxiety and depression	clinical	has potential but needs large scale trials	Ekeland
Hailey 2008(350)	tele-mental health generally	clinical	evidence of benefit in child psychiatry, depression, dementia, suicide prevention, PTSD, panic disorders, substance misuse and eating disorders. Less for OCD. Half of the studies were high quality	self
Powers 2008(351)	virtual reality exposure for anxiety especially phobias	clinical	slightly more effective than in-vivo gold standard	Ekeland
Norman 2006(93)	video consulting for mental health in UK	clinical, economic	effective to enhance mental health services, rural areas	self
Hyler 2005(95)	psychiatry assessment	clinical, meta-analysis	as accurate as in-person	Deshpande
Hilty 2004(90)	psychiatry	clinical, educational, economic	diagnostic reliability excellent, may improve patient outcomes, suggest less hospital admissions	Deshpande
Pesaama 2004(170)	video psychiatry, child & adolescent	clinical, satisfaction, economic	high satisfaction, estimated to save time and money	Deshpande
Monnier 2003(91)	psychiatry	clinical	effective for depression, high satisfaction	Deshpande
Hilty 2002(89)	psychiatry	clinical, educational	can be used successfully for clinical and educational purposes	Deshpande
Section 3.3.3 Home Care				
Wootten 2012(101)	telehealth chronic conditions	clinical	of 141 RCTs most positive, but short term, little economic analysis, conclusion that the overall evidence base is weak	MedLine
van den Berg 2012(109)	home telehealth for older persons	clinical, economic	mostly positive results for medical, behavioural and economic outcomes	self
McLean 2011(70)	telehealth for chronic conditions	clinical, utilisation	can reduce admissions without increasing mortality	MedLine
Pare 2010(104)	home telemonitoring for chronic conditions	clinical	effective in hypertension, trend in diabetes and asthma, heart failure not conclusive	MedLine
Gaikwad 2009(108)	home ICT interventions chronic conditions	clinical, economic	improve function and cognition, reduce cost, but evidence not robust	Ekeland
Polisena 2009b	home telehealth for chronic conditions	economic	cost-saving in most studies but quality of studies low	Ekeland
Rosser 2009(352)	technology for behaviour change in chronic illness	behavioural, process	high participant attrition, variable interventions	MedLine
Botsis 2008(106)	home telehealth elderly chronic disease	clinical, utilisation, qualitative	reported cost reduction, mostly satisfied	self
DelliFraine 2008(100)	home telehealth all types	clinical, meta-analysis	total effect size moderately positive	self
Demiris 2008(353)	smart homes for elderly & disabled	clinical	feasible but lack of evidence on outcomes	Ekeland
Tran 2008(105)	home telehealth for chronic conditions	clinical, economic	effective, need more research, economic studies low quality	Ekeland
Barlow 2007(354)	home telehealth for chronic conditions in the elderly	clinical, economic, organisational	automated vital signs monitoring effective in reducing health service use, cost-effectiveness not clear	Ekeland
Garcia-Lizana 2007(103)	all types telehealth for chronic conditions to home	clinical	cardiovascular was effective, others no clinical outcome improvements, benefits limited	Ekeland
Pare	home telemonitoring,	clinical,	effective for chest conditions, diabetes,	Ekeland

2007(102)	chronic conditions	economic	HT, limited effect heart disease, less hospital admissions, no economic conclusion	
Bensink 2006(107)	home telehealth all types	clinical	effective in diabetes, mental health, heart failure, pregnancy monitoring	self
Murray 2005(110)	interactive communication chronic conditions	clinical	improved outcomes, knowledge, social support, self-efficacy	Ekeland
Section 3.3.4 Cardiovascular Conditions a) Heart Failure				
Radhakrishnan 2012(355)	telehealth self-care heart failure	clinical	effective in promoting self-care in half of included studies	MedLine
Clarke 2011(113)	telemonitoring heart failure	clinical, meta-analysis	reduced all cause mortality and CHF hospital admissions	JTT
Inglis 2010(115)	telemonitoring heart failure	clinical, economic, meta-analysis	Cochrane review; reduced mortality and hospital admissions for CHF, improve QoL, reduced costs	MedLine
Polisena 2010(356)	home helehealth heart failure	clinical	reduced mortality, less hospitalisation, less service use	MedLine
Ciere 2010(357)	mediating role knowledge, self-efficacy, telehealth heart failure	impact of mediating factors in the patient	failed to replicate previously established relationships	JTT
Dang 2009(114)	telemonitoring heart failure	clinical, utilisation	reduction in admissions and mortality in RCTs	self
Klersy 2009(116)	telemonitoring heart failure	clinical, meta-analysis	reduced deaths and hospitalisations	MedLine
Maric 2009(358)	telemonitoring heart failure	clinical, economic	trend to improvement, poor quality studies	Ekeland
Chaudhry 2007(111)	telemonitoring heart failure	clinical, economic	some reduced mortality and hosp admissions, intervention costs higher more complex programs	Ekeland
Clark 2007(112)	telemonitoring heart failure	clinical, economic, meta-analysis	less mortality and hospital admissions, increased QoL	Ekeland
Martinez 2006(359)	telemonitoring for heart failure	clinical, economic, utilisation	improved QoL, decreased mortaility and hospital admissions	Ekeland
Louis 2003(360)	telemonitoring for heart failure	clinical, economic	suggest less morbidity, mortality, and hospital admissions	Deshpande
Cardiovascular Conditions b) other conditions				
de Waure 2012(121)	telehealth for acute cardiac events	clinical	telehealth systems reduced mortality, few studies	MedLine
Verberk 2011(120)	telemonitoring for hypertension	clinical	pooled results support telehealth over usual care	MedLine
AbuDagga 2010(118)	telemonitoring for hypertension	clinical	reduction of blood pressure, comparable efficacy to antihypertensive drugs	MedLine
Neubeck 2009(122)	2nd prevention of heart disease	clinical	less mortality, improved risk factors	Ekeland
Jaana 2007(119)	telemonitoring hypertension	clinical, economic	preliminary evidence improved blood pressure control	Ekeland
Diabetes				
Siriwardena 2012(131)	diabetes interventions	clinical	significant metabolic improvement in 44% of studies, promising alternative	JTT
Liang 2011(125)	mobile phone diabetes	clinical, meta-analysis	pooled results show improved glycaemic control and self management	MedLine
Shulman 2010(127)	Type 1 diabetes youth	clinical, economic	no difference HbA1c, QoL or cost	self
Verhoeven 2010(124)	teleconsultation diabetes	clinical, meta-analysis	non-significant reduction in HbA1c, increased contact with providers	MedLine
Costa 2009(361)	IT-based diabetes interventions	clinical	9 of 16 studies found improvement in HbA1c	MedLine
Polisena 2009(123)	home telehealth for diabetes management	clinical, meta-analysis	similar or better than usual care, reduced hospital admissions	Ekeland
Jaana 2007(128)	telemonitoring diabetes	clinical, utilisation	overall positive results for health care utilisation, attitudes and skills	Ekeland
Verhoeven	teleconsultations and	clinical,	no significant benefits	Ekeland

