

# JCU ePrints

This file is part of the following reference:

**Kimber, Michael B. (2007) *The application of telepharmacy as an enabling technology to facilitate the provision of quality pharmaceutical services to rural and remote areas of Australia.***  
**PhD thesis, James Cook University.**

Access to this file is available from:

<http://eprints.jcu.edu.au/2087>



**The application of telepharmacy as an enabling  
technology to facilitate the provision of quality  
pharmaceutical services to rural and remote areas of  
Australia**

**Thesis submitted by:**

**Michael B KIMBER**

**Diploma in Pharmacy, MPS**

**Graduate Diploma in Advanced Management, FAIM**

**in January 2007**

**for the Degree of Doctor of Philosophy**

**in the School of Pharmacy and Molecular Sciences**

**James Cook University**

## STATEMENT OF ACCESS

I, the undersigned, author of this work, understand that James Cook University will make this thesis available for use within the University Library and, via the Australian Digital Theses network, for use elsewhere.

I understand that, as an unpublished work, a thesis has significant protection under the Copyright Act and I do not wish to place any further restriction on access to this work.



Signature

Date: 17<sup>th</sup> May 2007

Michael Kimber

## STATEMENT OF SOURCES

### DECLARATION

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education.

Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.



Signature

Date: 17<sup>th</sup> May 2007

Michael Kimber

## ELECTRONIC COPY

I, the undersigned, the author of this work, declare that the electronic copy of this thesis provided to the James Cook University Library is an accurate copy of the print thesis submitted, within the limits of the technology available.

A handwritten signature in black ink, appearing to read 'Michael Kimber', with a horizontal line underneath.

Signature

Date: 17<sup>th</sup> May 2007

Michael Kimber

## ABSTRACT

The provision of quality pharmacy services to rural and remote communities is influenced by the National Strategy for the Quality Use of Medicines. The implementation of National Medicines Policy is challenged by the shortage of pharmacists in rural areas. Australia compares unfavourably with both the United Kingdom and the USA in this regard. The study by the Department of Employment and Workplace Relations in 2002 identified that there is a severe shortage of hospital pharmacists in New South Wales and acute shortages of community pharmacists in Queensland regional areas.

Although the lack of a telecommunications infrastructure has been a major impediment to the extension of telehealth into rural Australia, the challenge of delivering pharmaceutical services into rural areas may be augmented by the provision of telepharmacy applications such as remote dispensing of medications, counselling and implementing medication reviews by video conferencing.

The aims of this thesis were to ascertain the opinions of relevant healthcare professionals to the concepts of telepharmacy; to identify the requirements of a telepharmacy system suitable for use in rural Australia; to develop a pilot telepharmacy system and to demonstrate the system by dispensing a limited range of products locally and then remotely via telecommunications. Thereafter, to identify an area of telepharmacy where there is a clinical need and to demonstrate the applicability of telepharmacy by means of a trial involving volunteer patients.

This study initially involved interviewing healthcare workers in northern Queensland, the Tiwi Islands, and the western coast of Tasmania to assess the receptiveness, requirements and potential for telepharmacy applications in rural and remote regions in Australia.

Thereafter a comprehensive literature search on telepharmacy applications was conducted with a view to identifying suitable equipment for use in rural Australia. Whilst the search revealed a number of examples of commercial telepharmacy applications in the USA and Europe, none met all of the defined criteria for an ideal rural Australian telepharmacy system.

Accordingly, two pilot telepharmacy systems were developed and constructed, based upon the identified criteria. For remote controlled operations under video supervision, the criteria for a telepharmacy application were defined as:

- a system capable of storing a range of individual medications to suit the intended application;
- a standard commercial dispensary computer program;

- an automated method of removing individual packs from the storage unit;
- an image acquisition device to capture and store a picture of the dispensed pack, and
- a bar code reader to record the bar code of the dispensed product.

In addition, video conferencing capability was required to enable the remote pharmacist to provide counselling and medication review services to the patient.

