Heart Failure among Older Home Care Clients: An Examination of Client Needs, Medication Use and Outcomes

by

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I hereby declare that I am the sole author of this thesis.

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ABSTRACT

Population aging in Canada is associated with a rising burden of heart failure (HF), a condition associated with substantial morbidity, mortality and health service use. HF management involves pharmacotherapy, exercise, dietary restrictions and symptom monitoring. First-line combination pharmacotherapy for HF consists of an angiotensin converting enzyme inhibitor (ACE inhibitor) or angiotensin receptor blocker (ARB) in conjunction with a β-adrenergic receptor blocker (β-blocker). This combination therapy can reduce mortality, improve symptoms and reduce health service use. However, evidence about the benefits of these therapies has been derived from randomized controlled trials in younger patients from acute care and specialty clinic settings. Little work has explored outcomes among older individuals and those in the community setting. In purposely studying an older cohort of individuals with HF, the goals of this research were three-fold: to comprehensively describe their sociodemographic, clinical and service use characteristics; to describe rates of usage of first-line HF pharmacotherapy and correlates of non-use; and to examine the outcomes of mortality, long-term care (LTC) admission, long-stay hospitalization, admission, new cognitive decline and new functional decline as well as predictors of these outcomes. To achieve these aims, this work made use of the extensive data available through the Resident Assessment Instrument – Home Care (RAI-HC) database in Ontario. The RAI-HC is mandated for use in Ontario to assess all long-stay home care clients (those expected to receive home care service for at least 60 days). This assessment contains over 300 items about sociodemographic and clinical characteristics, diagnoses, service use and geriatric conditions, such as functional abilities and cognition. The study samples included long-stay home care clients older than 65 years of age.

The descriptive analyses (N=264,030) demonstrated that older home care clients with HF

are a more complex group than home care clients without HF, with more comorbidity and higher use of medications and health care services. From the analyses examining pharmacotherapy use (N=176,860), rates of use of first-line pharmacotherapy were low, with only 30% of clients with HF receiving recommended combination first-line therapies, a similar proportion receiving no therapies and the remainder receiving at least one therapy. The multivariate analyses revealed that hypertension and diabetes mellitus diagnoses affect first-line therapy use. Regardless of clinical subgroup, use of these therapies was less likely among older clients and those with functional impairment, airway disease or behavioural symptoms. Longitudinal analyses were done using Cox proportional hazards regression modeling (N=9,283) in which individuals were followed for nine months after each RAI-HC assessment. Results from these analyses showed that female gender and living alone reduced the risk of all outcomes except LTC admission, while age over 85 years generally increased the risk of all examined outcomes. Comprehensive clinical indicators, the Changes in Health, End-stage disease, Signs and Symptoms (CHESS) scale and Method for Assigning Priority Level (MAPLe) algorithm, increased the risk of all outcomes except new cognitive decline. ACE inhibitor use was protective of LTC admission and functional decline, but not mortality, long-stay hospitalizations or cognitive decline.

The complexity of older individuals with HF could impair self-care abilities and points to the need for initiatives to help such individuals manage their care at home with appropriate support and services. The low rates of use of first-line pharmacotherapy among older home care clients with HF highlights the need for better understanding of which factors affect prescribing practices. Better evidence, that is more applicable to older individuals with HF, is needed about the therapeutic benefits of first-line therapies to help enhance the evidence base and improve patient care.

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DEDICATION

This thesis is dedicated to my family. To my parents: I cannot begin to thank you enough for the love, support and encouragement you have unconditionally given me throughout my educational pursuits. I am lucky and thankful. To ‘the boys’: you have me outnumbered, but I couldn’t have asked for better brothers. Thanks for always reminding me to have a sense of humour. And to Tetka: this would not have been possible without you and I wish you had been able to see how great a gift you gave me.

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LIST OF ABBREVIATIONS

AA	Aldosterone Antagonist
ACC	American College of Cardiology
ACE	Angiotensin Converting Enzyme
ADL	Activities of Daily Living
AHA	American Heart Association
ARB	Angiotensin II type 1 Receptor Blocker
β-blocker	Beta Adrenergic Receptor Blocker
CABG	Coronary Artery Bypass Graft
CAD	Coronary Artery Disease
CAP	Clinical Assessment Protocol
CCAC	Community Care Access Centres
CCS	Canadian Cardiovascular Society
CDM	Chronic Disease Management
CHESS	Changes in Health, End-Stage disease and Signs and Symptoms
CI	Confidence Interval
CIHI	Canadian Institute for Health Information
CL	Confidence Limit
COPD	Chronic Obstructive Pulmonary Disease
CPS	Cognitive Performance Scale
DRS	Depression Rating Scale
ED	Emergency Department
EF	Ejection Fraction
HF	Heart Failure
HFPEF	Heart Failure with Preserved Ejection Fraction
HR	Hazard Ratio
IADL	Instrumental Activities of Daily Living
IHD	Ischemic Heart Disease
LHIN	Local Health Integration Network
LTC	Long-Term Care
LV	Left Ventricle
LVEF	Left Ventricular Ejection Fraction
MAPLe	Method for Assigning Priority Levels
MI	Myocardial Infarction
MOHLTC	Ministry of Health and Long-Term Care
NSAID	Non-Steroidal Anti-Inflammatory Drug
NYHA	New York Heart Association
OACCAC	Ontario Association of Community Care Access Centres
ODB	Ontario Drug Benefit
OR	Odds Ratio
RAA system	Renin-Aldosterone-Angiotensin system
RAI-HC	Resident Assessment Instrument – Home Care
RCT	Randomized Controlled Trial
SD	Standard Deviation
SE	Standard Error

1.0 INTRODUCTION

Heart failure (HF) is a chronic disease in which precipitating factors such as valvular or pericardial disease and systolic or diastolic left ventricular dysfunction increase the risk of clinical signs and symptoms of low cardiac output and systemic or pulmonary congestion. HF prevalence among Canadians exceeds 500,000 and is highest among those over age 65. HF is associated with high levels of morbidity and mortality, reduced quality of life, impaired functional ability and increased health service use. Management of HF is complex and involves dietary restrictions, exercise recommendations, monitoring of symptoms and pharmacotherapy.

Pharmacotherapies are recommended based on evidence from clinical trials, a research method considered to be the gold standard in medical literature. HF management has benefitted greatly from such trials and many medications are recommended in managing this disease. Pharmacotherapy for HF with reduced ejection fraction includes use of angiotensin converting enzyme (ACE) inhibitors, β-adrenergic receptor blockers (β-blockers), angiotensin II type I receptor blockers (ARB), aldosterone antagonists (AA) and digoxin. Trials of these medications have demonstrated effectiveness in improving HF outcomes. However, the majority of individuals in potential need of such therapies are not necessarily comparable to participants included in clinical trials. Selection criteria generally favour recruitment of younger individuals with less comorbidity and outcomes studied may not reflect the treatment goals of older individuals. Individuals with HF are often older, have more comorbidity and more concomitant medication use than trial participants. This disconnect means there is relatively little evidence upon which to base therapy for this population. Evidence suggests that older individuals are less likely to receive recommended pharmacotherapies although they may benefit from them. Pharmacotherapy use in older adults requires consideration of dosing, polypharmacy,

comorbidities and adherence. Underuse of therapy in older individuals could reflect poor disease management due to insufficient evidence of therapeutic benefit specific to this population. Better evidence upon which to base management in this cohort would help expand knowledge and quality of care in this area.

Much chronic disease management occurs in the community setting rather than in the acute health care system. Managing HF is representative of chronic disease management and is very complex. Medication therapy, exercise, dietary restrictions and education about changing symptoms are all components of care. Once needs are too great to be met through family support and home care services, transitions to long-term care occur. Understanding the needs of individuals with HF in the home care sector may help to allocate care more appropriately, but has been under-investigated.

Pharmacotherapy is an important component of care and understanding patterns of medication use as well as barriers to treatment is essential. Much evidence about rates of pharmacotherapy use comes from patients managed in specialized clinic settings. Whether such use is similar among older, community-dwelling individuals, who are predominantly managed by general physicians, is unknown. Patterns of medication use as well as factors that could be potential barriers to use are important to understand, but have been under-studied.

Perhaps more important is to understand whether medications recommended for treatment of younger individuals represented in clinical trials have similar effectiveness in older populations. Creating a more realistic picture of care in older populations with more medication use and more comorbidity would provide a more relevant sample on which to base clinical practice recommendations. However, the pre-eminence of clinical trial evidence has so far precluded research initiatives into population-based cohort studies. Arguably, such studies could

supplement evidence from clinical trials by examining the effects of proven therapies in more diverse patient populations. Further, many trials examine mortality and hospitalizations as outcomes. In older populations, quality of life outcomes, such as functional and cognitive decline, may be more important therapeutic goals. Understanding more diverse outcomes among older, complex patients would help inform clinical management.

Assessment instruments like the Resident Assessment Instrument-Home Care (RAI-HC) can help examine the care needs of individuals with HF, medication use and barriers to medication use, and outcomes of treatment over time. There are a number of strengths to performing pharmacoepidemiologic research using these tools, including comprehensive assessment of geriatric conditions, clinical and service use factors; size of the data set; and the longitudinal nature of the data collected.

This work will utilize Ontario RAI-HC data linked with Ontario Association of Community Care Access Centres (OACCAC) administrative data in a novel way to inform clinical management of HF. This research aims to provide evidence upon which to base management of older individuals with HF and assist with care planning and chronic disease management strategies. This work is well-aligned with recent health care movements towards promoting aging in the home environment and will allow the system to provide better care to older individuals. It is hoped that this research will be applicable to other chronic diseases and further enhance the care of aging populations.

1.1 Search Strategy

Retrieval of the clinical trials relevant to HF pharmacotherapies and other components of treatment was done by searching the electronic databases Science Direct, Medline, Web of Science and ClinicalTrials.gov (1980-2009); the websites of the Canadian Cardiovascular

Society, the American College of Cardiology, and the European Society of Cardiology; and the online journal issues of Heart, Canadian Journal of Cardiology, the Journal of Cardiac Failure, the European Heart Failure Journal, Journal of the American Geriatrics Society and the Journal of the American Medical Association. The inclusion of older articles allowed identification of early RCTs in the field. The search strategy combined the following terms: heart failure (congestive, left-sided, right-sided), cardiac failure, pharmacotherapy, cardiovascular drugs, trials, ACE inhibitors, beta-1 adrenergic blocking agents, aldosterone antagonists, angiotensin II type 1 receptor antagonists, sartans and digoxin. Article bibliographies were reviewed and additional relevant references, irrespective of their publication date, were obtained. Major clinical trials for each of the 5 therapeutic classes of interest were reviewed and summarized in Tables 1-5 (Appendix G). Many excellent review articles and meta-analyses were identified, and only articles published in English were included.

2.0 BACKGROUND

2.1 The Prevalence and Burden of Heart Failure

Cardiovascular diseases are the leading causes of morbidity and mortality worldwide, responsible for 16.7 million deaths annually. (1) HF is one such disease and is a major public health problem in Canada associated with high morbidity and mortality and substantial burden on the health care system. HF, as defined by the Canadian Cardiovascular Society (CCS), is a "complex syndrome in which abnormal heart function results in, or increases the subsequent risk of, clinical symptoms and signs of low cardiac output and or pulmonary or systemic congestion". (2) An estimated 500,000 Canadians live with HF and its prevalence increases with age. By age 80, the lifetime risk of HF development is approximately 20%. (2,3) Population aging and improved survival of individuals with hypertension and myocardial infarction (MI), two important risk factors for HF, are contributing to rising HF prevalence. (3,4,5) More worrisome, prevalence of HF among individuals over 65 years is anticipated to double over the next 30 years. (5,6)

Despite advances in the overall treatment and management of HF, survival and quality of life remain poor. (7) In the United States and Canada combined, approximately 300,000 people die each year from HF. (8) Depending on age, symptom severity, heart dysfunction, and other factors, HF is associated with annual mortality rates as high as 50%, and 25-40% of patients will die within one year of diagnosis. (2,9) Five-year survival rates are approximately 50%. (2) Evidence suggests that median survival following hospital discharge for HF, age at death, and one-year and five-year survival rates have all improved since 1986. (10)

In Canada, cardiovascular diseases are the most costly illness by diagnostic category, incurring $21.2 billion dollars in indirect and direct costs each year. (11) Expenditures on

cardiovascular medications and use of all drug classes, except nitroglycerin, have increased substantially in Canada over the past decade. (12) Diuretics, statins and ACE inhibitors were the most frequently used classes of medications, with costs associated with ACE inhibitors alone nearing $1 billion in 2006. (12) For HF, prescription medications and hospitalizations account for the majority of health system costs. (13) Health service utilization is especially high among older individuals with HF. Inpatient and outpatient costs associated with HF management make it one of the costliest health care problems in Canada. (14) One-year readmission rates as high as 33-50% following index HF hospitalization were reported in two large Canadian studies. (14,15) An early study of patients hospitalized for HF found that 53% of readmissions were preventable. (16) Management of HF to reduce health care system use and improve quality of life for patients is necessary.

2.2 Clinical Presentation and Diagnosis

2.2.1 Disease Presentation

HF is a chronic condition characterized by bouts of worsening symptoms and signs, termed decompensation of chronic HF. (17) This decompensation can lead to frequent hospitalizations and physician visits in individuals with previously stable disease. (17,18) HF is considered to be stable if it is managed and individuals experience few or no signs and symptoms. In clinical practice, the signs and symptoms often associated with HF result from an elevation of pulmonary and systemic venous pressure of cardiac origin. (19) Typically, the following signs and symptoms are associated with the presence of HF: shortness of breath with exertion or when lying down, swelling of the lower extremities, reduced exercise tolerance, increased pressure in the jugular vein, and crackling sounds in the lungs during inspiration (Appendix A: Figure 1). (2,20)

HF may present less typically in older persons, especially among those with concomitant functional impairment or frailty (Appendix A: Figure 2). (2) Such individuals often lead more sedentary lifestyles and may present with swelling in the hip region and no shortness of breath on exertion. (21) In individuals older than 80 years with HF, atypical symptoms include confusion, irritability, fatigue, anorexia, and reduced activity. (20) Further, behavioural changes including anxiety and depressed mood, as well as altered cognition, are more common in frail older individuals with HF and may be associated with symptomatic or undertreated HF. (22) These atypical symptoms can make identification of HF among older, frailer individuals difficult.

2.2.2 Heart Failure Diagnosis

HF diagnosis is based on the presence of symptoms (Appendix A: Figure 1) and objective evidence of cardiac dysfunction, usually through echocardiography. (19,23) The additional criterion of favourable response to treatment directed at HF may also be used. (23) Ideally, diagnosis of HF should be done while symptoms are present. (19)

2.2.3 Stages of Heart Failure

The most widely used classification system for severity and progression of HF is the New York Heart Association (NYHA) system. This system is based on functional measures, allowing movement between stages if HF is well managed with pharmacotherapy (Appendix B: Figure 1). (17,24) The American College of Cardiology and American Heart Association (ACC/AHA) guidelines for evaluating and managing HF also classify HF into four stages (Appendix B: Figure 2). (3,25) This classification system is based on physiological changes and the first stage identifies persons at high risk for HF development due to comorbid conditions. (3) Both systems recognize that once present, HF is usually a progressive disease. (3,17)

2.2.4 Heart Failure with Reduced and Preserved Ejection Fraction

HF was thought to result from primarily dysfunction of the left ventricle (LV) during systole, impairing the heart's ability to pump enough blood to the circulation. Confirmation of a reduced ejection fraction (EF) during systole, shown to be below 40 % on an echocardiogram, is the definition of HF with reduced EF. (17) It is becoming clear, however, that systolic function may be preserved in HF. Termed 'heart failure with preserved ejection fraction' (HFPEF), left ventricular ejection fraction (LVEF) is preserved, but the pressure needed to allow blood to fill the ventricle is higher. (26) As LV filling becomes compromised, pressure increases in the left atrium, pulmonary veins and capillaries, predisposing the individual to pulmonary congestion and HF. HF with preserved and reduced EF may not be mutually exclusive, and one or both may occur in the same individual. (27)

HFPEF increases in prevalence with age and is thought to account for more than 50% of HF cases in individuals older than 75 years. (19,25) It is more common in women, and individuals with chronic hypertension, coronary artery disease, and abnormal echocardiograms. HFPEF is associated with similar rates of mortality and rehospitalizations as HF with reduced EF. (26,28,29)

2.2.5 Underlying Pathophysiology and Aging

The aging process contributes to structural changes in the heart which may be associated with HF. In the LV, aging increases both stiffness and wall thickness, reduces compliance and early diastolic filling, and impairs relaxation, all of which increase mechanical stress. (27) This stress can lead to extensive structural changes, rendering the failing heart unable to meet cardiac output demands to tissues despite adequate LV filling pressure. (27) While aging can lead to such changes that predispose individuals to HF development, other underlying pathologies also

play a role. For example, conditions such as hypertension, myocardial ischemia (resulting from coronary artery disease) and LV hypertrophy can all contribute to reduced ventricular function. (30) As the heart fails, delivery of blood and oxygen is reduced and vascular resistance increases. (20) These changes impair the heart rate response to stress, reduce compliance and contractile reserve and increase the pressure needed to pump blood from the heart (Appendix C: Figure 1). (20)

HF is characterized by prolonged stimulation of the sympathetic nervous system and renin-aldosterone-angiotensin (RAA) system activation (Appendix C: Figure 2). The resulting angiotensin II, norepinephrine and cytokines produced normally compensate for changes in arterial pressure and cardiac output, but in HF they precipitate cardiac muscle cell death, endothelial dysfunction, vasoconstriction and renal retention of sodium and water (Appendix C: Figure 3). (27,31) As heart muscle dies, the LV experiences further dysfunction and increased wall stress which further promotes pathogenic structural changes. (27) The overall result is an inability of the heart to respond to stressors such as ischemia, tachycardia, illness and physical exertion, and clinical events that are well-tolerated at younger ages can lead to HF in older persons. (20) The aging process, as well as the presence of age-related chronic conditions, contributes to structural cardiovascular changes that precede HF development in older individuals.

2.3 Risk Factors

Among older populations, HF is often multi-factorial in nature. (27) Ischemic heart disease (IHD) is the predominant cause of HF in the Western world; other common etiologies include systemic hypertension, cardiomyopathies, valvular heart disease, LV hypertrophy, arrythmias, pericardial disease, and diabetes. (17,24,27) IHD and hypertension alone are

responsible for 70-80% of HF cases. (24,27) In older women with HFPEF, hypertension is the most common cause, while in older males it is IHD. (20) Given the relationship of HF to other cardiovascular conditions, investigators in the Physicians' Health Study in the United States examined whether lifestyle factors affect HF risk. (32) After more than 20 years of follow-up in 20,900 men, this study found that maintaining a normal weight, not smoking, exercising regularly, moderating alcohol intake and consuming breakfast cereals and fruits and vegetables individually reduced HF risk and together reduced HF risk by 22% compared to men with none of these healthy habits. (32) Strategies targeting prevention of cardiovascular disease may ultimately affect HF incidence. However, in individuals who already have HF, non-adherence with medications and diet are the most common causes of exacerbations. (16)

2.4 Comorbidities

With aging, the risk of developing chronic disease increases. In the Canadian National Population Health Survey, only 12% of participants aged 80 or older reported having no chronic conditions, while 41% of participants reported having three or more. (33) When examining HF in older populations, it is important to consider the implications of comorbidities. Anemia, cachexia, renal insufficiency, obstructive sleep apnea, chronic obstructive pulmonary disease (COPD), diabetes, hypertension and hyperlipidemia are all common in individuals with HF. (25,34,35) Such comorbidities have unfavourable implications for the prognosis of HF, play a role in the progression of HF and are often worsened by HF. (34) For example, anemia contributes to exercise intolerance and renal insufficiency worsens HF symptoms and prognosis and limits the use of pharmacotherapy. (25) A history of depression may affect HF prognosis by increasing the risk of mortality and cardiac events, reducing the likelihood of receiving cardiac procedures and education about HF management, and lengthening hospital stay. (36,37) Lastly,

the occurrence of comorbid conditions in individuals with HF very strongly affects quality of life and may impair self-care behaviours. (17)

2.5 Disease Outcomes

Improper management of HF is associated with adverse outcomes including mortality, hospitalizations, functional decline, cognitive impairment, and caregiver burden. The potentially relevant outcome of long-term care (LTC) admission among older HF patients in the community has not been studied. Evidence suggests that proper pharmacologic management of HF may improve some of these outcomes.

2.5.1 Mortality

HF is associated with significant morbidity and mortality, especially among older cohorts. (20) First-year mortality rates are as high as 50% and five-year survival is approximately 50%. (2) Whether HF mortality rates are similar between males and females is unclear, but overall, males and individuals with HF with reduced EF have shown greater improvements in mortality through pharmacotherapeutic interventions. (38,39)

2.5.2 Hospitalizations

Probably the largest economic impact of HF comes through its association with increased health service use including hospitalizations. HF is the most common cause of hospitalizations in people over the age of 65 in the United States and is the primary discharge diagnosis of almost 1,000,000 individuals annually. (8) In Canada, 50% of individuals with HF are readmitted to hospital in the year following HF diagnosis and more readmissions are seen among older individuals. (40) Non-adherence to drug therapy, non-adherence with dietary and exercise recommendations, living alone, post-hospitalization medication discrepancies, lack of cardiology consult at admission and pulmonary hypertension all increase the risk of rehospitalization for

HF. (41) In a large cohort study of patients presenting to a Canadian emergency department (ED) with acute HF, those who were not admitted were more likely to present again in the ED, be hospitalized and die within 30 days and one year. (42)

2.5.3 Functional Decline

Individuals with HF are significantly more likely to be frail, and both conditions increase the likelihood of functional decline. (43,44) Individuals hospitalized for HF often experience functional decline, which can lead to a greater need for home and community care services. As function continues to decline, individuals are at increased risk of hospitalization for HF. Decline in both measures of activities of daily living (ADL) and instrumental activities of daily living (IADL) represent clinical changes that have been associated with increased mortality and poor health-related quality of life among older persons with HF. (45) Near the end of life, individuals with HF exhibit much variability in changes in NYHA class and physical limitations, but late-life illness is generally characterized by long-term functional limitations with episodic disease exacerbations (Appendix D). (46,47)

2.5.4 Cognitive Impairment

Cognitive impairment is a common problem in HF thought to affect 20-50% of patients. (48-50) Cognitive impairment and HF share common risk factors including atherosclerosis, hypertension and diabetes. (48,49) In HF, it is thought that reduced cerebral blood flow due to systolic hypotension or microemboli-induced cerebral infarcts may lead to impaired cognition through deficits in memory, attention, processing speed, and learning. (21,49) Older individuals with HF seem more prone to developing chronic cognitive impairment and may develop acute and fluctuating impairment known as delirium, especially during decompensated HF. (22,49) Cognitive impairment in older individuals with HF can lead to difficulties in self-care including

non-adherence to therapy, medication mismanagement, failure to recognize early symptoms, rehospitalization, physical disability and increased mortality. (16,49-51) Optimization of HF therapy in older populations may improve cognitive function in a dose-dependent manner, and longitudinal studies of cognitive changes in HF have been identified as a gap in the current literature. (51,52)

2.5.5 Caregiver Burden

Caregiver burden is another important outcome associated with HF. For caregivers of individuals with HF, disease management is extremely complex in terms of promoting self-care, monitoring dietary and exercise adherence, transporting patients to appointments, and monitoring for signs of decompensation. (53) Studies of caregiver burden in HF have found that patient age, comorbidity, disease severity and LVEF were not predictive of caregiver burden. (53,54) However, disruption of daily schedule and patient's loss of physical strength were associated with increased burden. (54)

2.5.6 Other Outcomes

HF is associated with increased rates of depression and poorer quality of life, especially in older individuals. A community-based study of older individuals with HF (mean age 72 years) found that compared to gender-matched community-dwelling older controls, individuals with HF experienced significantly more depressive symptoms and reduced health-related quality of life (measured with the RAND-36 survey). (55) The diminished quality of life in HF has been linked to reduced physical, social and functional abilities as well as increased psychological distress. (55)

2.6 Management of Heart Failure

As a chronic condition, the management of HF is complex and many therapeutic

strategies exist. Treatment options for the management of HF include neurohormonal modulation through pharmacotherapy, salt and fluid intake restriction, exercise therapy and surgical interventions. Many individuals with HF will benefit from a combination of these therapeutic options in management of their disease.

2.6.1 Pharmacotherapy

Pharmacological management of HF is based on strong evidence from a large number of randomized controlled trials (RCTs), many of which focused on HF with reduced EF. A summary of these therapies is given in Figure 1 (Appendix E). There is much less evidence to support treatment of HFPEF. ACE inhibitor, β-blocker, ARB, AA and digoxin therapies are commonly used treatment options in HF management, in addition to diuretics.

2.6.1.1 Heart Failure with Reduced Ejection Fraction

Most of the therapeutic options recommended in managing HF are recommended in the treatment of HF with reduced EF. ACE inhibitor, ARB and β-blocker therapies are recommended for use in most individuals with HF with reduced EF. AA and digoxin, both older therapies, are recommended for some subpopulations and new evidence of potential benefits is emerging. Diuretics are used extensively and hydralazine and isosorbide dinitrate therapy is used in specific patient populations (Appendix F: Table 1). The following table is a summary of the evidence of therapeutic benefits for ACE inhibitor, β-blocker, ARB, AA and digoxin therapies. For more complete descriptions of the RCTs by drug class, refer to Appendix G.

Table 2.1: Summary of Evidence for Pharmacotherapies for Heart Failure with Reduced Ejection Fraction by Medication Class

Medication Class	Class Effect?	Evidence of Therapeutic Benefit from RCTs	Evidence from Meta-Analyses	Research Gaps
ACE inhibitors	Yes (56,57)	- improve survival, HF symptoms, NYHA class, exercise capacity, HF hospitalizations and HF development (58-63) - reduce recurrent MI and improve post-MI survival (64-67) - some may improve cognitive impairment in hypertensive adults (68)	- 25% reduction in all-cause mortality - 35% reduction in HF-specific mortality or hospitalization - improve NYHA class (57,69) - benefits in severe HF (70)	- inconclusive evidence on cognitive benefits - frequent use of composite endpoints - little research into quality of life outcomes, functional decline
ARB	No[a]	<u>Valsartan</u> - improves NYHA class, not mortality (71) <u>Candesartan</u> - with ACE inhibitor therapy, reduces cardiovascular death or hospitalization, but more adverse events (72) - reduces CV death or HF hospitalization in ACE inhibitor intolerant individuals (73) - equivalent to ACE inhibitors post-MI: reduces all-cause mortality, recurrent MI (74,75)	- with β-blocker therapy, some reduction in morbidity and hospitalizations (76) - not superior to ACE inhibitors in reducing mortality, but as effective in reducing hospitalizations (77,78)	- frequent use of combined endpoints - little research into functional, cognitive and quality of life outcomes - not all therapies investigated for all outcomes
β-Blocker	No[b]	<u>Bisoprolol</u> - improves exercise tolerance, quality of life and NYHA class (79) - may reduce sudden death, but increase hospitalizations (80) <u>Carvedilol</u> - improves symptoms, NYHA class, overall well-being, but not exercise tolerance (81-85)	- trend toward improved survival (86,88,92) - improve NYHA class, reduce all-cause mortality, prolong exercise tolerance time (93)	- frequent use of composite endpoints - no studies examining functional status or cognition - not all therapies investigated for all outcomes

Drug Class	Class Effect?	Evidence of Therapeutic Benefit from RCTs	Evidence from Meta-Analyses	Research Gaps
β-blocker		<u>Carvedilol</u> - reduces all-cause mortality, hospitalizations, slows disease progression, may improve survival over metoprolol (82,86-88) - reduces all-cause mortality and recurrent MI post-MI (89) <u>Metoprolol</u> - increases exercise tolerance, quality of life, improves NYHA class (87,90,91) - improves survival, all-cause mortality and hospitalization risk (86,87)		
AA	No	<u>Spironolactone</u> - reduces all-cause mortality, cardiac deaths, HF hospitalization (with use of ACE inhibitors, diuretics, digoxin) (94) - reduces renal function, quality of life (95) <u>Eplerenone</u> - reduces all-cause mortality, cardiovascular death or hospitalizations following MI (96)	No	- only mortality and hospitalizations endpoints examined - no research into functional or cognitive outcomes
Digoxin	Not applicable	- improves symptoms, functional class, exercise capacity, LVEF, reduces heart rate and body weight, may reduce hospitalizations (97-99) - reduces HF hospitalizations, not mortality, even in older individuals (100)	No	- most evidence from subgroup analysis, especially for older individuals - no research on cognitive or functional effects

Abbreviations: AA = Aldosterone Antagonist, **ACE** = Angiotensin Converting Enzyme, **ARB** = Angiotensin Receptor Blocker, **β–blocker** = β-Adrenergic Receptor Blocker, **CV** = Cardiovascular, **HF** = Heart Failure, **LVEF** = Left Ventricular Ejection Fraction, **MI** = Myocardial Infarction, **NYHA** = New York Heart Association (functional classification), **RCT** = Randomized Controlled Trial

[a]Evidence-based therapies: Candesartan and Valsartan

[b]Evidence-based therapies: Bisoprolol, Carvedilol and Metoprolol

The many benefits of ACE inhibitors, including improved survival and reduced hospitalizations, have been demonstrated in RCTs since the 1980s (see Appendix G: Table 1). ACE inhibitors show evidence of a class-effect, meaning that similar benefits have been observed with enalapril, captopril, ramipril, quinapril and lisinopril. (56,57) ACE inhibitors are recommended as first-line therapy for symptomatic HF with reduced EF (Appendix F). (2,3,101)

ARB therapies are also considered in managing HF, but are newer and only possibly confer survival benefits (see Appendix G: Table 2). (102) These therapies are primarily recommended for use in individuals who cannot tolerate ACE inhibitors, but in some cases, can be added to ACE inhibitor regimens. (2,3,101)

β-blocker therapy is another important component of pharmacotherapy for HF. Unlike ACE inhibitors, there is more variation in effectiveness seen with β-blockers (Appendix G: Table 3). The cardioselective β-blockers metoprolol, carvedilol and bisoprolol have been shown to reduce all-cause mortality by approximately 35% and are considered evidence-based therapies. (86,87,103-105) Long-term use of β-blockers has been associated with improved symptoms and NYHA class in individuals with HF, although these benefits are seen after a longer treatment period than ACE inhibitor benefits. (102) β-blocker therapy should be used in conjunction with ACE inhibitor or ARB therapy as first-line treatment in most individuals with HF with reduced EF (Appendix F). (2,3,101)

In addition to ACE inhibitor, ARB, and β-blocker therapy in HF management, use of aldosterone antagonists and digoxin are recommended in some cases. Spironolactone is the predominantly used AA and has shown benefits when added to standard therapy regimens of ACE inhibitors, β-blockers and diuretics. However, spironolactone is only recommended for patients with severe, persistent HF symptoms already receiving recommended therapies

(Appendix F). (2,3,101,105) Digoxin is a symptomatic therapy for HF that suppresses renin secretion by the kidneys and increases contractility. (97,106) It does not improve survival, but is recommended for use in individuals with HF with reduced EF who remain symptomatic despite optimal therapy (Appendix F). (2,101) Clearly the pharmacotherapy regimen for HF with reduced EF is complex. However, management of this type of HF has benefitted greatly from the large number of clinical trials and well-established clinical guidelines exist.