2007(130)	videoconferencing in diabetes	economic		
Jackson 2006(129)	interactive IT for diabetes	clinical, economic	significant impact clinical, behavioural and structural	Ekeland
Farmer 2005(126)	self-monitoring and data transfer diabetes	clinical, economic, organisational	feasible, did not reduce HbA1c compared to usual care, little evidence on costs or organisational change	Ekeland
Respiratory Conditions				
Bolton 2011(137)	telemonitoring COPD	clinical	insufficient evidence of effectiveness, limitations of studies	MedLine
McLean 2011a(134)	telehealth for asthma	clinical, utilisation	Cochrane review; reduced hospital admissions, no change QoL or ED visists	MedLine
McLean 2011b(135)	telehealth COPD	clinical, utilisation	Cochrane review; reduced ED visits, possible improvement in QoL	MedLine
Polisena 2010(136)	home telehealth COPD	clinical, utilisation	telemonitoring reduced hospital bed days and ED visits. Telephone support increased mortality, QoL no change	MedLine
Jaana 2009(133)	telemonitoring respiratory conditions	clinical, economic	clinical promising, little economic data	Ekeland
Bussey-Smith 2007(132)	interactive patient education asthma	clinical, economic	improved knowledge and symptoms, less information on outcomes	Ekeland
Sanders 2006(362)	monitoring, decision support, and education for asthma	clinical	few studies demonstrated improved clinical outcomes	Ekeland
Stroke Acute Treatment				
Johansson 2010(139)	telehealth acute stroke	clinical	increased thrombolysis, more outcome research needed	MedLine
Price 2009(140)	service configuration stroke thombolysis	clinical, organisational	local service configuration provides less thrombolysis than wider collaborations	Ekeland
Deshpande 2008(138)	acute management stroke	economic, organisational	improved access to thrombolysis	Ekeland
Wu 2006(141)	acute telemedicine for stroke	clinical, economic	feasible and reliable for assessment, increased use of thrombolysis	Ekeland
Rehabilitation (physical)				
Hailey 2011(143)	all types telehealth rehabilitation, multiple conditions	clinical	majority of telerehab applications were successful, shows promise, limited evidence of benefit	MedLine
Johansson 2011(363)	telerehabilitation for stroke care	clinical	can improve physical health no evidence for reduced resource use or cost-effectiveness	Medline
Kairy 2009(142)	rehabilitation	clinical, economic, organisational	outcomes improved, some evidence cost savings, healthcare utilisation differences unclear	Ekeland
van Dijk 2004(364)	rehabilitation for motor function	clinical	few studies, evidence limited but promising	self
Oncology and Palliative Care				
Oliver 2012(148)	telehealth in hospice care	clinical	medium strength evidence for use, needs more research	MedLine
Kitamura 2010(146)	videoconsultation in clinical oncology	clinical	feasible & effective small studies limited methodology	self
Kidd 2010(147)	all telehealth palliative care in UK	description of approaches	usable, acceptable in range of settings	MedLine
Hailey 2007(145)	all types telehealth for oncology	clinical, economic	economic analyses showed cost-benefit, clinical service delivery feasible, but not generalisable	Ekeland
Dermatology				
Levin 2009(149)	telehealth dermatology	clinical	reliability and accuracy, diagnosis and management compared to usual care	MedLine
Warshaw 2009(150)	telehealth in dermatology	clinical, economic	concordance and management accuracy equivalent, reduced time to treatment	MedLine
Single Area Reviews				
Antoniou 2012(161)	surgical mentoring laparoscopic	clinical	feasible, no high quality comparisons with in-person mentor	MedLine
Cohen	telehealth for paediatric	clinical	promising especially for rural patients but	self

2012(162)	obesity		limited evidence	
Gardiner 2012(160)	telehealth in plastic surgery	economic, organisational	increased access, reduce costs & unnecessary transfers	MedLine
Hilgart 2012(156)	telehealth in clinical genetic services	clinical	limited evidence, has potential	self
Wallace 2012(153)	telehealth burns care	clinical, economic	5 studies with controls, is feasible, has potential	MedLine
Magann 2011(159)	telehealth in obstetrics	clinical	demonstrated benefits need more research	MedLine
Young 2011a(365)	telehealth in ICU patient outcomes	clinical, meta-analysis	lower mortality and ICU length of stay	self
Boisvert 2010(152)	assessment and treatment, autism spectrum disorders	clinical	promising method of service delivery	MedLine
Swandpoel 2010(366)	telehealth applications audiology	clinical, organisational	equivalence to in-person, feasible	MedLine
Brignell 2007(157)	all types of telehealth geriatric medicine	clinical	variety of types telehealth safe and effective	self
Brebner JA 2006(154)	A&E teleconsultation for primary care	clinical, economic, organisational	most clinically effective, minority cost effective, half assisted local management	self
Access to Care				
Kehle 2011(167)	access to care Veterans	access	all studies positive impact on access, poor to fair quality studies	MedLine
Jennett 2003(165)	all types of telehealth and all conditions	economic, access, social	cardiology and paediatric specialist consults cost saving, improved access for First Nations	Deshpande
Acceptability of Telehealth				
Kraai 2011(171)	telemonitoring heart failure	patient satisfaction	high satisfaction rates, measurement methods poor	MedLine
Young 2011b(173)	telehealth in ICU staff acceptance	staff satisfaction	high levels of staff acceptance	MedLine
Demiris 2004(172)	dermatology	patient satisfaction	generally acceptable, some concerns	Deshpande
Williams 2001(169)	all types of telehealth and all conditions	patient satisfaction	high satisfaction, methodological problems	Deshpande
Mair 2000(168)	all types of telehealth and all conditions	patient satisfaction	high satisfaction, serious flaws in methodology	Deshpande

APPENDIX B – Mixed Methods Case Study Materials

ETHICS APPROVALS

THE UNIVERSITY OF ADELAIDE
AUSTRALIA

RESEARCH BRANCH
RESEARCH ETHICS AND COMPLIANCE UNIT

SABINE SCHREIBER
SECRETARY
HUMAN RESEARCH ETHICS COMMITTEE
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SA 5005
AUSTRALIA
TELEPHONE +61 8 8303 6028
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email: sabine.schreiber@adelaide.edu.au
CRICOS Provider Number 00123M

5 July 2010

Associate Professor JD Karnon
Discipline of Public Heatlh

Dear Associate Professor Karnon

PROJECT NO: *A case study of home medication management by videophone*
H-090-2010

I write to advise you that the Human Research Ethics Committee has approved the above project. Please refer to the enclosed endorsement sheet for further details and conditions that may be applicable to this approval.