Four trials were conducted using the constructed pilot telepharmacy equipment to demonstrate the validity, accuracy and reliability of the systems in dispensing a limited range of products locally and then remotely via telecommunications. These studies adequately demonstrated the operation of the telepharmacy dispensing systems and identified the requirement for a different design of bar code reader in any further trials. These studies also identified that the inclusion of video conferencing in a single remote telepharmacy application was not the optimum solution and that a separate video conferencing unit was required. A simple system of quality assurance, incorporating a dispensed pack image acquisition and bar code verification was also demonstrated, resulting in the addition of a significant patient safety factor to mitigate dispensing errors.

In order to ascertain the level of support for the concept of telepharmacy and its potential applications, four key healthcare professional groups in rural northern Australia were surveyed. Pharmacists and medical practitioners were surveyed by post and the nurse group was surveyed at the 2006 Royal College of Nursing annual conference in Cairns. The nurse/healthcare group was an online Internet survey, advertised in the Nursing Careers and Allied Health booklet published in June 2006. The major findings were that 87 per cent of all the healthcare respondents supported the use of telepharmacy to provide professional pharmaceutical services to rural and remote areas of Australia. The study did, however, identify that 70 per cent of the pharmacist group surveyed were not supportive, or neutral to, the use of remotely operated automated dispensing equipment as a telepharmacy application in rural areas, when the local pharmacy was closed. The pharmacist group were also not supportive of the use of such equipment in remote areas where there was no community pharmacy (58 per cent disagreed or were neutral). These results were further analysed and revealed that the younger pharmacist age group (less than 10 years experience), were in favour of the use of the automated dispensing equipment as a telepharmacy application, where there was no community pharmacy, compared to the older pharmacist group ( $P < 0.05$ ).

Medication reviews are a key objective of the Fourth Community Pharmacy Agreement and are provided as a fee for service basis for face to face reviews conducted in the home. They were

identified in the surveys as a clinical need which may be solved by a telepharmacy application due to the difficulty and expensive of providing medication reviews to patients in rural and remote areas.

A pilot study involving volunteer patients was conducted to demonstrate the use of a telepharmacy application in conducting medication reviews. The study recruited nine patients and the medication reviews were conducted by an accredited pharmacist via a local area wireless network, equivalent to a Broadband Internet connection. The telepharmacy interviews were recorded and provided valuable information for the pharmacist preparing the medication management reports. The patients were asked to complete a customer satisfaction questionnaire on conclusion of the video conference. Six of the patients rated the overall telepharmacy experience as excellent and three rated the experience as very good.

Whilst not removing, or negating, the need for personal professional pharmacy services, there are many potential benefits for telepharmacy applications directed at rural communities. However, it is important that it includes and retains the active role of the pharmacist in the delivery of pharmacy services to achieve the highest quality of care for rural communities and for the safety, and welfare of the public related to the use of pharmaceuticals. Pharmacist involvement is essential for patient counselling and medication reviews, with their exclusion increasing risks to the patient and leading to a higher incidence of medication errors, adverse events, and excessive drug costs. The study has thus provided evidence that telepharmacy applications may potentially lead to unique and innovative ways to deliver quality pharmacy services to rural and remote areas.



## CONTRIBUTION OF OTHERS

I acknowledge the contribution of others in the preparation of this work:

Carolyn Kimber and Dr Julie Kimber for assisting with the editing of this work and providing insightful and pertinent comments.

Rollo Manning for sharing his detailed knowledge about rural and remote pharmacy and providing Tiwi Island reference resources.

Joanne Roache for assisting with the sending of the survey forms to pharmacist and medical practitioners and collecting the replies.

Sue Carson for assisting as medication review pharmacist during the conduct of the medication review trial using telepharmacy techniques.

George Scevak and Dr Mike Steele for statistical advice.

James Cook University for meeting the postage and material costs for the surveys.

## ACKNOWLEDGEMENTS

I wish to acknowledge and offer my earnest gratitude to a number of people who have provided assistance and support throughout my doctoral studies and who have contributed to making my experience one of great learning and enjoyment. My studies involved supervisors from the Schools of Pharmacy from two Universities; James Cook University and the University of Tasmania. I am greatly indebted for the expert advice I received from my supervisors in each School.