2.6.1.2 Heart Failure with Preserved Ejection Fraction

HFPEF is now recognized as a common condition, especially among older individuals. Unlike HF with reduced EF, treatment for HFPEF is not well established. Non-pharmacological management of HFPEF is similar to that of HF with reduced EF. Daily weight monitoring, diet and lifestyle modifications, patient education and close follow-up are key components of care (107,108) and exercise training may be beneficial. (3)

There is less evidence about which pharmacotherapies should be used to treat HFPEF and no evidence-based therapies exist that improve clinical outcomes (Appendix H). (108) Treatment strategies for HFPEF are based on extrapolations from effective strategies used to treat HF with reduced EF and a small number of trials have examined the effect of these therapies in the treatment of HFPEF in older individuals. Such trials indicate that while β-blocker therapy may be beneficial in improving all-cause mortality or cardiovascular hospitalizations over placebo (109), ACE inhibitor and ARB therapies do not. (110,111) Further, while some ARBs (candesartan and losartan) have demonstrated effectiveness in improving exercise tolerance, quality of life and HF-related hospitalizations (112-114), others (irbesartan and valasartan) have shown less benefit. (111,115) Subgroup analyses from the Digitalis Investigation Group trial showed that digoxin did not improve the combined primary endpoint of HF hospitalization or

total cardiovascular mortality, did reduce HF hospitalizations, and led to an increase in unstable angina leading to more cardiovascular hospitalizations overall. (100) Finally, there is some research into management of HFPEF from cohort studies. A large cohort study in Ontario examined the effects of ACE inhibitor, β-blocker, spironolactone and digoxin therapy in individuals with EF above and below 50%. (116) None of these therapies reduced mortality or hospitalization rates in individuals with HFPEF. (116) A smaller subgroup analysis examined the effectiveness of pharmacotherapy in patients older than 80 years, finding no association between ARB, β-blocker, digoxin, statin or diuretic therapy and improved survival or hospitalizations. (117)

Despite the lack of clear evidence about effective therapies in the management of HFPEF, ACE inhibitor and β-blocker therapy are recommended for symptom relief in individuals with controlled hypertension. (2,3) Digoxin use should be avoided in most circumstances, unless required for heart rate control. (2,3)

2.6.1.3 Therapeutic Benefits in Older Individuals

HF management has benefitted greatly from results of well-designed clinical trials. However, many trials from which the evidence was generated excluded older (aged 75 +) subjects. Exclusion of older individuals from such trials has a number of limitations and implications for HF management. Although age is the number one risk factor for cardiovascular events, approximately 40% of cardiovascular medicine trials exclude older individuals. (118) Increasing life expectancies and increasing age of patients have not yet resulted in increased interest to provide best quality, evidence-based care for older individuals. (119) The generalizability of evidence from such trials is limited (118), leaving the evidence base for

prescribing to elderly populations small, even though such individuals are the largest consumers of prescription medications. (120)

To enhance care for elderly individuals, more and better data are needed and clinical trials designed appropriately for elderly individuals have been called for. (118,121) Trial participants and older persons with comorbidities may have different risk-to-benefit ratios with respect to therapy and this may prevent uptake of evidence-based care. (120) Thus, sometimes even with evidence, older persons do not receive quality care, and cohort studies on real patients with comorbidities would build the evidence base. (119) Despite the fact that most trials of HF pharmacotherapies have excluded older individuals, current treatment recommendations for HF are the same for older and younger individuals. Some smaller, observational studies have examined treatment effects in older populations, and subgroup analyses of older subjects from the larger trials have also been published.

Enough evidence exists for some to conclude that older individuals with HF benefit from ACE inhibitor therapy and should not be denied treatment. (122) Whether benefits are as great as those seen among younger individuals is more questionable. (70) Subgroup analyses and observational studies have found up to 41% reductions in mortality for older individuals, suggesting that benefits of ACE inhibitors seen in RCTs extend to older individuals. (122-125) Despite these potential benefits, increasing age has been shown to be an independent predictor of not receiving ACE inhibitor therapy. (123-125) Among older long-term care residents, ACE inhibitor therapy significantly reduced the rate of functional decline, independent of comorbidity or baseline physical function. (126) Thus ACE inhibitor therapy appears to have some benefit even in older populations.

Very little work has examined the effectiveness of ARB therapy in older populations.

Older individuals may be more prone to side effects of ACE inhibitor therapy, including coughs and rash, and therefore ARBs may be acceptable alternates to ACE inhibitor therapy in this cohort. (56) Subgroup analyses have found differing results on mortality, but valsartan and candesartan therapy are associated with improved NHYA class, LVEF, signs and symptoms of HF, hospitalizations and quality of life in older and younger age groups. (71,74)

The utility of β-blocker therapy in older populations has also been explored through subgroup analyses of larger trials and observational cohort studies. Subgroup analyses from trials of metoprolol and bisoprolol suggest mortality benefits in older individuals, except in those with severe renal impairment (127,128) and nebivolol reduced all-cause mortality and hospitalizations compared to placebo, but less effect was seen in the subgroup older than 75 years. (110) Cohort studies have found that all-cause mortality and HF-specific mortality were reduced at both high and low doses of β-blockers. (123) Lastly, in older individuals with HFPEF, there is some evidence of mortality benefits of β-blockers, overall suggesting that β-blockers be used to treat HF with preserved and reduced EF. (82,86,87,103,129)

The effectiveness of AA therapy in older populations is not well established. From the RALES study, adverse events declined significantly in all age groups, including a pre-defined subgroup of individuals older than 67 years. (93) However, a later population-based study of older individuals with HF (mean age 78 years) showed increased rates of hyperkalemia-associated morbidity and mortality with spironolactone use, although this may have been due to inappropriate dosing or monitoring. (130)

It is well recognized that the therapeutic index of digoxin is narrow, especially for older individuals. (25) In post-hoc analysis, age was an independent predictor of total mortality, all-cause hospitalization, HF hospitalization, HF death or hospital admission, hospitalization for

suspected digoxin toxicity and withdrawal from digoxin therapy (131), even at low serum digoxin concentrations (0.5-0.9 ng/mL). (100) Lastly, in older hospitalized individuals, cognitive performance improved significantly with digoxin therapy. (132)

2.6.1.4 Other Issues in Heart Failure Pharmacotherapy in Older Individuals

Clearly there are many limitations of the current evidence in terms of applicability to older populations. There are also many unique considerations that must be taken into account when deciding how to manage HF in older individuals. These include underuse and dosing, polypharmacy, adverse drug events, adherence and comorbidities. These factors extend beyond HF and are applicable to pharmacotherapy generally in older populations.

Underuse and Dosing of Heart Failure Pharmacotherapies

HF pharmacotherapies are underused in older HF populations. Even if therapies are prescribed, doses often fall short of those recommended from clinical trials. (56) Possibly due to less evidence about their clinical benefit in older individuals, ACE inhibitors and β-blocker therapies are underused in both primary care and specialty care settings. (40,122,133-135) Reasons identified for underuse of ACE inhibitors and β-blockers include underestimation of morbidity and mortality in HF, underestimation of benefits of therapy, concerns about adverse events, and age. (135) Use of ACE inhibitor, ARB and β-blocker therapies have improved over time, while use of older therapies such as digoxin have declined. (136) Use of ACE inhibitor or ARB therapies has been found to be as high as 83% among individuals deemed ideal for ACE inhibitor therapy across all age groups. (137,138) β-blocker use is usually lower than ACE inhibitor use in older cohorts and has been found to be as low as 10% among older individuals. (133,135) Age, comorbidity, COPD and a history of bradycardia were all identified as barriers to β-blocker use. (123) Individuals with IHD or hypertension and those on other medications, such

as ACE inhibitor therapy, were more likely to receive β-blockers. (123) Further, contraindications to β-blocker use, as well as side effects like fatigue and exercise intolerance, are more common in older individuals and limit the use of these therapies. (110) However, even if contraindications to therapy exist, ACE inhibitor therapy has been shown to be beneficial (139,140) and β-blocker therapy is recommended in individuals with stable pulmonary disease. (2) Thus, underuse of HF pharmacotherapy is prevalent, and while it may be justified in some cases, it may partially reflect resistance by providers in managing older individuals.

In addition to underuse of HF pharmacotherapy, under-dosing is also prevalent in older populations. Normally, ACE inhibitors are prescribed at lower doses and progressively titrated to higher doses to attain recommended dosages from clinical trial evidence. (137) In geriatric medicine, titration to the maximum tolerated dose is recommended. (2) However, many studies have shown that ACE inhibitors and β-blockers are often used at suboptimal doses, especially among older individuals. (133,137,138) Renal impairment, hypotension and low creatinine clearance were all identified as reasons for lower dosing of ACE inhibitors in these studies. (133,137,138) Alternately, under-dosing may represent physician reluctance to try higher doses in older individuals. (133) Consequences of suboptimal dosing have only been explored minimally. While some benefits are seen with lower doses of ACE inhibitors or β-blockers (141), optimal benefit is seen at recommended doses. (142) Further exploration into underuse and suboptimal dosing to determine effects on adverse outcomes may improve care and quality of life and reduce costs.

Polypharmacy and Adverse Drug Events

Polypharmacy, the use of multiple medications, is common among older individuals due to the high prevalence of comorbidity. (56) For individuals with HF, optimal therapy often

involves multiple medications and one study reported an average of seven medications in recently discharged individuals with HF. (143) With use of increasing numbers of medications, the potential for side effects and drug-drug interactions also increases. (56) The number of prescribed medications is the strongest risk factor for adverse drug events, independent of age. (144) Concomitant use of four drugs increases the risk of adverse events by 50%-60% and this risk approaches 100% with eight to nine prescribed medications. (144)

Many age-related physiological changes occur that can potentially alter the effects of medications and increase the risk of drug-drug interactions and adverse drug events. Renal function decreases with age, putting older individuals at risk for hypotension, renal failure and hyperkalemia. (56) Further, aging is associated with reductions in drug metabolism and clearance through the cytochrome P-450 family of enzymes. (144) Elimination half-lives generally increase with age, making the timing between doses of medication important considerations in older individuals. (144) Lastly, reduced skeletal muscle mass, decreased total body water and reduced intravascular volume all lead to a smaller area of distribution for medications in older individuals. (25) As a result of such physiological changes, clearance of ACE inhibitors, β-blockers and digoxin is affected. (25,144) ACE inhibitor dosing should be adapted to renal function, and monitoring of serum potassium and creatinine to detect impaired renal function should be done regularly. (25) Polypharmacy also increases the risk of drug-digoxin interactions, which can lead to reduced clearance, making older individuals more susceptible to digoxin toxicity, a clinical diagnosis that can lead to delirium. (145,146) Concerns over adverse drug events, including toxicities and side effects, are important barriers to prescribing HF medications in older individuals. (137,141,147)

Adherence

In older populations, adherence with prescribed drug therapy can affect therapeutic benefit. The World Health Organization defines adherence as 'the extent to which a person's behaviour (taking medications, following diet, and/or executing lifestyle changes) coincides with agreed recommendations from a health care provider'. (148) This definition reflects the importance of patients being in agreement with therapeutic recommendations. Comorbidity, depression, poor social support and social isolation may all reduce adherence with drugs, diet and exercise recommended in older individuals with HF. (20,149) Medication adherence rates as high as 73%-90% have been reported among HF patients discharged from hospital and self-reports. (143,150) Most individuals recall receiving advice on exercise and dietary restrictions as well; however, individuals with lower recall were shown to take fewer HF medications. (150)

The presence of cognitive impairment may have detrimental effects on adherence. Like HF, the prevalence of CI increases with age and the co-occurrence of these conditions is becoming more common. (52) Multiple small, cross-sectional studies have shown that cognitive impairment is highly prevalent in recently discharged individuals with HF, that it correlates with severity of NYHA symptoms, and that a history of chronic HF is associated with a greater risk of chronic cognitive impairment or dementia. (49,151) Cognitive impairment can interfere with the ability of individuals to recognize their illness and reduce adherence with prescribed therapies, including medications, leading to frequent hospitalizations. (144)

Persistence, the length of time that individuals are adherent with therapy, is also important to consider when treating older individuals. (148,152) Persistence with cardiovascular therapies generally decreases over time, with 12-month adherence rates found to be 63% compared to 10-year adherence rates of only 32%. (152-157) Studies into persistence with

recommended HF pharmacotherapy give insight into covariates of persistence, reasons for discontinuing therapy and the relationship between persistence and outcomes. (158-160) A large five-year follow-up study found persistence rates of ACE inhibitors/ARBs and β-blockers to be 79% and 65%, respectively. (159) Multiple drug therapy and more severe HF were associated with persistence and discontinuation was significantly associated with increased mortality. (159) A smaller cohort study of individuals from a specialized HF clinic found that β-blocker use at 6, 12, and 24 months was maintained between 69 and 74%. (158) Even in individuals with COPD who did not exhibit wheezing, 86% were able to tolerate therapy to the end of follow-up with careful observation. (158) Failure to restart therapy following hospitalization, more advanced symptoms, spironolactone use, no ACE inhibitor use, adverse drug reactions and medical reasons are common reasons for discontinuing therapy. (158,160)

Comorbidities

Among older populations, the presence of comorbidity is common. Comorbidities including anemia, renal insufficiency, diabetes, COPD and arthritis can play a role in the progression of HF and be worsened by HF. Management of HF can also affect other conditions. For example, diuretics can aggravate urinary incontinence issues and dietary restrictions can affect nutritional disorders. (25) Therapy with diuretics, vasodilators, and β-blockers can worsen hypotension and increase fall risk. (25) Frailty also worsens HF symptoms and quality of life, and can be worsened during hospitalizations leading to greater fall risk. (25)

The presence of comorbidity also has great influence on rates of prescription of HF pharmacotherapy. Renal dysfunction (serum creatinine greater than 170 μmol/L) is more common in older age and reduces ACE inhibitor and spironolactone use in individuals with HF. (133,140) After adjustment for age, gender and IHD diagnosis, it was found that renal

dysfunction, diabetes and respiratory disease were not significant predictors of ACE inhibitor use in individuals with HF. (133) Asthma, pulmonary disease and respiratory diseases (and consequent bronchodilator and steroidal therapies) can reduce the likelihood of receiving β-blocker therapy by up to 50%. (133,150)

Some conditions also increase the likelihood of receiving therapy. Diabetics are more likely to receive ACE inhibitor, but not β-blocker therapy. (133) Individuals with IHD, hypertension and atrial fibrillation are more likely to receive both ACE inhibitor and β-blocker therapy. (150) While comorbidity should flag the need for careful management and monitoring, it should not necessarily be a reason to withhold effective therapy.

2.6.1.5 Limitations of Evidence for Pharmacotherapy

Participants in clinical trials for HF pharmacotherapy are not representative of the individuals most likely to need therapy. Namely, older individuals with comorbidity represent the majority of patients with HF, but have generally been excluded from clinical trials. Trial participants are a highly select group that tend to be younger, male, and have HF with reduced EF as their sole or primary diagnosis. (161) Meanwhile, in the community, individuals with HF are older, more equally distributed by gender, have multiple comorbidities, take many concomitant medications and have high rates of HFPEF. (161) The limited generalizability of clinical trial findings to elderly populations has been noted, as has the potentially incorrect application of results from such trials in treating older individuals. (121) Nonetheless, guideline recommendations for HF are based on these clinical trials and generally apply to all individuals with HF with reduced EF regardless of age. (56) Study design, exclusion criteria, and relevant outcomes of interest all limit the value of clinical trial data in recommending care to older individuals with HF.

Study Design and Exclusion Criteria

Most studies of HF pharmacotherapy have been large, randomized, double blind, placebo-controlled trials, providing high quality evidence of interventions compared to placebo or standard therapy. (149) However, the generalizability of this evidence to HF patient populations is questionable. RCTs are the most rigorous method by which to evaluate the effectiveness of medical interventions like pharmacotherapy. (149) Often, trials do not enroll sufficient numbers of older persons to have enough power to examine individual outcomes. Some evidence about the benefits of pharmacotherapy in older populations comes from subgroup analyses of larger clinical trials, a weaker type of study design. Further evidence has come from prospective cohort studies in older individuals with HF. (123,130,162) While this study design is not considered as rigorous as an RCT, the results may be more relevant to the community-dwelling HF population, providing valuable evidence on which to base practice.

Many RCTs exclude older persons, especially those older than 75 years. (56,81,83,86,90) The average age of participants in HF RCTs is approximately 66 years, versus an average age of 75 years for the general population with HF; most community-dwelling individuals with HF would not qualify for trials. (122,141,163) Encouragingly, a review of RCTs of coronary syndromes found that the proportion of subjects over 75 years increased four-fold in 1991-2000 compared to 1966-1990, but concluded that older individuals are still under-represented. (164) Exclusion of older participants may be due to physician beliefs that age is associated with inferior outcomes or investigator concerns that many competing causes of adverse events could mask treatment benefits. (118,163) Some have begun to question whether chronological age is an appropriate criterion for determining participation in clinical trials or if physical ability, organ function, frailty and comorbidity status may provide better indication for suitability for trial

entry, while increasing the generalizability of results. (165,166) However, older individuals may not be willing to participate in RCTs due to age, illness, mobility, physical limitations, comorbidity, other appointments and care-giving roles. (167) So, while enrolling a more diverse cohort of older individuals in trials would add to the evidence base and extend generalizability, the feasibility of such studies may be questionable.

Many trials of HF pharmacotherapy have included only participants with impaired LVEF, usually below 35 or 40% (Appendix G), and this is another big difference between trial and community populations. (168) Women are more likely to have HFPEF and this selection criterion indirectly excludes many of them from trials. (161,163,167) Exclusion of individuals with HFPEF may partially account for the age differences observed between trial participants and the typical HF patient population. (122,161,167) More evidence is needed to guide management of individuals with HFPEF, who represent a large proportion of older patients. From the limited trials that have examined HFPEF, it can be seen that women and older individuals are more likely to be represented (Appendix H).

The presence of comorbidity also affects who is enrolled in HF trials. Presence of other comorbid conditions may increase the likelihood of competing causes of adverse outcomes, making trial organizers hesitant to enroll individuals with multiple comorbidities. (163,168) Additionally, individuals with multiple comorbidities often use many medications, another common exclusion criterion. (122,168) Impaired renal function is often an exclusion criterion, but worsens HF prognosis and is deserving of evidence to support disease management. (122)

Almost all major RCTs of HF therapy have been done in Western, industrialized countries. Whether results are applicable to non-Western populations, where HF burden is growing, is unknown. (122) Some studies indicate that individuals with mental illness, females

and older individuals may receive poorer care, increasing the risk of adverse outcomes. (169,170) However, a cohort study involving younger individuals with HF found similar rates of ACE inhibitor and β-blocker use among men and women and no difference in mortality rates was observed between those on optimal medication therapy. (171) Further, most trials studied individuals with NYHA class II-IV HF (see Appendix G). This means that therapeutic effects in people with more advanced HF have been better established than for those with milder HF, who may benefit more from pharmacotherapy to delay disease progression. Lastly, many trials recruit individuals from secondary and tertiary care centers, which likely leads to selection bias, increasing the likelihood of enrolling individuals receiving optimal HF management. (141)

Outcomes of Interest

Most clinical trials of HF pharmacotherapy examine all-cause mortality as the main outcome of interest. However, large numbers of individuals need to be enrolled to reach enough outcomes for adequate power. A common solution involves combining endpoints, but this strategy can mask the magnitude of therapeutic benefits associated with each outcome. (122,172) The applicability of such endpoints in individuals with severe disease or those who are frail is questionable. In older populations, improved functional independence, quality of life, symptom reduction and prevention of hospitalizations may be more valued than incremental survival benefits. More recent trials are starting to reflect some of these other treatment benefits by examining secondary endpoints like improvements of NYHA class, exercise tolerance and progression of HF. (122) From Tables 1-5 in Appendix G, it can be seen that many of the trials for therapies for HF with reduced EF examined all-cause mortality and use of the composite endpoint of all-cause mortality and all-cause hospital admission was common. Some trials examined quality of life outcomes, but only one of these studies involved individuals with

HFPEF (Appendices G and H). (83,90,98,111) Long-term medication toxicity may be another more appropriate endpoint in older populations who are continuing to live longer with chronic illness. (173)

2.6.1.6 Physician Perceptions and Awareness of Guidelines

Physician concerns over the applicability of clinical trial evidence to older individuals with HF and physician attitudes towards HF management have been the focus of much research. Specialists tend to prescribe HF therapy more than general physicians, who may have exaggerated concerns about treatment risk and side effects of HF pharmacotherapy. (122) Studies from primary care have demonstrated lower use of ACE inhibitor therapy in older individuals and those with comorbidities and polypharmacy because of perceived risk of adverse effects, lower perceived benefit, lack of confidence in the guidelines, difficulty of dose titration, monitoring and follow up, poor patient adherence, complexity of treatment, lack of diagnostic confidence, and difficulty applying RCT findings to older complex patients. (137,147,174) Further, while some work shows that application of therapeutic guidelines has improved (133), interventions to improve guideline adherence are less effective in older populations. (175) Age, gender and comorbidity have all been shown to affect whether individuals with HF receive guideline-recommended therapies. (170,176,177)

2.6.1.7 Treatment Decisions in Older Individuals

Use of pharmacotherapy for HF management is lower among older individuals. ACE inhibitors and β-blockers are underused in older individuals in both primary care and specialty care settings. (52,122,133-135) Age and concerns over adverse events are cited as reasons contributing to such underuse. (135) Clinicians may in fact be rational in their decisions to not

prescribe such therapies in older cohorts. However, whether such decisions are based upon good evidence is debatable.

Age-related physiological changes that alter the pharmacokinetics of drug therapies by reducing drug clearance and area for distribution increase the potential for adverse drug reactions. (25,144) Thus, consideration of the potential risk of adverse drug reactions is necessary when treating older individuals. However, in any decision to prescribe or withhold therapy, potential risks and benefits must be evaluated. When considering potential benefits of therapy in older populations, physicians may not have good evidence available upon which to base decisions. Evidence of therapeutic benefit comes almost exclusively from RCTs. Exclusion criteria of such trials means that participants are dissimilar from the majority of HF patient populations based on age, LVEF, comorbidity and medication use. It is often up to physicians to decide whether therapeutic benefits observed in trials can be expected in older populations. Physicians have identified difficulty applying trial findings to their patients as a reason for lower use of HF pharmacotherapies in older patients. (137,149,174)

Further, from clinical trial work, the endpoints of mortality and hospitalizations (often combined) are most commonly used. (57,70,76-78,81,85-96) Outcomes of potentially greater relevance in older populations, such as functional ability, cognition, quality of life and symptom management, are often not studied. Thus, whether such therapies offer benefits applicable to older individuals is not well established. Some work from older cohorts seems to indicate that benefits of ACE inhibitor and β-blocker therapy observed in trial participants does extend to older individuals as well. (122,123) Whether physicians are aware of such potential benefits is poorly understood.

There is also a dearth of information regarding outcomes of therapy over time, despite the fact that pharmacotherapy for HF will be used over the long-term. The CCS 2009 guidelines caution clinicians to balance the benefits of hypertension therapy in older individuals with the increased risk of side effects, especially in those with frailty or underlying comorbidity. (178) In summary, older individuals are less likely to receive HF pharmacotherapy, but the potential benefits of such therapy in this population are not well established. This means that while potential risks of treatment are well understood, potential benefits are not. To inform such decisions, research that establishes whether therapeutic benefit exists in older populations is needed.

2.6.2 Restricting Salt and Fluid Intake

Limiting the intake of salt and fluids is recommended in HF to manage weight and control edema. The CCS guidelines recommend that individuals with symptomatic HF restrict their dietary salt intake to 2-3g/day and adhere to a 'no-salt-added' diet. (2) In individuals with persisting fluid retention and congestion, daily fluid intake should be limited to 1.5-2 L/day. (2) Lastly, daily weight monitoring is important and medical attention should be sought if weight gain exceeding two kilograms in three days occurs. (101)

2.6.3 Exercise Therapy

Another component of HF management is exercise therapy. Coats and colleagues (179) have shown that exercise training can improve exercise tolerance, oxygen consumption and HF symptoms. CCS guidelines recommend that all individuals with stable, NYHA class II-III HF with reduced EF should aim to exercise 2-5 times per week for 30-45 minutes. (2) Through interval training or steady state exercise, benefits include increased physical capacity, improved HF symptoms and health-related quality of life, and reduced mortality and hospitalizations. (180)

2.6.4 Surgical Interventions

Surgical interventions in HF management are less commonly used than the previously described therapies. Coronary artery bypass grafting (CABG) is a treatment option for individuals with multi-vessel disease, but may not be feasible in individuals with comorbid conditions. (6) Implantable devices, including defibrillators, can help with heart rate control in individuals with HF with advanced HF (LVEF < 30%) who are at increased risk for atrial fibrillation. (6) Cardiac resynchronization therapy may be beneficial in individuals with persisting HF symptoms and impaired cardiac conduction. (2) Lastly, surgical ventricular remodeling is an experimental treatment. (6)

2.6.5 Chronic Disease Management and Heart Failure

In HF care, chronic disease management (CDM) programs have gained much recent attention and may enhance the quality of patient care. CDM programs generally refer to a multidisciplinary approach in which physicians and teams, consisting of nurses and possibly other health professionals, tailor and monitor care to individuals at all stages of HF. (181,182) Common components of CDM programs include education of patients and caregivers in self-care practices, case coordination (by clinical nurses or nurse practitioners), enhancement of self management skills, optimization of medication and follow-up with patients (Appendix E: Figure 2). (182-184) Educating patients and caregivers about the symptoms, signs, diagnosis, treatment, dietary issues and role of exercise can help promote self management and redirect the burden of care away from the acute health care system. (182)

CDM programs for HF have been advocated to increase prescription of pharmacotherapy, increase adherence to dietary restrictions and medication therapy, and reduce hospitalizations. (185,186) In older individuals, CDM programs can also address many treatment goals such as

relieving symptoms, improving functional capacity and quality of life, and reducing acute exacerbations and unnecessary hospitalizations. (182) CDM programs may be especially beneficial to individuals with other comorbidities or other barriers to care. (182)

2.6.5.1 Self-Care

An important goal of CDM programs is the promotion and facilitation of self-care practices through patient education. Self-care strategies include both self-maintenance and self-management behaviours. Self-maintenance refers to adherence to prescribed therapies and health practices, while self-management includes recognition and evaluation of signs and symptoms of HF, implementation of a treatment option and evaluation of the treatment chosen (Appendix E: Figure 3). (187-189) Self-management requires learning skills, insight, judgment, problem-solving and decision-making, and is more cognitively demanding than self-maintenance. A HF-specific tool to help clinicians evaluate the self-management capabilities of their patients has been developed. (190)

In HF, specific self-care behaviours include medication taking, symptom monitoring and adhering to dietary restrictions. CDM programs for HF strive to promote patient self-care and have been shown to improve quality of life and functional status, reduce unplanned and repeated hospitalizations and possibly reduce mortality. (182,191) Barriers to self-care include anxiety comorbidities, depression, sleep problems, cognitive impairment and poor health literacy. (189) There are no performance measures to address patient adherence to components of self-care in acute care settings, making it difficult for providers to know if education is working. (192)

2.6.5.2 Research Evidence for Chronic Disease Management Programs

Research evidence is beginning to highlight important benefits of CDM programs for HF management. Such programs may successfully reduce mortality and hospital admissions,

improve use of and adherence to pharmacotherapy, improve quality of life and prognosis and reduce resource use. (104,182-184) Improving adherence to drug therapy may in turn improve other outcomes including survival and reduction of hospitalizations in individuals with HF with reduced EF. (74,93,103,110) In Ontario, CDM is delivered to a large proportion of individuals with HF regardless of age, but some work found that males are more likely to receive CDM. (193)

Much research has examined interventions with coordinated CDM delivered through nurses and pharmacists. Such intensive interventions may reduce number of hospitalizations and number of days spent hospitalized related to HF in the short term (up to six months), but longer term benefits are questionable. (94,185) One recent meta-analysis (104) suggests that while targeted interventions reduce hospital readmissions, they do not affect mortality. Further, individuals with optimally treated, stable HF may be managed adequately through general practice, with HF clinics being useful in initial disease management. (194)

2.6.5.3 Role of Home Care in Chronic Disease Management

Home care may play an important role in optimal management of HF, possibly in conjunction with or following, CDM programs. Home care may help overcome the underuse of disease-modifying therapies, especially in older persons (183), improve adherence to medication, diet and exercise recommendations and help maintain the benefits seen in CDM programs. (2,16) In older individuals, CDM programs may be more effective with some home care component or strategy to address comorbidities, and social and financial issues associated with HF. (184) The role for home care in CDM is not well-developed, but home care may be able to provide CDM services complementary or in addition to those offered in general practice. Coordinating care between the home care sector and primary care sector where most HF patients are managed

could improve disease outcomes and quality of life.