Approval is current for one year. The expiry date for this project is: 31 July 2011

Where possible, participants taking part in the study should be given a copy of the Information Sheet and the signed Consent Form to retain.

Please note that any changes to the project which might affect its continued ethical acceptability will invalidate the project's approval. In such cases an amended protocol must be submitted to the Committee for further approval. It is a condition of approval that you immediately report anything which might warrant review of ethical approval including (a) serious or unexpected adverse effects on participants (b) proposed changes in the protocol; and (c) unforeseen events that might affect continued ethical acceptability of the project. It is also a condition of approval that you inform the Committee, giving reasons, if the project is discontinued before the expected date of completion.

A reporting form is available from the Committee's website. This may be used to renew ethical approval or report on project status including completion.

Yours sincerelv

per

Professor Garrett Cullity
Convenor
Human Research Ethics Committee

Government of South Australia
SA Health

Human Research Ethics Committee

ABN 97 643 356 590

Level 10, CitiCentre
11 Hindmarsh Square
Adelaide SA 5000

PO Box 287
Rundle Mall
Adelaide 5000
Telephone (08) 8226 6064
Facsimile (08) 8226 7088

Dr Victoria Wade
The University of Adelaide
Level 3, 122 Frome Street
Mail Drop DX 650 545
ADELAIDE SA 5005

Dear Dr Wade,

Re: A case study of home medication management by videophone.
HREC PROTOCOL NO: 380/06/2013

Thank you for responding to the conditions of approval outlined by the SA Health Human Research Ethics Committee in relation to the above project. Your response was considered out-of-session.

I am pleased to advise that final ethics approval has been granted to your project subject to the following standard conditions:

- The research must be conducted in accordance with the 'National Statement on Ethical Conduct in Human Research.'
- A progress report, at least annually, must be provided to the Committee.
- When the project is completed, a final report must be provided to the HREC.
- The HREC must be notified of any complaints by participants or of adverse events involving participants.
- The HREC must be notified immediately of any unforeseen events that might affect ethical acceptability of the project.
- Any proposed changes to the original proposal must be submitted to and approved by the HREC before they are implemented.

- If the project is discontinued before its completion, the HREC must be advised immediately and provided with reasons for discontinuing the project

Approval is given for a period of three (3) years only, and if the research is more prolonged than this, a new submission will be required.

Should you have any questions or concerns, please contact Sarah Lawson, Executive Officer of the HREC, Tel 8226 6367 or E-mail hrec@health.sa.gov.au

We wish you well with your project.

Yours sincerely,

Andrew Stanley
CHAIRPERSON
HUMAN RESEARCH ETHICS COMMITTEE

13/8/2010

16 July 2010

Government of South Australia
SA Health

Dr Victoria Wade
Discipline of Public Health
UNIVERSITY OF ADELAIDE

Royal Adelaide Hospital
North Terrace
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Research Ethics Committee
Level 3, Hanson Institute
Tel (08) 8222 4139
Fax (08) 8222 3035
Email:
Heather.O'Dea@health.sa.gov.au

Dear Dr Wade,

Re: "A case study of home medication management by videophone."

RAH PROTOCOL NO: 100709.

I am pleased to advise that Research Ethics Committee EXPEDITED APPROVAL is granted to the above project on the above date.

The following have been reviewed and approved:

- **Application coversheet and Protocol (University of Adelaide) dated 8 June 2010**
- **Information Sheet & Consent Form for RDNS Staff**
- **Information Sheet & Consent form for Chest Clinic Staff**
- **Information Sheet & Consent Form for RDNS Clients**
- **Introductory Letter to Clients**
- **Interview Schedules**
- **General Consent Record**
- **RDNS Consent Form, CR 5.00**

Please quote the RAH Protocol Number allocated to your study on all future correspondence.
Research Ethics Committee deliberations are guided by the NHMRC National Statement on Ethical Conduct in Human Research 2007.

GENERAL TERMS AND CONDITIONS OF ETHICAL APPROVAL:

- Adequate record-keeping is important. If the project involves signed consent, you should retain the completed consent forms which relate to this project and a list of all those participating in the project, to enable contact with them in the future if necessary. The duration of record retention for all clinical research data is 15 years.
- You must notify the Research Ethics Committee of any events which might warrant review of the approval or which warrant new information being presented to research participants, including:
  (a) serious or unexpected adverse events which warrant protocol change or notification to research participants,
  (b) changes to the protocol,
  (c) premature termination of the study,
  (d) a study completion report within 3 months of the project completion.
- The Committee must be notified within 72 hours of any serious adverse event occurring at this site.
- Approval is **ongoing**, subject to satisfactory annual review. Investigators are responsible for providing an annual review to the RAH REC Executive Officer each anniversary of the final approval date using the Annual Review Form available at: http://www.rah.sa.gov.au/rec/index.php The REC must be advised with a report or in writing when this study approval is complete so that the file can be closed.

Yours sincerely

Dr A Thornton
CHAIRMAN
RESEARCH ETHICS COMMITTEE

CONSENT FORM FOR HEALTH CARE STAFF WHO ARE PARTICIPANTS IN THE VIDEOPHONE RESEARCH PROJECT

1. I, …… *(please print name)*

   consent to take part in the research project entitled:

   A case study of home medication management by videophone

2. I acknowledge that I have read the attached Information Sheet entitled:

   The Videophone Research Information Sheet

3. I have had the project, so far as it affects me, fully explained to my satisfaction by the research worker. My consent is given freely.

4. Although I understand that the purpose of this research project is to improve the quality of health care, it has also been explained that my involvement may not be of any benefit to me.

5. I understand that the researcher will audio record an interview with me about my opinions of the home videophone service.

6. I have been informed that, while information gained during the study may be published, I will not be identified and my personal results will not be divulged.

7. I understand that I am free to withdraw from the project at any time.

8. I am aware that I should retain a copy of this Consent Form, when completed, and the attached Information Sheet.

……...
(signature) *(date)*

WITNESS

I have described to …….. *(name of subject)*

the nature of the research to be carried out. In my opinion she/he understood the explanation.

Status in Project**:** …….