I wish to express my unqualified appreciation to:

Professor Gregory Peterson, University of Tasmania School of Pharmacy, who gave me and my thesis detailed attention and the benefit of his considerable academic mind.

Professor Beverley Glass, Head of the Discipline of Pharmacy, James Cook University, for encouraging me to follow my interests and for providing expert guidance, support and encouragement. Her support was unrelenting and indispensable.

My special appreciation goes to my wife Carolan, who provided tireless assistance in the implementation and conduct of the medication review trial, guidance on many subjects including nursing; wonderful travelling companion and dedicated editor of my writings. My studies relied heavily on her love, support and efforts and could not have been accomplished without her help.

I wish to thank Associate Professor Alan Nimmo for his perseverance in assisting me through the early days when the initial studies on the Tiwi Islands, Queensland and Tasmania were cancelled due to unforeseen circumstances.

I would also like to thank Professor David Yellowlees, Head of School, JCU School of Pharmacy and Molecular Sciences, who supported me when the initial projects collapsed and kept on encouraging me to continue with my studies.

I am indebted to the staff at the JCU School of Pharmacy who offered their clinical skills to assist me with the medication review trial and for their friendship and support offered throughout my studies. Particularly, I wish to thank Sue Carson for her efforts in assisting with the medication review trial and

Joanne Roache for her tremendous efforts in sending out the hundreds of survey forms and collecting the replies for me to analyse and for doing all those little jobs that can take so much time.

I also acknowledge the wonderful people of the Tiwi Islands and their willingness to accept me as a researcher. It is a source of great regret that I was not able to complete my research on the Tiwi Islands as the project came to a sudden end when the Tiwi Island Health board was placed under administration. This unfortunate situation represented just another example of the difficulties remote communities must deal with on a daily basis.

My thanks are extended to the volunteer patients who participated in the medication review trial for their valuable time and effort and the help of the staff at Queensland Medical Laboratories and the Clifton Beach Medical Centre.

Also my thanks to Peter Scevak and Anne Poppelwell. No one could ask for better friends; always encouraging and ready to provide help and advice.

I wish to specially thank all of the members of my family, for their encouragement, understanding and support. They have always encouraged me to pursue my studies and offered their continual assistance.

To my beautiful daughter, Dr Julie Kimber, who was always available to answer my questions, act as a sounding board and unofficial PhD supervisor. Thank you for the invaluable support you gave to me.

I must also thank my sons, Richard and Shaun. Richard, even though living far away, provided me with a loving, sensible and reliable shoulder to lean on. Shaun, who kept my feet firmly on the ground, making sure that I realised that fun was a vital and necessary part of life and made me laugh, mostly at myself. Thank you to both of you.

A special thanks to my grandchildren Daniel and Zoe, and daughter-in-law Ann-Marie, for just being there to love.

Finally I must remember my Beagle dogs who spent so much of their time just keeping me company, sitting at my feet under my desk. Snoopy and Charlie, who both passed on during my studies and young Bertie who followed their loving example and took their place.

# TABLE OF CONTENTS

STATEMENT OF ACCESS.....	i
STATEMENT OF SOURCES.....	ii
ELECTRONIC COPY.....	iii
ABSTRACT.....	iv
CONTRIBUTION OF OTHERS.....	vii
ACKNOWLEDGEMENTS.....	viii
List of Publications.....	xiv
List of Tables.....	xv
List of Figures.....	xvii
Appendices.....	xxi
Chapter 1 Introduction and Thesis Overview.....	1
1.1 Thesis Title:.....	1
1.2 Introduction.....	1
1.3 Thesis overview.....	3
1.4 Study aims.....	4
1.5 Study hypotheses.....	5
Chapter 2 Review of Pharmacy Services.....	9
2.1 Pharmacy Services and Quality Use of Medicines.....	9
2.1.1 Definitions of Rural and Remote Areas.....	9
2.1.2 Quality Pharmacy Services.....	13
2.1.3 National Medicinal Drug Policies.....	14
2.1.4 Implications for Pharmacy Practice.....	20
2.1.5 Medication Reviews.....	23
2.1.6 Section 100.....	30
2.1.7 Dose Administration Aids.....	32
2.1.8 Implications for the provision of quality pharmaceutical services in rural Australia.....	35
Chapter 3 Review of Telemedicine and Telepharmacy.....	39
3.1 Introduction.....	39
3.2 A brief history of Telemedicine.....	40
3.3 Telemedicine today.....	44
3.4 Telepharmacy systems.....	48
3.4.1 Communication.....	48
3.4.2 Audio.....	49

