http://researchspace.auckland.ac.nz

ResearchSpace@Auckland

Copyright Statement

The digital copy of this thesis is protected by the Copyright Act 1994 (New Zealand).

This thesis may be consulted by you, provided you comply with the provisions of the Act and the following conditions of use:

- Any use you make of these documents or images must be for research or private study purposes only, and you may not make them available to any other person.
- Authors control the copyright of their thesis. You will recognise the author’s right to be identified as the author of this thesis, and due acknowledgement will be made to the author where appropriate.
- You will obtain the author’s permission before publishing any material from their thesis.

To request permissions please use the Feedback form on our webpage. http://researchspace.auckland.ac.nz/feedback

General copyright and disclaimer

In addition to the above conditions, authors give their consent for the digital copy of their work to be used subject to the conditions specified on the Library Thesis Consent Form and Deposit Licence.

Note : Masters Theses

The digital copy of a masters thesis is as submitted for examination and contains no corrections. The print copy, usually available in the University Library, may contain corrections made by hand, which have been requested by the supervisor.
The effects of three different implementation strategies for heart failure guidelines on the management of heart failure in New Zealand primary care: a cluster randomised trial

VOLUME 1

Victoria Sofie Haver Andersen

A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy in General Practice The University of Auckland, 2011.
Abstract

This thesis aimed to evaluate the effectiveness of three implementation strategies on change over time in the primary care management of heart failure (HF) in New Zealand. Emergence of the Internet as a tool for continuing medical education (CME) prompted the study, which compared an Internet-based CME course, small–group education sessions and a passive mail-out of national guidelines. These were “one-off” educational interventions as is common in CME.

A single-blind stratified cluster randomised controlled trial (cRCT) design was used. Sixty nine practices were randomised to one of the three implementation strategies. The two active arms participated in almost identical education sessions based on four recommendations of the 2001 New Zealand Heart Foundation HF guideline. These recommendations were selected as primary study outcomes because their performance was suboptimal. Two of the recommendations – use of echocardiography and use of high dose angiotensin converting enzyme inhibitors (ACEi) – were not new in HF management. Introduction of β-blockers to the treatment schedule illustrated a dramatic change in accepted treatment. The indication for reintroducing spironolactone for HF had changed.

Patients were identified using a HF scoring system. Twenty four practices completed the study and 359 patients participated. Retrospective data were collected from the patient cohort for up to five years.

Most echocardiograms were performed before the educational intervention. In each group, ACEi prescription decreased over time, β-blocker use increased and spironolactone use remained static. None of the three implementation strategies had a statistically significant effect on outcomes. Two patient variables that negatively predicted echocardiography referral and prescribing were older age and female sex. The increase in β-blocker prescribing was mainly attributed to initiations that occurred
in secondary care before the educational intervention. The intervention arms did not affect the dose prescribed. Older age was negatively associated with dose.

None of the implementation strategies was superior in promoting change in primary care. Changes that occurred either were negative or could be attributed to factors operating beyond the control of the study, not to education. Ongoing work is required to develop interventions that will reduce barriers to changing HF management in primary care.
Acknowledgements

I would like to acknowledge my supervisors, Professor Bruce Arroll and Associate Professor Stephen Buetow for their support and in seeing this thesis through to its conclusion.

I would also like to thank the other members who initially formed the study team, Professor Ross McCormick, Associate Professor Ngaire Kerse, Associate Professor Felicity Goodyear-Smith and Mr Dennis Kerins.

My thanks also go to Elizabeth Robinson, biostatistician, who was always a delight to work with.

There were many people who helped make this study possible. Thank you to the GPs, practice managers, nurses and other practice staff, and the large proportion of patients who participated. The work of the research assistants should also be recognised. Thanks also to HealthWest and Comprehensive PHOs who allowed the study to be undertaken in their districts. I am grateful to the RNZCGP for giving the study accreditation as a continuous quality improvement activity for GPs.

This study would not have proceeded without the funding from the New Zealand Medical Education Trust, the Campbell Maclaurin and Phil Barham Fund for the Support of Research & Development in Continuing Medical Education in General Practice (Auckland Medical Research Foundation), the University of Auckland Research Committee, and the Waitemata DHB.

Thank you to friends and Departmental staff members for their help along the way.

And finally, thank you to my Mother, Björg Andersen and my husband, Richard Eriksen for their love and support (and proof-reading) throughout the PhD process.

“... non confundar in aeternum.”
# Table of Contents

**Volume 1**

Abstract ................................................................................................................................. ii

Acknowledgements ............................................................................................................... iv

Table of Contents ................................................................................................................. v

Volume 1 ............................................................................................................................... v

List of Tables ......................................................................................................................... xii

List of Figures ....................................................................................................................... xvii

List of Abbreviations ........................................................................................................... xviii

1. Introduction ....................................................................................................................... 1

   1.1 Background .................................................................................................................. 1

   1.2 Conceptualising the thesis ......................................................................................... 3

   1.3 Structure of the Thesis ............................................................................................... 5

2. Translating Evidence into Practice .................................................................................. 7

   2.1 Introduction ................................................................................................................ 7

   2.2 Guidelines and evidence-based medicine .................................................................. 8

       2.2.1 Grading systems .............................................................................................. 11

       2.2.2 A description of the New Zealand Heart Failure Guideline ......................... 17

       2.2.3 Primary care attitudes towards guidelines and EBM ........................................ 20

       2.2.4 Summary .......................................................................................................... 22