Name: ……..…

……...
(signature) *(date)*

THE UNIVERSITY OF ADELAIDE
HUMAN RESEARCH ETHICS COMMITTEE

Document for people who are participants in a research project

CONTACTS FOR INFORMATION ON PROJECT AND INDEPENDENT COMPLAINTS PROCEDURE

The Human Research Ethics Committee is obliged to monitor approved research projects. In conjunction with other forms of monitoring it is necessary to provide an independent and confidential reporting mechanism to assure quality assurance of the institutional ethics committee system. This is done by providing research participants with an additional avenue for raising concerns regarding the conduct of any research in which they are involved.

The following study has been reviewed and approved by the University of Adelaide Human Research Ethics Committee:

Project title:

A case study of home medication management by videophone

1. If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult the project co-ordinator:

   Name: Dr Victoria Wade
   telephone: 0417 878 150 email: victoria.wade@adelaide.edu.au

   Name: Prof Janet Hiller
   telephone: 08 8303 3573 email: janet.hiller@adelaide.edu.au

2. If you wish to discuss with an independent person matters related to
   - making a complaint, or
   - raising concerns on the conduct of the project, or
   - the University policy on research involving human participants, or
   - your rights as a participant

contact the Human Research Ethics Committee's Secretary on phone (08) 8303 6028

THE UNIVERSITY OF ADELAIDE HUMAN RESEARCH ETHICS COMMITTEE

CONSENT FORM FOR RDNS CLIENTS WHO ARE PARTICIPANTS IN THE VIDEOPHONE RESEARCH PROJECT

1. I, …… *(please print name)* consent to take part in the research project entitled:

   A case study of home medication management by videophone

2. I acknowledge that I have read the attached Information Sheet entitled:

   The RDNS Home Videophone Research Project

3. I have had the project, so far as it affects me, fully explained to my satisfaction by the research worker. My consent is given freely.

4. Although I understand that the purpose of this research project is to improve the quality of medical care, it has also been explained that my involvement may not be of any benefit to me.

5. I have been given the opportunity to have a member of my family or a friend present while the project was explained to me.

6. I understand that the researcher will audio record an interview with me about my opinions of the home videophone service.

7. I have been informed that, while information gained during the study may be published, I will not be identified and my personal results will not be divulged.

8. I understand that I am free to withdraw from the project at any time and that this will not affect medical advice in the management of my health, now or in the future.

9. I am aware that I should retain a copy of this Consent Form, when completed, and the attached Information Sheet.

……
(signature) *(date)*

WITNESS

I have described to …….. *(name of subject)*

the nature of the research to be carried out. In my opinion she/he understood the explanation.

Status in Project**:** …….

Name: ……..…

……...
(signature) *(date)*

Independent Complaints Procedure

THE UNIVERSITY OF ADELAIDE
HUMAN RESEARCH ETHICS COMMITTEE

Document for people who are participants in a research project

CONTACTS FOR INFORMATION ON PROJECT AND INDEPENDENT COMPLAINTS PROCEDURE

The Human Research Ethics Committee is obliged to monitor approved research projects. In conjunction with other forms of monitoring it is necessary to provide an independent and confidential reporting mechanism to assure quality assurance of the institutional ethics committee system. This is done by providing research participants with an additional avenue for raising concerns regarding the conduct of any research in which they are involved.

The following study has been reviewed and approved by the University of Adelaide Human Research Ethics Committee:

Project title:

A case study of home medication management by videophone

1. If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult the project co-ordinator:

   Name: Dr Victoria Wade
   telephone: 0417 878 150 email: victoria.wade@adelaide.edu.au

   or alternatively, you may contact the project co-ordinator's primary supervisor:

   Name: Prof Janet Hiller
   telephone: 08 8303 3573 email: janet.hiller@adelaide.edu.au

2. If you wish to discuss with an independent person matters related to
   - making a complaint, or
   - raising concerns on the conduct of the project, or
   - the University policy on research involving human participants, or
   - your rights as a participant

contact the Human Research Ethics Committee's Secretary on phone (08) 8303 6028

The RDNS Home Videophone Research Project

Information Sheet for Chest Clinic Staff

You are invited to participate in a research project called "A case study of home medication management by videophone"

Researchers
This research project is being carried out by Dr Victoria Wade, who is studying for a PhD with the Discipline of Public Health at the University of Adelaide.
She is being supervised by Professor Janet Hiller, Professor Jon Karnon, Dr Adam Elshaug, and Dr Jaklin Eliott.

The aims of the research are:
- To describe the development of medication management by videophone from pilot project to an integrated service
- To understand the things that have helped and hindered the development of the service
- To investigate the effectiveness of the home videophone service for Directly Observed Therapy (DOT) for tuberculosis

Who will be involved?
Three groups of people will be interviewed:
- The clients receiving DOT from RDNS by videophone
- The staff at RDNS who are involved with the videophone service
- The staff at the Chest Clinic who are involved with the DOTS service for TB

It is completely your own choice as to whether or not you take part in the research

Summary of Chest Clinic Involvement in the Research
If you agree to join the research project, these are the things we are planning to do:
Interview
Dr Wade will interview you about your work with the DOT service, and your opinions about the RDNS videophone service, at a time that suits you. The interviews will be semi-structured, which means that they will have some pre-planned questions, but will also be flexible to allow particular points to be followed up, and participants will have the opportunity to add anything else they wish to say.
The interview can be done at your workplace, or at the University of Adelaide, if you would prefer this. The interviews will be audio recorded, because it is important to us to remember everything you have said, and we expect that they will last about half an hour.
Information from the Chest Clinic
De-identified information will also be collected from the Chest Clinic records, of numbers of patients being managed by the service, and on the DOT program.
Feedback to Participants
At the end of the research, we will send a letter to everyone who has helped us, with a summary of the results of the research.

Privacy and Confidentiality
We are taking care to protect your privacy. Any quotes taken from the interviews, or analysis of the interview transcripts will not identify you. In addition, once the interviews have been done, we will send you your interview transcript and give you the opportunity to have any part of it removed before the information in the interviews is analysed.
The audio recordings and the transcriptions will be stored confidentially and securely for seven years, and then they will be destroyed.

Publication of Results
We aim to publish the results of the research, and we may also speak about the research at conferences or give other presentations, however no names of participants or any other means of identifying them will be used when we do this.

Benefits of the Research
We hope that this research will benefit RDNS and its clients, because the information gained from the research will be used to improve RDNS services.
More information about using videophones to deliver DOT could also be useful for health services in other states or territories.

Risks and Adverse Events
We think that the risk of being part of this research is low, however it is possible that you might feel uncomfortable during the interview, in which case you can stop participating and withdraw from the research at any time. Also, we are protecting your privacy by doing all the things we have described above.

