



UNIVERSITY
OF TASMANIA

The Impact of Focused Transthoracic Echocardiography in Non-cardiac Anaesthesia and Surgery

by

David Jeffrey Canty

M.B.B.S (Hons) F.A.N.Z.C.A. PGDipEcho

Faculty of Medicine

**Submitted in fulfilment of the
requirements for the Degree of**

DOCTOR OF PHILOSOPHY

University of Tasmania November 2012

Dedication

**To Susan, Byron and Zara,
without their understanding and support,
this journey would not have been made.**

"A new idea is first condemned as ridiculous and then dismissed as trivial, until finally, it becomes what everybody knows"

Swami Vivekananda

19th century Indian saint, philosopher

Abstract

Transthoracic echocardiography (TTE), usually performed by cardiologists, is increasingly used by physicians at the patient's bedside. Focused TTE is an abbreviated study used as part of clinical assessment to improve diagnostic accuracy and aid clinical decision-making in real-time. Cardiac disease is a leading cause of perioperative mortality, which may be contributed to by poor preoperative cardiac assessment. The hypothesis is that focused TTE influences cardiovascular diagnosis and management by anaesthetists.

An audit of focused TTE revealed changes to anaesthetist's management plans in 53% of 87 patients undergoing emergency surgery (75%), elective surgery (56%) and preoperative assessment clinic assessment (22%). TTE helped guide preoperative cardiology referral, anaesthetic technique, invasive monitoring and postoperative disposition. TTE was possible in 10 out of 24 patients with intraoperative haemodynamic instability, avoiding need for transoesophageal echocardiography and associated risk of oesophageal injury.

I conducted prospective observational studies of 100 patients attending the preoperative assessment clinic for elective surgery; and 99 patients requiring emergency surgery. In patients with clinically suspected cardiac disease or age ≥ 65 years, the anaesthetist's management plan was compared before and after TTE performed by an independent anaesthetist.

In elective surgery, the TTE findings triaged patients to those with significant cardiac pathology leading to a step-up in care (20%), and those without, leading to a step-down in care (34%). Management was also altered in asymptomatic patients aged over 65 years (step-up in 10%, step-down in 15%). An overall reduction in hospital resource use (cardiology referral, invasive monitoring and intensive care) and improved efficiency (less delays and hospital visits) resulted.

In emergency surgery, TTE revealed significant cardiac pathology in 75%, altering preoperative assessment in 67% leading to a higher step-up (36%) than step-down (8%) in treatment. Haemodynamic treatment changes (such as fluids and invasive monitoring) were more common (30%) than changes to surgical workflow and postoperative intensive care (14%).

In a retrospective cohort sub-analysis, the mortality of 64 hip fracture patients who received preoperative TTE was compared to a randomised retrospective control group with similar risk factors. Mortality was lower in the TTE group over the 30 days (4.7% v 15.2%, $p=0.047$) and 12 months after surgery (17.1% versus 33.3%, $p=0.031$). Hazard of death over 12 months was reduced after adjustment for known risk factors (hazard ratio 0.41, 95% CI 0.2 to 0.85, $p=0.016$).

In surgical patients at increased risk of cardiac disease, preoperative focused TTE by anaesthetists frequently changed management decisions and may reduce mortality.

Declaration

This is to certify that

This thesis comprises only original work completed by the author for the degree Doctor of Philosophy at the University of Tasmania.

1. This thesis contains no material which has been accepted for a degree or diploma by the University or any other institution, except by way of background information and duly acknowledged in the thesis, and to the best of my knowledge and belief no material previously published or written by another person except where due acknowledgement is made in the text of the thesis, nor does the thesis contain any material that infringes copyright.
2. This thesis may be made available for loan and limited copying and communication in accordance with the Copyright Act 1968.
3. The research associated with this thesis abides by the international and Australian codes on human and animal experimentation, the guidelines by the Australian Government's Office of the Gene Technology Regulator and the rulings of the Safety, Ethics and Institutional Biosafety Committees of the University
4. The thesis is less than 100,000 words in length, exclusive of tables, figure legends, bibliographies and appendices.