   2.3 Implementing change in the primary care setting ...................................................... 23

       2.3.1 Sources of information ...................................................................................... 24

       2.3.2 Credibility of sources ....................................................................................... 30

       2.3.3 Format of information ....................................................................................... 31

       2.3.4 Uptake of therapies without an implementation strategy .................................. 34

       2.3.5 Type of GP most likely to implement change ...................................................... 36

       2.3.6 GP and Practice characteristics ........................................................................ 39

       2.3.7 Responsibility to implement change ................................................................... 44

       2.3.8 Summary .......................................................................................................... 45

   2.4 Methods of implementation ........................................................................................ 47
3. Heart Failure .................................................................................................................. 83

3.1 Defining heart failure................................................................................................... 85

3.2 Determining who has heart failure .............................................................................. 86

3.2.1 Prevalence and Incidence ....................................................................................... 86

3.2.1.1 Prevalence ......................................................................................................... 87

3.2.1.2 Incidence ............................................................................................................ 89

3.2.1.3 Knowledge of the extent of heart failure ......................................................... 90

3.2.2 Patients at Risk of Heart Failure ............................................................................ 91

3.2.3 Signs and Symptoms .............................................................................................. 95

3.2.4 Electrocardiogram .................................................................................................. 97

3.2.5 Chest X-Ray ........................................................................................................... 98

3.2.6 Echocardiography .................................................................................................. 99

3.2.6.1 Proportion of suspected HF patients receiving echocardiograms ............... 100

3.2.6.2 Reasons given for not using echocardiography .............................................. 102

3.2.6.3 Accuracy of echocardiography compared with clinical diagnosis .............. 105

3.2.6.4 Difficulties measuring echocardiograms ......................................................... 106

3.2.6.5 Provision of echocardiography reports to primary care ............................ 107

3.2.7 Brain Natriuretic Peptide ....................................................................................... 110

3.2.8 Process of Diagnosis ............................................................................................. 111

3.2.9 Diagnosis in the Elderly ......................................................................................... 116

3.2.10 Summary ............................................................................................................... 117

3.3 Treatment of Heart Failure ......................................................................................... 118

3.3.1 Trial evidence of beneficial treatment outcomes ................................................... 119

3.3.1.1 ACE Inhibitor Dosage ...................................................................................... 119

3.3.1.2 Angiotensin II Receptor Blockers .................................................................. 121

3.3.1.3 ß-blockers ........................................................................................................ 121

3.3.1.4 Spironolactone ............................................................................................... 123

3.3.1.5 Summary ......................................................................................................... 124

3.3.2 Comparability of HF patients in trials and in primary care ................................ 124

3.3.3 Actual treatment in primary care .......................................................................... 126

3.3.3.1 Examples of prescription rates ...................................................................... 127

3.3.3.2 Examples of doses prescribed ....................................................................... 136

3.3.3.3 Effect of age on treatment ............................................................................. 137

3.3.4 Secondary Care ....................................................................................................... 141

3.3.4.1 Diagnosis ........................................................................................................ 141

3.3.4.2 Treatment prescription and dose .................................................................. 144

3.3.4.3 Effect of care provider .................................................................................... 151

3.4 Conclusion .................................................................................................................. 154
4. Methods ........................................................................................................ 156

4.1 Background ................................................................................................. 156

4.1.1 Primary Aim – echocardiography and medications ................................. 156
4.1.2 Secondary Aim – doses of interest ............................................................. 156
4.1.3 Tertiary Aim – diagnosis, initiation of new medications and electrolyte monitoring, specialist input ................................................................. 157
4.1.4 Post-hoc analyses – effect of listed HF diagnosis ..................................... 157
4.1.5 Other – GP feedback ............................................................................... 157
4.1.6 Development of the study ....................................................................... 158

4.2 General Practitioners ................................................................................... 161

4.2.1 Setting ....................................................................................................... 161
4.2.2 Recruitment .............................................................................................. 162
4.2.3 Study design ............................................................................................. 164
4.2.3.1 Methodology and sample size ................................................................. 164
4.2.3.2 Stratification and randomisation ............................................................. 167

4.2.4 Intervention .............................................................................................. 171

4.2.4.1 Development and piloting of the educational intervention ................... 171
4.2.4.2 Contents of the educational intervention .............................................. 172
4.2.4.3 Implementation strategies for the educational intervention ................ 173
4.2.4.4 Monitoring participation ..................................................................... 175

4.3 Defining HF in primary care ....................................................................... 176

4.4 Identifying HF patients and data collection ............................................... 179

4.4.1 Search criteria to identify patients ......................................................... 180
4.4.1.1 Exclusion criteria ................................................................................ 181
4.4.2 Evaluation of potential HF ...................................................................... 182
4.4.2.1 Diagnosis ............................................................................................. 182
4.4.2.2 Contacting participants ..................................................................... 184

4.4.3 Patient characteristics and management ............................................... 185

4.4.3.1 Patient demographics ........................................................................ 185
4.4.3.2 Pre-intervention data ......................................................................... 187
4.4.3.2.1 Physiological variables ................................................................. 187
4.4.3.2.2 Pre-intervention medications ....................................................... 188
4.4.3.3 Post-intervention data ....................................................................... 189
4.4.3.4 Current management data .................................................................. 189