Voluntary Participation
We wish to assure you that participation in this study is completely voluntary, and that you can withdraw from the research at any time without this having any effect on your employment, or any other aspects of your work with the Chest Clinic.

Disclosure of Conflict of Interest
In addition to her studies with the University of Adelaide, Dr Victoria Wade has an unpaid position where she gives advice to the company who supplies the videophones to RDNS. Therefore she has a commercial interest in the use of videophones, as well as an academic interest in doing the research. However the company is not funding this research, nor will it have any effect on the results or the publication of this research.

Ethics Approval
This study has been approved by the University of Adelaide, the Department of Health, and the Royal Adelaide Hospital Human Research Ethics Committees.

Contact Details
Thank you very much for being interested in this research. If you have any more questions, please phone Dr Tori Wade on 0417 878 150, or email victoria.wade@adelaide.edu.au
If you have any questions about the ethics of this research or you wish to make a complaint, please contact the University of Adelaide Human Research Ethics Committee by phone on 08 8303 6028.

THE UNIVERSITY OF ADELAIDE
AUSTRALIA

SCHOOL OF POPULATION HEALTH AND CLINICAL PRACTICE
FACULTY OF HEALTH SCIENCES

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CRICOS Provider Number 00123M

The RDNS Home Videophone Research Project

(insert date of email)

Dear ……

I am conducting a research project on the development and operations of the RDNS home videophone medication management service. As part of the project, I am requesting interviews from all the RDNS staff who have been involved with creating or working within this service, and I'd like to ask if you would be willing to consider having an interview.

The types of things I will be asking about are descriptions of how the service is operating, its benefits, any problems or difficulties, and how these have been dealt with, how the service has changed over time, and your advice or suggestions for future development. I would also like to focus in some detail on the DOT clients, as I am aiming to interview DOT clients and understand their experiences of the service.

The management of the RDNS supports this research being done, however it is independent and external to the organisation, so is not required as part of your work. Therefore I want to assure you that participation is completely voluntary, and that your responses will be de-identified. Also, if you prefer, the interviews can be conducted off-site.

I have included an information sheet which give more details about the research, and if you have any more questions, please feel free to phone or email me.

To participate in the research, please email me at victoria.wade@adelaide.edu.au, or call me on 0417 878 150, and we can make a time for an interview. I think the interviews will take about half an hour, or possibly a little more. They can be conducted either face-to-face or over the telephone, whichever is more convenient for you.

I really appreciate and am most grateful for your help.

Kind regards,

Dr Victoria (Tori) Wade

PhD Candidate
Discipline of Public Health
The University of Adelaide

Dear

Last week, one of the nurses from RDNS called you to see if you would like to help with some research into the videophone service. I am the person who is doing the research, and I am writing to say thank you for being willing to have an interview with me about the videophones.

Because the videophones are a new way of delivering health care, it is important to find out what you think of the service, if there are any problems, and if there are any ways that it could be improved. I have included an information sheet with this letter, that tells you more about the research. Please can you have a look at this, and then next week I will phone you to make a time to do the interview.

If possible, I would like to see you in person, because it is easier to have a conversation face to face. I am happy to come to your home if this would suit you. If this is not convenient, I can also do the interview over the telephone or your videophone, so just let me know what would suit you best.

I've got a few things I'd like to discuss, but really would like to hear your thoughts, about anything you think would help us make this service work better – what is good, and what could be better. I hope that the interview will not be too stuffy or formal, but will be more like a friendly discussion, where I can listen to and understand your thoughts and feelings about the service.

Thank you very much, and I am looking forward to meeting you.

Kind regards

Interview Schedule DOTS Videophone Service

Dr Tori Wade
Public Health, University of Adelaide

Chest Clinic Staff

I'd like to start by asking you to tell me what you do at the Chest Clinic.

And next, what involvement do you have with the DOTS program?

Can you take me through how you manage patients with TB in the community?

What range of options do you have for monitoring treatment?

How do you decide which clients are offered each option?

Do patients move from one option to another? If so, how?

Turning now to your work with RDNS, how are clients chosen to be referred to the RDNS videophone service?

And how do you communicate with RDNS about the DOT service?

In general, what's your opinion of using home videophones to deliver DOT?

What are the best things about using the videophones for DOT patients?

Are there any problems with using the videophones for DOT patients?

Do you think home videophones have had any effect on the patients?

Has the videophone service led to any changes in the way you work with TB patients?

Do you have any advice or suggestions about the home videophone service?

Is there anything else that you would like to add?

Interview Schedule for RDNS DOT clients

The videophone service is actually very new, and is the first of its kind in the world, so we are really trying to understand both the good points and the bad points of the service. Please be very honest about what you think; if you have some criticisms or suggestions for improvement I'd really like to hear about it.

1. I'd like to start by asking you to tell me about how you use the videophone service, so that I can get an overall picture of what it is like for you. Prompts if necessary: How do you fit the video calls in with the rest of your life? How long do the calls last? Do you call RDNS or do they call you? How do you feel about being on the service? Do you ever talk about other things to do with your health?

Additional prompts: Can you give me an example of when they talked about other health issues? Do you think they work together well with the Chest Clinic? Have you noticed any communication problems?

2. Can you think back to when you first started using the videophone; what was your first impression? Were there any teething or starting up problems? Any concerns?

3. Can I ask you about the picture and sound on the videophone; how is that working for you?

Additional prompt: some people have said they have had a problem with the picture or the sound; has that happened to you?

4. What's the hardest thing about using the videophone?

5. Has there ever been a time when it has been really difficult? What happened?

6. What's it like when the videophone service is working really well? Have you got an example of that?

7. Overall, how would you compare having a home videophone to having a nurse come to your home in a car?

Alternative wording: before the RDNS used videophones, they used to send someone around in a car to see the person at home every day; what would you think of that way of doing things? Or sometimes they would ask the person to come to a local nursing clinic every day; what would you think of that?

What about the issue of privacy; is that important to you, and do you think one method of delivering the service is better than another?