3.4.3 The facsimile.....	49
3.4.4 Videophones.....	49
3.4.5 The personal computer.....	50
3.5 Telepharmacy: an enabling technology.....	58
3.5.1 Telepharmacy models.....	58
3.5.2 Telepharmacy in Australia.....	64
3.5.3 Pharmacy Automation.....	69
3.6 Chapter summary.....	72
Chapter 4 Field Studies.....	74
4.1 Far North Queensland.....	74
4.2 Tiwi Island Health Board and Birdsville.....	75
4.2.1 Pharmacy Assistant training programs - the Australian Qualifications Framework.....	76
4.2.2 Training of Indigenous Pharmacy Assistants.....	80
4.2.3 Implications for training Pharmacy Assistants on the Tiwi Islands.....	80
4.3 The Birdsville Project.....	81
4.3.1 Health Services.....	81
4.4 West Coast Tasmania Study.....	82
4.4.1 Project Rationale.....	82
4.4.2 Project Outline.....	82
4.5 Survey of Pharmacists on Telepharmacy.....	83
4.6 Chapter Summary.....	85
Chapter 5 Professional Opinions on Telepharmacy.....	87
5.1 Introduction.....	87
5.2 The Surveys.....	91
5.2.1 Introduction.....	91
5.2.2 Survey of Pharmacists in Northern Australia on Telepharmacy.....	93
5.2.3 Survey of Medical Practitioners in Northern Queensland on Telepharmacy.....	112
5.2.4 Survey of Nurses on Telepharmacy.....	122
5.2.5 Survey of Nurses/Healthcare workers on Telepharmacy.....	133
5.3 Discussion of Survey Results.....	139
5.3.1 Combined survey results.....	139
5.3.2 Survey results – pharmacist and medical practitioner groups combined.....	145
5.3.3 Free format comments.....	155
5.4 Hypothesis Testing.....	158
Hypothesis 1 a.....	161
Hypothesis 1 b.....	163

Hypothesis 1 c .....	165
Hypothesis 1 d.....	166
5.4.1 Further testing .....	170
5.4.2 Discussion .....	172
5.5 Chapter Summary .....	173
Chapter 6 Development of a telepharmacy system.....	176
6.1 Introduction.....	176
6.2 Development of a pilot automatic dispensing machine.....	184
6.2.1 Specifications .....	185
6.2.2 Calibration of the equipment.....	205
6.2.3 Study 1. Investigation of the operation of the pilot robotic dispensing machine .....	212
6.2.4 Study 2. Investigation of the operation of the pilot robotic dispensing machine when operated remotely.....	217
Study 3. Investigation of the operation of the pilot cabinet dispensing equipment. ....	224
6.2.5 Study 4. Investigation of the operation of the pilot cabinet dispensing equipment when operated remotely.....	228
6.2.6 Development of Video Conferencing and Imaging units.....	232
6.3 Hypothesis Testing.....	236
6.4 Chapter Summary .....	238
Chapter 7 Medication Reviews .....	240
7.1 Medication Reviews, a clinical area of pharmacy that is amenable to telepharmacy .....	240
7.2 The Medication Review trial.....	241
7.3 Design of the Medication Review Trial .....	242
7.3.1 Methodology and patient recruitment .....	243
7.3.2 Selecting a system .....	244
7.4 Procedure .....	244
7.5 Results .....	248
7.5.1 Patient Telepharmacy Experience Survey.....	250
7.6 Discussion .....	254
7.7 Hypothesis Testing.....	256
7.8 Chapter summary .....	257
Chapter 8 Discussion, Recommendations and Conclusion.....	258
8.1 Discussion .....	258
8.2 Recommendations .....	259
8.2.1 Training.....	259
8.2.2 Telepharmacy Systems Implementation .....	260

8.3 Further studies.....	265
8.4 Conclusion .....	266

## List of Publications

The following publication by the candidate has emanated from the work presented in this thesis. The paper is published in a refereed journal.