4.5 Outcomes and analysis ............................................................................... 190

4.5.1 Primary outcomes – echocardiography and medications ....................... 192
4.5.2 Secondary outcomes – doses of interest .................................................. 194
4.5.3 Tertiary outcomes – diagnosis, initiation of new medications and electrolyte monitoring, practitioner responsible for prescription, and specialist input .............................................................................. 196
4.5.4 Post-hoc analyses – effect of listed diagnosis ........................................ 198
4.5.5 Other – GP feedback .............................................................................. 201

5. Results ........................................................................................................... 202

5.1 GP and practice variables .......................................................................... 202

5.1.1 Practice and GP participation rate ......................................................... 202
5.1.2 GP characteristics .................................................................................. 203
5.1.3 Patients recruited into the study ............................................................... 206
5.1.4 Contribution of GP / practice variables to analysis ........................................207
5.2 Patient variables ........................................................................................................208
5.2.1 Age .........................................................................................................................208
5.2.2 Sex ............................................................................................................................208
5.2.3 Ethnicity ...................................................................................................................209
5.2.4 Blood Pressure ........................................................................................................211
5.2.5 Heart Rate ...............................................................................................................211
5.2.6 Electrolytes: Creatinine, Sodium, Potassium .......................................................213
5.2.6.1 Creatinine ........................................................................................................213
5.2.6.2 Sodium ................................................................................................................214
5.2.6.3 Potassium ............................................................................................................214
5.2.7 Comorbidities .........................................................................................................216
5.2.8 Contribution of patient variables to model .........................................................218
5.3 Primary outcomes – echocardiography and medications ........................................218
5.3.1 Rates of Echocardiography ....................................................................................219
5.3.1.1 Other diagnostic tests: NT-ProBNP ..................................................................221
5.3.2 Angiotensin inhibition ............................................................................................222
5.3.2.1 ACE inhibitors .....................................................................................................222
5.3.2.2 Angiotensin II receptor blockers .........................................................................224
5.3.2.3 Combined Angiotensin inhibition .....................................................................224
5.3.3 β-blockers ...............................................................................................................226
5.3.4 Spironolactone ........................................................................................................228
5.4 Secondary outcomes – doses of interest ....................................................................229
5.4.1 Prescribed doses of ACE inhibitors and Angiotensin Receptor blockers ..........230
5.4.1.1 ACE inhibitors .....................................................................................................230
5.4.1.2 Angiotensin Receptor blockers .........................................................................230
5.4.1.3 Combined Angiotensin inhibition .....................................................................233
5.4.2 Prescribed doses of β-blockers ...............................................................................235
5.4.3 Prescribed doses of Spironolactone ......................................................................235
5.5 Tertiary outcomes – diagnosis, initiation of new medications and electrolyte monitoring, specialist input .................................................................238
5.5.1 Responsibility for diagnosis ..................................................................................238
5.5.2 Initiation of new medications .................................................................................240
5.5.2.1 Initiation of ACEi and Angiotensin Receptor Blockers .....................................240
5.5.2.2 Initiation of β-blockers .......................................................................................241
5.5.2.3 Initiation of spironolactone .................................................................................242
5.5.2.4 Electrolyte testing and initiation of spironolactone ...........................................242
5.5.3 Practitioner responsible for initiating new medications .........................................245
5.5.3.1 ACE inhibitors .....................................................................................................245
5.5.3.2 Angiotensin Receptor Blockers .........................................................................245
5.5.3.3 β-blockers ............................................................................................................245
5.5.3.4 Spironolactone ....................................................................................................246
5.5.4 Specialist input into management .........................................................................246
5.5.4.1 Examples of letters from specialists .................................................................247
5.5.4.2 GP deliberation over initiating a β-blocker .........................................................252
5.6 Effect of listed diagnosis ............................................................................................253
5.6.1 Echocardiography and annotated HF diagnosis ................................................254
5.6.2 Angiotensin inhibition and annotated HF diagnosis ............................................255
5.6.3 β-blockers and annotated HF diagnosis ...............................................................256
6. Discussion ................................................................................................. 259

6.1 Primary outcomes – echocardiography and medications ...................... 261
  6.1.1 Echocardiography ........................................................................... 261
  6.1.2 Angiotensin inhibition (ACEi and ARB) ........................................ 262
  6.1.3 β-blockers .................................................................................... 263
  6.1.4 Spironolactone ............................................................................ 263
  6.1.5 Summary ..................................................................................... 264

6.2 Secondary outcomes – doses of interest .............................................. 265
  6.2.1 Angiotensin inhibition (ACEi and ARB) dose ................................ 265
  6.2.2 β-blocker dose ............................................................................ 266
  6.2.3 Spironolactone dose .................................................................... 266
  6.2.4 Summary ..................................................................................... 267

6.3 Tertiary outcomes – diagnosis, initiation of new medication and electrolyte monitoring, specialist input ............................................... 267
  6.3.1 Responsibility for diagnosis ......................................................... 268
  6.3.2 Initiation of new medications and electrolyte monitoring ............. 268
    6.3.2.1 Angiotensin inhibition .......................................................... 269
    6.3.2.2 β-blockers ............................................................................ 269
    6.3.2.3 Spironolactone .................................................................... 269
    6.3.2.4 Spironolactone and electrolyte testing ................................. 269
    6.3.2.5 Summary ............................................................................. 270
  6.3.3 Practitioner initiating new medications ........................................... 271
    6.3.3.1 Angiotensin inhibition .......................................................... 271
    6.3.3.2 β-blockers ............................................................................ 271
    6.3.3.3 Spironolactone .................................................................... 271
    6.3.3.4 Summary ............................................................................. 272
  6.3.4 Specialist input ............................................................................ 272