8. If you could change one thing about this service, what would it be?

9. Do you have any other advice or suggestions about the videophone service?

10. Is there anything else that you would like to say?

RDNS Staff Interviews - direct service and development

1. I'd like to start by asking you to give me an outline of your work with the videophone service, so that I can get an overall picture of what you do. Prompts if necessary: Could you describe the development of the service? What has your role been in this development?
2. Can you think back to when you first started working with the videophone service; what was your first impression? Were there any teething problems?
3. In the time that you have been working with the videophone service, how has it changed?
4. Can you take me through how you work with the clients of the service?
5. And in particular, can you take me through how you work with the DOT clients?
6. Can I ask you about the picture on the videophone; how is that working for you? And what about the sound?
7. What's the hardest thing about using the videophone with the DOT clients? Has there ever been a time when it has been really difficult? What happened?
8. What's it like when the videophone service is working really well? Prompt if necessary: What is it that makes it work well?
9. Overall, how would you compare the home videophone service to the drive around service for DOT clients? Prompt if not mentioned: Have you also worked in the field service? If yes, how do you find the difference?
10. Thinking about your role as a nurse, could you talk about how using the videophone changes that? (or if the participant is not a nurse, then "Thinking about the role of the nurse")
11. How does the videophone service work together with the other services in RDNS? What about other services outside RDNS?
12. What do you think has helped the service get to the place where it is now? Prompt if necessary: have you got any specific examples?
13. What sort of problems or challenges is the videophone service facing at the moment? Prompt if necessary: have you got any specific examples? Any minor irritations or bugbears?
14. Do you see the home videophone service as something that will keep going into the future? Prompts if necessary: Is there anything that you see would get in the way of the service continuing, or cause it to shut down? What helps the service to keep going?
15. If you could change one thing about this service, what would it be?
16. Do you have any other advice or suggestions about the videophone service?
17. Is there anything else that you would like to say?

APPENDIX C – Telehealth Services Study Materials

THE UNIVERSITY OF ADELAIDE
AUSTRALIA

SCHOOL OF POPULATION HEALTH AND CLINICAL PRACTICE
FACULTY OF HEALTH SCIENCES

LEVEL 9, 10 PULTENEY STREET
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TELEPHONE +61 8 8303 3884
FACSIMILE +61 8 8303 3339
gabriele.matzke@adelaide.edu.au
CRICOS Provider Number 00123M

Date

Telehealth Services Research Project

Dear,

We are seeking people who are working, or have worked, in telehealth, to participate in a research interview about telehealth services. The intention is to investigate the barriers and enablers to telehealth becoming an ongoing and sustainable part of health care services. The research is being conducted by Dr Victoria Wade as part of a PhD in Public Health at the University of Adelaide, with supervision from Professor Janet Hiller.

What are the potential benefits from participating in this research?
This research is intended to help patients and the health care system by identifying the factors that make telehealth services sustainable. The findings will be publically disseminated, and it is hoped they will be useful to health care providers who are either operating a telehealth service, or are intending to set one up. The only benefits to individuals who participate will be the opportunity to reflect on these issues, and to have your opinions contribute to the results.

How have you been selected to approach?
Potential participants have been found by looking at the published literature in telehealth, through websites, and by direct contact with health care services.

Further information
An information sheet providing more details of the study is attached to this letter.

Ethics approval
This study has been approved by the Human Research Ethics Committee of the University of Adelaide. A Consent Form and an Independent Complaints Form are also attached.

Who should I contact if I have any questions?
Dr Victoria Wade
Ph 0417 878 150
Email victoria.wade@adelaide.edu.au or twade@thevidco.com

How do I participate?
If you are interested in contributing to this study, please let us know by return email or telephone. Dr Wade will then contact you to answer any further questions, arrange for you to sign the consent form, and organise a time for an interview. The interviews will take about an hour and may be conducted in person or over the telephone, depending upon your location.

Thank you very much for your help.

Yours sincerely,

Dr Victoria (Tori) Wade
PhD Candidate

Professor Janet Hiller
Deputy Head
School of Population Health and Clinical Practice

THE UNIVERSITY OF ADELAIDE DISCIPLINE OF PUBLIC HEALTH

Information about the Telehealth Services Research Project

Dr Victoria Wade, a PhD Candidate with the Discipline of Public Health at the University of Adelaide, is undertaking research during 2009 and 2010, on the uptake and sustainability of telehealth services.

What is the purpose of the research?
Telehealth has the potential to improve the efficiency, effectiveness and equity of health care delivery, yet implementing telehealth as part of normal health care services has been difficult. This research aims to find out why this is the case, by investigating the barriers and enablers to telehealth services becoming an ongoing and sustainable part of health care delivery. Both currently operating and ceased telehealth services will be studied.

Who will be involved?
Clinicians, managers and researchers who are or have been involved with the operation of telehealth services

How can I contribute?
By participating in an interview with the researcher, in which your experience and opinions about telehealth will be sought. The main focus will be on the telehealth service with which you have been directly involved. Participants can withdraw from the study at any time.

Information about the interviews
The interviews will have a semi-structured format. This means that participants will first be asked broad questions on the topic and encouraged to speak in as much length and depth as they require. More specific questions to hone in on particular points will then be asked as needed. Each interview may last up to an hour, although the exact time will depend on how long each participant wishes to take. Two shorter interviews can be arranged at separate times if this is more convenient. The researcher and participant will arrange a mutually agreed time and place. If in or near Adelaide the interviews could take place in person, but otherwise will be conducted over the telephone.

Confidentiality and security of the results
All interviews will be audio recorded, and transcribed into text documents. These will be stored confidentially and securely.

Identification or De-identification of participants
Participants may choose to be either identified or de-identified; this decision is entirely at the discretion of the participant, and may be changed at any time up to the publication of the work or the completion of the PhD, whichever comes first.

- If a participant chooses not to be identified, neither they nor any organisations or services which they mention will be identified in any published work or presentations.
- If a participant chooses to be identified, then their name and the names of services and organisations may be used in publications and in the PhD thesis, but will not be used in seminars or conference presentations.

Identification will allow your name and service to be available in publications to others interested in telehealth, and may enhance knowledge sharing. De-identification will protect your identity and may assist you to speak more freely. If you are not certain which option to choose, please select de-identification.

Declaration of Interest
In addition to her PhD Candidature, Dr Victoria Wade is the Medical Director of Design Networks Pty Ltd, a company which is developing and operating telehealth services.

THE UNIVERSITY OF ADELAIDE HUMAN RESEARCH ETHICS COMMITTEE
CONSENT FORM for the TELEHEALTH SERVICES RESEARCH PROJECT

ATTENTION: Victoria Wade

FAX to 08 8303 6899. This fax number connects to a confidential, password protected in-box.

1. I, …… *(please print name)* consent to take part in the research project entitled: The uptake and sustainability of telehealth services
2. I acknowledge that I have read the attached Information Sheet entitled: Information about the Telehealth Services Research Project
3. I have had the project, so far as it affects me, fully explained to my satisfaction by the research worker. My consent is given freely.
4. Although I understand that the purpose of this research project is to improve the quality of health care, it has also been explained that my involvement may not be of any benefit to me.
5. I have been informed that information gained during the study may be published, and I am choosing one of the two options below, by placing my signature in the appropriate box:
   A. I do not wish to be identified, and the study results, including direct quotations from interviews, will not identify me and/or the organisations or services that I mention in my interview/s.
   ……
   B. I wish to be identified, and the study results, including direct quotations from interviews, may identify me and/or the organisations or services that I mention in my interview/s.
   ……
   I understand that I may change my option to be either identified or de-identified at any time upto the publication of work or the conclusion of the PhD, whichever comes first.
6. I understand that I am free to withdraw from the project at any time.
7. I am aware that I should retain a copy of this Consent Form, when completed, and the attached Information Sheet.