Kimber MB, Peterson GM. Telepharmacy - Enabling Technology to Provide Quality Pharmacy Services in Rural and Remote Communities.

Journal of Pharmacy Practice and Research. June 2006; Volume 36(2):pages 128-33.

### List of Conference Presentations

The following presentations have been delivered at international pharmacy conferences during the candidature period.

Kimber MB, Rasiah R, Nimmo A, Manning RW. Can Remotely Situated Dispensing and Counselling Units, Controlled by a Pharmacist situated in a Call Centre, provide Quality Pharmaceutical Services to Rural Communities in Outback Australia? World Congress of Pharmacy and Pharmaceutical Sciences

4-9 September 2003; Sydney: FIP; 2003. (Poster Presentation).

Kimber MB. A program for remote communities to resolve access to pharmacists; supply of medicines, and recording of video link pharmacist-patient counselling and secure access to recorded video conferences. World Congress of Pharmacy and Pharmaceutical Sciences 2004; 2004 4-9 September; New Orleans: FIP; 2004. (Poster Presentation).

Kimber MB. Pharmacopoeial standards for medicines in the proposed joint Australia /New Zealand therapeutic products agency. Quality-International 2005 Conference; 21-22 November 2005; London: FIP and RPSGB. (Poster Presentation).

Copies of the above appear in Appendix D



## List of Tables

Table 1: Soviet space missions and their telemedicine applications.....	42
Table 2: NASA space missions and their telemedicine applications .....	42
Table 3: Ten remote sites located at least 2 hours from an urban centre in Queensland .....	45
Table 4: International Telecommunication Union (ITU) Protocols <sup>(102)</sup> .....	56
Table 5: Summary of the available bandwidth of various types of communication networks. ....	57
Table 6: Examples of Rural Dispensing Models.....	68
Table 7: The Australian Qualifications Framework (AQF).....	77
Table 8: Pharmacist Respondents by PhARIA .....	95
Table 9 Summary of Responses - Pharmacist Survey Section 1.....	97
Table 10: Summary of Responses - Pharmacist Survey Section 2.....	100
Table 11: Responses to Pharmacist Survey by Gender - Pearson Chi-Square Tests .....	102
Table 12: Responses to Pharmacist Survey by ARIAGrouping - Pearson Chi-Square .....	105
Table 13: Responses to Pharmacist Survey by Experience Grouping - Pearson Chi-Square .....	107
Table 14: Medical Practitioner ARIA Categories .....	114
Table 15: Summary of Responses - Doctor Survey Section 1 .....	115
Table 16: Summary of Responses - Doctor Survey Section 2 .....	117
Table 17: Responses to Medical Practitioner Survey by Gender –Chi-Square, Kruskal-Wallis test.	119
Table 18: Nurse ARIA Categories .....	124
Table 19: Survey of Nurses Section 1 .....	124
Table 20: Nurse Survey Section 2.....	127
Table 21: Section 1 Responses to Nurse Survey by Gender - Chi-Square, Kruskal-Wallis test..	129
Table 22: Section 2 Responses to Nurse Survey by Gender – Chi-Square, Kruskal-Wallis test.	129
Table 23: Population Nurse Survey Gender Cross-tabulation .....	130
Table 24: Nurse Healthcare worker ARIA Categories.....	134
Table 25: Nurse Healthcare Worker Survey Section 1 .....	135
Table 26: Nurse Healthcare Worker Survey Section 2 .....	137
Table 27: Total Combined Surveys (Pharmacists, Doctors, Nurses and HCWs) Section 1 – Descriptive Statistics and Chi-square.....	139
Table 28: Total Combined Surveys (Pharmacists, Doctors, Nurses and HCWs) Section 2 - Descriptive Statistics and Chi-square.....	142
Table 29: Combined Pharmacist and Medical Practitioner Surveys Section 1 – Descriptive Statistics and Chi-square .....	146