6.4 Post-hoc analyses – effect of listed HF diagnosis ............................... 274
  6.4.1 HF in problem list and echocardiography .................................... 275
  6.4.2 HF in problem list and angiotensin inhibition ............................. 276
  6.4.3 HF in problem list and β-blocker ............................................... 276
  6.4.4 HF in problem list and spironolactone ...................................... 277
  6.4.5 Summary ..................................................................................... 277

6.5 Practice, GP and patient populations ............................................... 278
  6.5.1 GP and practice variables ............................................................ 278
  6.5.2 Patient variables ........................................................................ 279

6.6 Update on HF management in primary care and Internet implementation research ............................................................ 280
  6.6.1 Internet-delivered interventions ................................................. 281
  6.6.2 Improving HF management in primary care ............................... 283
  6.6.3 Back to basics: the Chronic Care Model ..................................... 288
  6.6.4 Forward to the future: reminders to CDSS ................................. 293
  6.6.5 At a fork in the road ................................................................. 296

6.7 Effects of implementation strategies in HF management .................... 296
  6.7.1 Introduction – the different faces of randomised controlled trials .... 297
  6.7.2 Study outcomes ........................................................................ 299
4H. Carvedilol Special Authority application form .............................................. 99
4I. Re-contact letter, questionnaire and second round survey ...................... 101
4J. Patient mail-out pack .................................................................................. 118
4K. Boston Score sheet and completion instructions for research assistants . 123
4L. Patient Demographics data collection sheet and completion instructions for research assistants .......................................................... 132
4M. Pre- and Post-Intervention data collection sheet and completion instructions for research assistants .......................................................... 136
4N. Current Management data collection sheet ............................................... 144
4O. Grouping of listed diagnoses and free text comorbidities ...................... 146
4P. Coding schedule for medications and doses ............................................. 148
4Q. HF scoring systems .................................................................................. 152
  1. WHO criteria ........................................................................................... 154
  2. Framingham criteria ................................................................................ 154
  3. NHANES ................................................................................................ 157
  4. Men born in 1913 .................................................................................... 157
  5. Walma ..................................................................................................... 159
  6. Gheorghiade ............................................................................................ 160
  7. Boston score ........................................................................................... 161

Appendices for Chapter 5. Results .................................................................. 164
5A. Patient numbers by GP, practice size and IPA / PHO ............................... 165
5B. Expanded grouping of ethnicities ............................................................ 168
5C. Angiotensin inhibition prescription by HF group over time ................... 169
5D. β-blocker prescription by HF group over time ....................................... 170
5E. Spironolactone prescription by HF group over time ............................... 171
5F. Prescribed doses of ACE inhibitors ....................................................... 172
5G. Prescribed doses of Angiotensin Receptor Blockers ............................... 173
5H. Combined prescribed doses of ACEI and ARBs .................................... 174
5I. Adjusted means of ACEI for recommended dose and greater ............... 175
5J. Adjusted means of ACEI and ARBs for recommended dose and greater . 175
5K. Prescribed doses of β-blockers ............................................................... 176
5L. Adjusted means of β-blockers for half to recommended dose ............... 177
5M. Prescribed doses of Spironolactone ....................................................... 178
List of Tables