……
(signature) *(date)*

(Note: do not sign the Witness section: I will sign this myself after I have discussed the research with you. Thanks, Tori Wade)

WITNESS

I have described to …… *(name of subject)*

the nature of the research to be carried out. In my opinion she/he understood the explanation.
Status in Project: ……

Name: ……

……..
(signature) *(date)*

THE UNIVERSITY OF ADELAIDE
HUMAN RESEARCH ETHICS COMMITTEE

Document for people who are participants in a research project

CONTACTS FOR INFORMATION ON PROJECT AND INDEPENDENT COMPLAINTS PROCEDURE

The Human Research Ethics Committee is obliged to monitor approved research projects. In conjunction with other forms of monitoring it is necessary to provide an independent and confidential reporting mechanism to assure quality assurance of the institutional ethics committee system. This is done by providing research participants with an additional avenue for raising concerns regarding the conduct of any research in which they are involved.

The following study has been reviewed and approved by the University of Adelaide Human Research Ethics Committee:

Project title: The Uptake and Sustainability of Telehealth Services

1. If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult the project co-ordinator:

   Name: Dr Victoria Wade
   telephone: 0417 878 150 email: victoria.wade@adelaide.edu.au

   or alternatively, you may contact the project co-ordinator's primary supervisor:

   Name: Professor Janet Hiller
   telephone: 08 8303 3573 email: janet.hiller@adelaide.edu.au

2. If you wish to discuss with an independent person matters related to
   - making a complaint, or
   - raising concerns on the conduct of the project, or
   - the University policy on research involving human participants, or
   - your rights as a participant

contact the Human Research Ethics Committee's Secretary on phone (08) 8303 6028

Follow Up Interview Guide

General Questions

I'd like to start by asking, in general terms, what has happened with the telehealth service since I last spoke to you about two years ago? (or insert time)

Have there been any changes to the way it operates, or the types of services it provides?

Any changes to numbers of services, or places that it operates to?

How sustainable do you think the service is at present?

What would you say are the things enabling the service to keep going at present?

Are there any barriers to uptake or sustainability at present?

Specific Questions

Have the new Medicare item numbers for telehealth had any impact on the service?

Are there any plans to use the item numbers in the future?

Could ask about using the item numbers to work with GPs, if relevant.

One area I'm particularly looking at right now is the role of clinician support. Do you think clinician support, or lack of it, affects your service? If so, how? What degree of clinician support do you think you have at present?

Conclusion

Is there anything else you would like to add?

Last time I had contact with you, you chose to be identified/de-identified. Do you want to stay with that or to change to identified/de-identified?

Telehealth Sustainability Study

Dr Tori Wade, PhD Candidate
Discipline of Public Health, University of Adelaide

Semi-structured interview guide

After the introduction, the different sections of the interview will begin with broad questions about the telehealth service, with participants being given minimal prompting to continue talking in their own words. A series of more specific prompts, as set out below, will be used when needed to ask for more details or to fill in gaps in responses.

Section 1. Interview Introduction

An introductory section will cover the following areas before the data gathering part of the interview begins. Participants will be:

- Reminded that the purpose of the interview is to gather data on the uptake and sustainability of telehealth services, which will be used in a program of research for a PhD.
- Asked if they wish to continue with the interview.
- Reminded that they can cease participation at any time.
- Asked if they wish to be identified or de-identified in published work.
- Reminded that they can change their mind about their identification status, up to the point of publication or completion of the PhD, whichever comes first.
- Assured of confidentiality of data.
- Asked if they have any questions at this point.

Section 2. Telehealth Service Description:

Firstly, I have some introductory questions about the telehealth service you are/were involved with.
Prompts for description:
What is/was your role in the operation of the telehealth service?
When did the telehealth service start?
Is it still operating? If not, when did it cease operating?
What types of telehealth services are/were delivered?
How many sites are/were included in the service?
Do you know what volume of services are/were delivered? Per week/month/year?

Section 3. Factors affecting uptake and sustainability

Please tell me how the telehealth service got started and was able to continue operating.
Prompts for startup:
What do you think were the important factors enabling the telehealth service to start operating?
Were there any barriers to overcome to start operations? How were these dealt with?
Prompts for operations:
Did the service change the way it operated over time? If so, please describe what happened.
Did the service change in size, ie grow or shrink over time? If yes, what factors affected the changes in size of service?
Did the types of services change? If yes, please describe.
Were there any unexpected challenges or difficulties? If yes, how were they dealt with?

Prompts for continuing services:

Do you think that the service is currently sustainable, that is, able to continue operating for the foreseeable future?
What factors helped the service to become sustainable?
What factors hindered sustainability?
Are there any threats to its sustainability?
Are efforts required to ensure sustainability?
How do you see the service developing in the future?
Prompts for ceased services:
Can you describe what happened when the service closed down?
What factors do you think led to the service closing down?
Were there any efforts made to keep the service operating? If yes, please describe.

Section 4. Topic Prompts

Topic prompts will be used in the next section of the interview, if the interviewee has not mentioned these areas earlier.
How do you think the following factors affected the sustainability of the telehealth service:

- Funding and budget issues
- Technical matters, ie issues to do with the telehealth equipment or telecommunications
- Clinical issues, ie the ability to deliver the service using telehealth, quality of service
- Health provider issues, ie acceptability, availability, other?
- Health workforce issues
- Administrative or management issues
- The policy environment
- Political issues, either at the local level or in the larger environment
- Patient or client issues
- Ethical issues, eg privacy, confidentiality
- Legal issues, eg indemnity, professional registration
- Research and evaluation issues
- Any other factors not yet mentioned?

Section 5. Importance of Factors

Of all the factors affecting the telehealth service that you have discussed with me, which ones do you think are/were most important in determining whether or not the service continued? Can you tell me in more detail how these factors affected the outcome?

Section 6. Interview Conclusion

Is there anything else you would like to say?
If I have some additional questions to ask you at a later date, would you be willing to be contacted again? Whether or not you choose to participate in a second interview would be entirely your choice at the time.
Would you like to receive information about the outcomes of this study?
Thank you very much!