Table 30: Combined Pharmacist and Medical Practitioner Surveys Section 2 – Descriptive Statistics and Chi-square .....	149
Table 31: Section 2 Questions Collapsed variables – Total Combined Surveys (Pharmacists, Doctors, Nurses and HCWs).....	159
Table 32: Section2 Pharmacist Group Questions, 7&8 analysed by grouping variables .....	168
Table 33: Section 2 Questions Collapsed variables – Combined Pharmacist/Medical Practitioner Surveys.....	170
Table 34: Automated Dispensing and Telepharmacy - Relevant Patents .....	181
Table 35: Example of program routine to move a product pack from location A1(Fig 69) .....	204
Table 36: Robotic Calibration cycle times and final pack positions .....	208
Table 37: Robotic local run cycle times and final pack positions.....	214
Table 38: Robotic local run, cycle times and final pack positions.....	215
Table 39: Robotic Remote Run Cycle times.....	219
Table 40: Robotic Remote Place Precision.....	220
Table 41: Cabinet version cycle times .....	226
Table 42: Cabinet version remote operation - cycle times.....	230
Table 43: Webcam and Video Conference Software Evaluation.....	233
Table 44: Medication Review Trial - Audio and Video Quality.....	248
Table 45: Patient Telepharmacy Experience Survey Responses .....	249
Table 46: Gender and Birth Year of Telepharmacy Medicine Review Trial Participants .....	250
Table 47: Patient Telepharmacy Medicine Review Trial Opinions on Quality of Video .....	250
Table 48: Patient Telepharmacy Medicine Review Trial Opinions on Quality of Sound.....	251
Table 49: Patient Telepharmacy Medicine Review Trial Opinions on the time taken to organise the video conference. ....	251
Table 50: Patient Telepharmacy Medicine Review Trial Opinions on the privacy of the video conference. ....	252
Table 51: Patient Telepharmacy Medicine Review Trial Opinions on how well the pharmacist answered his/her questions during the video conference.....	252
Table 52: Patient Telepharmacy Medicine Review Trial Opinions on the overall telepharmacy experience. ....	253
Table 53: Patient Telepharmacy Medicine Review Trial Opinions if telephone could be used for a Medication Review if videoconferencing was not available. ....	253

## List of Figures

Figure 1: Localities further than 80 km from a pharmacy – dark shaded areas (GISCA) .....	1
Figure 2: Prescription Collection Box in a Supermarket – Rural Australia 2004 .....	2
Figure 3: Graphical representation of the structure of the thesis .....	7
Figure 4: DAA packaging (Webster® packs) in the Tiwi Islands <sup>(71)</sup> .....	34
Figure 5: Primary Telemedicine Research .....	47
Figure 6: Example of peripheral devices for the personal computer. ....	50
Figure 7: D. Example of bar code reader. ....	51
Figure 8: C. Web camera example (Logitech Quickcam Sphere).....	51
Figure 9: D. Data (image) acquisition device on stand .....	52
Figure 10: Example of a set top videoconferencing unit (PolyCom Corp).....	55
Figure 11: North Dakota Telepharmacy Flow Chart .....	59
Figure 12: Washington State Telepharmacy - Clifton et al. - Provision of pharmacy services to underserved populations via remote dispensing and two-way videoconferencing. <sup>(115)</sup> .....	61
Figure 13: RFDS Medical Chest (1) .....	64
Figure 14: RFDS Medical Chest (2) .....	64
Figure 15: Possible Telepharmacy applications: Medication Reviews via video-link.....	67
Figure 16: Cape York Peninsula Clinic and Dispensary - no pharmacist available.....	75
Figure 17: Pharmacy respondents by PhARIA area where they practice. ....	95
Figure 18: Pharmacist survey-Population of the town/city where practising by ARIA group. ...	104
Figure 19: Pharmacist survey-Medication reviews, carried out by using telepharmacy, would require the help of a trained assistant, by ARIA group. ....	104
Figure 20: Pharmacist thinks that it is feasible to use telepharmacy to provide professional health care services.....	108
Figure 21: Pharmacist thinks that HMRs could be carried out by using telepharmacy. ....	109
Figure 22: Pharmacist thinks there is potential for a Call Centre, operated by pharmacists, using telepharmacy, to dispense prescriptions for rural and remote communities when the local pharmacy is closed. ....	109
Figure 23: Pharmacist thinks there is potential for pharmacies using telepharmacy to deliver pharmacy services to remote areas, without pharmacies. ....	110
Figure 24: Doctor provides rural medication services where there is no pharmacy. ....	121
Figure 25: Nurse Group, population of the town/city where practising by ARIA group.....	131