Table 2.2.a. AHCPR evidence source, levels and grades ................................................. 11
Table 2.2.b. Grading system used by SIGN and NICE.................................................... 12
Table 2.2.c. Additional grades of evidence from NICE guidelines .................................. 12
Table 2.2.d. SIGN revised grading system for levels of evidence ................................... 14
Table 2.2.e. SIGN revised system for grades of recommendations ................................... 14
Table 2.2.f. Level of Evidence definitions from ESC and ACC/AHA guidelines over time ......................................................................................................................... 15
Table 2.3.a. Information sources used in primary care .................................................... 26
Table 2.3.b. Influences and important information sources for new drug prescribing ....... 27
Table 2.3.c. Comparison of demographics of oldest and youngest GP groups ............... 39
Table 2.3.d. Demographic differences between single-handed and group practices ....... 41
Table 2.3.e. Comparison of practice indicators for single-handed and group practices 42
Table 2.4.a. Barriers and potential solutions ...................................................................... 50
Table 2.4.b. Barriers that can impact on behaviour change and guideline adherence .... 51
Table 2.4.c. Methods used to change practice ..................................................................... 54
Table 2.4.d. Strength of influences seen in each implementation strategy ................. 55
Table 2.4.e. Expanded domains of Understanding, Psycho-social and cognitive, Resources, and Change in practice ............................................................................. 55
Table 2.4.f. Access to and use of Internet (general and specific) over time ..................... 63
Table 2.4.g. Effect of age on use of Internet for queries about patient care ................. 63
Table 2.4.h. Effect of sex on use of Internet for queries about patient care ................. 64
Table 2.4.i. Information recorded in hospital letters to GPs ............................................ 78
Table 3.2.a. Prevalences of HF by age in the Framingham study ................................... 87
Table 3.2.b. HF prevalence (determined by echocardiography LVEF≤30%) by age-bands for symptomatic patients only ................................................................. 87
Table 3.2.c. Prevalence of HF (expressed as per 1000 patients) in north-west London ... 88
Table 3.2.d. Prevalence of HF by age band for all patients, males and females............ 89
Table 3.2.e. Figures for definite HF and figures for possible HF ........................................ 90
Table 3.2.f. Comparison of annual HF incidence rates for two studies ......................... 90
Table 3.2.g. Comparison across studies of risk factors for developing HF ................. 93
Table 3.2.g continued. Comparison across studies of risk factors for developing HF .. 94
Table 3.2.h. Signs and symptoms thought by GPs to be most suggestive of HF .......... 96
Table 3.2.i. Theoretical domains that can influence behaviour in ordering echocardiograms, initiating prescribing and increasing drug doses in HF ................. 104
Table 3.2.j. Comparison of study definitions of impaired left ventricular systolic function ......................................................................................................................... 109
Table 3.2.k. Diagnostic indicators for HF specified by Euro-HF GPs ............................ 112
Table 3.2.l. Diagnostic tests used in newly diagnosed HF by CASE study GPs .......... 113
Table 3.2.m. Patients with COPD, determined as having HF present or absent and medications and comorbidities ................................................................. 114
Table 3.3.a. Benefits of β-blocker treatment in HF .................................................. 123
Table 3.3.b. Benefits of spironolactone treatment in HF .......................................... 123
Table 3.3.c. Clinical trial enrolment criteria and application to and eligibility of community HF patients ........................................................................................................... 125
Table 3.3.d. Prescription of HF drugs by diagnosis group ........................................... 128
Table 3.3.e. Proportion of prescriptions at target doses .............................................. 136
Table 3.3.f. Mean, median and recommended doses of ACE from the CASE study.. 136
Table 3.3.g. Doses prescribed and proportion titrated to higher doses ...................... 139
Table 3.3.h. Comparison of outcomes for no ACEi and high dose ACEi ................... 140
Table 3.3.i. Dose scale decreases or discontinuations for ACEi ................................. 140
Table 3.3.j. Comparison of echocardiography rates in suspected HF patients admitted to hospital ............................................................. 142
Table 3.3.k. Comparison of investigation rates and patient age ................................. 143
Table 3.3.l. Hospital prescription rates on discharge of ACEi and/or ARBs .............. 145
Table 3.3.m. EuroHeart Failure study ACEi daily doses and ESC 2001 HF guidelines recommended doses ................................................................. 146
Table 3.3.n. Prescription rates of β-blockers by hospitalisations ............................. 148
Table 3.3.o. EuroHeart Failure β-blocker daily doses and ESC 2001 HF guidelines recommended doses ................................................................. 148
Table 3.3.p. Prescription rates of spironolactone by hospitalisation ......................... 149
Table 3.3.q. EuroHeart Failure ORs for receiving HF medications ......................... 150
Table 3.3.r. Mortality associated with ACEi prescription ............................................ 150
Table 3.3.s. Differences in prescription of ACEi and β-blocker by hospital ward ....... 151
Table 3.3.t. Comparison of specialist delivery of care and patient age ..................... 152
Table 4.2.a. Results by practice size of randomisation after stratification .............. 168
Table 4.2.b. Numbers and proportions of GPs who took part in the two active intervention arms comparing the start and conclusion of the study ....................... 175
Table 4.2.c. Numbers and proportions of GPs who returned their PRAs comparing the start and conclusion of the study .................................................. 176
Table 4.3.a. Differences in electrolyte reference values during the study ............... 187
Table 4.5.a. Comparison of carvedilol doses achieved between clinical trials and outpatient / primary care ......................................................................................... 195
Table 4.5.b. Comparison of metoprolol succinate doses achieved between clinical trials and outpatient / primary care .................................................. 195
Table 5.1.a. Participation rate of GPs and practices by study arm ............................. 203
Table 5.1.b. Table of GPs’ sex and date of qualification as GP for those who had eligible HF patients .................................................................................................................. 204