2.7 Summary of Current Literature

Heart failure, with reduced or preserved EF, is common among older individuals and is associated with reduced survival, functional ability and quality of life, as well as increased health service use and caregiver burden. Chronic disease management programs can help older populations manage this complex disease. An important part of such programs, and a cornerstone of HF care, is pharmacotherapy. ACE inhibitors, β-blockers, ARB, AA and digoxin are all recommended for use in HF with reduced EF and while less evidence exists about the effectiveness of these therapies in HFPEF, there are some recommendations for use among these individuals. Pharmacotherapies for HF have been well-evaluated in RCTs. Benefits of pharmacotherapy include prolonged survival, reduced hospitalizations and improvements in symptom severity, function and exercise tolerance. ACE inhibitor and β-blocker therapies have shown the most beneficial effects in individuals with HF and reduced EF and are recommended for use in most individuals.

The representation of older individuals in clinical trials of HF pharmacotherapy is poor. The exclusion of older individuals, women, those with comorbidity and those on other medications limits the likelihood that evidence gained from RCTs will be applicable to larger HF populations in the community. Even when trials enroll older subjects, highly selective inclusion criteria continue to promote enrollment of individuals with less comorbidity and medication use. Another weakness of the current evidence in HF management is in managing HFPEF. Recommendations are sparse for all individuals, and effective therapies in older populations have not been well explored. However, emerging from the observational cohort studies in HFPEF management is a trend towards better representation of community-dwelling HF clients. These

trials enroll more women and do not usually limit EF above 40%. More cohort studies will begin to advance knowledge in this field, providing evidence for therapies in older populations. Excellent systematic reviews and meta-analyses of the larger trials for ACE inhibitors, β-blockers and ARBs have been published and are invaluable in providing direction for the management of HF.

Whether older individuals with HF benefit from pharmacotherapy to the same degree as trial participants is not well established. Some evidence suggests that similar benefits are seen in older populations, particularly for ACE inhibitor therapy. However, the few studies examining therapeutic effects in older populations have many limitations. The cut-off ages remain low, and most of these studies still did not include very old individuals (age 80 or older). Difficulties in recruiting older adults may still be a barrier. Additionally, subgroup analyses of large trials can potentially add to knowledge about therapeutic effectiveness in older individuals, but are usually not adequately powered to provide statistically strong evidence. Further, many populations of older individuals with HF continue to be excluded from studies, including those receiving home care and those in institutions. Some of these populations may be captured in the post-hospitalization studies, but nonetheless, this exclusion is a weakness of current research.

The CCS 2006 HF guidelines include recommendations for HF management in older individuals based on some smaller RCTs and observational data. (2) Recommendations are based on symptom control and mortality outcomes, which are applicable to older populations. However, effects of therapy on outcomes such as functional or cognitive decline have not been well explored, even though these quality of life outcomes may be of particular importance to older populations. Trials commonly use combined endpoints to observe statistically significant differences between treatment groups, but this method may mask the magnitude of benefit in

individual outcomes. Following older cohorts receiving therapy to examine benefits or adverse outcomes may be of the most utility in providing new evidence to inform practice.

Underuse and suboptimal dosing of HF therapies among older populations is problematic, suggesting suboptimal quality of care. Older individuals may only tolerate lower doses than those shown to be effective from RCTs, to adjust for reduced creatinine clearance. There is evidence that therapeutic benefit occurs even at suboptimal dosing, suggesting that underuse of these proven therapies is a more worrisome problem than suboptimal dosing. Many barriers at the physician level have been identified. Physicians may not feel recommendations are easy to follow, may disagree with recommendations or may be hesitant about perceived risks of HF therapy. Further understanding about the use of pharmacotherapy could be generated by exploring more patient-level factors, particularly across care settings. Additionally, the issues observed with pharmacotherapy for HF in older individuals apply to older individuals more broadly and not just those with HF. Thus, management of chronic conditions in older persons could benefit from some changes in trial design to ensure that the majority of those needing therapy are represented in the trials on which recommendations are based. Whether enough evidence about benefits in older populations exists to make informed treatment decisions is important. Observational cohort studies of therapies proven to be effective in younger cohorts would add to the knowledge base and build upon existing trial evidence.

Dissemination of knowledge about the most current evidence is challenging. Increasing knowledge uptake of smaller, observational trials in older individuals may also improve physician confidence in providing HF pharmacotherapy in this cohort. Furthermore, investigation of methods to improve adherence generally, and specifically among older individuals who may face more challenges, would be beneficial. Studies of persistence with

cardiovascular medications have shown promising results. Linking persistence of therapy and non-use of therapy to outcomes is a logical research direction and ultimately examines quality of care. Thus, while management of HF has progressed over the past three decades, meeting the needs of older individuals, creating more comprehensive trials and ensuring effective knowledge exchange are all important in improving future care.

3.0 STUDY CONTEXT AND RATIONALE

3.1 Home Care in Ontario

The organizational structure of home care in Ontario is important in understanding the context in which this research is being conducted. The local health integration networks (LHIN) and community care access centres (CCAC) in the province and the provincial reimbursement plan for seniors' medications are important contextual components.

3.1.1 The Structure of Home Care in Ontario

Home care is becoming an increasingly important component of Ontario's health care continuum. Although Ontario had a trial home care program as early as 1958, home care in Canada was introduced in the 1970's. (1) In 1988, all provinces and territories established programs for both acute and long-term clients, and home care has since expanded rapidly. (2,3) Canadian health reform has seen the expansion of community care at the expense of hospital care, and the Romanow Report (2002) highlighted the increasing importance and necessity of such expansion. (4,5) Home care is not included as an essential service in the Canada Health Act, though some recommend its inclusion. (4,5) As such, there is no portability of home care services between provinces. (3) However, all provinces and territories have public funding and basic service provision to some degree. (3,6) Funding for home care has increased dramatically in the last two decades, but still represents only a small part of overall health care spending. (6) Further, more recent spending for home care services has not expanded as rapidly since the 1990's. (7)

Home care refers to the provision of a comprehensive range of coordinated health services in the home to enable individuals of all ages to remain at home with appropriate care and promote, maintain and restore health. (3) Home care services allow older individuals with

chronic conditions to remain at home and also facilitate returns home following hospital stays. (8) Such services can often prevent, delay or substitute for long-term or acute care (9), and are intended to complement informal supports for individuals at home. The variability in home care policies is evident across Canada, with one example being the access to supportive services for individuals with chronic conditions. (3)

Most clients receive home care services in their own home, but some services are accessed by clients in LTC facilities or assisted or supportive housing facilities. Further, the majority of clients are long-stay, meaning they are expected to receive services for 60 days or more. (3) One study found that while the proportion of clients receiving home care did not change significantly, there was a large increase in the proportion of clients receiving nursing and specialty care in an eight-year period. (10) At any given time, the number of people receiving home care generally exceeds that getting facility-based services (11), with up to 5% of the national population receiving services. (3) In Ontario, over 5.5 million home care visits were delivered in 2005/2006, to approximately 600,000 clients. (12-14) Most of these visits (67%) involved personal support and homemaking services and nursing was provided in more than one-quarter of visits. (14) It is expected that with current demographic and health care trends, the demand for home care services in Canada will continue to rise. (1) The population is aging, the prevalence of chronic conditions is rising and more individuals wish to remain at home for care. (1) Technological advances have facilitated the shift for home care services, as have trends towards shorter hospital stays, and shifts away from long-term care. (1) For these reasons, home care is likely to remain a vital component of the health care system.

In Ontario, the 14 LHINs oversee the distribution of more than 20 billion health care dollars (15) and plan, integrate and fund local health services including home care. (3) The

province's 14 CCACs correspond to the geographic boundaries of each of the 14 LHINs. The CCACs are locally funded through the LHINs to provide access to government-funded home and community services and LTC in the province. (15) CCACs are the single point of access for individuals requiring home care services. CCAC case managers determine eligibility for home care services and arrange for health care professionals to provide a range of care including nursing services, personal support, physiotherapy, occupational therapy, social work, nutritional counseling and medical supplies and equipment. (16) CCACs also coordinate community support services for clients as needed. (16) In 2001, the Canadian Institute for Health Information (CIHI) developed the Home Care Reporting System to improve quality and accountability of home care services by providing a set of indicators allowing regional comparisons. (17)

The Ontario Ministry of Health and Long-Term Care (MOHLTC) launched the Aging at Home strategy in 2007, committing over 1 billion dollars to support seniors to live healthy and independent lives while remaining at home. (18) Specific goals of this initiative include avoiding premature admission to LTC facilities and hospitals, finding innovative ways to support seniors in the community, creating integration across the continuum of community-based services, supporting caregivers and promoting health system sustainability. This is a key initiative in alleviating the burden on existing inpatient and residential facilities and preparing for future increases in health service use. Even more recently, the MOHLTC announced that province-wide quality measures and a reporting system for home care will be introduced to ensure high-quality health care. (12)

3.1.2 The Ontario Drug Benefit Plan and Formulary

Seniors older than 65 years of age are eligible for subsidized drug programs in Canada,

but programs in each province vary. In Ontario, the MOHLTC covers most of the cost of many drug products for seniors through the Ontario Drug Benefit (ODB) plan. (19) Seniors with valid Ontario health insurance who are 65 years and older are automatically eligible for coverage. (19) Medication costs are subsidized depending on marital status and income levels, with many seniors paying a $100 copayment each year, after which prescriptions cost $6.11. (19) The ODB formulary is a comprehensive list of drug products that are included in the provincial drug benefit program. As of September 2009, the Ontario formulary contained more than 3200 drug products. For most cardiovascular medications, including all medication classes indicated for HF management, there are few restrictions on use and many have interchangeable medications approved for use. (20) Table 1 in Appendix I provides a list of HF medications included in the provincial formulary.

3.2 The Resident Assessment Instrument – Home Care

Across the care continuum, data about client needs and preferences are needed to improve care. interRAI instruments enable the collection of high-quality data to enhance care quality in many care settings. interRAI is an international, collaborative research network with members from more than 30 countries. This network strives to improve health care in vulnerable populations by promoting evidence-based clinical practice and policies based on high-quality data about individual needs and outcomes across the continuum of health care. Assessment tools developed by interRAI are designed for use in specific care settings and include a set of core items considered relevant to all settings. However, all assessments incorporate common clinical concepts, language and data collection methods to allow comparisons across care settings. (21,22) A newer suite of assessments was released in 2009 (198) across the continuum of care.

Improvements have been made to standardized items and the new suite contains common items and definitions. (23)

interRAI instruments allow comprehensive, standardized data to be collected across many domains including sociodemographic characteristics, functional and cognitive status, psychological conditions, disease diagnoses and service use. Such data can then be used for individual care planning, measuring outcomes of interest and developing quality indicators.

interRAI has developed assessment instruments designed for use across the care continuum. The RAI-HC was designed for use in home care populations. This assessment instrument consists of over 300 questions designed to assess the needs, strengths and preferences of clients receiving home care services. The RAI-HC database contains detailed clinical and sociodemographic information including cognitive status, mood and behaviour patterns, informal support services, physical function, clinical diagnoses, medication use (both prescription and non-prescription) in the seven days prior to assessment and acute service utilization (including hospitalizations and ED visits) in the 90 days prior to assessment. (24) Embedded within the RAI-HC, Clinical Assessment Protocols (CAPs) help with further assessment and care planning, as well as needs analysis and patient safety analysis at an aggregate level. (25) This breadth of information creates a rich data source, which provides comprehensive information about home care client populations. Trained clinicians complete RAI-HC assessments and use clinical judgment in recording diagnoses. Accuracy of recorded information is routinely verified through discussions with physicians, family and caregivers. Assessors are trained to review medical records if necessary. The reliability and validity of the tool have been established previously and items contained within the RAI-HC, including key areas of functional and cognitive status, have excellent inter-rater and test-retest reliability. (22,26-30)

The RAI-HC is used in a number of provinces and territories in Canada and in 2003, the Ontario MOHLTC mandated the use of the RAI-HC to assess every long-stay home care client in the province. (3) The majority of clients expected to be long-stay receive a RAI-HC assessment within 14 days of initiation of home care services, regardless of whether they remain on service. Further, clients who were not expected to be long-stay are assessed by day 60 f they remain on service. Reassessments of clients who continue to receive services are done semi-annually. While most long-stay clients are assessed in the community, some are assessed in hospital to facilitate placement into LTC facilities. Approximately 150,000 assessments are completed each year. Assessments are completed by trained assessors within each CCAC in the province; the CCACs transmit their assessment information (along with their administrative records and medication data) to the OACCAC. Through a data sharing agreement, the University of Waterloo receives data cuts from the OACCAC approximately every 6 months. Medication data are routinely collected at each assessment as part of normal clinical practice. The newer interRAI HC instrument is not yet in use in Canada, but mandates the use of standardized medications codes where they exist. (23) The RAI-HC and all interRAI instruments are available for purchase through www.interrai.org.

3.2.1 Data Source

The RAI-HC database has a number of strengths that make it an unparalleled choice for population health research. This database contains extensive and detailed clinical information about geriatric conditions such as functionsl and cognitive status, mood and behaviour patterns, clinical diagnoses, and medication use (both prescription and non-prescription). Further, information is routinely collected about informal support services and acute service utilization (including hospitalizations and ED visits) in the 90 days prior to assessment. Since data

collection is mandated, no additional burden is placed on individuals to collect this information. Adding to the strengths of this data set, items for assessing presence of clinical diagnoses like HF are included in RAI-HC assessments. The validity of such information has been demonstrated. (30) Further, a number of summary health scales are embedded within the assessment and these scales have been validated for use with the RAI-HC. (26,28,31-34) The RAI-HC is mandated for use in Ontario, allowing census-level evaluation of the care needs of all long-stay home care clients in the province. This comprehensiveness means that the data are representative of the entire long-stay home care population in Ontario. Lastly, the RAI-HC has been used in Ontario since 2003. There are currently more than 1,000,000 assessments in the database and the longitudinal nature of these data allows for analysis of trends over time. In summary, this rich data source is second to none in Canada in size, comprehensiveness, representativeness and longitudinal nature.

3.2.2 Outcome Measures

Many outcome measures can be generated from the longitudinal use of embedded scales (combinations of items) on interRAI instruments. In cross-sectional analysis, these scales can summarize client characteristics in a number of domains. The embedded scales automatically calculate scores for individual clients that help assess clinical status and care needs. This research will utilize five health index scales (outcome measures) for functional ability, cognition, depression and health instability. These are: 1) the Activities of Daily Living (ADL) self-performance hierarchy scale (28), 2) the Instrumental Activities of Daily Living (IADL) capacity scale (26), 3) the Cognitive Performance Scale (CPS) (29,32), 4) the Depression Rating Scale (DRS) (33), and 5) the Changes in Health, End-stage disease and Signs and Symptoms (CHESS) Scale (31), respectively. Each scale has been developed and validated for use with the RAI-HC

and higher scores in each measure indicate more severe impairment. (26,28,31-34) The scales are described in detail below.

The Activities of Daily Living Self-performance Hierarchy Scale

The ADL self-performance hierarchy scale is a 7-level scale (range from 0 – independent to 6 – most dependent) calculated based on the toileting, locomotion, eating and personal hygiene items from the RAI-HC. This scale accounts for the typical stages of ADL loss and has been validated against other scales. (26,28)

The Instrumental Activities of Daily Living Capacity Scale

The IADL difficulty scale is a 7-level scale (range from 0 – no difficulty to 6 - great difficulty) calculated using the meal preparation, ordinary housework and phone use items from the RAI-HC. (26) This scale measures the capacity to perform IADLs, regardless of whether the opportunity to do so exists.

The Cognitive Performance Scale

The CPS is used to measure cognitive function and is a 7-level scale (range from 0 - intact to 6 – very severe impairment) composed of items that measure short-term memory, cognitive skills for daily decision making, expressive communication and eating self-performance. (32) The CPS has been validated against the Mini Mental State Exam. (29)

The Depression Rating Scale

The DRS is a 15-level scale (range from 0 – no depressive symptoms to 14 – many depressive symptoms) based on seven RAI-HC items: negative statements; persistent anger; expressions of unrealistic fears; repetitive health and anxious complaints; facial expressions that are sad, pained or worried; and tearfulness. It has been validated against the Hamilton and

Cornell depression scales and scores above three are generally interpreted to indicate possible depression. (33)

The Changes in Health, End-stage Disease and Signs and Symptoms Scale

The CHESS is a 6-level scale (range from 0 – no instability to 5 – highest level of instability) that provides a measure of health instability and frailty. The CHESS score is created from subscores based on the presence of the following health symptoms: vomiting, dehydration, loss of appetite, weight loss, shortness of breath and edema. This subscale is then added to declines in cognitive or ADL functions, as well as end-stage disease items. It was a strong predictor of survival in an LTC population and is validated for use in the home care setting. (26,31,34)

3.2.3 interRAI Research in Pharmacoepidemiology

The comprehensive information collected using interRAI instruments has been used extensively in geriatric research and to a smaller extent in pharmacoepidemiological research. Much of this work has examined older populations in the LTC and home care environments. The RAI-HC assessment has been used in many countries to examine pharmacotherapy use among older individuals receiving home care services. Patterns of use of antipsychotics, analgesics and outcomes of therapy have been described in European and Canadian home care populations. (35-37) Much more work has examined medication use in LTC populations for diseases including Parkinson's, HF, dementia, hypertension and pain. (38,39,40-46) Some work has also examined patient outcomes related to medication therapy (25,39) and potentially inappropriate medication use. (47,48) It is clear that the comprehensive data collected using interRAI instruments can be used to undertake pharmacoepidemiological studies and inform clinical practice. In particular, the ability to access comprehensive person-level clinical and sociodemographic information is an

attribute often lacking in databases traditionally used for pharmacoepidemiological studies. Nonetheless, little work has focused on outcomes over time and none has examined use of medications among community-dwelling individuals with HF receiving home care services. Thus, while interRAI instruments have the potential to contribute greatly to the field of pharmacoepidemiology for many chronic conditions, this potential is only beginning to be realized.

3.3 Study Rationale

Given the overall prevalence of chronic diseases like HF, as well as the many negative outcomes of such conditions, research in this area has the potential to be informative and wide-reaching. The proposed research aims to address gaps in current knowledge about chronic disease management in HF in the community setting.

3.3.1 Gaps in Current Knowledge

Much work on pharmacotherapy in HF has come from RCTs and some from hospital and specialty clinic settings. Knowledge about disease characteristics and service needs of community-dwelling older persons with HF is lacking. Further, much research has examined the outcomes of mortality and hospitalizations, which may not be the only relevant outcomes among to older individuals with HF. There is evidence that therapies used to manage HF are underused in older populations, but again, most of this research involved hospitalized individuals or those receiving care through specialized clinics. This may not be representative of other sub-populations of patients, particularly those receiving home care services. Further, little is known about potential barriers to implementing CDM programs for HF. Lastly, there is a dearth of evidence about the effectiveness of pharmacotherapy for HF in older individuals, and evidence thus far is primarily limited to the outcomes of mortality and hospitalization.

3.3.2 Proposed Research

This research will attempt to address some of the identified gaps in the current knowledge of pharmacotherapeutic management of HF. In doing so, there will be three main research areas, each of which will be described in detail in its own chapter of this dissertation. All analyses will make use of the extensive Ontario RAI-HC and OACCAC data available at the University of Waterloo. Application of the interRAI instruments to the area of outcomes of pharmacotherapy is novel in Ontario and Canada. All work will be retrospective and involve secondary data analysis of data contained within the databases at the University of Waterloo. Ethics approval was obtained from the Office of Research Ethics at the University of Waterloo (certificate #14761).

3.3.2.1 A Profile of Older Community-Dwelling Home Care Clients with Heart Failure in Ontario

A first step in beginning to understand therapeutic effectiveness in older populations is to characterize a more typical HF population than those represented in the current literature. This first initiative will characterize HF individuals who are receiving home care services with respect to sociodemographic and clinical characteristics, medication use and service use. This will not only create a comprehensive description of individuals in an increasingly important health care sector, but will add to the current literature, which currently under-represents older individuals with HF. This will be one of the first comprehensive studies of a representative population of older individuals in the community setting. Specifically, this research will:

1) determine prevalence estimates of HF in long-stay home care clients;

2) describe sociodemographic and clinical characteristics of long-stay home care clients according to HF diagnosis; and

3) examine informal supports and acute service use among long-stay home care clients according to HF diagnosis.

3.3.2.2 Correlates of Non-Use of Pharmacotherapy in Heart Failure

First-line pharmacotherapy, consisting of an ACE inhibitor or ARB in conjunction with a β-blocker, is recommended for most individuals with HF. It is well understood that older individuals in hospital, specialty practice and general practice settings are less likely than their younger counterparts to receive recommended therapies for HF. Whether this holds true for HF clients receiving home care services is unknown. Further, many provider-level factors associated with use of these therapies have been identified in the literature, but less is known about patient-level factors. Understanding factors associated with medication use in this population can assist with care planning and help inform intervention strategies to overcome gaps in care. This research will examine use of ACE inhibitor, ARB and β-blocker therapy in the home care setting and examine factors associated with non-use of these therapies. Making use of the extensive sociodemographic and clinical variables available in the RAI-HC database, this research aims to:

1) estimate the prevalence of ACE inhibitor, ARB and β-blocker therapy use among long-stay home care clients with HF, and

2) identify correlates of non-use of first-line pharmacotherapy among long-stay home care clients with HF.

3.3.2.3 Outcomes among Older Home Care Clients with Heart Failure

The last research initiative will examine the outcomes of mortality, LTC admission, long-stay hospitalization, functional decline and cognitive decline over time. The current literature with respect to such outcomes in older HF populations is sparse and predominantly focuses on the outcomes of mortality and hospitalizations. These five outcomes will be explored using the longitudinal data in the RAI-HC database. Proportional hazards regression analysis will be used to model time to each outcome. The ability to examine quality of life outcomes will provide valuable evidence to inform practice. This will be one of the most comprehensive studies of

outcomes in community-dwelling individuals with HF to date and will also answer key questions about factors associated with relevant geriatric outcomes. Specifically, this work will:

1) determine rates of mortality, LTC admission, long-stay hospitalization, functional decline and cognitive decline among long-stay home care clients with HF, and

2) examine a comprehensive set of sociodemographic, clinical, medication and service use factors potentially associated with each outcome.

3.4 Research Goals

Using Ontario data, it is hoped that this work will generate evidence upon which to inform future policy and practice in home care. While this research focuses on chronic disease management of HF, this research model can be extended to other chronic diseases, generating future evidence. Research dissemination will be performed in a variety of ways, and will target diverse audiences. Early results have been presented at clinical and research-oriented conferences, as well as to policy-makers in a variety of networking forums. Manuscripts from early results have been published or are in press, and future work will be published once complete. Preliminary research findings were presented to key stakeholders in policy and across care-settings in May 2010. Ultimately, it is hoped that this research will inform new policies and practices to improve the delivery of chronic disease care in the community, eventually translating to improved quality of life for individuals with HF through interventions designed to target those at risk of adverse outcomes.

4.0 A PROFILE OF OLDER COMMUNITY-DWELLING HOME CARE CLIENTS WITH HEART FAILURE IN ONTARIO

(The text for Chapter 4.0 is taken verbatim from the published manuscript.)

This chapter is based on a study first reported in Chronic Diseases in Canada. The primary publication can be found at: Foebel AD, Hirdes JP, Heckman GA, Tyas SL, Tjam EY. A Profile of Older Community-Dwelling Home Care Clients with Heart Failure in Ontario. Chronic Dis Can. 2011;31(2):49-57.

4.1 Introduction

Heart failure (HF) is a "complex syndrome in which abnormal heart function results in, or increases the subsequent risk of, clinical symptoms and signs of low cardiac output and/or pulmonary or systemic congestion." (1) An estimated 500,000 Canadians live with HF (2) and its prevalence increases with age. (3) At age 80, both men and women have approximately a 20% lifetime risk of developing HF. (3) Population aging and improved survival of patients with hypertension and myocardial infarction, two important risk factors for HF, contribute to the rising prevalence of HF. (4,5) Already a substantial burden on the Canadian health care system, projections of the future burden of HF are worrisome: HF incidence is projected to double in Canada by 2025 due to population aging, with the most rapid growth in prevalence expected in those over 85 years old. (6,7)

Despite advances in the overall treatment and management of HF, survival and quality of life remain poor. In Canada, 4,430 deaths were attributable to HF in 2004. (8) HF is associated with annual mortality rates as high as 50%, and 25% to 40% of patients will die within one year of diagnosis. (1,9) HF patients today are primarily 65 years or older and suffer from multiple comorbidities including hypertension, diabetes, arthritis, cognitive impairment and depression. (10,11)

The prevalence of HF translates into high costs to the Canadian health care system. The repeated hospitalizations, complex treatment regimen and cost of pharmacotherapy strain many components of health care including primary and specialty care, emergency departments (ED) and hospitals. (12) Among Canadians over 85 years of age, HF is responsible for more hospitalizations than ischemic heart disease or heart attack. (8) Readmission rates for disease complications can reach 33% within three to six months. (13) Patients with HF are re-admitted

because of poor clinical status, which may continue to worsen in hospital. Hospitalization itself, in fact, appears to lead to progressive functional decline and eventual placement into a long-term care (LTC) facility. (14-16) More than 10% of hospitalizations of older adults resulting in Alternate Level of Care designations are for cardiovascular disease, particularly HF, as are up to 20% of transfers of LTC residents to hospital. (17,18) LTC residents hospitalized with HF may experience long ED waits and spend on average six days in hospital. (18) Further, 7.4% of LTC residents hospitalized for HF remain in hospital as Alternate Level of Care patients awaiting transfer back to their LTC home. (18) Such admissions are often unsuitable and potentially preventable if HF were better managed in primary care. (19-23) Specifically, the health care system needs new approaches for the management of HF targeted towards reducing the risk and duration of hospitalizations. (7)

Effective management of HF is challenging as it involves complex pharmacotherapeutic regimens, periodic adjustment of medication doses, elaborate dietary and fluid intake regimens, exercise therapy, and ongoing patient education to ensure appropriate self-care. The Canadian Heart Health Strategy and Action Plan recommends the Chronic Disease Management (CDM) model as the preferred model for care delivery for cardiovascular disease. (24) A fundamental characteristic of CDM is patient-centered emphasis on disease self-care, which incorporates both self-maintenance and self-management. Self-maintenance requires adherence to prescribed treatments and health practices (25), while self-management builds on self-maintenance and includes recognition of signs and symptoms of HF, evaluation of the importance of these signs and symptoms, implementation of a treatment option and evaluation of the treatment chosen. (25,26) Self-management requires learning skills, insight, judgment, problem-solving and decision-making, and is more cognitively demanding than self-maintenance. CDM programs

targeting HF strive to promote patient self-care and have been shown to improve quality of life and functional status, reduce unplanned and repeated hospitalizations and possibly reduce mortality. (27,28) However, HF in older patients is often associated with multiple medical comorbidities and polypharmacy, as well as with depression and cognitive impairment, all of which can interfere with self-care and prevent patients from fully benefitting from CDM programs. (29,30) Further, there is no clear understanding of the ideal duration of such programs or the most effective mode of follow-up. (28,31)

Given the high prevalence of HF in populations over 65 years old, the acute health care system needs enhanced CDM for HF to ease the burden on itself. Working in partnership with primary care physicians and specialty HF clinics, home care is a potentially important component of CDM for HF and may also provide a means of follow-up beyond the initial program. (32) Developing methodologies to assess levels of risk, identify barriers to self-care and deliver specific community-based interventions to home care clients with HF would make a significant contribution to an overall CDM strategy for HF.

HF is a common disease, but there is little research on the demographic and clinical characteristics, service use and needs of these clients in home care. This study seeks to 1) describe the sociodemographic and clinical characteristics of long-stay home care clients with HF and 2) examine service use among long-stay home care clients with HF to promote management at home with appropriate services.

4.2 Methods

4.2.1 Data Source

Sociodemographic, clinical and service use data were retrieved from the Ontario Resident Assessment Instrument-Home Care (RAI-HC) database, a repository of all completed RAI-HC

assessments in Ontario, a province of approximately 13.2 million people. The RAI-HC evaluates the care needs of all long-stay home care clients in the province (i.e. those expected to receive services for longer than 60 days). The assessment consists of over 300 questions designed to generate Client Assessment Protocols (CAPs) that help with further assessment and care planning, as well as to provide outcome measures for cognition, depression and physical function. Trained clinicians conduct the RAI-HC assessments and use clinical judgment to record diagnoses. The accuracy of the recorded information is verified through discussions with physicians, family and caregivers, and assessors are trained to review medical records if necessary. The RAI-HC is considered both reliable and valid and the items contained within have excellent inter-rater and test-retest reliability. (33-36) The RAI-HC database contains detailed clinical and demographic information accumulated in the previous seven days, including cognitive status, mood and behaviour patterns, informal support services, physical function, clinical diagnoses, prescription and non-prescription medication use, and acute service utilization in the 90 days prior to assessment, including hospitalizations and ED visits. This breadth of information provides a comprehensive description of all long-stay home care clients within Ontario.