Figure 26: Experience variable -nurse group; potential for pharmacies using telepharmacy to act as a site to deliver pharmacy services (e.g. dispensing by trained assistants under video supervision. ....	132
Figure 27: Provides medicine supply services in any rural and remote areas, where there are no physical pharmacies. ....	148
Figure 28: Pharmacist vs. Doctor-Telepharmacy can improve the provision of health care by pharmacists to rural and remote communities, who may have poor access to health services. ....	153
Figure 29: Pharmacist vs. Doctor-Medication reviews (e.g. HMRs) could be carried out by using telepharmacy. ....	154
Figure 30: Pharmacist vs. Doctor-Medication reviews, carried out by using telepharmacy, would require the help of a trained person or healthcare worker in the remote location to assist the patient during the review. ....	154
Figure 31: Pharmacist vs. Doctor-There is potential for a Call Centre, operated by pharmacists, using telepharmacy, to provide professional health care services like patient counselling, to rural and remote communities when the local pharmacy is closed. ....	155
Figure 32: Pharmacist vs. Doctor-There is potential for a Call Centre, operated by pharmacists, using telepharmacy, to dispense prescriptions for rural and remote communities when the local pharmacy is closed, by operating a remote automated dispensing machine. ....	155
Figure 33: Hypothesis 1: Flow Chart.....	160
Figure 34: Hypothesis 1a-General Question Section 2:1 .....	161
Figure 35: Hypothesis 1a-General Question Section 2:2.....	162
Figure 36: Hypothesis 1a-General Question Section 2:6.....	162
Figure 37: Hypothesis 1b-General Question Section 2:3.....	164
Figure 38: Hypothesis 1b-General Question Section 2:4.....	164
Figure 39: Hypothesis 1c-General Question Section 2:5 .....	165
Figure 40: Hypothesis 1d-General Question Section 2:7.....	166
Figure 41: Hypothesis 1d-General Question Section 2:8.....	167
Figure 42 Section 2: Question 8, by Years of Experience .....	169
Figure 43: Hypothesis 1: Flow Chart pharmacist, medical practitioner group combined.....	171
Figure 44: Hypothesis 1d-Combined Groups - General Question Section 2:7 .....	172
Figure 45: Hypothesis 1d-Combined Groups - General Question Section 2:8 .....	172
Figure 46: Australian Vending Innovations Flow Chart.....	178
Figure 47: Remote controlled dispensing machine (Manning).....	180
Figure 48: ADDS machine - Telepharmacy Solutions (www.telepharmacysolutions.com).....	182
Figure 49: RobotRx McKesson Automation (www.mckesson.com).....	182