Table 5.1.c. Table of GPs’ sex and time since graduation for non-participating GPs. 204
Table 5.1.d. Table of GPs’ sex and time since graduation presented all randomised GPs .................................................................................................................. 205
Table 5.1.e. 2005 RNZCGP membership survey: sex and length of practice .......... 206
Table 5.1.f. Comparative data of vocational training .................................................. 206
Table 5.1.g. Practices, GPs and patients in the guideline study arm ....................... 206
Table 5.1.h. Practices, GPs and patients in the small group study arm .................. 207
Table 5.1.i. Practices, GPs and patients in the Internet study arm ........................................ 207
Table 5.2.a. Baseline data (demographics, clinical characteristics) for entire patient sample, then by intervention arm for age, sex and ethnicity .......................................................... 210
Table 5.2.b. Pre- and post-intervention blood pressures (systolic and diastolic) and heart rates ......................................................................................................................... 212
Table 5.2.c. Median values for electrolytes measured pre-intervention and post-intervention .................................................................................................................... 215
Table 5.2.d. Comorbidities recorded at the time of data collection ........................................ 217
Table 5.3.a. Patients receiving first-time echocardiogram over time ................................ 219
Table 5.3.b. Reported results for the 209 first-time echocardiograms .............................. 220
Table 5.3.c. Overall ACE inhibitor prescription over time ................................................. 222
Table 5.3.d. ACE inhibitor prescription over time for each study arm ............................. 222
Table 5.3.e. Changes in ACEi prescription between time periods for each group ............ 223
Table 5.3.f. ARB prescription over time .......................................................................... 224
Table 5.3.g. Combined ACEi and ARB prescription over time ....................................... 225
Table 5.3.h. Prescription of combined Angiotensin inhibition for each study group over time ....................................................................................................................... 225
Table 5.3.i. Changes in prescription of angiotensin inhibitors between time periods (raw and adjusted data) ....................................................................................... 226
Table 5.3.j. Overall β-blocker prescription over time ...................................................... 226
Table 5.3.k. β-blocker prescription over time for each study arm .................................. 227
Table 5.3.l. Changes in β-blocker prescription over time for each group ....................... 228
Table 5.3.m. Spironolactone prescription for all groups over time ................................ 228
Table 5.3.n. Spironolactone prescription rates for each arm over time ......................... 229
Table 5.4.a. Comparison of ACE inhibitor doses prescribed in pre-intervention, post-intervention and at 3 years after intervention .................................................. 231
Table 5.4.b. Comparison by study arm of ACE inhibitor doses prescribed in pre-intervention, post-intervention and at 3 years after intervention ........................... 231
Table 5.4.c. Comparison of ARB doses prescribed in pre-intervention, post-intervention and at 3 years after intervention .................................................. 232
Table 5.4.d. Comparison by study arm of ARB doses prescribed in pre-intervention, post-intervention and at 3 years after intervention .................................. 232
Table 5.4.e. Comparison of ACE inhibitor and ARB doses prescribed in pre-intervention, post-intervention and at 3 years after intervention ............................ 234
Table 5.4.f. Comparison by study arm of ACE inhibitor and ARB doses prescribed in pre-intervention, post-intervention and at 3 years after intervention ............... 234
Table 5.4.g. Comparison of β-blocker doses prescribed in pre-intervention, post-intervention and at 3 years after intervention .................................................. 236
Table 5.4.h. Comparison by study arm of β-blocker doses prescribed in pre-intervention, post-intervention and at 3 years after intervention ............................ 236
Table 5.4.i. Comparison of spironolactone doses prescribed in pre-intervention, post-intervention and at 3 years after intervention ............................................. 237
Table 5.4.j. Comparison by study arm of spironolactone doses prescribed in pre-intervention, post-intervention and at 3 years after intervention ......................... 237
Table 5.5.a. New and total prescriptions for ACEi pre- and post-intervention .......... 240
Table 5.5.b. New and total prescriptions for ARBs pre- and post-intervention ..........240
Table 5.5.c. New and total prescriptions for ACEi and ARBs pre- and post-intervention ........................................................................................................241
Table 5.5.d. New and total prescriptions for β-blockers pre- and post-intervention ...242
Table 5.5.e. New and total prescriptions for spironolactone pre- and post-intervention ........................................................................................................242
Table 5.5.f. Number of doctors who initiated prescriptions of ACE inhibitors ....245
Table 5.5.g. Number of doctors who initiated prescriptions of ARBs ..................245
Table 5.5.h. Number of doctors who initiated prescriptions of β-blockers ..........245
Table 5.5.i. Number of doctors who initiated prescriptions of spironolactone .......246
Table 5.6.a. Timing of listed HF diagnosis by intervention study arm ..254
Table 5.6.b. Rates of echocardiography (adjusted) by HF group ........................254
Table 5.6.c. Analysis of variables for echocardiography and HF group ...............255
Table 5.6.d. Angiotensin inhibition prescription (adjusted) by HF group ...............255
Table 5.6.e. Analysis of variables for angiotensin inhibition and HF group ..........256
Table 5.6.f. β-blocker prescription (adjusted) by HF group .................................257
Table 5.6.g. Analysis of variables for β-blocker prescription and HF group .........257
Table 5.6.h. Spironolactone prescription (adjusted) by HF group .......................258
Table 5.6.i. Analysis of variables for spironolactone prescription and HF group ......258
Table 6.6.a. Comparison of intervention and control education for guideline adherence ...............................................................284
Table 6.6.b. A comparison of drugs entered into template, CDSS suggestions and GP changes ........................................................................................................295
Table 6.9.a. Examples of prescribing indicators that could be useful for HF .........323