4.2.2 Sample

All home care clients aged 65 years or older who received their most recent RAI-HC assessment between January 2004 and December 2007 were eligible for this analysis, regardless of functional or cognitive status, or presence of comorbidity (N = 264,030). Using only the most recent assessment allowed for a prevalence sample, providing a comprehensive profile of HF clients in home care. Assessments took place either in a community or hospital setting; this study

included only clients assessed in the community. The Office of Research at the University of Waterloo provided ethics approval for the analyses of the anonymized data in the current study.

4.2.3 Measures

The RAI-HC includes valid and reliable items to assess HF (as well as other conditions) (37); clients were defined as having HF if this condition was recorded in the assessment. Trained assessors routinely verify this information through self-report, discussions with caregivers and health providers, as well as review of medical records if necessary. Accuracy of the diagnostic and medication information collected using the interRAI instruments has also been established. (37) Among individuals with HF in nursing homes and LTC facilities, the positive predictive value and sensitivity for the interRAI diagnosis of HF was greater than 0.80 compared to what is found with administrative databases. (37,38) Clinical measures such as ejection fraction and New York Heart Association (NYHA) class were not available from this data source.

Based on previous literature and in consultation with a geriatrician (Dr. George Heckman), key sociodemographic and health-related variables were identified to describe the HF sample (1,11,29,40), including age, gender, living arrangement, marital status, caregiver presence, caregiver stress, health region within Ontario (as defined by the geographic boundaries of each of 14 Community Care Access Centres [CCACs], which align with Local Health Integration Networks in Ontario), daily pain, edema, falls, number of medications, shortness of breath, incontinence and presence of comorbidity. The following comorbidities were used in describing this sample: coronary artery disease (CAD), arthritis, diabetes, airway disease (including asthma, chronic obstructive pulmonary disease [COPD] and emphysema) and hypertension. The analysis also included five summary health scales for functional ability, cognition, depression and health instability. These were: 1) the Activities of Daily Living (ADL)

self-performance hierarchy scale (range 0–6); 2) the Instrumental Activities of Daily Living (IADL) capacity scale (range 0–6); 3) the Cognitive Performance Scale (CPS) (range 0–6); 4) the Depression Rating Scale (DRS) (range 0–14); and 5) the Changes in Health, End-stage disease and Signs and Symptoms (CHESS) scale (range 0–5). (35,41-44) Each scale has been developed and validated for use with the RAI-HC, and higher scores in each measure indicate more severe impairment. (36,41-44) Service use in the seven days prior to assessment was captured with the RAI-HC assessment and use of nursing, homemaking, physiotherapy and meal services were analyzed. Hospitalizations, ED visits and use of emergent care (defined as any unplanned visit to a non-ED health provider) in the past 90 days were also investigated.

4.2.4 Analysis

Scores from each of the five summary scales used (ADL, IADL, CPS, DRS and CHESS) were collapsed into three levels to differentiate between levels of impairment. Similarly, the variables for age, falls, hospitalizations, ED visits and use of emergent care were collapsed into three levels. Use of nursing, homemaking, physiotherapy and meal services in the home were all analyzed by comparing receipt of any service versus no services. Three classes of commonly used HF medications (angiotensin-converting enzyme inhibitors, angiotensin receptor blockers and beta-adrenergic receptor blockers) were excluded from the medication counts. Comorbidity and medication counts were collapsed into three and four levels, respectively. Differences in characteristics between groups were tested using unpaired, two-tailed t-tests and Satterthwaite's unequal variance assumption for continuous variables and chi-square tests for categorical variables (significance level $p < .05$). Stratification by age groups addressed potential confounding of observed age group differences with clinical and service use variables. All analyses were conducted using SAS software (version 9.0, SAS Institute Inc., Cary, NC).

4.3 Results

Between January 2004 and December 2007, the RAI-HC assessed 264,030 unique clients and identified 39,247 home care clients with HF (14.9%) in total. The proportion of clients with HF in each CCAC varied significantly ($p < .0001$) (see Figure 4.1). The proportion of clients with HF was highest in the North East CCAC (19.5%) and lowest in the Central West CCAC (11.3%).

Table 4.1 lists the sociodemographic characteristics of clients according to the presence of HF. Given the size of the sample, most observed differences are statistically significant. Compared with clients without HF, those with HF are older (mean age 83.5 years vs. 81.8 years, standard deviation [SD] 7.5 and 7.6, respectively), less likely to be women and less likely to be living alone. More clients with HF have caregivers, but there is no significant difference in levels of caregiver stress.

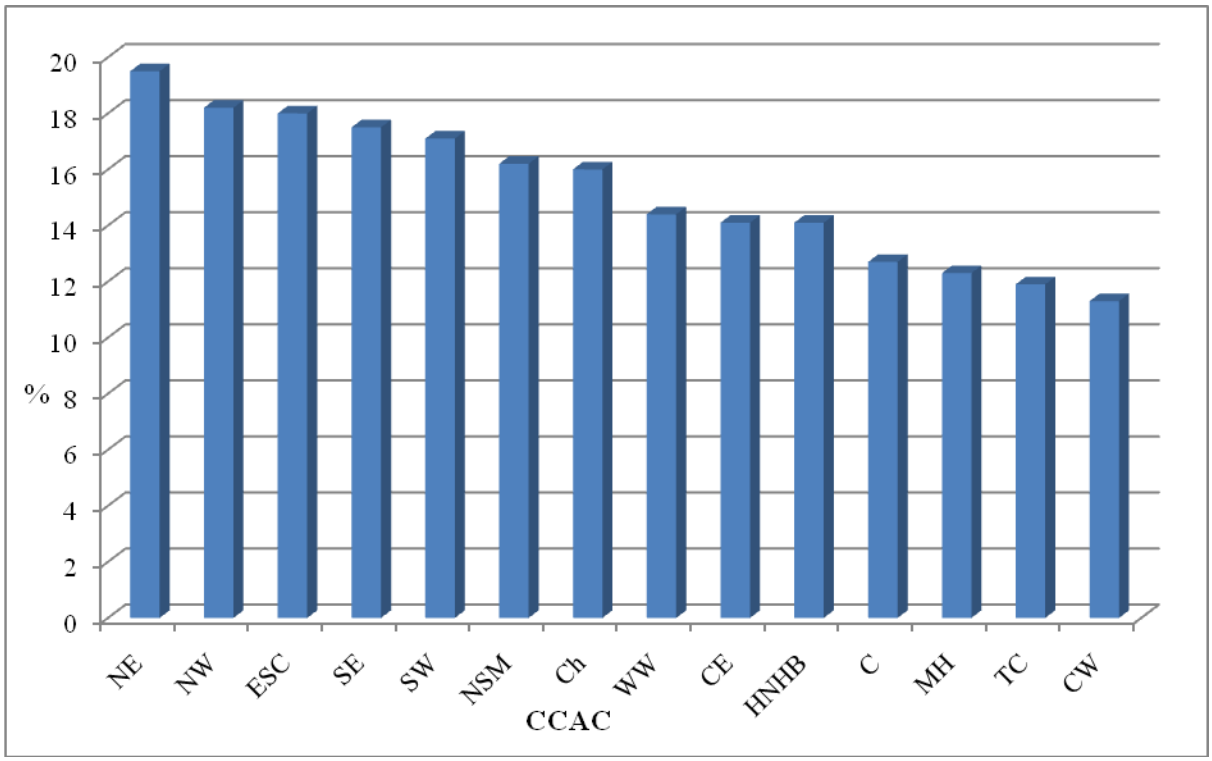
Table 4.2 shows the clinical characteristics of home care clients by HF diagnosis. Again, due to the large sample size most observed differences are statistically significant; only clinically significant findings are reported here. HF clients have more complex functional needs than those without and exhibit more health instability (as measured by the CHESS scale); as expected, they also experience significantly higher levels of edema and shortness of breath. They have less cognitive impairment, as measured by the CPS scale, although the overall proportion of HF patients with some degree of cognitive impairment is high. Prevalence of depression or a history of falls in the previous 90 days does not differ by HF status.

HF clients use more medications and have more comorbid conditions than those without HF. After exclusion of three classes of medications recommended for the treatment of HF (angiotensin-converting enzyme inhibitors, angiotensin receptor blockers and beta-adrenergic

receptor blockers), the mean number of medications in the HF group is 9.3 (SD = 4.1) compared with 7.2 (SD = 2.9) for the group without. Further, 58.0% of the HF sample take 9 or more medications compared to only 35.0% of clients without HF. Almost half the clients with HF (45.1%) have five or more comorbid conditions, while only 26.5% of those without HF experience that level of comorbidity. Hypertension, arthritis, CAD, diabetes, osteoporosis and airway disease (including COPD) are the most prevalent comorbidities in the entire sample studied. Except for osteoporosis, rates of comorbidity are higher among clients with HF. Stratification was done to explore potential confounding by age (not shown) and apart from some variation in rates of depression and falls, there are no differences due to age for the clinical characteristics presented.

Clients with HF receive significantly more nursing, homemaking and meal services compared with the group without HF (see Table 4.3), though receipt of physiotherapy services is low in both groups. Home care clients with HF received an average of 1.3 days of nursing services in the seven days prior to RAI-HC assessment while clients without HF received an average of 1.0 days. HF clients are hospitalized more frequently, with 37.4% hospitalized at least once in the previous 90 days compared to only 26.1% of clients without HF. They also report significantly more ED visits and use more emergent care. Potential confounding by age was explored using stratification and the results do not differ from those reported in Table 4.3.

Figure 4.1: Variation in Prevalence of Heart Failure by Community Care Access Centre among Older Home Care Clients, Ontario 2004-2007 (N=264,030)



Abbreviations: C = Central , **CCAC** = Community Care Access Centre, **CE** = Central East, **Ch** = Champlain, **CW** = Central West, **ESC** = Erie St. Clair, **HNHB** = Hamilton Niagara Haldimand Brant, **MH** = Mississauga Halton, **NE** = North East, **NSM** = North Simcoe Muskoka, **NW** = North West, **SE** = South East, **SW** = South West, **TC** = Toronto Central, **WW** = Waterloo Wellington

Table 4.1: Sociodemographic Characteristics among Older Home Care Clients, Ontario 2004-2007 (N=264,030)

		HF Sample N=39,247	Non-HF Sample N=224,783	*p value*
		% (n)	% (n)	
Age	65-74 years	12.9 (4,639)	18.8 (38,741)	
	75-84 years	39.0 (14,060)	43.0 (88,643)	<0.0001
	85+ years	48.1 (17,387)	38.2 (78,934)	
Gender	Female	64.1 (25,140)	66.6 (149,563)	<0.0001
Married		35.0 (13,740)	38.1 (85,607)	<0.0001
Living Alone		32.7 (7,021)	34.5 (45,850)	<0.0001
Caregiver Available		87.3 (34,267)	85.9 (193,115)	<0.0001
Caregiver Stress		16.7 (6,535)	17.0 (38,238)	0.08

Abbreviations: HF = Heart Failure

Table 4.2: Clinical Characteristics among Older Home Care Clients, Ontario 2004-2007 (N=264,030)

			HF Sample N=39,247	Non-HF Sample N=224,783	*p value*
Clinical Characteristics			%	%	
ADL Hierarchy Scale score[a]		0	62.1(24,343)	64.5 (144,891)	
		1-2	24.1 (9,464)	22.6 (50,839)	<0.0001
		3+	13.8 (5,426)	12.9 (28,960)	
IADL Capacity Scale score[b]		0	2.2 (864)	4.6 (10,477)	
		1-2	17.1 (6,704)	21.4 (48,071)	<0.0001
		3+	80.7 (31,676)	74.0 (166,198)	
CPS score[c]		0	48.3 (18,937)	46.5 (104,540)	
		1-2	41.5 (16,285)	39.5 (88,690)	<0.0001
		3+	10.2 (4,012)	14.0 (31,477)	
DRS score[d]		0	63.0 (24,714)	63.8 (143,179)	
		1-2	23.3 (9,122)	22.5 (50,597)	0.94
		3+	13.7 (5,375)	13.7 (30,816)	
CHESS Scale score[e]		0	20.5 (8,031)	33.0 (74,216)	
		1-2	58.1 (22,817)	55.4 (124,449)	<0.0001
		3+	21.4 (8,382)	11.6 (25,998)	
Daily Pain			48.9 (17,648)	45.3 (94,028)	<0.0001
Edema			37.0 (14,510)	21.4 (48,071)	<0.0001
Shortness of Breath			46.5 (18,252)	21.2 (47,561)	<0.0001
Incontinence			43.4 (17,023)	39.1 (87,750)	<0.0001
Falls		0	67.9 (26,631)	68.8 (154,603)	
		1-2	24.8 (9,743)	24.0 (53,871)	0.42
		3+	7.3 (2,860)	7.2 (16,226)	
Number of Comorbid Conditions[f]		0-1	5.9 (2,299)	11.8 (26,463)	
		2-4	49.0 (19,241)	61.7 (138,767)	<0.0001
		5+	45.1 (17,707)	26.5 (59,553)	
Common Comorbidities	Hypertension		63.2 (24,784)	54.5 (122,604)	<0.0001
	Arthritis		58.8 (23,093)	52.5 (117,911)	0.0002
	CAD		46.2 (18,143)	23.6 (53,091)	<0.0001
	Diabetes Mellitus		32.7 (12,839)	22.6 (50,774)	<0.0001
	Airway Disease[g]		28.7 (11,264)	15.0 (33,695)	<0.0001
	Osteoporosis		21.1 (8,290)	22.1 (49,732)	<0.0001
Number of Medications[h]		0	1.1 (419)	2.6 (5,808)	
		1-4	9.1 (3,552)	23.8 (53,610)	
		5-8	31.8 (12,496)	38.5 (86,562)	<0.0001
		9+	58.0 (22,780)	35.0 (78,803)	

Abbreviations: ADL = Activities of Daily Living, **CAD** = Coronary Artery Disease, **CHESS** = Changes in Health, End-stage disease and Signs and Symptoms, **CPS** = Cognitive Performance Scale, **DRS** = Depression Rating Scale, **HF** = Heart Failure, **IADL** = Independent Activities of Daily Living

[a] 0 = no impairment; 1-2 = some functional impairment; 3+ = severe functional impairment

[b] 0 = no difficulty; 1-2 = some difficulty; 3+ = great difficulty

[c] 0 = cognitively intact; 1-2 = mild cognitive impairment; 3+ = cognitively impaired
[d] 0 = no indicators of depression; 1-2 = some indicators of depression; 3+ = indicators of probable depression
[e] 0 = no health instability; 1-2 = some health instability; 3+ = moderate to high health instability
[f] excludes HF
[g] includes chronic obstructive pulmonary disease (COPD), emphysema and asthma
[h] excludes ACE inhibitor, β-blocker and ARB therapies

Table 4.3: Home Care and Acute Health Care Service Use among Older Home Care Clients, Ontario 2004-2007 (N=264,030)

		HF Sample N=39,247	Non-HF Sample N= 224,783	*p value*
		%	%	
Home Care Service Use[a]				
Any Nursing		39.4 (15,447)	29.8 (67,037)	<0.0001
Any Homemaking		46.3 (18,154)	40.3 (90,646)	<0.0001
Any Meals		20.8 (8,154)	18.4 (41,371)	<0.0001
Any Physiotherapy		7.8 (3,057)	9.0 (20,133)	<0.0001
Acute Health Care Service Use[b]				
Number of Emergent Care visits	0	91.2 (35,772)	92.9 (208,765)	
	1	6.5 (2,565)	5.5 (12,417)	<0.0001
	2+	2.3 (910)	1.6 (3,601)	
Number of ED visits	0	78.1 (30,655)	81.7 (183,567)	
	1	16.0 (6,265)	14.2 (31,965)	<0.0001
	2+	5.9 (2,327)	4.1 (9,151)	
Number of Hospitalizations	0	62.6 (24,547)	74.0 (166,188)	
	1	28.8 (11,314)	22.5 (50,552)	<0.0001
	2+	8.6 (3,386)	3.6 (8,043)	

Abbreviations: **ED** = Emergency Department, **HF** = Heart Failure

[a] measured in 7 days prior to assessment

[b] measured in 90 days prior to assessment

4.4 Discussion

This study provides a comprehensive description of older home care clients with HF in Ontario. The extensive RAI-HC data allowed the examination of many sociodemographic and clinical characteristics as well as service use, both through home care and acute care services. These descriptors are useful in identifying care needs as well as patterns of service use among older, community-dwelling home care clients. These analyses are also useful in identifying areas for further study or intervention strategies.

The clustering of diseases that share risk factors with HF, such as diabetes, as well as the clustering of diseases that can precipitate HF, such as hypertension and CAD, is expected among clients with HF. These data show this clustering and provide an estimate of the co-occurrence of such conditions in this older cohort. The observed clustering of HF with other diseases of aging, such as arthritis and airway disease, indicates that this group is more complex medically. Further, these particular comorbidities may, in the setting of a history of HF, present additional therapeutic challenges (e.g. NSAIDs for arthritis) and diagnostic challenges (e.g. dyspnea from HF or airway disease). The complex needs of the HF group are also reflected in the significantly higher levels of medication use in this group, even after adjustment to exclude three classes of medications recommended for HF. This means that these clients need to be more active in monitoring for adverse drug events as a component of their self-care.

HF clients are significantly older than their counterparts without HF. Older home-care clients with HF exhibit more complex clinical characteristics than those without (Table 4.2); they have more health instability (as measured by the CHESS scale), are less able to look after themselves (impaired in instrumental and basic ADLs), and experience more daily pain, edema, shortness of breath and incontinence. While shortness of breath is more prevalent among HF

clients, this symptom is not universal in this group, likely because such individuals are frail and present atypically, especially among older populations. (1,45,46) However, it may also be possible that such hallmark symptoms are not present in the sample due to proper management of HF through pharmacotherapy and other treatment modalities. The significantly higher prevalence of daily pain and incontinence among the HF group may represent common yet underappreciated HF manifestations (1,45), as may the overall higher prevalence of other comorbid conditions in this group.

Clients with HF are less likely to be severely cognitively impaired than clients without HF, though rates of cognitive impairment are still high among both groups. Cognitive impairment in persons with HF is associated with poorer outcomes including a greater risk of mortality and hospitalization and consequently institutionalization. In a cross-sectional study such as this, people with HF and concomitant cognitive impairment may be so unable to look after themselves that they have been referred to more intensive care settings. (30) Alternately, cognitive impairment may be underestimated through CPS scores, as IADL impairment is also prevalent among clients with HF, reflecting the presence of executive dysfunction common in this population. (30) Atypical symptoms of HF in older populations may include alterations in mood and behavioural symptoms, but the similar rates of depression among HF and non-HF clients do not support this interpretation. (46,47) History of falls is also similar between the two groups (Table 4.2) and fall prevalence is lower than reported in similar populations. (48) These results indicate that the clinical complexity of HF clients receiving home care services is more distinguishable from non-HF clients through functional characteristics such as ADL and IADL impairment than cognitive or depressive characteristics.

Given the clinical characteristics and medical complexity of home care clients with HF, it is likely that there are many barriers to self-care. An indirect indication of difficulty with self-care may be the high rates of access to an informal caregiver. It is possible that without caregivers, clients with HF are at higher risk of death or placement to a LTC facility and are thus less likely to be seen in this home care sample.

Managing multiple medical conditions and medications, and dealing with depression, cognitive impairment and functional decline are likely all barriers to effective self-care. Cognitive impairment and depressive symptoms are present in 51.7% and 37.0% of clients with HF, respectively. Clinic-based CDM programs may not be designed to overcome such barriers to self-care and the care setting may be inappropriate for such persons with HF. Functional impairment is high among home care clients with HF and may limit access to clinic-based programs. Further, having to schedule and attend numerous appointments for follow-up of multiple chronic conditions with many care providers may also be a barrier to attending clinic-based programs. Transitional care programs for seniors, in which specially trained Advanced Practice Nurses help coordinate care and enhance the self-care skills of patients with HF and their caregivers reduce readmission rates after discharge from hospital. (49) However, the extension of such programs to frail home care clients with HF has not been evaluated. Home care may be a more suitable setting than LTC facilities in which to provide CDM for these medically complex clients. (50) interRAI assessment instruments used in the home care setting can offer risk assessment for adverse outcomes, identify barriers to self-care and provide a potential platform for CDM delivery.

The geographic variation in HF prevalence is an interesting finding. Due to the standardized training given to RAI assessors throughout the province, it is unlikely that these

differences are due to variability between raters in recording diagnoses. Given that HF risk increases with age, the age structures of the client bases of each CCAC may explain some of this variation. HF prevalence, however, is not highest in the CCACs with the oldest populations. Thus, such variations may indicate differences in access to home care services for older individuals with HF or, conversely, different management strategies for HF on the part of the CCAC. Some CCACs may be more likely to push for LTC admission for clients with HF, while others may promote more aggressive management within the home. There are other implications of such variations in HF prevalence and such profiles could help CCACs prioritize service planning, initiate chronic disease management strategies and re-allocate staffing as necessary.

This descriptive work demonstrates that HF is prevalent among older home care clients in Ontario and that clients with HF are clinically complex, using home care and acute care more frequently than their counterparts without HF. There are some limitations to this work. First, the cross-sectional study design allows a snapshot of this sample during a given time period, but does not allow any assessment of the temporality of the associations observed. For example, it is not known whether use of services followed or preceded HF diagnosis. Further, when examining hospitalizations, ED use or emergent care use, the reason for the health care service encounter was not collected. These data indicate, however, that the more clinically complex clients with HF do indeed use more services both in the home and in the broader health care system. Additionally, these data do not include information regarding HF severity, which may influence service use, although the CHESS scale embedded within the RAI-HC allows some assessment of health instability and can be predictive of mortality in LTC patients. (51) Clients with HF scored significantly higher on this item, indicating more disease instability overall. Another limitation is that this sample is drawn from clients already receiving home care service in Ontario and is not

representative of other populations, either in institutions or in the community, that do not seek out or receive referrals for home care services. Lastly, given the demographics of this sample, it is likely that HF with preserved ejection fraction (HFPEF) is prevalent. HFPEF is more common in women and is thought to account for more than half of HF cases in those older than 75 years. (52,53) Given that almost 80% of the sample with HF was older than age 75, HFPEF likely affects a large proportion of these clients. This could not be verified from the data set used, but is worth noting as it has implications for CDM. There is much less evidence about the effectiveness of pharmacotherapy in the management of HFPEF compared to HF with reduced ejection fraction. Other aspects of HF management, however, are applicable to both populations. As better treatment modalities are identified for HFPEF, CDM programs will need to adapt accordingly.

This research has unique strengths. It provides a clear picture of the burden of HF in home care clients in Ontario and allows regional differences to be identified. It makes use of the extensive information available in the RAI-HC assessment to richly describe the clinical characteristics, presence of other diseases and service use in this population. Lastly, it assesses all long-stay home care clients in Ontario; since the number of HF clients identified in this sample is quite large, it was possible to fully describe the clinical and functional characteristics of HF clients.

These results depict home care clients with HF as a complex, high-needs group with high rates of medication use, frequent use of health care services and many potential barriers to self-care, as shown by the high levels of functional impairment, cognitive impairment, depression, comorbidity and medication use. Any new CDM strategy for home care clients with HF should take these factors into consideration. Capable caregivers may have an important role to play,

although programs would need to be designed to avoid undue caregiver stress. Targeting intervention strategies to improve self-care skills may significantly reduce the burden on other parts of the health care system. Improving communication between primary care providers, geriatric or cardiology consultants, and home care could allow such vulnerable populations to remain at home and independent. Such interventions would align well with the Aging at Home Strategy in Ontario, as well as with the Comprehensive Canadian Heart Health Strategy and Action Plan. An initial step to such strategies may be to identify and target the highest-needs individuals for such interventions. This work has provided a potentially important first step in achieving that goal.

5.0 CORRELATES OF NON-USE OF PHARMACOTHERAPY IN HEART FAILURE

(This text for is taken verbatim from the manuscript as accepted prior to publication.)

5.1 Introduction

HF currently affects over 500,000 Canadians and its prevalence among persons 65 years and older is expected to double over the next three decades. (1-3) HF is a leading cause of hospital admissions among older Canadians and the associated inpatient and outpatient costs make it one of the most clinically burdensome and expensive health care problems in Canada. (4) In the United States and Canada alone, more than five million individuals have an HF diagnosis and the costs of the disease exceed $20 billion (USD) annually. (5)

Pharmacotherapy is a cornerstone of successful HF management, in addition to dietary and exercise modifications and proper clinical follow up. The Canadian Cardiovascular Society (CCS) Consensus Conference Guideline recommendations state that combination therapy consisting of an ACE inhibitor and β-blocker should be offered to all HF patients with reduced left ventricular ejection fraction (LVEF). (2) For patients with intolerance to ACE inhibitors, the CCS Guidelines recommend the use of ARB therapy. (2) The CCS Guidelines also recommend that ACE inhibitors and β-blockers also be offered to most patients with HF and preserved LVEF, while recognizing the relative paucity of clinical trials addressing this condition. (2) This combination therapy forms a cornerstone upon which other therapies, such as digoxin, spironolactone, or nitrates and hydralazine, may be prescribed to patients with significant and persistent symptoms. (2) Patient-related factors and the presence of absolute contraindications and intolerance will ultimately influence prescriber decisions regarding HF therapy.

The clinical trials on which these recommendations are based generally excluded older patients or those with multiple comorbid conditions, although data from small clinical trials and numerous observational studies suggest that these recommendations are applicable to all adult patients with HF, regardless of age. (6-10) ACE inhibitor therapy in older HF patients may

improve survival post-hospitalization, reduce the risk of functional decline, and improve cognition, particularly in patients with reduced LVEF. (11-13) β-blocker therapy has also been shown to reduce mortality and hospitalizations in older HF patients. (14,15) Despite these potential benefits, uptake of guideline recommendations is low in older patients and underuse of both ACE inhibitors and β-blockers has been documented. (16) Older patients may be less likely to receive the recommended therapy due to concern over greater risk of adverse drug events, such as dizziness, hypotension and falls; contraindications; polypharmacy; titration of therapy; and lack of confidence in guidelines based on non-elderly populations. (17-22) Whether patient characteristics influence such prescribing is poorly understood and the extent to which Canadian HF guidelines are followed in the community is unclear.

Individuals with HF who receive home care services in Ontario represent a clinically complex group at high risk of health service utilization and institutionalization. (23) Further, with a push towards shorter hospital stays in both the U.S. and Canada, more individuals with HF are discharged earlier, increasing the burden on home care service providers. (24,25) As such, these patients are in regular contact with regulated health care professionals in the primary care setting and represent a group who might benefit from a targeted chronic disease management program designed specifically for home care clients with HF. However, implementing such a program would require a greater understanding of the clinical characteristics and patterns of medication use in this complex and precarious population than is known currently.

This research aimed to describe clients' clinical characteristics and home care service use, and determine the utilization and clinical/service use correlates of first-line HF pharmacotherapy in a population-based sample of older home care clients in Ontario, Canada.

5.2 Methods

5.2.1 Study Design and Data Source

This population-level, cross-sectional study was based on data from long-stay home care clients in all 14 health regions in Ontario, a Canadian province of approximately 13.2 million people. Ontario's Resident Assessment Instrument-Home Care (RAI-HC) database is a repository of all RAI-HC assessments, which identify care needs of all long-stay home care clients in Ontario. This RAI-HC is mandated for use in Ontario and many other regions across Canada, as well as internationally in 12 other countries including the United States. (26) The RAI-HC includes over 300 questions designed to generate Clinical Assessment Protocols (CAPs) to guide care planning, as well as outcome measures for cognition, depression and physical function. Assessments are conducted by case managers (usually nurses or social workers) who receive standardized training in the completion of the RAI-HC and use professional judgment to record disease diagnoses and to verify accuracy of this information through discussions with physicians, other health professionals, family, and caregivers, and review of medical records when necessary. The reliability and validity of the tool have been established previously. (27-29) RAI-HC items have excellent inter-rater and test-retest reliability, including in key areas of functional and cognitive status. (30) The RAI-HC database contains detailed clinical and sociodemographic information, including cognitive status, mood and behavioral patterns, informal support services, physical function, clinical diagnoses and symptoms, service utilization in the 90 days prior to assessment and use of non-prescription and prescription drugs in the past seven days. Diagnostic accuracy of information recorded on RAI assessments has been shown to be high when compared with administrative data. (31,32) The breadth of information creates a rich data source comprised of all long-stay home care clients within the province of Ontario.

All home care clients aged 65 years or older receiving their first RAI-HC assessment between January 2004 and December 2007 were included in the study, regardless of functional status, cognitive status or presence of comorbidity (n=176,860). The Office of Research at the University of Waterloo provided ethics approval for the analyses of the anonymized data in the current study.

5.2.2 Measures

Clients were defined as having HF if it was recorded in the RAI-HC by the assessing nurse clinician. Among individuals in nursing homes and long-term care facilities in Ontario, a diagnosis of HF on the RAI was shown to have greater than 80% sensitivity compared to administrative databases. (31,32) First-line combination therapy, in accordance with the CCS Guidelines, was defined as use of ACE inhibitor and/or ARB therapy in conjunction with a β-blocker. Henceforth, the term therapy will refer to this first-line pharmacotherapy. Table 5.1 lists the medications included for analysis. While some therapies are recommended for use based on evidence from clinical trials, others are not. (33,34) Certain therapies (ACE inhibitors: captopril, enalapril, ramipril, lisinopril; β-blockers: carvedilol, bisoprolol; ARBs: candesartan, valsartan) are specifically recommended by the CCS Consensus Conference Guidelines because they were evaluated in large clinical trials. (2) As evidence suggests that providers are often unaware of this distinction, (35) however, drug class was considered more important than specific therapies. Medications used in the previous seven days were manually recorded from medication containers at the time of assessment and the case managers verified information with clients and caregivers, as well as through review of medical records. Medications were transcribed electronically, allowing for many variations of medication names. Identification of variants of each medication was performed manually and more than 12,000 unique identifiers were retrieved.