Figure 50: ROWA Speed Case ARX Ltd (www.arxinter.net).....	183
Figure 51: MedStation Pyxis® Corporation (www.pyxis.com).....	183
Figure 52: Plan Layout Drawing Design A – Robotic version .....	186
Figure 53: Process Flow chart - Design A – Robotic Version .....	187
Figure 54: Design A – Robotic Version.....	188
Figure 55: Pilot dispensing machine storage compartments.....	189
Figure 56: Vertical elevation - operating envelope Lynx 5 Axis Arm.....	190
Figure 57: Lynx 5 Axis Arm- Version 1 .....	191
Figure 58: Modified Lynx 5 Axis Arm- Version 2 .....	191
Figure 59: Modified Lynx 5 Axis Arm- Version 3 .....	192
Figure 60: Data acquisition and barcode reading.....	193
Figure 61: Design A – Robotic Version.....	194
Figure 62: Flow chart - Design B – Cabinet Version.....	196
Figure 63: Cabinet style storage drawers .....	197
Figure 64: Cabinet style storage drawers, showing top drawer carousel .....	198
Figure 65: Cabinet style storage drawers, showing opening mechanism.....	198
Figure 66: Cabinet style storage drawers, diagram of opening mechanism.....	199
Figure 67: Software Components.....	200
Figure 68: WiniFRED program interface .....	201
Figure 69: Location storage points corresponding to location storage and program routines .....	202
Figure 70: 5 Axes item descriptions.....	203
Figure 71: 5 Axes program interface .....	203
Figure 72: (a) Pick up Point .....	205
Figure 73: (b) Pick up Point.....	206
Figure 74: (a) Discharge Point .....	206
Figure 75: (b) Discharge Point with pack .....	207
Figure 76: Calibration set up.....	207
Figure 77: Robotic Calibration cycle times .....	208
Figure 78: Robotic Calibration final pack positions .....	209
Figure 79: Image of bottom of the pack.....	210
Figure 80: Image of the top of the pack .....	210
Figure 81: Layout of Robotic Dispensing Equipment .....	212
Figure 82: Flow Chart of the Process – Local operation of the robotic dispensing machine.....	213
Figure 83: Robotic local run cycle times .....	214
Figure 84: Robotic local run, final pack placement positions.....	215
Figure 85: Laptop operating remote computer.....	217

Figure 86: Flow Chart of the Process – Remote operation of the robotic dispensing machine ...	218
Figure 87: Robotic Remote Run Cycle times .....	219
Figure 88: Robotic Remote Run Placement Precision .....	220
Figure 89: Robotic Dispensing Equipment with Video Conferencing capability via a second dedicated PC.....	223
Figure 90: Flow Chart of the Process – Local operation of the cabinet dispensing equipment ...	224
Figure 91: Cabinet dispensing unit .....	225
Figure 92: Cabinet version cycle times.....	226
Figure 93: Image and Bar Code acquisition- remote operation of the cabinet dispensing equipment .....	228
Figure 94: Flow Chart of the Process – Remote operation of the cabinet dispensing equipment	229
Figure 95: LHS-SPARC type video kiosk and RHS-Pilot videoconferencing trial unit (Mk 2) .	232
Figure 96: Image Capture Devices.....	234
Figure 97: Images from webcams - C = PC, D = iMac.....	235
Figure 98: WiniFred Note section with pack image file details.....	237
Figure 99: Room Layout for Medication Review Trial .....	245
Figure 100: Videoconference, Pharmacist View, Interview Room 2.....	246
Figure 101: Medication Review Trial product images.....	246
Figure 102: Videoconference, Patient View, Interview Room 1 .....	247
Figure 103: Third computer with imaging device attached Interview Room 1 .....	247
Figure 104: Implementation progression pyramid .....	261
Figure 105: Tiwi Island Pharmacy Project touch screen dispensing system demonstrated by an AHW at Nguiu Pharmacy, Tiwi Islands. <sup>(71)</sup> .....	262
Figure 106: Imaging device .....	263

## **Appendices**

**Appendix A – Ethical Approvals**

**Appendix B – Surveys**

**Appendix C – Patient Trial**

**Appendix D - Publications**

**Appendix E – West Coast Tasmania Report**

**Appendix F – North Dakota Manuscript and Approval to distribute**

**Appendix G – Medication Reviews – Recorded Patient Video Conference DVD**