Dr. David Canty (candidate)

Date

Statement of co-authorship

The following people and institutions contributed to the publication of work undertaken as part of this thesis:

Dr David Canty, School of Medicine, University of Tasmania

Professor Colin Royse, Department of Pharmacology, University of Melbourne

Professor David Kilpatrick, Department of Medicine, University of Tasmania

Professor Alistair Royse, Department of Surgery, University of Melbourne

Dr. Leigh Bowman, Department of Cardiology, The Royal Hobart Hospital

Dr. Andrea Bowyer, Department of Anaesthesia and Pain Management, The Royal Melbourne Hospital

A/Professor John Faris, Freemantle School of Medicine, University of Notre Dame

A/Professor Michael Veltman, Department of Anaesthesia and Pain Management, Joondalup Hospital

Dr. Darsim Haji, Department of Emergency Medicine, Frankston Hospital

Paper 1 Located in chapter 2

Canty DJ, Royse CF. Audit of anaesthetist-performed echocardiography on perioperative management decisions for non-cardiac surgery. *British Journal of Anaesthesia* 2009; **103**: 352-8.

Candidate was the primary author (75%) and with author 2 (25%) contributed to the idea, its formalisation and development.

Paper 2 Located in chapter 3

Canty DJ, Royse CF, Kilpatrick D, Bowman L, Royse AG. The impact of focused transthoracic echocardiography in the pre-operative clinic. *Anaesthesia* 2012; **67**: 618-25.

Candidate was the primary author (70%) and with author 2 (20%) and 5 (5%) contributed to the idea, its formalisation and development. Candidate performed all data collection which was reviewed by author 4 (5%). Author 3 (5%) contributed to the manuscript.

Paper 3 Located in chapter 4

Canty DJ, Royse CF, Kilpatrick D, Williams DL, Royse AG. The impact of pre-operative focused transthoracic echocardiography in emergency non-cardiac surgery patients with known or risk of cardiac disease. *Anaesthesia* 2012; **67**: 714-20.

Candidate was the primary author (70%) and with author 2 (15%) and 5 (10%) contributed to the idea, its formalisation and development. Candidate performed most of the data collection which was contributed to by author 2 and 5. Authors 3 and 4 (5%) contributed to the manuscript.

Paper 4 Located in chapter 5

Canty DJ, Royse CF, Kilpatrick D, Bowyer A, Royse AG. The impact on cardiac diagnosis and mortality of focused transthoracic echocardiography in hip fracture surgery patients with increased risk of cardiac disease: a retrospective cohort study. *Anaesthesia* 2012; Nov;67(11):1202-9.

Candidate was the primary author (70%) and with author 2 (15%) and 5 (5%) contributed to the idea, its formalisation and development. Candidate supervised the data collection by research nurses and author 4 (5%). Author 3 (5%) contributed to the manuscript.

Paper 5 Located in chapter 1 and 6

Royse C, Canty D, Faris J, Haji D, Veltam M, Royse A. Core review: Physician-performed ultrasound: the time has come for routine use in acute care medicine. *Anesthesia & Analgesia* 2012; Nov; 115(5):1007-28.

Author 1 (35%) and candidate (35%) equal primary authors who contributed to the idea, its formalisation and development. Authors 3 (10%), 4 (5%), 5 (5%) and 6 (5%) contributed to the manuscript

We the undersigned agree with the above stated “proportion of work undertaken” for each of the above published (or submitted) peer-reviewed manuscripts contributing to this thesis:

Signed: _____	_____	_____
Prof Colin Royse	Prof David Kilpatrick	Prof James Vickers
Supervisor	Supervisor	Head of School
School of Medicine	School of Medicine	School of Medicine
University of Melbourne	University of Tasmania	University of Tasmania

Date: _____	_____	_____
-------------	-------	-------

Acknowledgements

Professor Colin Royse provided the vision, guidance and support for this research program and he continues to be a remarkable role-model and I am honoured to work with him and his team. Professor Alistair Royse provided considerable support from design to print, was the information technology expert and also performed echocardiography. Professor David Kilpatrick provided valuable insight from a cardiologist's point of view and provided guidance and administrative support as a supervisor from The University of Tasmania. I also was inspired and encouraged by other original members of the Ultrasound Education Group including A/Prof John Faris and A/Prof Michael Veltam. Dr Darsim Haji, a fellow candidate, provided valuable assistance, comradeship and good company

I am grateful for the assistance of a number of staff at the Royal Melbourne and Royal Hobart hospitals, including the Directors of Anaesthesia; Dr Stephen Reid, Dr Haydn Perndt and A/Prof Daryl Williams, and the research nurses who performed screening and recruitment of subjects and data collection and entry: Mrs Zelda Williams, Ms Jenny Pang, Ms Susan Kelly, Mr Rodney Jansen, Ms Penelope Turner and Ms Teresa Grabek. I also thank the anaesthetists who assisted in performing echocardiographic studies: Dr. David Andrews, Dr. Paul Soeding and Dr. Andrew MacCormick. Statistical advice was given by Dr. Sandy Clarke from The University of Melbourne.