Table 5.1: Heart Failure Medications Included in Analyses of Older Home Care Clients, Ontario 2004-2007

Medication Class	Generic Name
ACE inhibitor	benazepril
	captopril
	cilazapril
	enalapril
	fosinopril
	lisinopril
	perindopril
	quinapril
	ramipril
	trandolapril
β-blocker	acebutolol
	atenolol
	bisoprolol
	carvedilol
	metoprolol
	nadalol
	propronalol
ARB	candesartan
	eprosartan
	irbesartan
	losartan
	telmisartan
	valsartan

Abbreviations: ACE = Angiotensin Converting Enzyme, **ARB =** Angiotensin Receptor Blocker, **β-blocker** = β-Adrenergic Receptor Blocker

Potential predictors of HF pharmacotherapies, selected based on clinical relevance and previous research, were explored as possible correlates of therapy. (2,7,17,32) These included age, gender, education, living arrangement, marital status, caregiver distress, presence of comorbidity (including coronary artery disease [CAD], arthritis, diabetes mellitus, and hypertension), health regions within Ontario (the 14 Local Health Integration Networks [LHIN]), daily pain, edema, use of acute care services, end stage disease, self-rated health, shortness of breath, and year of assessment. Presence of airway disease (including chronic obstructive pulmonary disease [COPD], asthma and emphysema), number of medications, adherence with prescribed medications and falls - all of which are potential barriers to therapy - were also included in the analyses, as was receipt of nursing, homemaking and physical therapy services. Other measures included four summary health index measures for functional ability, cognition, depression and health instability. These were: 1) the Activities of Daily Living (ADL) self-performance hierarchy scale (range 0-6), 2) the Cognitive Performance Scale (CPS) (range 0-6), 3) the Depression Rating Scale (DRS) (range 0-14), and 4) the Changes in Health, End-stage disease and Signs and Symptoms (CHESS) score (range 0-5). Each measure has been developed and validated for use with the RAI-HC and higher scores in each measure indicate more severe impairment. (28,30,36,37) Behavioural symptoms were a composite measure of the presence of any of the following characteristics on the RAI: wandering, verbally abusive, physically abusive, socially inappropriate or disruptive behaviour, and resisting care.

5.2.3 Analysis

HF prevalence and use of HF medications were summarized using descriptive statistics. Differences between groups were tested using t-tests for continuous variables and chi-square tests for categorical variables (significance level $p < 0.05$). Predictors of non-receipt of therapy

were first identified using bivariate analyses and evidence from the literature and then included in subsequent multivariable logistic regression analyses. Two-way interaction effects were tested at $p<0.05$ and models were stratified by significant effect modifiers. The criterion for statistical significance for entry of variables in the final models was set to alpha=0.05 and selected variables were examined in multivariable analyses using regression models with stepwise elimination. Alternative forms of the models were examined to rule out order of entry/deletion effects. Model fit was assessed using standard lack of fit and regression diagnostics. All analyses were conducted using SAS software (version 9.2, SAS Institute Inc., Cary, NC).

5.3 Results

Between January 2004 and December 2007, 176,860 initial RAI-HC assessments were completed. A total of 21,968 home care clients with HF (12.4%) were identified. Clients with HF were significantly older and less likely to be female, married or cognitively impaired than clients without HF (Table 5.2). HF clients were also significantly more likely to exhibit functional (ADL) impairment and health instability (as seen with CHESS scores), have higher numbers of current medications and comorbid conditions and report more use of nursing and homemaking services. Use of specific HF medications was less frequent in clients without HF; however, over one-quarter of HF clients (n=6,287) received none of the HF therapies, whereas only 28% were receiving recommended combination therapy. Of the clients with HF who received β-blocker therapy, approximately one-quarter were receiving evidence-based therapy. Usage of other HF medications is depicted in Table 5.2.

Table 5.3 lists the differences observed between HF clients receiving no HF therapy and those receiving at least one medication. Clients receiving any therapy were significantly more likely to be married. Clients receiving no therapy were significantly older and more functionally

and cognitively impaired, exhibited more health instability and depression, and were taking fewer medications. Clients receiving therapy were significantly more likely to have received nursing and physical therapy services in the past week, although the differences observed were small. Over the four-year period, the proportion of clients with HF who received no therapy declined from 31.4% to 25.2% (Table 5.4). While functional impairment could reduce the ability to access medications, only a small proportion of those with ADL impairments (scores of 2 or more on the ADL hierarchy scale) reported no medication use (data not shown).

Table 5.5 summarizes the results of the multivariable analyses stratified by hypertension status, which was a significant effect modifier. Among clients without hypertension, the presence of either CAD or diabetes mellitus was associated with an increased likelihood of receiving therapy, whereas functional impairment, behavioural symptoms and airway disease were associated with non-receipt of therapy. Age, gender, health region, depressive symptoms, health instability, and number of medications and comorbidities were not significantly associated with non-receipt of therapy in this group. In hypertensive clients, use of therapy varied by diabetic status. Among hypertensive clients with concomitant diabetes mellitus, functional impairment, airway disease and age over 85 years were associated with non-receipt of therapy. Gender, health region, depressive symptoms, health instability, and numbers of medications and comorbid conditions were not significantly associated with therapy in this group. Among hypertensive clients without diabetes mellitus, functional impairment and presence of airway disease were associated with non-receipt of therapy, while presence of CAD was associated with an increased likelihood of receiving therapy. In all models, receipt of home care services (nursing, homemaking or physical therapy) was not associated with use of therapy.

Table 5.2: Sociodemographic, Clinical, Pharmacotherapy and Service Use Characteristics of Older Home Care Clients, Ontario 2004-2007 (N = 176,860)

			HF Sample (N = 21,968) % (n)	Non-HF Sample (N = 154,898) % (n)	*p value*
Sociodemographic Characteristics					
Age		65-74 years	15.3 (3,369)	21.0 (32,454)	
		75-84 years	45.1 (9,897)	47.7 (73,904)	<0.001
		85+ years	39.6 (8,702)	31.3 (48,540)	
Mean Age in years (SD)			82.8 (7.2)	81.2 (7.3)	
Gender		Female	58.8 (12,905)	64.1 (99,221)	<0.001
Married			37.9 (8,321)	39.6 (61,397)	<0.001
Living Alone			33.4 (7,329)	35.4 (54,828)	<0.001
Clinical Characteristics					
ADL Hierarchy Scale score[a]		0	55.8 (12,263)	61.1 (94,542)	
		1-2	25.0 (5,477)	23.3 (36,004)	<0.001
		3+	19.2 (4,215)	15.7 (24,273)	
CPS score[b]		0	46.2 (10,143)	44.1 (68,298)	
		1-2	42.1 (9,250)	41.4 (64,191)	<0.001
		3+	11.7 (2,572)	14.5 (22,376)	
DRS score[c]		0	62.6 (13,742)	62.6 (96,821)	0.75
		1-2	23.5 (5,149)	23.3 (36,115)	
		3+	13.9 (3,056)	14.1 (21,827)	
CHESS Scale score[d]		0	11.9 (2,604)	22.3 (34,536)	
		1-2	57.9 (12,710)	62.2 (96,222)	<0.001
		3+	30.2 (6,646)	15.5 (24,071)	
Behavioural Symptoms			10.0 (1,903)	12.7 (20,049)	<0.001
Number of Comorbid Conditions[e]		0-1	8.4 (1,839)	14.6 (22,587)	
		2-4	54.5 (11,967)	54.2 (99,404)	<0.001
		5+	37.2 (8,162)	21.2 (32,907)	
Mean (SD)			4.0 (2.0)	3.3 (1.8)	
Common Comorbidities	Hypertension		59.1 (12,975)	52.5 (81,243)	<0.001
	Arthritis		46.7(10,258)	44.5 (68,894)	<0.001
	CAD		43.3 (9,510)	21.5 (33,367)	<0.001
	Diabetes Mellitus		30.4 (6,673)	21.2 (32,861)	<0.001
	Airway Disease[f]		26.5 (5,810)	13.8 (21,330)	<0.001
	Stroke		19.8 (4,345)	17.9 (27,669)	<0.001
	Osteoporosis		16.7 (3,657)	18.6 (28,879)	<0.001
Pharmacotherapy					
Number of Medications[g]		0	2.4 (533)	3.7 (5,789)	
		1-4	12.6 (2,767)	27.6 (42,703)	<0.001
		5-8	34.4 (7,554)	38.7 (59,972)	
		9+	50.6 (11,114)	30.0 (46,434)	
Mean (SD)			8.44 (4.0)	6.8 (3.9)	

		HF Sample (N = 21,968) % (n)	Non-HF Sample (N = 154,898) % (n)	*p value*
Pharmacotherapy				
Use of First-Line HF Medications	ACE inhibitor + β-blocker	23.0 (5,043)	10.5 (16,267)	
	ARB + β-blocker	4.2 (931)	2.3 (3,596)	
	ACE inhibitor + ARB	0.7 (153)	0.6 (887)	
	ACE inhibitor + ARB + β-blocker	0.8 (171)	0.4 (645)	
	ACE inhibitor only	22.1 (4,844)	19.5 (30,147)	<0.001
	Any ACE inhibitor	46.6 (10,211)	31.0 (47,946)	
	ARB only	4.3 (952)	4.8 (7,450)	
	β-blocker only	16.3 (3,587)	11.8 (18,269)	
	Any β-blocker	44.3 (9,732)	25.0 (38,777)	
	EB[h] β-blocker	25.9[i] (2,523)	12.5[i] (4,838)	
	No Medications[j]	28.6 (6,287)	50.1 (77,637)	
Other HF Medications	Furosemide	62.8 (13,804)	14.3 (22,075)	
	Spironolactone	1.5 (2,297)	1.8 (2,823)	<0.001
	Digoxin	23.8 (5,224)	5.8 (8,963)	
Service Use				
Home Care Service Use[k]	Any Nursing	33.9 (6,835)	25.3 (37,007)	<0.001
	Any Homemaking	35.9 (7,228)	31.4 (45,964)	<0.001
	Any Physiotherapy	11.1 (2,230)	12.3 (18,029)	<0.001

Abbreviations: ACE = Angiotensin Converting Enzyme, **ADL** = Activities of Daily Living, **ARB** = Angiotensin Receptor Blocker, **β-blocker** = β-Adrenergic Receptor Blocker, **CAD** = Coronary Artery Disease, **CHESS** = Changes in Health, End-stage disease and Signs and Symptoms, **CPS** = Cognitive Performance Scale, **DRS** = Depression Rating Scale **EB** = Evidence-based, **HF** = Heart Failure, **SD** = Standard Deviation

[a] 0 = no impairment; 1-2 = some functional impairment; 3+ = severe functional impairment

[b] 0 = cognitively intact; 1-2 = mild cognitive impairment; 3+ = cognitively impaired

[c] 0 = no indicators of depression; 1-2 = some indicators of depression; 3+ = indicators of probable depression

[d] 0 = no health instability; 1-2 = some health instability; 3+ = moderate to high health instability

[e] excludes HF

[f] includes chronic obstructive pulmonary disease (COPD), emphysema and asthma

[g] excludes ACE inhibitor, β- blocker and ARB therapies

[h] Evidence-based β-blocker therapy (bisoprolol or carvedilol)

[i] (%) shown is a proportion of the Any β-blocker group

[j] no ACE inhibitor, β- blocker or ARB use

[k] measured in 7 days prior to assessment

Table 5.3: Sociodemographic, Clinical, Pharmacotherapy and Service Use Characteristics of Older Home Care Clients with Heart Failure by Pharmacotherapy Status, Ontario 2004-2007 (N = 21,968)

			No First-line Pharmacotherapy (N = 6,287) % (n)	Any First-line Pharmacotherapy (N = 15,681) % (n)	*p value*
Sociodemographic Characteristics					
Age		85+ years	44.8 (2,814)	37.6 (5,888)	<0.001
Gender		Female	58.7 (3,687)	58.8 (9,218)	0.90
Married			35.3 (2,219)	38.9 (6,102)	<0.001
Clinical Characteristics					
Functional Impairment[a]			40.7 (2,558)	30.0 (4,703)	<0.001
Cognitive Impairment[b]			14.8 (929)	10.5 (1,643)	<0.001
Depression[c]			14.8 (931)	13.6 (2,125)	0.02
Unstable Health[d]			33.0 (2,071)	29.2 (4,575)	<0.001
Behavioural Symptoms			11.0 (692)	7.7 (1,211)	<0.001
Number of Comorbid Conditions[e]		0-1	11.0 (692)	7.3 (1,147)	<0.001
		2-4	55.7 (3,504)	54.0 (8,463)	
		5+	33.3 (2,091)	38.7 (6,071)	
Mean (SD)			2.2 (0.6)	2.3 (0.6)	
Common Comorbidities	Hypertension		45.7 (2,871)	64.4 (10,104)	<0.001
	Arthritis		44.6 (2,806)	47. 5 (7,452)	<0.001
	CAD		36.0 (2,266)	46.2 (7,244)	<0.001
	Diabetes Mellitus		23.2 (1,460)	33.2 (5,213)	<0.001
	Airway disease[f]		32.0 (2,013)	24.2 (3,797)	<0.001
Pharmacotherapy					
Number of Medications[g]		0	8.4 (526)	0.04 (7)	<0.001
		1-4	21.4 (1,346)	9.1 (1,421)	
		5-8	28.2 (1,772)	36.9 (5,782)	
		9+	42.0 (2,643)	54.0 (8,471)	
Mean (SD)			7.2 (4.6)	8.9 (3.6)	
Service Use					
Home Care Service Use[h]	Any Nursing		33.4 (1,795)	34.1 (5,040)	<0.001
	Any Homemaking		36.2 (1,948)	35.7 (5,280)	<0.001
	Any Physiotherapy		10.4 (557)	11.3 (1,673)	<0.001

Abbreviations: CAD = Coronary Artery Disease, **SD** = Standard Deviation

[a] score of 2 or more on the Activities of Daily Living (ADL) Hierarchy Scale = limited to extensive impairment

[b] score of 3 or more on the Cognitive Performance Scale (CPS) = cognitive impairment

[c] score of 3 or more on the Depression Rating Scale (DRS) = indicators of probable depression

[d] score of 3 or more on the Changes in Health, End-stage disease and Signs and Symptoms (CHESS) scale = moderate to high health instability
[e] excludes HF
[f] includes chronic obstructive pulmonary disease (COPD), asthma and emphysema
[g] excludes ACE inhibitor, β-blocker and ARB therapies
[h] measured in 7 days prior to assessment

Table 5.4: Prevalence Estimates of No First-Line Pharmacotherapy Use among Older Home Care Clients with Heart Failure, Ontario 2004-2007 (N = 21,968)

Year	No Pharmacotherapy % (n)
2004	31.4 (1,664)
2005	29.4 (1,772)
2006	28.1 (1,619)
2007	25.2 (1,232)
Overall	28.6 (6,461)

Table 5.5: Multivariable Analysis of Predictors of No First-Line Pharmacotherapy among Older Home Care Clients with Heart Failure, Ontario 2004-2007 (N = 21,968)

Model 1:	**Non-Hypertensive Clients**	
Covariate	**Odds Ratio (95% CI)**	***p value***
Functional Impairment[a]	1.39 (1.26, 1.53)	<0.001
Behavioural Symptoms	1.44 (1.24, 1.68)	<0.001
CAD	0.66 (0.60, 0.73)	<0.001
Airway Disease[b]	1.36 (1.23, 1.50)	<0.001
Diabetes Mellitus	0.55 (0.49, 0.61)	<0.001
	Hypertensive Clients	
Model 2:	**with Diabetes Mellitus**	
Covariate	**Odds Ratio (95% CI)**	***p value***
Functional Impairment[a]	1.73 (1.46, 2.04)	<0.001
Airway Disease[b]	1.77 (1.49, 2.10)	<0.001
Age 75-84[c]	1.15 (0.93, 1.42)	0.24
Age 85+[c]	1.60 (1.27, 2.03)	<0.001
Model 3:	**without Diabetes Mellitus**	
Covariate	**Odds Ratio (95% CI)**	***p value***
Functional Impairment[a]	1.70 (1.53, 1.90)	<0.001
Airway Disease[b]	1.54 (1.37, 1.73)	<0.001
CAD	0.67 (0.60, 0.75)	<0.001

In each model, above variables were included simultaneously (all variables were adjusted for each other).

Abbreviations: CAD = Coronary Artery Disease, **CI** = Confidence Interval
[a] score of 2 points or more on the ADL Hierarchy Scale
[b] includes chronic obstructive pulmonary disease (COPD), emphysema and asthma
[c] Reference Group: Age 65-74 years

5.4 Discussion

The results of this study provide a depiction of patterns of HF medication use in a representative population of vulnerable community-dwelling seniors. In this study of 21,968 older home care clients with HF, nearly 30% (n=6,287) were not receiving any first-line HF therapies, potentially leaving them at risk of further functional decline, worsening of HF symptoms and increased service use. Previous studies suggest that underuse of such therapies may occur due to patient non-adherence, possible treatment bias or physicians' concerns about potential side effects and contraindications, especially in older vulnerable patients. Consistent with previous studies, this study shows that advanced age and the presence of airway disease (including COPD) were associated with non-use of therapy. Ageism in prescribing HF therapies has been documented in the literature (17) and while Canadian HF guidelines caution the use of β-blocker therapy in individuals with untreated COPD, therapies are recommended for those with stable disease. (2) Novel associations identified in this study included a reduced likelihood of HF therapy use among selected clients with functional impairment and behavioural symptoms. Taken together, these findings appear to support previous work which demonstrated that those at the highest risk of outcomes are the least likely to receive therapy. (38) The modest increase in the use of therapy for HF over the four-year period may reflect partial uptake of two sets of guidelines published in Canada in 2003 and 2006 – including one focusing on the management of heart disease in older patients. (2,39) Nonetheless, as evidence supporting the use of ACE inhibitor and β-blocker in HF management has been available for over a decade, the high proportion of HF clients who continue to receive neither of these medications is a concern. (8-10, 12-15)

In Ontario, persons aged 65 and older are eligible for prescription coverage under the Ontario Drug Benefit Plan, and thus these results are likely not explained by cost barriers. Older home care clients with HF are a vulnerable population, and the association of functional impairment with non-use of therapy suggests that prescribing physicians may have concerns about precipitating adverse events, such as falls. While concerns over postural hypotension and fall risk have been raised as reasons for withholding therapy in other studies (17), having had one or more falls (in the 90 days prior to assessment) was not found to be related to medication use in this study. Cognitive impairment and depressive symptoms were common among clients with HF, and although not found to be associated with medication use in this study, their presence may complicate adherence to therapy. The presence of behavioural symptoms was found to be a predictor of non-receipt of HF therapy. Such symptoms often occur in patients with vascular cognitive impairment and may represent a proxy for impaired executive function that impedes the ability of these patients to properly manage their medications. (40) Executive dysfunction may be captured to a degree by the CPS; however, behavioural symptoms, and not CPS scores, were found to be associated with use of therapy. Alternatively, underuse among such patients may reflect altered physician prescribing behaviours resulting from perceived clinical management challenges, such as therapeutic nihilism in patients deemed too frail to benefit from therapy. Of particular concern is the possibility that the association of functional impairment and behavioural symptoms with underuse of therapies may to a certain extent reflect under-treated and unrecognized HF presenting with atypical symptoms. (41) Functional impairment and dementia have been found to predict mortality among older individuals hospitalized for HF. (42) This study has also demonstrated that functional impairment is associated with non-use of first-line HF pharmacotherapy. This is an important finding that illustrates that geriatric conditions,

which are often not taken into account in clinical trials or studies using administrative data, are important considerations. The ability to explore a breadth of clinical factors including key geriatric conditions using RAI-HC data is an important strength of this study.

The associations observed for CAD, diabetes mellitus, and airway disease are consistent with findings from other studies in older adults. (20,34,43) ACE inhibitors and β-blockers are also used to treat CAD, diabetes mellitus and hypertension, and the co-occurrence of these conditions in older persons with HF may provide additional indications for physicians to prescribe these medications. Previous literature indicates that residence in long-term care facilities and cognitive impairment may be associated with underuse of HF therapy. (41) In this study, all subjects were community-dwelling and cognitive impairment was not associated with non-receipt of therapy for HF. It may be that the co-occurrence of cognitive impairment in complex HF patients may pose too great a management challenge in a community setting, requiring transfer to more intensive LTC settings. In contrast to other studies, gender, health region, depressive symptoms and health instability were not associated with receipt of therapy for HF. (18,20,44,45) The consideration of other clinical and sociodemographic variables in multivariable analyses may have identified factors, particularly those related to frailty, that explained the gender effect.

While this study has begun to develop a profile of older clients with HF who are not receiving HF medications, it is not possible to determine how such profiles translate into prescribing practices. Primary care providers may be more concerned with adverse outcomes, such as falls or polypharmacy, or may be unaware of the potential benefits of first-line combination therapy on geriatric outcomes. (21,46,47) Further, physicians may be uncertain about the potential risks of therapy because older, frail individuals are under-represented in

clinical trials, or may mismanage HF in the context of other comorbidities. (38) Whether clients had access to a physician or a chronic disease management program was not ascertainable from these data, nor were previous medication records. It is possible that other unmeasured patient factors, such as non-adherence to HF medications and intolerance to therapy could lead to discontinuation of therapy resulting in non-use. It is not possible to determine how much of the observed non-use could be explained by such factors. This study considered prevalent HF and did not have information about duration or severity of the syndrome, such as LVEF assessment and New York Heart Association functional class. However, the CHESS scale for health instability has been shown to be superior in predicting mortality in frail individuals with HF, indicating that disease severity is captured to some extent. (48) Patients with HF and preserved LVEF (HFPEF) may be less likely to receive these medications; although recommended for most patients with HFPEF by the CCS Guidelines, the recommendations for their use are strongest for HF with reduced LVEF. (2) While a large study of community-based patients found HFPEF prevalence to be 36% (49), it is possible that HFPEF affects a large subset of this sample. Other studies have shown that older females with HF, such as those in our study sample, are less likely to receive echocardiography to determine EF. (50) Thus it is unlikely that EF would have been known in most of our sample, reflecting true community practice. There is strong evidence for the reliability and validity of diagnostic items in the interRAI instruments, with positive predictive values and sensitivity of HF diagnosis being 0.83 and 0.80, respectively. (31,32) This sensitivity of HF diagnosis is high compared with other administrative databases. (51,52) Nonetheless, there is the potential that not all cases of HF were identified in this sample. The decision to consider medications in the same class as first-line, whether evidence-based or not, reflects the fact that most care providers are unaware that such a distinction is made in the CCS

Guidelines. This inclusion of evidence-based and non-evidence-based therapies likely means that the proportion of clients receiving optimal therapy is overestimated. Lastly, the cross-sectional study design prevented exploration of dynamic factors associated with drug use. Others have demonstrated that long-term patient adherence to prescribed therapy could be improved through continuity of care and physician follow-up. (53) It is not possible to determine how many clients in this sample were receiving medications long-term.

This work shows that nearly 30% of home care clients with HF were not receiving first-line therapies and that only 28% were receiving the first-line combination therapy recommended by national guidelines. These are both important findings and suggest that there is much room for improvement in HF care among older community-dwelling adults. Further, this study has begun to explore factors associated with non-use of medications and identified factors such as functional impairment and other comorbidity. This provides an important baseline upon which to develop future studies of potential barriers associated with optimal medication use and areas for targeted interventions to improve care. Investigating factors associated with combination therapy use would be an important follow-up study. For clinicians, this work serves as a potential reminder to follow guideline recommendations in HF management among older, vulnerable adults, particularly those with other comorbidities and functional impairment. Improving management in this population could improve disease outcomes, reduce hospitalizations, avoid long-term care placement and help promote independence.

5.5 Conclusions

Novel patient-level factors associated with underuse of HF medications have been identified: whether and how these factors act as true barriers to prescribing remains to be determined. Use of medications in HF management in home care may be a proxy for quality of

care. Identifying ways to utilize existing services with the aim to improve HF management is a logical continuation of this work. Consideration of client characteristics and other potential barriers to medication use will be crucial in designing successful HF management programs for vulnerable home care clients. The RAI-HC, now in widespread use across Canada (54) and in at least 12 other countries (26), may be particularly useful in conducting such work in order to better inform clinical practice among typical vulnerable seniors. (55) This work has demonstrated the utility of routinely collected health information in identifying factors associated with HF management. To make full use of such tools, strategies designed to link primary care and home care for HF management are worthy of future research.

6.0 OUTCOMES AMONG OLDER HOME CARE CLIENTS WITH HEART FAILURE: MORTALITY, LONG-TERM CARE ADMISSION, HOSPITALIZATIONS, FUNCTIONAL DECLINE AND COGNITIVE DECLINE

6.1 Introduction

HF is a chronic condition affecting approximately 1 in 5 individuals over the age of 80. (1) It is associated with significant morbidity and mortality and individuals with HF experience mortality and frequent hospitalizations. (2-5) Annual mortality rates due to HF reach 50% (2), and among Canadians over 85 years, HF leads to more hospitalizations than ischemic heart disease or heart attack. (3) Effective management of HF includes dietary and fluid restrictions, symptom monitoring, exercise therapy and combination pharmacotherapy. (2)

According to the CCS guidelines, first-line pharmacotherapy, recommended for most individuals with HF, consists of ACE inhibitor or ARB therapy in conjunction with β-blocker therapy. (2) These recommendations are based on evidence from a large number of clinical trials. Such trials commonly examine the outcomes of mortality and hospitalization, but other outcomes such as LTC admission, functional decline or cognitive decline, which may also be relevant to older individuals, are often not studied. ACE inhibitor therapies have been shown to reduce mortality and improve the combined outcome of death or hospitalization, as well as improve disease severity in randomized trials of individuals with HF and reduced EF. (6,7) Some work indicates that ACE inhibitor therapy may also improve cognitive impairment in individuals with HF. (8) ARB therapy is used primarily in individuals who cannot tolerate ACE inhibitor therapy and has been shown to reduce hospitalizations, but not mortality. (9,10) β-blockers may also improve survival, as well as HF severity and exercise tolerance, but do not exhibit class effects like ACE inhibitors. (11,12)

While good evidence for pharmacotherapy exists from trials, its applicability to all HF patients is questionable. Although prevalence of HF increases with age, the majority of trials studies have been done in populations that are younger and healthier than typical HF patients.

(13,14) Outcomes explored through such studies are primarily mortality and hospitalization and often these outcomes are combined to achieve enough events to detect differences between treatment groups (see Tables 1-3 in Appendix G). Such studies are necessary to determine the efficacy of pharmacotherapy, but may not be useful in informing management of HF in older individuals with multiple comorbidities, multiple medications and geriatric conditions. Further, for older individuals with HF, outcomes such as LTC admission, functional decline and cognitive decline may be outcomes of as much importance as mortality or hospitalizations. Only a few studies have examined the effectiveness of ACE inhibitor therapy on cognition and exercise tolerance, and β-blocker therapy on exercise capacity. (15-17) These studies predominantly enrolled younger men with less comorbidity and medication use than more typical HF populations. Arguably, outcomes that are under-studied, such as LTC placement and cognitive and functional decline, may be especially relevant to older HF patients.

Another discrepancy between most study populations and HF patients overall is the setting in which HF is managed. Many study populations are derived from acute or tertiary care settings, but approximately 90% of individuals with HF in Ontario are managed through primary care. (18) Therefore, outcomes observed in groups receiving specialist care may not be representative of typically managed HF patients. Most work on outcomes of HF has involved medication use as predictors of mortality and hospitalization. For older, frail populations with HF, such as long-stay home care clients, little is known about all outcomes, specifically those beyond mortality and hospitalizations. There is a dearth of information about factors associated with each outcome.

The purpose of this study was to examine mortality, LTC placement, long-stay hospitalization, functional decline and cognitive decline over time in a population of older

community-dwelling long-stay home care clients with HF. Using the comprehensive sociodemographic, clinical, diagnostic and medication data available from the RAI-HC, factors associated with these outcomes were explored.

6.2 Methods

6.2.1 Study Design and Data Source

This was an observational study that examined five outcomes (mortality, LTC admission, long-stay hospitalization, functional decline and cognitive decline) among long-stay home care clients in Ontario with HF.

All data on sociodemographic and clinical characteristics, as well as home care and acute service use were obtained from the Ontario RAI-HC database. The RAI-HC was mandated for use in Ontario in 2003 to assess all long-stay (expected to receive service for 60 days or longer) home care clients (19) and the database now contains more than one million assessment records for all such clients receiving services in the province. Outcome data for mortality, LTC admission and long-stay hospitalizations were obtained from the OACCAC administrative database. This database contains home care service records for all long-stay home care clients in the province as well as discharge information.