Volume 2

Table 4D.i. CHS/Comprehensive GPs and practices randomised and participating ....21
Table 4D.ii. IPCS/HealthWest GPs and practices randomised and participating ........21
Table 4D.iii. CHS/Comprehensive GPs and practices randomised and participating ...21
Table 4D.iv. IPCS/HealthWest GPs and practices randomised and participating ......22
Table 4D.v. CHS/Comprehensive GPs and practices randomised and participating ...22
Table 4D.vi. IPCS/Health West GPs and practices randomised and participating ......22
Table 4Q.i. WHO criteria for HF diagnosis ............................................................154
Table 4Q.ii. Framingham criteria for the diagnosis of HF .....................................155
Table 4Q.iii. Calculations for Framingham criteria from the Rotterdam Study .......156
Table 4Q.iv. HF present or absent by Framingham score and comparative EF ........156
Table 4Q.v. Calculations for NHANES criteria from the Rotterdam Study ..........157
Table 4Q.vi. Scoring system for HF from Men born in 1913 ..................................158
Table 4Q.vii. Calculations for Men born in 1913 criteria from the Rotterdam Study ....158
Table 4Q.viii. Walma HF scoring system .........................................................159
Table 4Q.ix. Calculations of diagnostic accuracy for Walma criteria ....................159
Table 4Q.x. Calculations for Gheorghiade criteria ................................................................. 160
Table 4Q.xi. Criteria for scoring the certainty of HF diagnosis, the Boston score ............. 161
Table 4Q.xii. Relationship between clinical classification and LVEF .................................. 162
Table 4Q.xiii. Calculations for Boston score from the Rotterdam Study ............................ 162
Table 5A.i. Patients per GP for CHS/Comprehensive guideline arm .................................. 165
Table 5A.ii. Patients per GP for IPCS/HealthWest guideline arm ..................................... 165
Table 5A.iii. Patients per GP for CHS/Comprehensive small group arm ......................... 166
Table 5A.iv. Patients per GP for IPCS/HealthWest GPs in the small group arm ............. 166
Table 5A.v. Patients per GP for CHS/Comprehensive Internet study arm ..................... 167
Table 5A.vi. Patients per GP for IPCS/HealthWest Internet study arm ......................... 167
5B.i. Reported ethnicities for all patients who participated in the study ............................. 168
Table 5C.i. Timing of diagnosis and Angiotensin inhibitor prescription, pre-intervention .......................................................................................................................... 169
Table 5C.ii. Timing of diagnosis and Angiotensin inhibitor prescription, post-intervention .......................................................................................................................... 169
Table 5C.iii. Timing of diagnosis and Angiotensin inhibitor prescription, current management .......................................................................................................................... 169
Table 5D.i. Timing of diagnosis and β-blocker prescription, pre-intervention .................. 170
Table 5D.ii. Timing of diagnosis and β-blocker prescription, post-intervention .............. 170
Table 5D.iii. Timing of diagnosis and β-blocker prescription, current management ......... 170
Table 5E.i. Timing of diagnosis and spironolactone prescription, pre-intervention ........... 171
Table 5E.ii. Timing of diagnosis and spironolactone prescription, post-intervention ...... 171
Table 5E.iii. Timing of diagnosis and spironolactone prescription, current management .......................................................................................................................... 171
5F.i. ACEi doses prescribed over time, all dose scales ....................................................... 172
5F.ii. ACEi doses prescribed over time by each study arm, all dose scales ..................... 172
5G.i. ARB doses prescribed over time, all dose scales ....................................................... 173
5G.ii. ARB doses prescribed over time by each study arm, all dose scales ..................... 173
5H.i. ACEi and ARB doses prescribed over time, all dose scales ..................................... 174
5G.iii. ACEi and ARB doses prescribed over time by each study arm, all dose scales ...... 174
5I.i. Adjusted means and 95%CI for ACEi guideline-recommended dose and higher by study arm and time period ......................................................................................... 175
5I.ii. Adjusted means and 95%CI for ACEi and ARBs at guideline-recommended dose and higher by study arm and time period ......................................................................................... 175
5K.i. β-blocker doses prescribed over time, all dose scales .............................................. 176
5K.ii. β-blocker doses prescribed over time by each study arm, all dose scales .............. 176
5L.i. Adjusted means and 95%CI for β-blockers at half to guideline-recommended dose by study arm and time period ......................................................................................... 177
5M.i. Spironolactone doses prescribed over time, all dose scales ................................ 178
5M.ii. Spironolactone doses prescribed over time by each study arm, all dose scales 178
List of Figures