This PhD candidature was funded by a scholarship grant provided by Australasian and New Zealand College of Anaesthetists. Additional funding was provided by The University of Melbourne (Department of Pharmacology).

I am indebted to both my parents for setting me on track and providing inspiration and support.

TABLE OF CONTENTS

ABSTRACT	IV
DECLARATION	V
STATEMENT OF CO-AUTHORSHIP	VI
ACKNOWLEDGEMENTS	VIII
TABLE OF CONTENTS	IX
TABLE OF FIGURES	XI
LIST OF TABLES	XII
ABBREVIATIONS	XIII
PREFACE	XIV

CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW	15
1.1. INTRODUCTION	16
1.2. ULTRASOUND FOR NON-CARDIOLOGISTS-WHERE DID IT START?	17
1.3. THE ROLE OF TECHNOLOGY IN THE EVOLUTION OF ULTRASOUND USE	19
1.4. THE EXPERTISE PYRAMID	21
1.4.1.ULTRASOUND IN INTENSIVE CARE.....	24
1.4.2.ULTRASOUND IN ANAESTHESIA	24
1.5. IS ULTRASOUND EFFECTIVE?	27
1.5.1.TRANSOESOPHAGEAL ECHOCARDIOGRAPHY.....	27
1.5.2 TRANSTHORACIC ECHOCARDIOGRAPHY	33
1.5.3.LUNG ULTRASOUND	37
1.5.4.ULTRASOUND-GUIDED VASCULAR ACCESS.....	38
1.5.5.ULTRASOUND-GUIDED REGIONAL ANAESTHESIA	38
1.5.6.GOAL-FOCUSED TTE:	
SEPARATING THE “GOOD, THE BAD AND THE UGLY”	39
1.6. AIMS AND OBJECTIVES OF THIS WORK.....	43
1.6.1.AUDIT OF ANAESTHETIST-PERFORMED ECHOCARDIOGRAPHY.....	44
1.6.2.PREOPERATIVE ASSESSMENT CLINIC	45
1.6.3EMERGENCY SURGERY	47
1.6.4.OUTCOME AFTER HIP FRACTURE SURGERY	48

CHAPTER 2

AUDIT OF ANAESTHETIST PERFORMED ECHOCARDIOGRAPHY....	49
2.1. INTRODUCTION	50
2.2. METHODS	51
2.3. RESULTS.....	52
2.3.1.PREOPERATIVE ASSESSMENT CLINIC	58
2.3.2.TTE BEFORE ANAESTHESIA AND SURGERY	58
2.3.3.UNDER ANAESTHESIA AND DURING SURGERY	59
2.3.4.POSTOPERATIVE STUDIES	59
2.4. DISCUSSION.....	60

CHAPTER 3	
FOCUSED TTE IN THE PREOPERATIVE ASSESSMENT CLINIC	63
3.1. INTRODUCTION	64
3.2. METHODS.....	66
3.3. RESULTS.....	68
3.4. DISCUSSION.....	73
CHAPTER 4	
FOCUSED TTE IN EMERGENCY SURGERY	75
4.1. INTRODUCTION	76
4.2. METHODS.....	77
4.3. RESULTS.....	79
4.4. DISCUSSION.....	84
CHAPTER 5	
FOCUSED TTE AND OUTCOME AFTER HIP FRACTURE SURGERY ..	86
5.1. INTRODUCTION	87
5.2. METHODS.....	89
5.3. RESULTS.....	90
5.4. DISCUSSION.....	96
CHAPTER 6	
SUMMARY	99
6.1. OVERVIEW.....	100
6.2. SUMMARY OF THE OUTCOMES OF THE LITERATURE REVIEW.....	101
6.3. SUMMARY OF THE RESEARCH FINDINGS AND ITS RELEVANCE TO THE LITERATURE	102
6.4. STRENGTHS AND LIMITATIONS OF THE RESEARCH	107
6.5. FUTURE AVENUES OF RESEARCH.....	109
6.6. HOW DO WE ACHIEVE ULTRASOUND FOR EVERYONE?.....	111
6.7. IS THERE A DANGER IN WIDESPREAD ADOPTION OF ULTRASOUND?.....	114
6.8. SUMMARY	115
APPENDIX.....	116
APPENDIX 1 HEARTSCAN PROTOCOL.....	117
APPENDIX 2 HEARTSCAN REPORT FORM.	119
APPENDIX 3 RESEARCH QUESTIONNAIRES PREOPERATIVE CLINIC STUDY	120
APPENDIX 4 RESEARCH QUESTIONNAIRES EMERGENCY SURGERY STUDY	123
APPENDIX 5 RESEARCH GRANTS, PRESENTATIONS AND AWARDS	126
REFERENCES.....	128