The RAI-HC assessment has been described previously and consists of over 300 questions covering sociodemographic, functional, cognitive and clinical domains. (20) The RAI-HC database also contains information about medication use (both over-the-counter and prescription) in the seven days prior to assessment, as well as use of acute care and home care services in the 90 days prior to assessment. interRAI assessments are completed by assessors who receive intensive, standardized training. These assessors are often social workers or nurses, who routinely verify information collected with clients, caregivers, and other health care

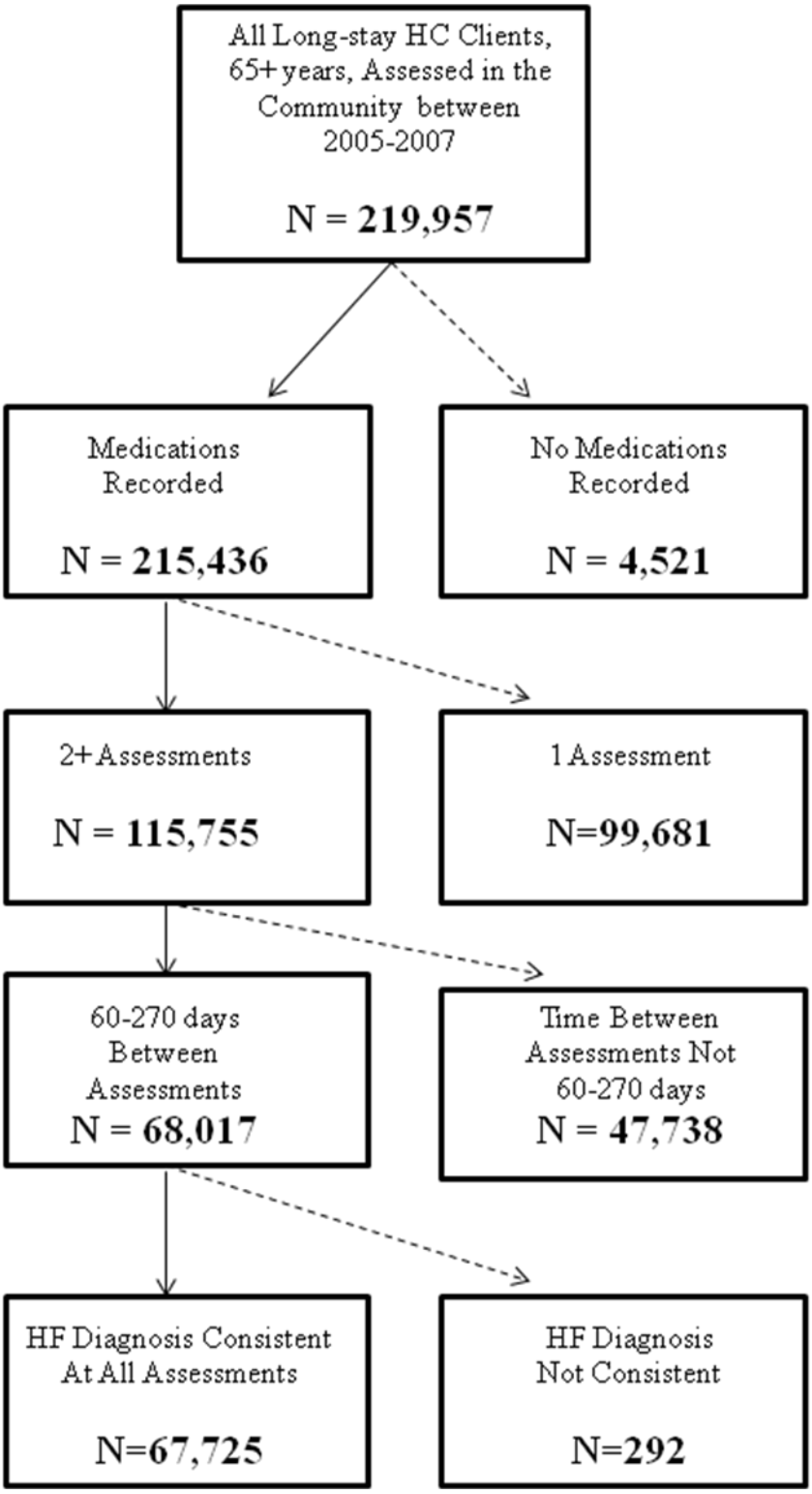
professionals. The assessors may also review medical records if necessary. interRAI assessments including the RAI-HC have been shown to be both reliable and valid for use in older home care populations. (20-23) The ability to link data from the RAI-HC to service records and discharge data from the OACCAC database allowed the outcomes of interest to be comprehensively examined.

6.2.2 Sample

The sample was selected from all long-stay home care clients in Ontario aged 65 years and older who were assessed with the RAI-HC between January 1, 2005 and December 31, 2007. Outcomes of interest were captured from both the OACCAC and RAI-HC databases until September 30, 2008, allowing clients to be at risk for each outcome for a minimum period of nine months. Individuals were included for study regardless of functional or cognitive impairment or presence of comorbidity. Individuals were excluded if no medications were recorded during any assessment. To create a longitudinal data set from the RAI-HC database, individual assessments were coded as either a first, second, third or fourth assessment, and merged by unique, anonymized client identification codes. Individuals with only one assessment were not included in this longitudinal data set. For individuals with four or more assessments, only the first four assessments were included in the longitudinal data set. HF diagnosis was considered to be consistent if 1) all assessments had a diagnosis of HF recorded, 2) no assessment had a diagnosis of HF recorded, or 3) initial assessments did not contain a diagnosis of HF, but all subsequent assessments did (new HF). If HF status was inconsistent across assessments for an individual, the individual was excluded from this data set. Individuals were also excluded if the gap between two consecutive assessments was not between 60-270 days. This was done to help ensure the sample did not include potentially sicker clients (who were

assessed more frequently) as well as those who were more healthy (and assessed less frequently). Figure 6.1 depicts the inclusion criteria for the sample. From Figure 6.1, it can be seen that the RAI-HC database included 219,957 long-stay home care clients older than 65 years assessed in the community between 2005 and 2007. From this sample, those with no medications recorded (n = 4,521), those with only one assessment (n = 99,681), those with assessment gaps of less than 60 days or more than 270 days (n=47,738), and those with inconsistent HF diagnoses (n = 242) were excluded. This left a final sample of 67,725 individuals.

Figure 6.1: Flow Diagram of Study Sample



6.2.3 Measures

Key sociodemographic and health-related variables were chosen as potential covariates of interest from items available on the RAI-HC assessment, based on previous research and clinical relevance. These were classified as sociodemographic, clinical, diagnostic, pharmacotherapy or service use characteristics. Most variables were categorized as either present or not present when examining their main effect on the outcomes of interest.

The sociodemographic variables examined were age, gender, marital status, living arrangement (living alone versus not) and caregiver stress. Age was collapsed into three groups: 65-74 years (reference group), 75-84 years and 85+ years. Caregiver stress was indicated by caregivers reporting an inability to continue with caring activities or expressing feelings of distress, anger or depression.

Clinical characteristics explored included number of comorbid conditions, impaired medication management, behavioural symptoms, impairment with stairs, incontinence and non-adherence to medications. Impaired medication management is an item captured in the physical function section of the RAI-HC and is recorded if individuals have difficulty remembering to take medications, opening medication containers, taking correct dosages, performing injections or applying ointments. The behavioural symptom variable was a composite measure of any of the following individual items on the RAI-HC: wandering, verbal or physical abuse, inappropriate or disruptive behaviour, or resisting care. Using the medication non-adherence item on the RAI-HC, non-adherence was defined as adherence less than 80% of the time.

Additional clinical characteristics explored were derived from summary scales, algorithms and CAPs embedded in the RAI-HC. Four scales were used in the analyses. The ADL self-performance hierarchy scale (range 0 – no difficulty, to 6 – severe difficulty) was used as a

measure of functional ability. (24) The IADL capacity scale is a hierarchical index that assesses difficulty with meal preparation, ordinary housework and phone use, and ranges from 0 – no difficulty in any task, to 6 – great difficulty in all tasks. (21) The CPS measures cognitive status, ranging from 0 – cognitively intact, to 6 – very severe impairment. (25,26) The CHESS scale measures health instability and is a composite measure across the following symptoms: vomiting, dehydration, loss of appetite, weight loss, shortness of breath and edema. Scores on the CHESS scale can range from 0 – no symptoms of instability, to 5 – high level of instability. (27) Additionally, the MAPLe algorithm was used, and is a measure of assigning priority level of clients based on function and cognition. (28) This algorithm assigns to individuals scores between 1 – low priority, to 5 – high priority. Scores from these clinical scales and algorithms were collapsed categorically for descriptive purposes, but were not collapsed during subsequent multivariate modeling. interRAI instruments also contain CAPs to help with care planning and trigger areas for further follow-up. Two CAPs, the falls and mood CAPs, were used in the analyses. The falls CAP is not triggered if individuals had no previous falls, is triggered at a low-risk level for individuals with one previous fall, and is triggered at a high-risk level for individuals with two or more previous falls. (29) The mood CAP assesses depressive symptoms and is not triggered if individuals exhibit no indicators of depression, is triggered at a low-risk level if individuals have indicators of possible depression, and is triggered at a high-risk level if individuals exhibit indicators of probable depression. (29) CAP levels were reported in descriptive and longitudinal analyses, with the reference group being those who did not trigger the respective CAP.

Diagnostic covariates that were examined in all analyses were diabetes mellitus, stroke, coronary artery disease, hypertension, arthritis, osteoporosis, dementia (Alzheimer's and non-

Alzheimer's), cancer and airway disease (a measure that includes asthma, emphysema and COPD). These diagnoses, as well as HF, are recorded on the RAI-HC during assessment, and are routinely verified through discussions with clients, caregivers, health care professionals, and review of medical charts if needed. Previous work done using Canadian LTC populations has shown that sensitivity of interRAI tools in HF diagnosis is high (above 80 percent) when compared to provincial discharge data. (30)

The RAI-HC captures pharmacotherapy use in the seven days prior to assessment. Medications are recorded at the time of assessment and verified using medication containers, conversations with clients and caregivers, and medical records. Recorded medications are electronically entered into the database and a manual search for medication names and variants was done to identify medications in the three classes of interest. Covariates explored were use of any ACE inhibitor therapy (including benazepril, captopril, cilazapril, enalapril, fosinopril, lisinopril, perindopril, quinapril, ramipril, and trandolapril), ARB therapy (including candesartan, eprosartan, irbesartan, losartan, telmisartan and valsartan) or β-blocker therapy (including acebutolol, atenolol, bisoprolol, carvedilol, metoprolol, nadolol and propranolol). A continuous use variable was created for each of these classes of medications for individuals who reported use at every assessment.

Service use characteristics explored included home care services (home help, physiotherapy, nursing and homemaking) and acute care services (emergency department visits and hospitalizations). Clients with any service use were compared to those with none. A weekly cost variable was created based on total home care service costs. This variable was created using home care service records data from the OACCAC database. The number of hours of each type of service (including nursing, nutritional services, physical and occupational therapy, speech

therapy, social work, homemaking and respite care) are recorded in this database. The total service hours were multiplied by the standard CCAC cost associated with each type of service. To create the weekly cost variable, the total cost of all services received in the one-week period prior to the most recent RAI-HC assessment were added and for the purposes of the analyses, this cost variable was converted to increments of $100.

The five outcomes of interest were mortality, LTC admission, long-stay hospitalization, functional decline and cognitive decline. In the OACCAC database, clients are assigned a discharge code and date when home care services are terminated. Mortality, LTC placement and long-stay hospitalizations (14 days or longer) are three of the discharge codes used. If a discharge for these reasons was recorded, the event was said to have occurred. The outcomes of functional and cognitive decline were derived from changes in the ADL hierarchy scale and CPS scale embedded in the RAI-HC assessment. The definitions of decline for both function and cognition were consistent with those described in the home care quality indicators for use with interRAI home care instruments. (31) New functional decline was defined as an increase of two or more points on the ADL hierarchy scale among individuals with no functional impairment at the first assessment (ADL hierarchy score = 0). This decline represents a change to at least limited functional impairment. For cognition, new decline was defined as a one or more point increase on the CPS among individuals who were initially cognitively intact (CPS = 0 at assessment 1). This change corresponds to at least a six point reduction in Mini Mental State Exam scores. (26)

6.2.4 Analysis

Sociodemographic, clinical, functional, pharmacotherapy and service use characteristics were summarized using descriptive statistics. Individuals with only one assessment were

compared to those with two or more assessments on all characteristics of interest. Differences between groups (by HF status, number of assessments and time between assessments) were examined using chi-square tests for categorical variables (significance level $p<0.05$). Potential predictors of each of the five outcomes of interest were initially identified using bivariate analysis. Discrete survival analysis was done using Cox proportional hazards modeling. For the outcomes of mortality, LTC admission and long-stay hospitalization, events that occurred in the nine months following assessment were recorded. If the individual did not experience the event following an assessment, and had a subsequent assessment, event occurrence in the nine months following the subsequent assessment was recorded (i.e., individuals were renewed in the at-risk set). Individuals were right-censored if they had not experienced the event following the final assessment. Time to mortality, LTC admission and long-stay hospitalization was calculated from the relevant assessment date to the discharge date for each outcome. For the outcomes of functional and cognitive decline, a different approach was necessary. Because RAI-HC assessments are repeated at approximately six-month intervals, the exact date of decline is unknown, but is known to have occurred between two consecutive assessments. This makes the functional and cognitive decline events interval censored and avoids problems associated with arbitrarily assigning a date (such as the midpoint of the interval). Time to decline was calculated as the number of days between the two assessment dates during which the decline occurred. For clients with no decline during the first interval, event occurrence in subsequent intervals was explored. However, only the first occurrence of decline was recorded. Previous unpublished work done using RAI-HC data has shown that such interval censoring has minimal effect on odds ratio estimates, and this method has been used in analyses of time to first hip fracture using Ontario RAI-HC data. (32)

Factors potentially associated with each of the respective outcomes were initially identified using bivariate analyses and evidence from the literature. Significant covariates were included in subsequent multivariate proportional hazards regression analyses, initially done using stepwise selection with the criterion for statistical significance for entry of variables into the final model set to alpha=0.05. Covariates for age, gender and medication use were forced into models to examine their main effects and allow for comparisons between models and to previous findings from the literature. The binary covariates for any ACE inhibitor, ARB or β-blocker use, as well as the weekly cost of services covariate were treated as time-dependent covariates, meaning that the value of the covariate at the assessment prior to the outcome date was used in the model. Exploration of alternate models was done using composite comorbidity measures substituted for individual comorbid conditions and the weekly cost variable in place of the four home care service covariates. To minimize the potential effects of collinearity, covariates for marital status and living alone were examined separately in models for each outcome. Further, the MAPLe algorithm incorporates both ADL hierarchy scale scores and CPS scores. MAPLe algorithm scores were examined in models separately from ADL hierarchy scale scores and CPS scores for each outcome. Alternate forms of the models were examined to ensure that entry and deletion effects were ruled out. Proportionality assumptions were checked for each covariate in the final models by creating dummy variables of each covariate multiplied by the log of the time to discharge or time to decline. Two-way interaction effects were tested at $p<0.05$. Examination of potentially influential outliers was done for all covariates and apart from some high weekly costs, none were identified. For models that included the weekly cost covariate, clients with costs in the highest one percentile were excluded to minimize the effect of these potentially influential outliers. In the final models, hazard ratios and 95% confidence limits are reported for each

covariate. All analyses were conducted using SAS software (version 9.2, SAS Institute Inc., Cary, NC.).

6.3 Results

From the final sample of 67,725 individuals (see Figure 6.1), 1,842 individuals with new HF were identified, but not included in the longitudinal analyses. A total of 9,283 (14.1%) individuals with HF were identified from this sample. Of these individuals, 3.3% (n = 312) died, 2.3% (n = 209) were admitted to long-term care, 8.5% (n = 793) had long-stay hospitalizations, 11.9% (n = 1,105) experienced functional decline and 12.8% (n=1,191) experienced cognitive decline. Of those who experienced functional or cognitive decline, 429 and 680 individuals, respectively, experienced new decline.

Table 6.1 presents the sociodemographic, clinical, functional, pharmacotherapy and service use characteristics of older home care clients in Ontario by HF diagnostic status. The table includes individuals with one assessment only, who were excluded from further analyses. Differences between groups, by both assessment number (one versus two or more assessments) and HF diagnosis, were examined. All groups were significantly different except for presence of diabetes mellitus, any use of ACE inhibitor or ARB therapy, falls CAP scores and mood CAP scores, as indicated in the table. Overall, the group with HF was older and less likely to be female or married than the non-HF group. Individuals with HF also demonstrated lower priority level on the MAPLe algorithm, less cognitive impairment, more difficulty with IADLs, greater health instability (based on CHESS scale scores), more comorbidity, more medication use (including HF specific medications) and more homemaking and home help service use than their counterparts without HF. Compared to individuals with only one assessment, those with two or more assessments were older, less likely to be married, more likely to be female, and exhibited

less functional impairment, cognitive impairment and health instability. However, the group with two or more assessments reported more comorbid conditions and medication use, higher rates of incontinence and more service use. Use of ACE inhibitor and ARB therapies was not different between individuals with one assessment compared to those with two or more.

Only individuals with two or more assessments and consistently diagnosed HF were included in further outcomes analyses (n= 9,283). Table 6.2 illustrates the characteristics of this sample with respect to key sociodemographic variables, clinical scales and medication use. The proportion of individuals with HF remained constant over time, with these individuals making up approximately 14% of the entire sample at each assessment. Over time, an increasing proportion of individuals lived alone and females made up a larger proportion of the group. Levels of functional and cognitive impairment remained relatively stable over time, and by the fourth assessment, individuals exhibited less health instability and lower rates of falls than at the first assessment. The number of comorbidities and medications increased over time, but the reported rates of ACE inhibitor, ARB and β-blocker use remained relatively stable.

Since individuals were excluded based on time between assessments, comparisons between individuals with 60-270 days between assessments and those with less or more time between assessments were done to explore potential differences between groups. Results of this analysis can be found in Table 1 of Appendix J. While differences between groups are statistically significant, there appears to be no evidence to suggest that the groups differ clinically in substantively meaningful ways.

Tables 6.3 – 6.7 provide the five proportional hazards regression models for mortality, LTC admission, long-stay hospitalization, new functional decline and new cognitive decline, respectively. No two-way interaction effects with gender or between the three binary drug

variables were significant in any of the final models. The proportionality assumption was not violated for any of the chosen models. In Appendix J, Tables 2 through 6 display the results of initial bivariate logistic regression analyses of associations between individual covariates with each outcome of interest.

Table 6.3 depicts the model for time to mortality. Living alone and female gender were associated with a lower risk of mortality in the nine months following assessment, while health instability and IADL impairments were associated with an increased risk. Age and any ACE inhibitor, ARB or β-blocker use were not found to be significantly associated with mortality.

Factors associated with LTC admission within nine months are shown in Table 6.4. Older age was associated with an increased risk of admission (HR = 1.95 for individuals older than 85 years compared to those 65-74 years). Increasing MAPLe scores and IADL impairment also increased admission risk, while more comorbid conditions reduced the risk. Gender was not significantly associated with LTC admission. Any use of an ACE inhibitor showed a protective effect for placement, but use of ARB or β-blocker therapy did not.

The selected model for time to long-stay hospitalization within nine months is shown in Table 6.5. Females had a reduced risk of long-stay hospitalizations, with a HR of 0.85 compared to males with similar characteristics for other covariates. Increasing health instability, impairments with stairs, and, to a lesser degree, number of medications were associated with a higher risk of long-stay hospitalization. Use of any HF medications was not found to be associated with risk of long-stay hospitalization.

Table 6.6 provides the model for factors associated with new functional decline. Living alone, female gender and reported ACE inhibitor use were all associated with a reduced risk of new functional decline. Older age, MAPLe score, IADL impairment and higher costs of home

care services were all found to increase the likelihood of new decline. Factors associated with any functional decline irrespective of baseline status were also explored and the proportional hazards regression model can be found in Table 7 of Appendix J. Similar to the model for new functional decline, older age and MAPLe score increased the likelihood of any functional decline, while living alone, female gender and ACE inhibitor therapy reduced the likelihood.

In Table 6.7, the selected model for new cognitive decline is shown. Being female was associated with a reduced risk of new cognitive decline. Increasing age, ADL impairment, history of falls, indicators of depression and impaired medication management were all associated with a higher risk of new decline. A diagnosis of dementia was the strongest predictor of new decline, with an associated HR of 4.06 compared to individuals with similar covariates, but no dementia. Use of any ACE inhibitor, β-blocker, and ARB therapy was not significantly associated with new decline. Investigation of factors associated with any cognitive decline irrespective of baseline status was also done and the final model can be found in Table 8 of Appendix J. Older age, ADL impairment, indicators of depression, impaired medication management and a diagnosis of dementia increased the risk of new cognitive decline, while living alone, female gender, and MAPLe score reduced the risk.

Table 6.1: Sociodemographic, Clinical, Diagnostic, Pharmacotherapy and Service Use Characteristics of Older Home Care Clients by Heart Failure Diagnosis and Number of Assessments, Ontario 2005-2007 (N =165,564)

		1 Assessment Only N = 99,681		2+ Assessments N = 65,883	
		HF Sample n=12,764 % (n)	**Non-HF Sample n=86,917 % (n)**	**HF Sample n=9,283 % (n)**	**Non-HF Sample n=56,600 % (n)**
Sociodemographic Characteristics					
Age	65-74 years	17.6 (2,244)	24.2 (21,048)	15.1 (1,403)	20.6 (11,679)
	75 – 84 years	43.4 (5,539)	45.5 (39,511)	44.0 (4,083)	46.5 (26,330)
	85+ years	39.0 (4,981)	30.3 (26,538)	40.9 (3,797)	32.9 (18,591)
Gender	Female	57.9 (7,389)	63.4 (55,086)	66.7 (6,195)	69.1 (39,113)
Married		39.2 (5,007)	41.3 (35,888)	35.3 (3,281)	39.0 (22,065)
Living Alone		31.8 (4,054)	34.3 (29,836)	39.4 (3,658)	38.0 (21,479)
Caregiver Stress		17.1 (2,180)	17.1 (14,835)	12.5 (1,164)	13.9 (7,839)
Clinical Characteristics					
ADL Hierarchy Scale score[a]	0	64.2 (8194)	68.3 (59,388)	72.3 (6,711)	70.9 (40,117)
	1-2	24.1 (3,074)	21.3 (18,485)	20.0 (1,854)	20.5 (11,568)
	3+	11.7 (1,495)	10.4 (9,027)	7.7 (717)	8.6 (4,896)
IADL Capacity Scale score[b]	0	3.4 (429)	6.7 (5,821)	2.1 (191)	4.2 (2,382)
	1-2	18.4 (2,354)	23.5 (20,458)	22.0 (2,041)	24.6 (13,903)
	3+	78.2 (9,981)	69.8 (60,635)	75.9 (7,049)	71.2 (40,312)
CPS score[c]	0	50.7 (6,470)	50.6 (44,009)	55.8 (5,178)	50.5 (28,618)
	1-2	40.1 (5,115)	37.8 (32,866)	38.1 (3,536)	39.5 (22,326)
	3+	9.2 (1,179)	11.6 (10,037)	6.1 (569)	10.0 (5,655)
CHESS Scale score[d]	0	16.5 (2,103)	28.2 (24,494)	21.7 (2,013)	35.3 (19,952)
	1-2	57.4 (7,324)	58.1 (50,514)	61.3 (5,687)	56.1 (31,746)
	3+	26.1 (3,335)	13.7 (11,900)	17.0 (1,582)	8.7 (4,893)
MAPLe Algorithm score[e]	1	20.7 (2,640)	26.7 (23,215)	22.8 (2,114)	24.9 (14,118)
	2-3	48.1 (6,139)	38.7 (33,607)	52.6 (4,884)	43.3 (24,498)
	4-5	31.2 (3,985)	34.6 (30,095)	24.6 (2,285)	31.8 (17,984)
Incontinent		35.1 (4,484)	31.5 (27,410)	39.8 (3,694)	36.3 (20,559)

		1 Assessment Only N = 99,681		2+ Assessments N = 65,883	
		HF Sample n=12,764 % (n)	**Non-HF Sample n=86,917 % (n)**	**HF Sample n=9,283 % (n)**	**Non-HF Sample n=56,600 % (n)**
Behavioural Symptoms		7.5 (952)	9.2 (7,949)	4.1 (376)	6.8 (3,857)
Impairment with Stairs		69.3 (8,850)	58.2 (50,554)	66.6 (6,185)	59.4 (33,638)
Falls CAP[†f]	0	64.8 (8,272)	65.4 (56,800)	69.9 (6,486)	69.3 (39,239)
	1	20.1 (2,558)	20.1 (17,450)	17.8 (1,653)	18.2 (10,321)
	2	15.1 (1,931)	14.6 (12,660)	12.3 (1,144)	12.4 (7,038)
Mood CAP[†g]	0	63.4 (8,094)	64.5 (56,012)	68.0 (6,310)	67.6 (38,258)
	1	23.1 (2,945)	22.0 (19,083)	21.0 (1,952)	21.1 (11,919)
	2	13.5 (1,720)	13.5 (11,795)	11.0 (1,016)	11.3 (6,404)
Number of Comorbid Conditions[h]	0,1	8.1 (1,030)	14.8 (12,839)	6.3 (580)	11.0 (6,201)
	2-4	54.4 (6,945)	64.6 (56,155)	51.4 (4,771)	64.4 (36,444)
	5+	37.5 (4,789)	20.6 (17,923)	42.4 (3,932)	24.6 (13,955)
Diagnoses					
Hypertension		60.2 (7,683)	53.1 (46,208)	63.3 (5,876)	55.1 (31,181)
Arthritis		50.3 (6,416)	46.5 (40,393)	60.7 (5,635)	54.8 (36,001)
CAD		43.6 (5,569)	21.8 (18,957)	46.3 (4,301)	24.0 (13,568)
Diabetes Mellitus[‡]		31.9 (4,071)	22.1 (19,166)	32.5 (3,019)	22.3 (12,594)
Airway Disease[i]		27.0 (3,446)	13.9 (12,066)	28.3 (2,625)	14.5 (8,216)
Stroke		18.5 (2,367)	15.9 (13,845)	20.7 (1,919)	19.4 (10,976)
Osteoporosis		18.0 (2,293)	19.0 (16,539)	20.5 (1,902)	22.3 (12,647)
Any Dementia		14.7 (1,871)	20.7 (17,963)	12.0 (1,115)	20.1 (11,374)
Cancer		13.0 (1,654)	18.4 (15,965)	10.6 (981)	12.7 (7,206)
Pharmacotherapy					
Number of Medications[j]	1-4	6.8 (871)	23.7 (20,605)	5.4 (497)	19.8 (11,192)
	5-8	28.5 (3,639)	39.0 (33,922)	26.4 (2,455)	38.3 (21,673)
	9+	64.7 (8,254)	37.3 (32,390)	68.2 (6,331)	41.9 (23,735)
Impaired Medication Management		62.4 (7,962)	53.0 (46,048)	56.9 (5,277)	52.3 (29,584)
Medication Non-Adherence[k]		1.3 (167)	1.9 (1,647)	1.0 (89)	1.3 (725)

		1 Assessment Only N = 99,681		2+ Assessments N = 65,883	
		HF Sample n=12,764 % (n)	**Non-HF Sample n=86,917 % (n)**	**HF Sample n=9,283 % (n)**	**Non-HF Sample n=56,600 % (n)**
Pharmacotherapy					
Any ACE inhibitor use[‡]		48.7 (6,217)	32.6 (28,310)	48.9 (4,541)	33.5 (18,985)
Any ARB use[‡]		11.4 (1,460)	9.1 (7,918)	12.0 (1,118)	9.0 (5,065)
Any β–blocker use		46.8 (5,979)	26.4 (22,930)	42.9 (3,985)	25.4 (14,361)
Service Use					
Home Care Service Use[l]	Any Nursing	42.9 (5,473)	33.3 (28,916)	36.2 (3,359)	26.2 (14,809)
	Any Homemaking	34.8 (4,435)	29.7 (25,853)	47.0 (4,360)	41.6 (23,540)
	Any Physiotherapy	10.6 (1,353)	12.6 (10,953)	8.2 (764)	9.3 (5,279)
	Any Home Help	48.8 (6,232)	41.0 (35,648)	66.3 (6,157)	59.5 (33,649)
Acute Care Service Use[m]	Any ED visit	25.3 (3,230)	22.5 (19,542)	21.4 (1,989)	17.4 (9,856)
	Any Hospitalization	50.4 (6,434)	36.3 (31,584)	37.7 (3,503)	25.2 (14,268)

Abbreviations: ACE = Angiotensin Converting Enzyme, **ADL** = Activities of Daily Living, **ARB** = Angiotensin Receptor Blocker, **β-blocker** = β-Adrenergic Receptor Blocker, **CAD** = Coronary Artery Disease, **CAP** = Clinical Assessment Protocol, **CHESS** = Changes in Health, End-stage disease and Signs and Symptoms, **CPS** = Cognitive Performance Scale, **ED** = Emergency Department, **HF** = Heart Failure, **IADL** = Instrumental Activities of Daily Living, **MAPLe** = Method for Assigning Priority Levels

[†] indicates that differences between groups by HF diagnosis were not significant at $p < 0.05$

[‡] indicates that differences between groups by assessment number (1 versus 2 or more) were not significant at $p < 0.05$

[a] 0 = no impairment; 1-2 = some functional impairment; 3+ = severe functional impairment

[b] 0 = no difficulty; 1-2 = some difficulty; 3+ = great difficulty

[c] 0 = cognitively intact; 1-2 = mild cognitive impairment; 3+ = cognitively impaired

[d] 0 = no health instability; 1-2 = some health instability; 3+ = moderate to high health instability

[e] 1 = low priority; 2-3 = mild/moderate priority; 4-5 = high priority

[f] 0 = no prior falls; 1 – 1 prior fall; 2 – multiple prior falls

[g] 0 = no indicators of depression; 1-2 = some indicators of depression; 3+ = indicators of probable depression

[h] excludes HF

[i] includes chronic obstructive pulmonary disease (COPD), emphysema and asthma

[j] excludes ACE inhibitor, β-blocker and ARB therapies

[k] adherent less than 80% of the time

[l] measured in 7 days prior to assessment

[m] measured in 90 days prior to assessment

Table 6.2: Characteristics of Older Home Care Clients with Heart Failure over Time, Ontario 2005-2007 (N = 9,283)

