Human-Centred Evaluation of Broadband Telehealth for Tertiary Outpatient Consultations: A Case Study Approach

A thesis submitted for the degree of

Doctor of Philosophy

of

The Australian National University

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Declaration

Except where otherwise indicated this thesis is my own original work.

Duncan Stevenson
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Table of Contents

Preface

Research context and research colleagues

In parallel to being enrolled as a full-time student, reading for the degree of Doctor of Philosophy, at the Australian National University (ANU), I was employed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in its Information and Communications Technologies (ICT) Centre. I had permission from my CSIRO ICT Centre Director to use the results and intellectual property from my work at CSIRO towards my degree and corresponding approval from the ANU to be enrolled as a full-time doctoral student. The team in which I worked came under the umbrella of a six-year funded project from the then Australian Department of Communications, Information Technology and the Arts as part of its "Building on Information Technology Strengths" Program.

This project, called the Centre for Networking Technologies for the Information Economy (CeNTIE), established a gigabit per second research network across Australia and developed a range of experiments and demonstration applications to showcase the use of broadband Internet under appropriate Quality-of-Service regimes (Wilson and Percival 2002). The project was managed through a series of activities and milestones. The milestones were typically reported as demonstrations of completed work to an appropriate industrial or academic audience. My team focused on developing, deploying and evaluating telehealth applications for a range of telehealth situations.

The emphasis of our work was to engage with application partners for each of our case studies. Our case studies, therefore, had a basis in the real world of application requirements. Our field trials and evaluations were done in real-world contexts, appropriately constrained to meet the realities of our working prototypes. This application emphasis enabled us to concentrate on the technical issues of developing and deploying our work and on the human issues of real-world requirements and access to actual application participants in our trials and evaluations.

Motivation for this work

Although the projects conducted under CeNTIE funding all had strong industrial linkages, the milestone-based management model limited our scope for fully reporting on our work. Two aspects, in particular, were inadequately represented. Firstly, the importance of using a real-world setting to demonstrate the results of any particular project was not adequately explored or discussed. Secondly, the evaluations of the projects tended to be primarily at the technical or implementation level rather than at the level of engagement by people who would use the application in their everyday working environment. The research activity described in this thesis, undertaken during the second 3-year funding phase of CeNTIE, provided an opportunity for me to focus on these two aspects as a core part of my project work with CSIRO.

Note on gender of participants

In this thesis I have used the term “he or she” and equivalents where reference is made to an abstract person. Where reference is made to specific people I have used the appropriate gender of the pronoun. For example, in planning for a surgeon to use our telehealth system I use “he or she”. In referring to any of the five male surgeons who took part in our trial I use “he”. This emphasises the individual nature of their responses to the trial and its evaluation.

Publications arising from this research work

Material from this research work has been published in three conference papers; all were double-blind reviewed with multiple reviewers:

1. Stevenson, D (2006) Evaluating an In-Vivo Surgical Training Demonstration over Broadband Internet, presented at the Australasian Computer-Human Interaction Conference, OZCHI 2006, in Sydney. This paper presented an evaluation of a preliminary case study which explored the use of an international advanced-broadband link to demonstrate a surgical training master class constructed around live 3D video of the surgery.
2. Stevenson, D, J Li, J, Smith and M Hutchins (2008) A Collaborative Guidance Case Study, presented at the Ninth Australasian User Interface Conference, AUIC 2008, in Wollongong. This paper presented a laboratory study conducted to assess the way in which our implementation of remote guidance technologies supported the collaborative tasks identified as representative of aspects of remote examination of child patients.
3. Stevenson, D (2008) Training and Process Change: A Collaborative Telehealth Case Study, presented at the Australasian Computer-Human Interaction Conference, OZCHI 2008, in Cairns. This paper presented observations from the training sessions conducted for clinical staff prior to the major telehealth study of this thesis.

Two journal papers have been written and submitted:

1. Wilson, Stevenson and Cregan Telehealth trials on advanced broadband networks, to Telemedicine and e-Health and accepted for publication with revisions.
2. Stevenson, Hutchins and Smith Human-Centred Evaluation for Broadband Tertiary Outpatient Telehealth: A Case Study, to The International Journal for Human-Computer Interaction, special issue on evaluation in healthcare.

Acknowledgements

Firstly I acknowledge and thank the members of my supervisory panel, Professor Tom Gedeon, Associate Professor Henry Gardner (both in the School of Computer Science, ANU) and Dr Cécile Paris (CSIRO ICT Centre).

The research work that supports this thesis was done in the context of my employment at the CSIRO ICT Centre and later as a Visiting Scientist, and I thank my CSIRO ICT Centre Director, Dr Alex Zelinsky, for his support. The funding for this work came from the CSIRO ICT Centre and the Australian Government through the Advanced

Networks Program of the then Department of Communications, Information Technology and the Arts.