Figure 4.1.a. Study Timeline ............................................................................................................. 160
Figure 4.2.a. Flow chart detailing the process of recruitment and follow up ......................... 163
Figure 4.2.b. Flowchart of recruitment of practices and GPs. Practice and GP numbers at the start, randomisation, participation and conclusion of the study. ...................... 170
Figure 5.3.a. Note regarding cost of BNP tests, recorded on test results from late 2005 .......................................................................................................................... 221
Figure 5.5.a. Example from patient 001003 regarding ACE inhibitor and β-blocker . 247
Figure 5.5.b. Example from patient 135003 regarding ACEi dose and blood pressure .......................................................................................................................... 247
Figure 5.5.c. Patient 135003 further adjustments to medications ............................................. 248
Figure 5.5.d. From patient 057006. Electrolyte testing advised after spironolactone and benefits of β-blocker emphasised ........................................................................ 248
Figure 5.5.e. Less informative letter regarding management of patient 057006 ................. 249
Figure 5.5.f. Detailed letter to GP of patient 101005 at the end of 2001 ................................. 249
Figure 5.5.g. Detailed follow-up letter regarding patient 101005 ........................................... 249
Figure 5.5.h. Details of patient’s symptoms, possible causes and the steps the cardiologist took, including reinforcing patient education, and re-iteration of evidence .......................................................................................................................... 250
Figure 5.5.i. Cardiologist indicating the steps that they will take to manage the patient (054003) ......................................................................................................................... 250
Figure 5.5.j. Vague management recommendations from the hospital cardiologist.............. 251
Figure 5.5.k. Instruction to GP to commence spironolactone .................................................. 251
Figure 5.5.l. Reasoning for not introducing β-blocker in an ‘elderly’ patient (057004) ............. 251
Figure 5.5.m. Instructions given to GP on increasing ACEi dose ............................................. 251
Figure 5.5.n. GP’s notes considering the initiation of β-blocker in a patient ......................... 252
Figure 5.5.o. Initiating a β-blocker still in the forefront of management for this patient .......... 252
## List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACC</td>
<td>American College of Cardiology</td>
</tr>
<tr>
<td>ACEi</td>
<td>Angiotensin Converting Enzyme inhibitor</td>
</tr>
<tr>
<td>AGREE</td>
<td>Appraisal of Guidelines Research and Evaluation (Instrument)</td>
</tr>
<tr>
<td>AHA</td>
<td>American Heart Association</td>
</tr>
<tr>
<td>AHCA</td>
<td>Agency for Health Care Policy and Research – now the AHRQ</td>
</tr>
<tr>
<td>AHRQ</td>
<td>Agency for Healthcare Research and Quality – formerly the AHCPR</td>
</tr>
<tr>
<td>ARB</td>
<td>Angiotensin Receptor Blocker</td>
</tr>
<tr>
<td>BMI</td>
<td>Body Mass Index</td>
</tr>
<tr>
<td>BNF</td>
<td>British National Formulary</td>
</tr>
<tr>
<td>BNP</td>
<td>Brain Natriuretic Peptide (see also NT-Pro BNP)</td>
</tr>
<tr>
<td>CABG</td>
<td>Coronary Artery Bypass Graft</td>
</tr>
<tr>
<td>CFPC</td>
<td>The College of Family Physicians of Canada</td>
</tr>
<tr>
<td>CHD</td>
<td>Coronary Heart Disease</td>
</tr>
<tr>
<td>CI</td>
<td>Confidence Interval</td>
</tr>
<tr>
<td>CME</td>
<td>Continuing Medical Education</td>
</tr>
<tr>
<td>COPD</td>
<td>Chronic Obstructive Pulmonary Disease</td>
</tr>
<tr>
<td>cRCT / cRT</td>
<td>cluster Randomised Controlled Trial / cluster Randomised Trial</td>
</tr>
<tr>
<td>CTR</td>
<td>Cardio Thoracic Ratio</td>
</tr>
<tr>
<td>CXR</td>
<td>Chest X-Ray</td>
</tr>
<tr>
<td>DHB</td>
<td>District Health Board (NZ)</td>
</tr>
<tr>
<td>DM</td>
<td>Diabetes Mellitus</td>
</tr>
<tr>
<td>DTB</td>
<td>Drugs and Therapeutics Bulletin</td>
</tr>
<tr>
<td>EBM</td>
<td>Evidence-Based Medicine</td>
</tr>
<tr>
<td>ECG</td>
<td>Electrocardiograph / Electrocardiography / Electrocardiogram</td>
</tr>
<tr>
<td>Echo</td>
<td>Echocardiograph / Echocardiography / Echocardiogram</td>
</tr>
<tr>
<td>EF</td>
<td>Ejection Fraction</td>
</tr>
<tr>
<td>ESC</td>
<td>European Society of Cardiology</td>
</tr>
<tr>
<td>GP</td>
<td>General Practitioner</td>
</tr>
<tr>
<td>HF</td>
<td>Heart Failure</td>
</tr>
<tr>
<td>IPA</td>
<td>Independent Practitioner Association (NZ) became PHO</td>
</tr>
<tr>
<td>JVP</td>
<td>Jugular Venous Pressure</td>
</tr>
<tr>
<td>LV</td>
<td>Left Ventricle / Ventricular</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>LVD</td>
<td>Left Ventricular Dysfunction</td>
</tr>
<tr>
<td>LVEF</td>
<td>Left Ventricular Ejection Fraction</td>
</tr>
<tr>
<td>LVF</td>
<td>Left Ventricular Failure</td>
</tr>
<tr>
<td>LVFx</td>
<td>Left Ventricular Function</td>
</tr>
<tr>
<td>LVSD</td>
<td>Left Ventricular Systolic Dysfunction</td>
</tr>
<tr>
<td>LVSFx</td>
<td>Left Ventricular Systolic Function</td>
</tr>
<tr>
<td>MI</td>
<td>Myocardial Infarction</td>
</tr>
<tr>
<td>MIMS</td>
<td>Monthly Index of Medical Specialities</td>
</tr>
<tr>
<td>NICE</td>
<td>National Institute for Clinical Excellence or since April 2005 National Institute for Health and Clinical Excellence.</td>
</tr>
<tr>
<td>NPV</td>
<td>Negative Predictive Value</td>
</tr>
<tr>
<td>NT-ProBNP</td>
<td>N-Terminal-Prohormone Brain Natriuretic Peptide (see also BNP)</td>
</tr>
<tr>
<td>NYHA</td>
<td>New York Heart Association</td>
</tr>
<tr>
<td>NZGG</td>
<td>New Zealand Guidelines Group</td>
</tr>
<tr>
<td>OR</td>
<td>Odds Ratio</td>
</tr>
<tr>
<td>Pharmac</td>
<td>Pharmaceutical Management Agency (NZ)</td>
</tr>
<tr>
<td>PHO</td>
<td>Primary Health Organisation (NZ) previously IPA</td>
</tr>
<tr>
<td>PPV</td>
<td>Positive Predictive Value</td>
</tr>
<tr>
<td>PTCA</td>
<td>Percutaneous Transluminal Coronary Angioplasty</td>
</tr>
<tr>
<td>RAAS</td>
<td>Renin Angiotensin Aldosterone System</td>
</tr>
<tr>
<td>RCT</td>
<td>Randomised Controlled Trial</td>
</tr>
<tr>
<td>RNZCGP</td>
<td>Royal New Zealand College of General Practitioners</td>
</tr>
<tr>
<td>SIGN</td>
<td>Scottish Intercollegiate Guidelines Network</td>
</tr>
</tbody>
</table>