Assessment		First N=65,883	Second N=65,883	Third N=38,265	Fourth N=24,906
		% (n)	% (n)	% (n)	% (n)
HF		14.1 (9,283)	14.1 (9,283)	14.3 (5,456)	14.5 (3,613)
Sociodemographic Characteristics					
Age	65-74 years	15.1 (1,403)	13.9 (1,289)	12.6 (686)	11.7 (423)
	75 – 84 years	44.0 (4,083)	42.5 (3,941)	41.2 (2,249)	39.2 (1,417)
	85+ years	40.9 (3,797)	43.7 (4,053)	46.2 (2,521)	39.1 (1,773)
Gender	Female	66.7 (6,195)	66.7 (6,195)	70.2 (3,828)	72.7 (2,625)
Living Alone		39.4 (3,658)	39.9 (3,702)	42.9 (2,338)	44.8 (1,616)
Clinical Characteristics					
ADL Hierarchy Scale score[a]	0	72.3 (6,711)	69.1 (6,412)	69.6 (3,796)	70.5 (2,546)
	1-2	20.0 (1,854)	21.1 (1,961)	20.4 (1,111)	19.7 (712)
	3+	7.7 (717)	9.7 (909)	10.1 (549)	9.8 (355)
IADL Capacity Scale score[b]	0	2.1 (191)	1.6 (151)	1.2 (67)	1.3 (47)
	1-2	22.0 (2,041)	20.5 (1,902)	21.2 (1,155)	21.1 (761)
	3+	75.9 (7,049)	77.9 (7,230)	77.6 (4,234)	77.6 (2,805)
CPS score[c]	0	55.8 (5,178)	51.8 (4,804)	52.8 (2,883)	54.2 (1,957)
	1-2	38.1 (3,536)	40.4 (3,753)	39.6 (2,162)	38.4 (1,389)
	3+	6.1 (569)	7.8 (725)	7.5 (411)	7.4 (267)
CHESS Scale score[d]	0	21.7 (2,013)	25.3 (2,351)	27.4 (1,492)	27.5 (992)
	1-2	61.3 (5,687)	61.2 (5,677)	61.3 (3,343)	61.8 (2,234)
	3+	17.0 (1,582)	13.5 (1,254)	11.4 (621)	10.7 (387)
MAPLe[e]	1	22.8 (2,114)	21.0 (1,950)	20.1 (1,096)	19.9 (720)
	2-3	52.6 (4,884)	52.5 (4,874)	55.3 (3,016)	56.2 (2,031)
	4-5	24.6 (2,285)	26.5 (2,459)	24.6 (1,344)	23.9 (862)
Falls CAP[f]	0	69.9 (6,486)	73.4 (6,815)	76.5 (4,175)	77.1 (2,786)
	1	17.8 (1,653)	16.0 (1,486)	14.3 (780)	15.1 (544)
	2	12.3 (1,144)	10.6 (982)	9.2 (501)	7.8 (283)
Mood CAP[g]	0	68.0 (6,310)	66.5 (6,173)	66.2 (3,610)	66.8 (2,413)
	1	21.0 (1,952)	21.9 (2,032)	22.4 (1,220)	22.9 (828)
	2	11.0 (1,016)	11.6 (1,078)	11.4 (626)	10.3 (372)
Number of Comorbid Conditions[h]	0,1	6.2 (580)	4.8 (441)	3.8 (210)	3.1 (112)
	2-4	51.4 (4,771)	48.1 (4,469)	45.1 (2,463)	42.9 (1,551)
	5+	42.4 (3,932)	47.1 (4,373)	51.0 (2,783)	54.0 (1,950)
Pharmacotherapy					
Number of Medications[i]	1-4	7.9 (497)	4.5 (417)	3.7 (202)	3.7 (134)
	5-8	26.5 (2,455)	23.6 (2,188)	22.4 (1,225)	21.2 (764)
	9+	68.2 (6,331)	71.9 (6,678)	73.8 (4,029)	75.1 (2,715)

Assessment	First N=65,883	Second N=65,883	Third N=38,265	Fourth N=24,906
	% (n)	% (n)	% (n)	% (n)
Pharmacotherapy				
Any ACE inhibitor use	48.9 (4,541)	48.4 (4,497)	48.5 (2,648)	47.3 (1,708)
Any ARB use	12.0 (1,118)	12.7 (1,174)	13.6 (741)	14.7 (530)
Any β-blocker use	42.9 (3,985)	43.7 (4,058)	45.3 (2,371)	43.9 (1,585)

Abbreviations: ACE = Angiotensin Converting Enzyme, **ADL** = Activities of Daily Living, **ARB** = Angiotensin Receptor Blocker, **β-blocker** = β-Adrenergic Receptor Blocker, **CAP** = Clinical Assessment Protocol, **CHESS** = Changes in Health, End-stage disease and Signs and Symptoms, **CPS** = Cognitive Performance Scale, **HF** = Heart Failure, **IADL** = Instrumental Activities of Daily Living, **MAPLe** = Method for Assigning Priority Levels

[a] 0 = no impairment; 1-2 = some functional impairment; 3+ = severe functional impairment

[b] 0 = no difficulty; 1-2 = some difficulty; 3+ = great difficulty

[c] 0 = cognitively intact; 1-2 = mild cognitive impairment; 3+ = cognitively impaired

[d] 0 = no health instability; 1-2 = some health instability; 3+ = moderate to high health instability

[e] 1 = low priority; 2-3 = mild/moderate priority; 4-5 = high priority

[f] 0 = no prior falls; 1 = 1 prior fall; 2 = multiple prior falls

[g] 0 = no indicators of depression; 1-2 = some indicators of depression; 3+ = indicators of probable depression

[h] excludes HF

[i] excludes ACE inhibitor, β-blocker and ARB therapies

Table 6.3: Proportional Hazards Regression Model of Time to Mortality among Older Home Care Clients with Heart Failure, Ontario 2005-2007 (N=9,283)

	Parameter Estimate (SE)	Hazard Ratio (95% CL)	*p value*
Sociodemographic Characteristics			
Age 75-84 years[a]	0.28 (0.18)	1.32 (0.92, 1.89)	0.13
Age 85+ years[a]	0.33 (0.19)	1.40 (0.97, 2.01)	0.07
Female	-0.51 (0.12)	0.60 (0.48, 0.76)	<0.001
Living Alone	-0.47 (0.14)	0.62 (0.47, 0.83)	0.001
Clinical Characteristics			
IADL Capacity Scale score	0.18 (0.05)	1.20 (1.09, 1.32)	<0.001
CHESS Scale score	0.22 (0.05)	1.24 (1.12, 1.38)	<0.001
Pharmacotherapy			
Any ACE inhibitor use	-0.01 (0.12)	0.99 (0.79, 1.25)	0.95
Any ARB use	-0.21 (0.20)	0.81 (0.55, 1.20)	0.30
Any β-blocker use	-0.10 (0.12)	0.91 (0.72, 1.14)	0.39

Individuals were followed for 9 months following each assessment. 312 individuals died. **Abbreviations: ACE** = Angiotensin Converting Enzyme, **ARB** = Angiotensin Receptor Blocker, **β–blocker** = β-Adrenergic Receptor Blocker, **CHESS** = Changes in Health, End-stage disease, Signs and Symptoms, **CL** = Confidence Limit, **IADL** = Instrumental Activities of Daily Living, **SE** = Standard Error
[a] Reference Group: Age 65-74 years

Table 6.4: Proportional Hazards Regression Model of Time to Long-Term Care Admission among Older Home Care Clients with Heart Failure, Ontario 2005-2007 (N=9,283)

	Parameter Estimate (SE)	Hazard Ratio (95% CL)	*p value*
Sociodemographic Characteristics			
Age 75-84 years[a]	0.30 (0.26)	1.34 (0.80, 2.25)	0.26
Age 85+ years[a]	0.67 (0.26)	1.95 (1.18, 3.22)	0.009
Female	0.04 (0.15)	1.04 (0.78, 1.39)	0.79
Clinical Characteristics			
IADL Capacity Scale score	0.21 (0.06)	1.23 (1.09, 1.40)	0.001
MAPLe Algorithm score	0.40 (0.07)	1.50 (1.30, 1.73)	<0.001
Number of Comorbid Conditions[b]	-0.49 (0.23)	0.62 (0.39, 0.97)	0.04
Pharmacotherapy			
Any ACE inhibitor use	-0.40 (0.15)	0.67 (0.50, 0.89)	0.006
Any ARB use	0.08 (0.21)	1.09 (0.72, 1.63)	0.69
Any β-blocker use	-0.02 (0.14)	0.99 (0.74, 1.30)	0.92

Individuals were followed for 9 months following each assessment. 209 individuals were admitted to long-term care. **Abbreviations: ACE** = Angiotensin Converting Enzyme, **ARB** = Angiotensin Receptor Blocker, **β–blocker** = β-Adrenergic Receptor Blocker, **CL** = Confidence Limit, **IADL** = Instrumental Activities of Daily Living, **MAPLe** = Method for Assigning Priority Levels, **SE** = Standard Error

[a] Reference Group: Age 65-74 years

[b] excludes heart failure (HF)

Table 6.5: Proportional Hazards Regression Model of Time to Long-Stay Hospitalization among Older Home Care Clients with Heart Failure, Ontario 2005-2007 (N=9,283)

	Parameter Estimate (SE)	Hazard Ratio (95% CL)	*p value*
Sociodemographic Characteristics			
Age 75-84 years[a]	-0.13 (0.10)	0.88 (0.72, 1.06)	0.18
Age 85+ years[a]	-0.23 (0.10)	0.79 (0.65, 0.98)	0.03
Female	-0.16 (0.07)	0.85 (0.73, 0.98)	0.03
Clinical Characteristics			
CHESS Scale score	0.18 (0.03)	1.20 (1.12, 1.28)	<0.001
Impairment with Stairs	0.19 (0.08)	1.21 (1.04, 1.42)	0.03
Pharmacotherapy			
Number of Medications[b]	0.03 (0.01)	1.04 (1.01, 1.06)	<0.001
Any ACE inhibitor use	-0.05 (0.07)	0.95 (0.82, 1.10)	0.48
Any ARB use	-0.13 (0.12)	0.88 (0.70, 1.10)	0.27
Any β-blocker use	-0.01 (0.07)	1.02 (0.88, 1.17)	0.84

Individuals were followed for 9 months following each assessment. 793 individuals had long-stay hospitalizations. **Abbreviations: ACE** = Angiotensin Converting Enzyme, **ARB** = Angiotensin Receptor Blocker, **β–blocker** = β-Adrenergic Receptor Blocker, **CHESS** = Changes in Health, End-stage disease, Signs and Symptoms, **CL** = Confidence Limit, **SE** = Standard Error

[a] Reference Group: Age 65-74 years

[b] excludes ACE inhibitor, β-blocker and ARB therapies

Table 6.6: Proportional Hazards Regression Model of Time to New Functional Decline among Older Home Care Clients with Heart Failure, Ontario 2005-2007 (N=9,283)

	Parameter Estimate (SE)	Hazard Ratio (95% CL)	*p value*
Sociodemographic Characteristics			
Age 75-84 years[a]	0.13 (0.17)	1.14 (0.82, 1.59)	0.45
Age 85+ years[a]	0.31 (0.17)	1.36 (0.98, 1.90)	0.07
Female	-0.24 (0.11)	0.79 (0.63, 0.98)	0.03
Living Alone	-0.61 (0.13)	0.54 (0.42, 0.70)	<0.001
Clinical Characteristics			
IADL Capacity Scale score	0.28 (0.05)	1.33 (1.20, 1.46)	<0.001
MAPLe Algorithm score	0.23 (0.05)	1.26 (1.14, 1.40)	<0.001
Pharmacotherapy			
Any ACE inhibitor use	-0.25 (0.11)	0.78 (0.62, 0.96)	0.02
Any ARB use	-0.01 (0.17)	1.00 (0.72, 1.38)	0.98
Any β-blocker use	-0.02 (0.11)	0.98 (0.79, 1.21)	0.86
Service Use			
Weekly Cost of Home Care[b]	0.21 (0.01)	1.24 (1.21, 1.27)	<0.001

Individuals were followed for 9 months following each assessment. 429 individuals experienced new functional decline. **Abbreviations: ACE** = Angiotensin Converting Enzyme, **ARB** = Angiotensin Receptor Blocker, **β–blocker** = β-Adrenergic Receptor Blocker, **CL** = Confidence Limit, **IADL** = Instrumental Activities of Daily Living, **MAPLe** = Method for Assigning Priority Levels, **SE** = Standard Error

[a] Reference Group: Age 65-74 years

[b] measured in increments of $100

Table 6.7: Proportional Hazards Regression Model of Time to New Cognitive Decline among Older Home Care Clients with Heart Failure, Ontario 2005-2007 (N=9,283)

		Parameter Estimate (SE)	Hazard Ratio (95% CL)	*p value*
Sociodemographic Characteristics				
Age 75-84 years[a]		0.52 (0.13)	1.69 (1.32, 2.17)	<0.001
Age 85+ years[a]		0.65 (0.13)	1.91 (1.49, 2.47)	<0.001
Female		-0.26 (0.08)	0.77 (0.66, 0.91)	0.002
Clinical Characteristics				
ADL Hierarchy Scale score		0.10 (0.04)	1.11 (1.03, 1.20)	0.009
Falls CAP	1[b]	0.29 (0.10)	1.34 (1.10, 1.63)	0.003
	2[c]	0.65 (0.11)	1.92 (1.54, 2.38)	<0.001
Mood CAP	1[d]	0.13 (0.10)	1.14 (0.94, 1.38)	0.19
	2[e]	0.53 (0.12)	1.70 (1.34, 2.15)	<0.001
Diagnoses				
Any Dementia		1.40 (0.26)	4.06 (2.45, 6.71)	<0.001
Pharmacotherapy				
Impaired Medication Management		0.34 (0.08)	1.40 (1.19, 1.64)	<0.001
Any ACE inhibitor use		0.03 (0.09)	1.03 (0.88, 1.21)	0.69
Any ARB use		0.06 (0.12)	1.06 (0.84, 1.34)	0.61
Any β-blocker use		0.01 (0.08)	1.01 (0.87, 1.18)	0.90

Individuals were followed for 9 months following each assessment. 680 individuals experienced new cognitive decline. **Abbreviations: ACE** = Angiotensin Converting Enzyme, **ARB** = Angiotensin Receptor Blocker, **ADL** = Activities of Daily Living, **β–blocker** = β-Adrenergic Receptor Blocker, **CAP** = Clinical Assessment Protocol; **CL** = Confidence Limit, **SE** = Standard Error

[a] Reference Group: Age 65-74 years

[b] 1 prior fall: Reference Group: Level 0 = no prior falls

[c] 2 or more prior falls: Reference Group: Level 0 = no prior falls

[d] Depression Rating Scale Score of 1-2, indicating some depressive symptoms: Reference Group: Level 0 = no depressive symptoms

[e] Depression Rating Scale score of 3 or more, indicating probably depression: Reference Group: Level 0 = no depressive symptoms

6.4 Discussion

This work has investigated factors associated with outcomes in a group of older, community-dwelling individuals receiving home care services. This population exhibits high rates of comorbidity, medication use and IADL impairment. Five outcomes relevant to this population were explored in this study – mortality, LTC admission, long-stay hospitalization, functional decline and cognitive decline. After exploration of a number of key covariates including sociodemographic characteristics, other diagnoses and conditions relevant to geriatric populations, including functional and cognitive ability and health instability, age and gender, as well as comprehensive health status indicators (CHESS and MAPLe scores) were associated with most outcomes. Interestingly, of the medications for HF examined, only ACE inhibitor therapy appeared to confer protective effects, for both LTC admission and functional decline. While these findings are novel, the absence of a protective effect for outcomes such as mortality and long-stay hospitalizations may raise some questions about the applicability of earlier RCT evidence to this population.

The sociodemographic characteristics examined were found to be associated with many of the studied outcomes. Older age increased the risk of all outcomes except mortality and long-stay hospitalization within nine months. In models where age was associated with the outcome, the 85 years and older group was at the highest risk of events, demonstrating that age remains a strong predictor of outcomes even among older individuals. However, age did not predict time to mortality. When other factors, such as health instability and functional decline are taken into account, the effect of age on these outcomes is diminished. Biological age, and not chronological age has been shown to be more highly associated with death in retrospective analyses of older Canadians (33) and the findings of this study would support this. Gender was also a consistent

predictor, with females being at lower risk of all outcomes except LTC placement. This sample was predominantly female, as is typical of older populations and two-way interaction effects with gender were explored, but not found to be significant in any of the final models. These findings are important as many studies into cardiovascular disease enroll predominantly male populations, although this is changing. Previous work from the Rotterdam Study (n=7,734) has shown that, unlike the current findings, gender did not affect five-year survival among older individuals with HF. (34) Females have been shown to have better adherence to HF therapies (35), possibly indicating better health behaviours overall, which could partly explain the current finding. Living alone was also a fairly consistent protective factor, with significant effects for mortality, functional decline and any cognitive decline. It is likely that once other factors impair the ability to live alone, individuals are transferred to more intensive care settings. The fact that a higher proportion of individuals are living alone by the fourth assessment also depicts the survivor effect in the sample, as those unable to continue on their own are lost from home care.

From the clinical characteristics explored, the CHESS scale and MAPLe algorithm scores were commonly associated with all outcomes except new cognitive decline. These composite indicators of health status may have particular use in identifying persons at risk of acute events. The CHESS scale has been shown to be a better predictor of mortality than NYHA functional class (36) and these results show that it may also be associated with long-stay hospitalization and functional decline. The MAPLe algorithm score has been shown to predict LTC placement in earlier work and these findings support this utility. (27)

The IADL capacity scale and ADL hierarchy scale scores, as well as impairments with stairs (all measures of functional impairment) predicted shorter time to outcomes. These covariates likely indicate underlying changes leading to decline in overall health status, putting

individuals at risk of adverse outcomes. A history of falls was also associated with any functional decline and new cognitive decline. Increasing prevalence of falls may reflect a general increase in frailty that is also associated with functional and cognitive decline. (37,38) Depressive symptoms, as measured through the mood CAP, were associated with cognitive decline. This finding is consistent with that of other studies done in community-dwelling older adults, where depression has been associated with higher incidence of mild cognitive impairment and dementia. (39,40) Much recent literature has explored the potential disease continuum from depression to mild cognitive impairment to dementia (39-42), although underlying mechanisms for such relationships remain under investigation. (42) Depressive symptoms may also indicate under-treated HF and could impair self-care abilities.

This study explored a number of medication-related covariates, some of which were strong predictors of cognitive and functional decline. ACE inhibitor therapy was found to be protective for LTC placement and functional decline. As functional decline is related to LTC placement, these findings indicate that ACE inhibitor therapy may protect from LTC admission through effects on functional decline. There is some previous evidence to indicate that ACE inhibitor therapy may improve function (15,16) and these results appear to support this. However, this is the first study to examine LTC placement in older community-dwelling individuals with HF, and the finding that ACE inhibitors may reduce placement risk is novel. β-blocker or ARB therapies were not significant predictors of any outcomes studied. Unlike ACE inhibitors, there is not a recognized class effect for β-blocker therapy. By examining all β-blockers, not only those considered to be evidence-based, there is the possibility that potential therapeutic benefits have been diluted. ARB therapies are newer, and used in individuals who are intolerant to ACE inhibitor therapy. (2) Such individuals may be a more severely impaired subset

of all HF patients, minimizing the potential effectiveness of ARB treatment. It is also possible that a large proportion of the population studied had HF with preserved ejection fraction (HFPEF). If this was the case, associations with medication use may not be observed as evidence of effectiveness for such individuals is not established. (43) However, a large community-based study found that 66% of HF patients had reduced EF (44), making it possible that this sample included mostly individuals for whom therapies are recommended. Also, CCS HF guidelines recommend use of combination ACE inhibitor or ARB therapy in conjunction with a β-blocker. (2) Two-way interaction effects of the three medication classes were examined in all models. None were significant indicating that the baseline risk associated with ACE inhibitor therapy alone did not change if ARB or β-blocker therapies were also present. This could be explained in part by the potentially large number of individuals with HFPEF, for whom combination therapy may not be as effective. However, it may be that combination therapy confers no benefit over ACE inhibitor therapy alone in this population and trials to examine effectiveness of combination therapy in older, frail individuals may be warranted. Interestingly, ACE inhibitor therapy did not protect individuals from mortality, long-stay hospitalizations or cognitive decline. Many clinical trials have established that ACE inhibitors are helpful in reducing mortality, but these results indicate that this benefit may not apply to older individuals with other comorbidities and geriatric conditions. The study population is clearly different from those in clinical trials, in age as well as medication use and comorbidity profiles. Such differences may account for the lack of observed associations with ACE inhibitors. It is worth noting that the presence of continuous ACE inhibitor or ARB therapy (at all assessments) was protective of all outcomes in bivariate analyses (see Tables 2-6 in Appendix J). These protective effects were not maintained in multivariate analyses suggesting that such effects are minimal once other factors

associated with outcomes are considered. A large European study of older adults with HF also found that ACE inhibitor, ARB and β-blocker use reduced three-month and one-year mortality post-hospital discharge, but did not explore medication use in multivariate analyses. (45) The fact that these associations were not maintained in multivariate models could indicate that potential benefits of pharmacotherapy are not as strongly associated with these outcomes as other covariates. Alternately, it may be difficult to interpret prognostic roles of HF therapies from this study, as confounding factors driving prescribing could not be adjusted for. It is still important to recognize that clinical trial results may not be as relevant in more complex populations such as the one studied.

Increasing number of medications was found to be associated with a higher risk of long-stay hospitalizations. While this study could not examine prevalence of adverse drug reactions, they are well-known risk factors for long-stay hospitalizations (46,47) and this could partially explain this finding. Impaired medication management increased the risk of both functional and cognitive decline. The inability to manage medications could potentially lead to reduced medication intake and adverse outcomes or act as a proxy for cognitive decline.

Overall, this work depicts a situation in which a core set of relatively strong predictors emerges for the outcomes studied. Medication use does not seem to emerge as a strong predictor though important results have been noted.

6.4.1 Limitations

There are issues regarding potential biases with this work that need to be addressed as potential alternative explanations for the results. First, this is a sample of older, community-dwelling HF patients receiving home care services. Such individuals are not necessarily representative of all older adults who may not seek or receive home care services and this could

introduce selection bias. As shown in Chapter 4.0, such individuals represent a more clinically complex population than home care clients without HF. It is possible that more outcomes were seen because a sicker population was studied. The potential for survivor bias to affect these findings is important to consider. In Table 6.2, individuals with four assessments appear to be better off in a number of clinical characteristics. This means that over time, healthier individuals were studied. These people may have better informal supports or have more health promoting behaviours than clients who are lost. However, if individuals no longer require home care services, they would not continue to be represented in this sample. So, while there is the potential for survivor bias to partially explain these findings, these individuals were still sick or impaired to some extent.

Other potential sources of selection bias arise from the exclusion criteria used. Individuals who were excluded due to having only one assessment or an assessment gap that was not between 60 and 270 days were explored. These clients did not appear to differ clinically from those with assessment times between 60 and 270 days. This is interesting, as RAI-HC assessments are supposed to be repeated at six-month intervals, or when significant clinical changes occur, possibly leading to a situation in which sicker clients are assessed more frequently than those in better health. This does not appear to be the case. Table 6.1 shows that individuals with only one assessment were different and generally sicker than those with two or more assessments. Again, this indicates a survivor effect and may mean that healthier home care clients with HF were included.

The lack of continuous drug data could threaten the internal validity of this study. As data about medication use are only collected during assessments, patterns of medication use between assessments are unknown. However, most (more than 80%) of the individuals in the sample were

in the continuous user group (therapy recorded at all assessments) or the never user group (no therapy recorded at any assessment) for each HF medication, as shown in Table 9 in Appendix J. Continuous users may represent a healthier subgroup than individuals who discontinue therapy due to worsening disease or medication intolerance. This discontinuation, initiated either by physicians or patients, could lead to protopathic bias since these former users may be at higher risk of adverse events. In this sample, only six, five and three percent of individuals with HF discontinued ACE inhibitor, β-blocker or ARB therapy, respectively. However, if a large number of events occurred in this group, it could lead to overestimates of therapeutic benefits since they were considered to be non-users. Outcomes among discontinuers were examined and the proportion of individuals in this group who experienced outcomes was similar or slightly higher than continuous or never users (see Tables 10-13 in Appendix J). While there is the potential that such individuals may be sicker and different from other clients, they represent a very small proportion of the sample, somewhat reducing the concern of such bias. There is also the potential that individuals who were said to be never users had prior use of HF medications, but this could not be verified using RAI-HC data.

Non-adherence in the sample was reported to be low. Nonetheless, with a lack of continuous drug data and a corresponding measure of adherence, it is possible that non-adherence to medications could account for some of the observed results. Previous studies have found adherence with HF pharmacotherapy to range between 30-60%, with adherence to lifestyle modifications being lower. (48) However, early studies have shown that women, individuals older than 85 years, and those with multiple medications were more likely to be adherent. (35) Thus, the reported adherence rates may accurately describe this sample.

Analyses were done discretely, meaning that individuals were considered to be at risk for each outcome independently. There is the potential that competing risks could affect some of the observed relationships between covariates and outcomes of interest. However, in the cause-specific models presented, once individuals were discharged due to mortality or LTC placement, they no longer appeared in the data set. Individuals hospitalized for 14 days or longer are considered to be discharged to hospital, and may return home and receive home care services. Such individuals may appear in more than one event group, but if LTC placement or death occurs, they are no longer in the data set. No overly protective effects for long-stay hospitalization or LTC placement were observed that were also strongly associated with mortality, so the potential for competing risks influencing these findings appears to be minimal. Functional and cognitive decline were not considered to be competing risks for the outcomes of mortality, LTC placement or long-stay hospitalizations. The inability to capture shorter hospital stays is another weakness of this study, making the prevalence of any hospitalization higher than reported.

Medication and diagnostic data were collected from RAI-HC assessments and there is the potential for misclassification bias. If individuals were incorrectly classified as having HF, it would overestimate HF prevalence, potentially reducing the magnitude of the observed associations. In an attempt to reduce such misclassification bias, individuals whose HF diagnosis was not consistent at all assessments were excluded. Only 242 individuals were excluded for this reason, giving some confidence in diagnostic accuracy. Further, previous work with interRAI instruments has demonstrated high consistency between interRAI diagnoses and administrative data. (30,49) As for medication data, there is the potential that not all medications were captured at the time of assessment. If medications were missed, it could lead to underestimation of

prevalence and weaker associations with outcomes. A bias towards exclusion of HF medications specifically would not be expected, but individuals for whom no medications were recorded were excluded from the study sample. As medication use among older adults is known to be high (50), no recorded medications could indicate potential data quality issues. Assessors may have neglected to record medications or may have attached a separate form that was not transcribed into electronic records. However, a record of no medications could have been accurate, meaning that some individuals were excluded without reason. It is possible that during the search for medications of interest, some medications were missed due to spelling errors that were not captured during searching. This could underestimate prevalence of ACE inhibitor, ARB and β-blocker use, and is a limitation of the current Ontario RAI-HC medication data. As stated previously, most individuals in these analyses had consistent medication status for HF medications, with more than 85% being either continuous or never users of ACE inhibitor, ARB or β-blocker therapy. This gives some assurances about data quality. A further consideration is that some medications may exacerbate HF and lead to higher rates of adverse outcomes. Use of other types of medications was not explored and could affect these findings by reducing observed effectiveness of HF medications.

6.4.2 Strengths

The population studied is an important, but often under-studied one. Individuals with HF receiving home care services are a frail, medically complex group. Until recently, this was a relatively inaccessible group to study, but mandatory introduction of RAI-HC assessments in the past decade allowed valuable data to be collected in Ontario. Earlier work has comprehensively described older adults with HF who are receiving home care services and explored prevalence of medication use as well as factors associated with non-use of HF medications. The home care

population is worthy of study as it represents individuals who are independent enough to remain at home, but have frequent contact with the health care system. Further, this group is particularly suited to interventions to improve care as the potential to avoid adverse outcomes and maintain independence at home can reduce burden on other areas of the health care system. Approximately 90% of individuals with HF in Ontario are managed by family physicians, not specialists. (18) However, most clinical trials and effectiveness studies examine individuals receiving care in specialty clinic settings. Thus, this sample likely provides a more realistic picture of community-dwelling HF patients. Lastly, as the RAI-HC is mandated for use in Ontario, this sample captures the entire long-stay home care population.

The size of the database allowed for a large sample to be followed over time, with enough events occurring to allow exploration of factors associated with each outcome independently. Clinical trials often use combined outcomes to achieve enough power to detect differences between treatment groups (Tables 1-3 in Appendix G), but this may mask effects on individual outcomes. The sample size also permitted exploration of interaction effects which is not always possible with smaller samples.

The exploration of multiple outcomes in this population is novel, but especially relevant to older adults are the outcomes of LTC admission, and cognitive and functional decline. The ability to explore a comprehensive set of factors potentially associated with these outcomes is a unique strength of this work. Little work has explored LTC placement, functional decline and cognitive decline in older adults. The Canadian Study of Health and Aging (n = 10,263) is one of the few studies to examine these outcomes in older adults, but was not specific to individuals with HF. In this study, individuals older than 65 years were enrolled and followed for five years.