As is typical in CSIRO, I worked with a team of highly skilled and dedicated scientists. I acknowledge and thank them for their collegiate approach:

In the Canberra laboratory: Chris Gunn, Matthew Hutchins, Jocelyn Smith, Doug Palmer, Matt Adcock, Alexander Krumpholz and Ken Taylor

In the Sydney laboratory: Susan Hansen, Jane Li, Laurie Wilson, Tony Adriaansen, Alex Krumm-Heller, Keith Bengston, Bob Shields, Dean Economou, Leila Alem and Rosemary Hollowell.

Under the combination of CeNTIE and ICT Centre funding we had an unparalleled opportunity, not normally available to doctoral students and academics, to develop advanced ICT research prototypes and to deploy them in realistic application settings. In Section 1.5 I specifically acknowledge where the work of my colleagues overlaps with the work presented herein.

The case studies presented in this thesis were conducted with many external participants. The preliminary case study was conducted in collaboration with the Stanford University Medical Media and Information Technologies (SUMMIT) group (Dr Parvati Dev, Prof. LeRoy Heinrichs, Robert Cheng, Margaret Krebs, Dr Pat Youngblood), with Stanford University Hospital (Dr Camran Nezhat and colleagues) and with Nepean Hospital (Dr Pat Cregan and colleagues). Funding for the SUMMIT group in the USA was partly supported by the National Library of Medicine, contract number N01-LM-3-3512.

The three laboratory case studies were conducted with volunteer participants from our work, university and local communities. I thank them for their willingness to be involved. I also thank the secretary of the CSIRO Human Research Ethics Committee (HREC), Caroline Bull, for her assistance in preparing our HREC applications.

Many people at the Royal Children's Hospital, Melbourne, contributed to the success of the telehealth pilot trial that we conducted there: John Meara, Leo Donnan and Andrew Greensmith championed the project, Annette Da Costa helped us prepare the Ethics Committee application and Michelle Vu project managed the hospital's role in the trial. The surgeons who took part were Andrew Greensmith, Abhay Khot, Chris Harris, Chris Coombs and Michael Johnson. Hospital staff members who took the roles of clinic assistant and who managed recruitment of patients for the trial were Kylie Pollard, Cheryl Dingey, Meredith Cadwallader, Derek Neoh, Derek Carr, Lachlan Currie, Aaron Cook and Rodrigo Teixeira.

I acknowledge and thank the patients and their families who took part in the trial and who were willing to share their experiences with the research team.

At home, my wife Caroline and my three children have provided warmth, support and encouragement during my enrolment as a student at the ANU.

Abstract

Outpatient consultations form a large part of the healthcare of patients at tertiary hospitals, both as a precursor to in-patient treatment and for the management of on-going health conditions or long-term rehabilitation and monitoring after treatment. These outpatient consultations are generally conducted at the hospitals, most often located in large cities. Patients who live outside these cities face extensive travel to attend these consultations, placing a burden on themselves and on their families or carers. An ability of a tertiary hospital to deliver outpatient consultations in a telehealth mode to regional or remote locations closer to the patients' homes would potentially relieve much of this burden of travel.

Tertiary healthcare is highly complex. It can involve multiple clinicians, can require long time periods for its completion and often includes the patients and their families in the management of the healthcare situation. Outpatient consultations typically involve high levels of interpersonal discussion supported by access to data about the patient. Telehealth methods of delivering these outpatient consultations will be very demanding on the network connection between hospital and remote telehealth nodes. The next generation of Internet or intranet, often referred to as "broadband", will have the capacity to deliver multiple high-quality, low-latency video streams and to provide shared access to large data sets. The prospective match of the capabilities of broadband networks and the needs of tertiary-level telehealth opens the possibility of effective, tertiary-level outpatient consultations in a telehealth mode of delivery.

In this thesis I use a case-study-based approach to evaluate the development and pilot trial of a broadband telehealth system in a tertiary paediatric context. I use the data from these case studies to explore the way that a human-centred approach can be used to evaluate outpatient telehealth trials at a tertiary level of healthcare. My results show that human-centred evaluation for this level of telehealth must take a broad approach; that the telehealth activities must take place in a realistic setting; that qualitative and quantitative responses from participants must be complemented by observational data; that data must be gathered from all the participants; and that their competence to give meaningful responses must be recognised and their multiple, and possibly differing, points of view must be taken into account. Finally, my results show that the researchers must take into account the wider clinical and hospital contexts and in particular the participants' view of these contexts, when interpreting evaluation data.

My overall prediction is that telehealth applications for tertiary-level outpatient consultations will have important, transient phases in their development, and that a human-centred evaluation approach is the appropriate way to evaluate telehealth applications during these phases. These transient phases are not reported in conventional telehealth literature but my analysis of my case studies suggests that they are central to this class of tertiary level telehealth delivery.