APPENDIX D – Letter of Acceptance for Publication Subject to Review

From: QHR-Editor@nurs.utah.edu
Subject: **QHR - Decision on Manuscript ID QHR-2012-0790**
Date: 23 May 2013 9:42:19 AM ACST
To: Victoria Wade <victoria.wade@adelaide.edu.au>

22-May-2013

Dear Ms. Wade:

RE: Manuscript # QHR-2012-0790, entitled "Clinician Acceptance is the Key Factor for Sustainable Telehealth Services"
The review process has been completed for the manuscript you submitted to Qualitative Health Research (QHR). The comments from the reviewers are included below.
The reviewers have recommended revisions to your manuscript, and I invite you to respond to their comments and revise and resubmit your manuscript for further consideration. Please do so within the next 60 days. If you are unable to meet this deadline, please contact us for an extension and wait for our response. Please DO NOT submit your revision as a "new" manuscript.

In revising your manuscript please do the following:

1. Submit only a "clean" manuscript; do not use Track Changes, highlighting, or any other markings to indicate your changes.
2. Attend to the comments and suggestions made by the reviewers.
3. Remove all anthropomorphic language from the manuscript (see, for example, p. 1, line 12: "Theories . . . take a multifactorial approach").
4. Refer to the QHR Manuscript Guidelines and correct:
- Improper use of italics
- Line spacing
- Paragraph formatting
- Length of paragraphs
- Headings
- Insert a proper callout for placement of Figure 1
- Seriation style
- Quotation marks
5. You must use the past tense when writing about things that happened, were said, or were written in the past.
6. You must use U.S.-English spelling.
7. Please avoid use of the word "interviewee."
8. Note that participant quotations must be properly capitalized and punctuated.
9. The manuscript contains words/word usage contrary to journal style; refer to the QHR Guidelines and correct this.
10. Your references are not compliant with APA, 6th edition, and must be corrected. Also, your reference list is quite long; please use only essential references.
11. Figure 1 is not compliant with the QHR Manuscript Guidelines and must be corrected. When reformatting the figure document, be sure to keep the figure within the 1-inch margins.
12. The above list is not all-inclusive. Make sure your entire manuscript is prepared in accordance with the QHR Manuscript Guidelines dated September 2011. The Guidelines can be accessed at http://mc.manuscriptcentral.com/qhr; click on "Instructions and Forms," and select "Manuscript Submission Guidelines."

After all revisions have been made, print your manuscript and proofread it carefully from the hard copy prior to submission. Once the revised manuscript is prepared, you can upload it through your Author Center. Be sure to delete all former versions of your manuscript.

To submit a revised manuscript, logon to http://mc.manuscriptcentral.com/qhr and enter your Author Center, where you will find your manuscript listed under “Manuscripts with Decisions.” In the table,

under “Actions,” click on “Create a Revision.”

Please be aware that your revised manuscript might be sent out for further peer review.
If you have questions or need assistance, please contact us at QHR-Journal@nurs.utah.edu.

We look forward to receiving your revised manuscript in the near future. Thank you for your support of Qualitative Health Research.

Sincerely yours,

Janice M. Morse, PhD, FAAN
Editor, Qualitative Health Research

Reviewers' Comments to the Author(s):

Reviewer: 1

1. Importance of submission: What are the manuscript's strengths? Is it significant? Does it contain new and unique information?
The main objective of this research is to provide a theoretical framework to determine factors for the telehealth success from the perspective of clinician. This addresses a current lack in the theory-building process and provides therefore a significant contribution to this research domain taking also into account previous works. As the personal acceptance of telehealth services by clinicians is strongly linked to the success and the availability of such services, putting them as a key stakeholder into the center is adequate.

2. Theoretical evaluation: Is the manuscript logical? Is the theory parsimonious? Complete? Useful?
The manuscript follows a logical structure and provides the essential parts needed for an article. The approach chosen by the authors is interesting and from an scientific point of view reasonable. Nether the less the focus on only interviews with telehealth services providers seems to be a thin data base to provide guidance in this domain and could be improved by combining methods. Especially as the paper claims to provide guidance for the implementation of telehealth services, a broader approach would be useful.
On page 14, the connection between the factors “workforce availability” and “demand for service” by “technology” is mentioned, but not shown in the attached Figure 1. Please explain this.
In Figure 1, it would be necessary to make the essential concepts visible and to design the Figure more intuitive.

3. Methodological assessment: Inductive approach? Appropriate method and design? Is the sample appropriate and adequate? Are data saturated? Theoretical analysis? Linked with theory and/or praxis?
The data for the sample was collected already for a previous study via academic literature and therefore doesn’t take into account publications later then 2007. It would be necessary to search the newer literature as well at least in an overview to show the direction of the research field.

4. Adherence to ethical standards?
Yes.

5. Manuscript style and format: (Please evaluate writing style, organization, clarity, grammar, appropriate citations, etc.). Is this manuscript unnecessarily long?
Size and style of the manuscript are appropriate [Please format according to the QHR Manuscript Guidelines. -Editor]. The abstract need to be more precise about the purpose statement (the major objective or intent to the study). Please check the manuscript for “..” in the text.
Reviewer: 2

1. Importance of submission: What are the manuscript's strengths? Is it significant? Does it contain new and unique information?

I felt that there were inconsistencies between the researcher's aim and results of this grounded theory study. The research identifies "clinician acceptance" as the key element in the success of TeleHealth operations, but then qualifies acceptance with factors identified by other information systems models. This research could be strengthened by providing further support for an existing theory or model versus proposing another model.

2. Theoretical evaluation: Is the manuscript logical? Is the theory parsimonious? Complete? Useful?
This research attempts to find one specific area that can be singularly identified as a leverage point to influence TeleHealth Services. The researcher explicitly states that current models and theories of TeleHealth and acceptance are multifaceted and therefore are not effective in identifying a single leverage point. However, In this grounded theory study, the researcher concludes that clinician acceptance is that advantage point, but qualifies "clinician acceptance" with many elements that have been described in other models(e.g., unified theory of acceptance and use of technology) mentioned in the literature review by the author. This approach seems contradictory.
I was struck by how closely the authors conclusions of clinician acceptance support "Technology Acceptance Model" with the distinction that the key stakeholders influencing acceptance are clinicians. A rich description or analysis to explicate why clinicians are the most influential stakeholders given current conditions and settings would provide a baseline for future research or program development in TeleHealh Services.

3. Methodological assessment: Inductive approach? Appropriate method and design? Is the sample appropriate and adequate? Are data saturated? Theoretical analysis? Linked with theory and/or praxis?
Very strong area of study

4. Adherence to ethical standards?
No issues noted

5. Manuscript style and format: (Please evaluate writing style, organization, clarity, grammar, appropriate citations, etc.). Is this manuscript unnecessarily long?
No issues noted

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