Rates of mortality and LTC placement were high and decline in function and cognition occurred in more than two-thirds of participants. (51)

Individuals with HF are known to have high rates of cognitive impairment (52-54) and end-stage HF is characterized by long-term functional limitations. (55) Some work has examined the utility of ACE inhibitor and β-blocker therapy in functional decline (15-17) and ACE inhibitor therapy in cognitive decline (8), but did not examine the breadth of clinical factors explored in this study. Arguably, explorations of factors associated with outcomes in frail, elderly individuals should be done as inclusively as possible. Some argue that enrollment of older adults in clinical trials is feasible (13,56), but improving the evidence base through strong observational studies may also be of use.

Another important strength of this work is the potential to utilize the breadth of information captured in the RAI-HC. The comprehensive clinical characteristics available in the assessment, including key geriatric conditions such as dementia, cognition and functional ability, are attributes of this data set. Additionally, the ability to examine these factors as well as HF medication use concurrently is unique. In contrast to clinical trials, which commonly exclude individuals with other medication use, other comorbidities and functional and cognitive impairment, this sample was inclusive on these characteristics. This allows exploration of how these factors come into play in the context of each other. This study was also able to capture current medication use by treating HF medications as time-dependent covariates, allowing for changes in current exposures over time. Lastly, but importantly, this study is one of few to examine factors associated with functional and cognitive decline among older individuals with HF, outcomes which may particularly important to this population. The findings suggest that ACE inhibitor therapy may confer protection to functional decline, a novel finding that is

consistent with earlier work done on ACE inhibitor use and exercise capacity in non-HF populations (57) and early studies of ACE inhibitors in HF populations. (15,16)

6.5 Conclusions

Individuals with HF who receive home care services are a unique group in which to study outcomes associated with the disease. They are an independent population that is able to remain at home, but is vulnerable enough to require home care services. Presumably, this delicate balance can be shifted towards either further independence or adverse outcomes. (38) Functional and cognitive decline are common in this group, and ACE inhibitor therapy may be protective of at least functional decline. A number of clinical and sociodemographic factors including age, gender, living arrangement, comprehensive health status indicators and medication use were found to be associated with outcomes examined.

Implications of this work are potentially important, especially for older individuals with HF. The results indicate that certain geriatric conditions like functional impairment are associated with adverse outcomes, while number of comorbid conditions is not. ACE inhibitor therapy may be of some utility in avoiding LTC placement and functional decline. Targeted interventions aimed at maintaining function and minimizing the effect of disability could have a large effect on reducing adverse outcomes. Also, while ACE inhibitor therapy seems to confer some benefit, this work points to the need for further study into use of ACE inhibitor, ARB and β-blocker therapy to determine if results from trials are relevant to older, frail individuals. Further, medications are only one component of comprehensive CDM programs for HF. This work can be used to inform the development of CDM programs that account for the functional and cognitive impairments common among older individuals, but further initiatives to promote other components of these programs, such as nutritional counseling and smoking cessation are

necessary. Home care clients could lend themselves well to inclusion into future studies as they are routinely assessed, accessible and in contact with primary care. Future RCTs that examine treatment benefits of ACE inhibitor therapy, both alone and in combination with β-blocker therapy, would be invaluable in adding to the evidence base. Lastly, this work also demonstrates the utility of interRAI data in exploring outcomes over time in the context of other comorbidity and medication use.

7.0 GENERAL DISCUSSION AND SUMMARY

Heart failure was found to be a significant problem among the older community-dwelling home care client sample, with a prevalence of approximately 15%. Individuals receiving home care services represent a clinically complex group with many care needs and high service use. Only 30% of individuals received recommended first-line combination therapy. This may represent underuse of HF medications, but this underuse may be due to dissimilarities between trial populations and the older, frail individuals studied here. However, the benefits of first-line therapies are not well established in older populations and individuals with poorly managed HF may be at risk for adverse events. Whether medications are beneficial in preventing adverse outcomes is not clear from this work. Overall, this research has implications for future research, clinical practice and policy.

7.1 Descriptive Characteristics of Older Home Care Clients with Heart Failure

Using RAI-HC data, the prevalence of HF in Ontario's older long-stay home care population was found to be similar to that observed in population-based studies, and lower than the prevalence observed in long-term care populations. (1,2) Compared to home care clients without HF, individuals with HF were a more clinically complex population, with more hospitalizations, ED visits and use of emergent care. This is consistent with work done in Canada on the burden and outcomes of HF. (3) Importantly, comparisons between these individuals and those represented in clinical trials show great disparity. This disparity has been addressed in the literature (4), but the current work demonstrates that home care clients with HF are older, have many comorbid conditions, use many medications and have high rates of functional and cognitive impairment. Additionally, the high rates of health instability among individuals with HF puts them at risk for adverse outcomes. Together, such factors could greatly impair self-care

abilities, and CDM programs must consider these care needs when developing new interventions to improve management in this population. As the majority of individuals studied have caregiver support, caregivers could be an important resource in such initiatives, but precautions to minimize potential caregiver distress should be taken. This is the first such comprehensive description of community-dwelling individuals with HF who receive home care services.

7.2 Medication Use among Older Home Care Clients with Heart Failure

Only 28% of older home care clients with HF were receiving combination pharmacotherapy. A further 28% were receiving none of the recommended first-line pharmacotherapies for HF. Treatment of HF following new diagnosis has been shown to be suboptimal in vulnerable, community-dwelling older adults, with ACE inhibitor and β–blocker use being 65% and 48%, respectively. (5) However, whether the results of the current study indicate undertreatment is uncertain. The differences observed between trial participants and the study population may limit the applicability of the evidence of these medications and this underuse may be appropriate. Ageism may also play a role in the low rates of medication use observed, as has been shown with other work. (6) The current study also revealed that functional impairment, age, and comorbid conditions including hypertension, diabetes, coronary artery disease and airway diseases were all associated with non-use of pharmacotherapy. The association of comorbidities with use of HF pharmacotherapy has been shown previously. (7-9) These findings seem to indicate that with the co-occurrence of conditions like hypertension and diabetes mellitus, older individuals are more likely to receive appropriate care. The association of functional impairment with non-use of HF therapy is novel and the high rates of functional impairment in this cohort may be an important reason for the low use of HF pharmacotherapy

observed. Other factors including gender, depressive symptoms, and health instability were not associated with non-use in the present study, contrary to some previous work. (7,10-12)

7.3 Outcomes among Older Home Care Clients with Heart Failure

Making use of the longitudinal nature of data collected using the RAI-HC, individuals with more assessments were found to be healthier on a number of summary scales, despite high rates of comorbidity and medication use. Health instability was associated with an increased risk of mortality within nine months and age, comorbidity and medication use were not associated with this outcome, contrary to some studies in older populations. (13) These results underline the fact that frailty, or biological age, may be more important in predicting mortality than chronological age. Studies examining mortality outcomes in older adults should try to account for contributors to biological age.

Age, MAPLe scores and IADL impairment all increased the risk of LTC admission in this cohort. Work from the Canadian Study on Health and Aging found that female gender, being unmarried, cognitive and functional impairment and some comorbidities were associated with institutionalized populations. (14) The MAPLe score accounts for functional and cognitive abilities, creating some parallels with this work. However, the current study modeled predictors of LTC placement among older home care clients, which could explain some of the remaining discrepancies. The finding that number of comorbidities was associated with lower risk of placement seems counterintuitive, but could indicate that individuals from home care are too complex and are preferentially referred to complex continuing care, not LTC facilities. This outcome could not be explored with the data available. ACE inhibitor therapy reduced the risk of LTC placement and this potential benefit of these medications is novel.

Health instability was also associated with shorter time to long-stay hospitalization, as was increasing number of medications. These are important findings because more than two-thirds of the HF group reported use of more than nine medications in the week prior to assessment. With use of an increasing number of medications, the potential for adverse drug reactions and subsequent hospitalizations also rises. (15,16) It is very likely that some of the observed long-stay hospitalizations were due to adverse drug reactions and were potentially avoidable. It is worth noting that many individuals with HF were not receiving pharmacotherapy, the initiation of therapy could further increase the risk of adverse drug reactions and hospitalizations.

Time to new functional decline was increased for females, those who lived alone and those using ACE inhibitor therapies. Thus, the protective effect for ACE inhibitors and LTC admission may occur through benefits on function. The most important predictor of new cognitive decline was a diagnosis of dementia, but impaired medication management, older age and history of falls were also strong predictors. Functional impairment also reduced the time to new cognitive decline.

This work demonstrates that older individuals with HF in the home care setting are a clinically complex group with functional impairment and high levels of comorbidity and medication use. These individuals receive fewer optimal HF therapies than populations studied in hospitals or HF clinic settings. (17) Mortality, LTC admission, long-stay hospitalization, functional decline and cognitive decline were common in this sample. Taken together, this work depicts a population of HF patients who are very different from most study populations. It is important to note that a number of characteristics that were prevalent among older home care clients with HF were subsequently associated with non-use of medications and the outcomes

explored. This work highlights the importance of exploring geriatric conditions when studying outcomes in older populations.

7.4 Considerations about the Study Population and Care Setting

RAI-HC assessments are done for all long-stay home care clients in Ontario and this work arguably provides an accurate picture of characteristics, medication use and outcomes among frail, community-dwelling individuals. The burden of HF in the home care population is similar to rates reported in previous work from population-based cohorts. (1) The home care population is important to study, as the potential to avoid adverse outcomes may be especially high in this community-dwelling group. However, the substantial rates of comorbidity, medication use, service use, and health instability make management challenging. As the home care sector continues to play a vital role in the continuum of care, strategies to improve management of chronic diseases like HF will become increasingly important.

It would appear that individuals with HF in the home care setting could be better managed. CCAC services, in their current form, may not be adequate for CDM in HF or other conditions. As the burden of HF is expected to rise substantially over the next three decades (18), strategies to improve management will be critical. Home care may be a more appropriate setting for HF management for a number of reasons. First, as HF burden is projected to increase substantially, individuals with HF could overwhelm acute care services if not adequately managed. Second, as demonstrated with this work, individuals with HF have high rates of functional impairment and frequently experience both functional and cognitive decline. These problems may make attending HF clinics for management difficult and underuse of clinic-based programs has been demonstrated. (19) Third, individuals in home care are routinely assessed, making identification of decline and inadequate management easier. Fourth, the majority of

clients are managed by primary care (20) and links between primary care and the CCACs are already in place. Last, there are many new technologies that may help facilitate self-care, monitoring and management of HF that could be used in the home setting. Structured telephone support programs and telemonitoring may reduce all-cause mortality, HF hospitalizations and health care costs, as well as improve quality of life and use of evidence-based therapies. (21) Telemonitoring involves patients monitoring their vital signs at least once a day and sending this information to health providers through telephone or internet connections. This form of follow-up engages patients in self-care and could facilitate discharge planning, as well as reduce hospital admissions, days spent in hospital and mortality. (21) However, some recent work suggests no benefit among recently hospitalized patients. (22) Encouragingly, satisfaction with this modality of care and learning to use the technology was evident even for older individuals. (21) Interventions like telemonitoring could provide specialized HF care and monitoring to many individuals who may not be able to access health care services.

This work examined pharmacotherapy, but did not explore other important components of CDM for HF. Exercise therapy, dietary and fluid restrictions, smoking cessation and education about self-care are recommended in addition to pharmacotherapy in comprehensive disease management. The home care setting may provide a unique setting in which to examine interventions designed to improve adherence to these other recommended treatment modalities. CDM programs linked with home care could ensure nursing visits to patients exhibiting difficulty and allow continued follow-up. Interventions examining ways to facilitate HF management by improving barriers to self-care, promoting functional abilities and checking medication adherence could be important initial steps. Integrating CDM programs into the home care setting may help bring the benefits of such programs to a wider population. (23) CDM

programs have been shown to be cost-effective and targeting more patients, not only those at high risk, may be helpful. However, identifying effective ways to incorporate CDM into home care will be challenging, and must take into account the complex needs identified in this population.

7.5 Pharmacotherapy Considerations

This work has also highlighted a number of issues related to the pharmacotherapeutic management of HF. Older individuals with HF are less likely to report use of any HF medications (10, 24-27) and the findings from Chapter 5.0 also demonstrate that use of these medications is low in this older, frail population. However, this research was cross-sectional in nature and whether such low use reflects prescribing practices or appropriate care could not be examined. There are many reasons for which non-use of medications may be appropriate, including intolerance to therapy, declining health, contraindications and patient preferences. Other work has demonstrated that high rates of ACE inhibitor and β-blocker use are achievable (10,24,28,29), but the evidence for the use of these medications is strongest for younger, healthier patients. Physicians may be reluctant to prescribe due to concerns over adverse events or lack of confidence in guideline recommendations. While this work has begun to build evidence about reasons for non-use among community-dwelling patients, further exploration of prescribing patterns is needed.

From Chapter 6.0, ACE inhibitor use was not associated with mortality or long-stay hospitalizations. However, work from clinical trials has previously established this benefit (see Appendix G: Table 3). Also, β-blocker and ARB therapies were not found to be associated with any of the outcomes measured here, again showing a disconnect with earlier work (see Appendix G: Table 3). Associations observed with ACE inhibitors were not affected by concurrent use of

ARB or β-blocker therapies in the current study. Combination ACE inhibitor and β-blocker therapy is recommended for most individuals with HF by national guidelines (30) and these findings raise questions about the added benefit of β-blocker therapy for those taking ACE inhibitors. Rates of HFPEF were unknown in this sample. If a large proportion of the sample had HFPEF, this could partially explain the lack of observed therapeutic benefit, as first-line therapies are less effective in treating this type of HF. Continuous medication data were not available, making patterns of medication use and adherence difficult to establish. However, this work at least raises the possibility that results from clinical trials are not as applicable in older, frail, clinically complex populations who are followed less frequently. Some observational work and subgroup analyses have also found that survival benefits of ACE inhibitor therapy may not be as great among those older than 65 years. (31) The current study and observational studies lack the controls associated with randomized trials, but inconsistent results about therapeutic effectiveness between such studies and randomized trials are important when considering HF management in older individuals. The novel associations of ACE inhibitor use and reduced risk of LTC admission and functional decline could indicate other benefits in older populations. These outcomes may be particularly relevant to older, frail individuals. However, the current study did not show benefits of ACE inhibitor therapy for cognitive decline, another potentially relevant outcome for geriatric populations. This finding is inconsistent with early work into potential benefits of ACE inhibitor therapy, but such work was done among older adults with hypertension, not HF. (32) Further studies of therapeutic benefits in older adults should explore more diverse outcomes to establish potential benefits specific to this population and guide clinical care.

7.6 Limitations

There are some high-level limitations of this work that are worthy of mention. Perhaps most important are the issues of potential selection bias and uncertainties surrounding diagnostic and medication information on the RAI-HC. By studying home care clients, including sub-sets with prevalent HF and multiple assessments, selection bias as a contributor to the findings cannot be ruled out. Including prevalent cases of HF means that individuals with severe, rapidly progressing disease may be under-represented. Similar problems could arise from the decision to perform longitudinal analyses on individuals with two or more assessments, but this was necessary for some of the outcomes of interest. As such, a healthier subset of community-dwelling home care clients may have been included, making the findings less generalizable to all home care clients with HF.

Another important limitation is that most data were obtained from RAI-HC assessments. While this instrument contains comprehensive clinical information, issues of diagnostic uncertainty may arise. While HF diagnoses could have been under-reported, earlier work has demonstrated relatively high agreement between RAI diagnostic data and administrative databases. (33,34) Creating linkages to other databases such as the CIHI Discharge Abstracts Database or National Ambulatory Care Reporting System Database, or use of International Classification of Diseases codes on RAI assessments would help overcome this limitation. This was not possible in the current study. However, most individuals had consistently recorded HF (or non-HF), giving some indication of diagnostic reliability.

This study did not explore general risk factors for HF and other cardiovascular diseases such as smoking, alcohol use, physical activity and nutrition. It is possible that such risk factors could have played a role in tolerance to medications, adherence to therapies and outcomes.

Further work into prescribing patterns and outcomes in older HF populations should incorporate such risk factors.

For medication data, the RAI-HC as implemented in Ontario does not use standardized drug classification system codes and medications are manually recorded leading to many variants in medication names. This creates the possibility that some medications were missed, leading to underestimates of prevalence. Also, as data are collected at 6-month intervals, continuous drug data were not available. Thus, medication use at the time of assessment may not accurately reflect patterns of use between assessments.

This is the first study to examine medication use over time using interRAI data and while there is much potential for future pharmacoepidemiological work, improvements to data collection and recording are necessary. Linking RAI-HC data to provincial health care and pharmacy databases would be useful in facilitating strong future work. With implementation of the new suite of interRAI instruments, medication data will be recorded using standardized medication codes. This would facilitate wider access to the medication data, while maintaining core assessment items to allow continuation of the current work. Further, the new instruments will utilize existing scales and allow more sensitive measures to ease the detection of clinically meaningful changes. While data from RAI-HC assessments are comprehensive in some respects, information about certain clinical measures is unavailable. Knowledge about HF specific measures like ejection fraction, β-type natriuretic peptide levels and NYHA functional class were not available. This makes comparisons to other work difficult. The inability to determine NYHA functional class means that findings from this work cannot be related to disease severity. However, the CHESS scale on interRAI instruments may be a better predictor of mortality and adverse outcomes than NYHA functional class. (35) Thus, while NYHA classifications were

unavailable, some disease severity was captured. Given the high rates of health instability shown in CHESS scores, it is likely that individuals with moderate to severe HF (NYHA class II-IV) made up a large proportion of the sample. This work was not a randomized study and the role of chance and other potential confounders in the results cannot be ruled out completely. Lastly, some of the work was cross-sectional in nature, limiting the potential to determine causality or explore dynamic factors associated with medication use.

7.7 Strengths

The limitations of this work should not overshadow its unique and important strengths. Using the data available from RAI-HC assessments and OACCAC administrative records, this work has improved on many common exclusion criteria and controlled for many important potential confounders. The commonly used outcomes of mortality and hospitalizations were examined, as were LTC admission, functional decline and cognitive decline. Arguably these three latter outcomes may be of particular relevance to geriatric populations. There is a dearth of evidence about such outcomes for older individuals, particularly in community-dwelling populations. By exploring many covariates, including some especially pertinent to older populations, this work has begun to fill a large gap in current knowledge. This work has also demonstrated that pharmacotherapy use among this cohort is low. Whether this undertreatment is related to greater risk of adverse outcomes needs more attention.

The size of the data set allowed for all outcomes to be examined independently. This is an improvement over many clinical trial findings in which the use of combined endpoints is necessary to overcome inadequate power. By including age and gender in all longitudinal models, potential confounders have been controlled for, allowing comparisons with other studies. The ability to make use of the longitudinal nature of RAI data is another key strength of this

study and has shown the importance of many client characteristics in medication use and outcomes.

7.8 Significance and Potential Implications

This work adds to current knowledge in many ways. It has examined an older, frail population representative of many home care clients across Ontario and possibly of other populations as well. This population is clinically complex and potential barriers to self-care abilities are present. The examination of medication use and outcomes in this population is unique. interRAI and OACCAC data allowed a comprehensive exploration of factors related to medication use and outcomes, including geriatric conditions. The importance of considering geriatric outcomes in underuse of cardiovascular medications is being recognized (36), and the current study extensively examined factors potentially related to underuse. The longitudinal RAI-HC data have the potential to allow examination of outcomes, inform policy and improve clinical practice. The potential benefits of ACE inhibitor therapy in delaying LTC placement and functional decline are novel findings. These benefits could reduce health care costs associated with LTC admission and hospitalizations, but importantly, could improve quality of life and promote maintenance of independence for older adults. Further, such benefits may also be relevant to older individuals with HFPEF.

For clinicians, this work highlights the complexity of individuals receiving home care services as well as the uncertainties clinicians may have in managing older, complex individuals. Importantly, these findings raise questions about the potential benefits of such therapies in older individuals. There is little evidence about therapeutic effectiveness in older, complex patients, making treatment decisions and application of current guideline recommendations difficult. Improved evidence upon which to base such recommendations could help improve adherence to

guideline recommendations. Nonetheless, adherence to guideline recommendations may help prevent LTC placement and function decline among older, frail individuals. Guideline panels could encourage greater exploration into benefits of therapy in older adults to provide better evidence to guide clinicians. Lastly, the utility of RAI-HC data in identifying under-treatment and characteristics potentially associated with adverse outcomes has been demonstrated. Engaging clinicians in ways to disseminate and use this information should be explored.

From a policy perspective, the burden of chronic disease among older home care clients potentially means that initiatives to promote better management in this specific population are warranted. Aligning with recent initiatives to promote independence and reduce acute health care service costs, such initiatives could have great potential benefit. The potential role of pharmacists and technologies in such strategies is also worthy of mention. Given the high rates of medication use among older home care clients, pharmacists are in a unique position to oversee all medications, identifying potentially inappropriate management and risk of adverse drug events. The relationship between number of medications and increased risk of hospitalizations could occur through adverse drug reactions, and pharmacists may be able to minimize the potential risks through medication reviews. Policies to promote access to pharmacist care should be explored. Telemonitoring and home base interventions using such technologies have the potential to improve care in the home setting and assist caregivers and service providers and specific funding priorities here may help improve management. All of these initiatives would align well with the provincial Aging at Home strategy, which strives to alleviate burden on inpatient and residential facilities. As this strategy comes to a close, building capacity across the research, home care and primary care sectors to promote more effective management of HF would be invaluable.

7.9 Recommendations for Future Research

This work has explored a vulnerable community-dwelling population and comprehensively described their needs, patterns of medication use and outcomes over time. A number of unanswered questions remain and there is much potential for future research to build on these findings.

Many important research questions have arisen from the current study. Whether the management of HF or other chronic conditions through home care varies by CCAC is unknown. Variations in HF prevalence by CCAC were observed, but were not found to correspond to age distributions. Exploration of CDM strategies by CCAC and identifying practices associated with improved outcomes could guide a standardized approach to chronic disease care throughout the province. Many factors potentially associated with non-use of HF medications were identified. However, this work was cross-sectional in nature and causal associations could not be established. Further exploration into the effect of such factors on prescribing patterns, as well as factors associated with non-use of combination therapy would be logical future research steps.

Two important research initiatives are obvious continuations of the current work. The examination of long-term therapeutic effectiveness and risks among older, complex populations is necessary. This would help provide an evidence base upon which to create care guidelines and improve management in the majority of individuals with HF. In the United States, the Sentinel program will use large insurance databases to measure outcomes of routine medication use in millions of patients (37), providing invaluable information about potential benefits of therapy in the context of other medications and comorbid conditions. Initiation of such a program in Canada, while daunting, could be facilitated through linking RAI data with administrative records to provide better evidence for management of HF and other chronic diseases in older

Canadians. However, such studies will not provide the rigour and quality of evidence associated with RCTs. The second proposed research strategy would be an RCT of ACE inhibitor therapy with or without β-blocker therapy in older, complex individuals with HF. Such an RCT should include the outcomes of functional and cognitive decline in addition to mortality and hospitalizations. This would contribute high quality evidence about the potential benefits of ACE inhibitor therapy and fill in the gap identified about whether combination therapy adds benefit. Identification of trial participants from the home care setting would make the outcome of LTC admission applicable of study, and allow the use of the comprehensive data about geriatric conditions from the RAI-HC to be utilized. An extension of such an RCT could also examine the effectiveness of interventions that address other CDM components such as dietary and exercise recommendations. Such research initiatives would generate valuable evidence applicable to a population of HF patients currently under-represented in trials.

In the interim, investigation of interventions to improve HF management within the home care population could be explored. Finding effective ways to improve self-care skills, promote functional abilities and ensure appropriate medication management could help improve HF care. Effective communication with primary care providers could also play an important role in improving care. The ability to identify individuals who are inappropriately managed and potentially at risk of adverse events is possible through interRAI assessments. Feasibility studies examining the potential for interRAI data to identify individuals for follow-up in primary care is a potential research initiative. Linking such individuals with effective, tailored interventions could greatly improve outcomes.

In summary, HF management has benefitted from much past research. However, there are a number of key questions that need to be addressed to improve care in older, frail

populations, such as individuals receiving home care services. The current work has described client needs, patterns of medication use and outcomes over time. Building upon these findings to identify strategies to make full use of assessment data and improve outcomes would likely be invaluable, not only to individuals with HF, but those with other chronic conditions as well as the health care system.

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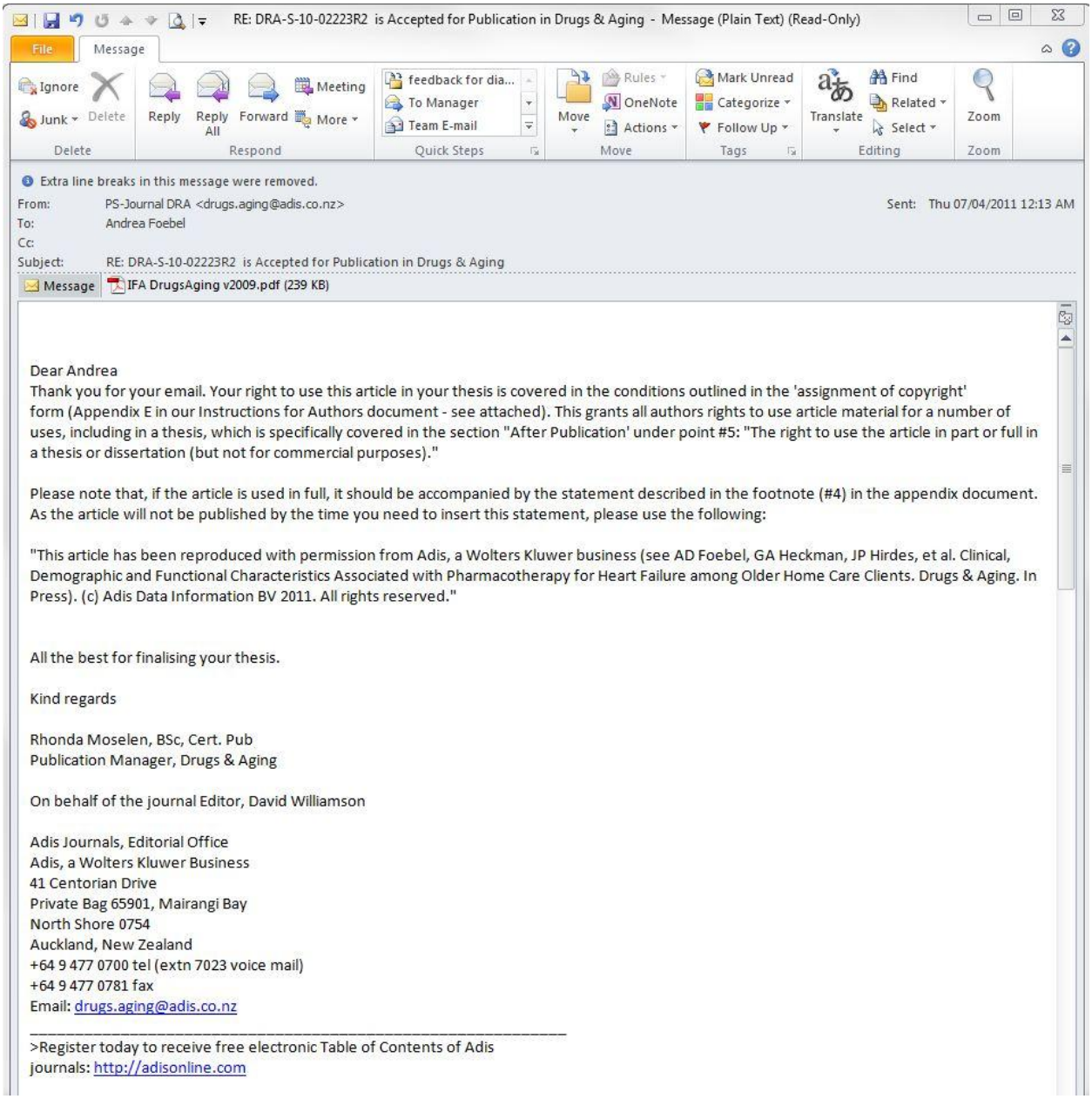

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Chapter 7.0

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APPENDICES

APPENDIX A: Disease Presentation

Figure 1: Signs and Symptoms of Heart Failure

Symptoms	Signs
Dyspnoea (on exertion, nocturnal)	Oedema, ascites
Reduced exercise tolerance	Elevated jugular venous pressure
Fatigue, lethargy	Crepitations or wheeze
Orthopnoea	Tachycardia
Nocturnal cough	Third heart sound, murmurs
Wheeze	Hepatomegaly
Anorexia	Displaced apex beat
Confusion/delirium (elderly)	Cachexia and muscle wasting

Source:
Mosterd A, Hoes AW. Clinical epidemiology of heart failure. Heart. 2007;93:p.1139.

Figure 2: Clinical Presentation of Heart Failure

Common	Uncommon
Dyspnea	Cognitive impairment*
Orthopnea	Altered mentation or delirium*
Paroxysmal nocturnal dyspnea	Nausea
Fatigue	Abdominal discomfort
Weakness	Oliguria
Exercise intolerance	Anorexia
Dependent edema	Cyanosis
Cough	
Weight gain	
Abdominal distension	
Nocturia	
Cool extremities	

**May be a more common presentation in elderly patients*

Source:
Arnold JM, Liu P, Demers C, Dorian P, Giannetti N, Haddad H, et al. Canadian Cardiovascular Society consensus conference recommendations on heart failure 2006: diagnosis and management. Can J Cardiol. 2006;22(1):p. 25.

APPENDIX B: Classification of Disease Severity

Figure 1: New York Heart Association Functional Classification of Heart Failure

Class	Definition
I	No symptoms
II	Symptoms with ordinary activity
III	Symptoms with less than ordinary activity
IV	Symptoms at rest or with any minimal activity

Source:
Arnold JM, Liu P, Demers C, Dorian P, Giannetti N, Haddad H, et al. Canadian Cardiovascular Society consensus conference recommendations on heart failure 2006: diagnosis and management. Can J Cardiol. 2006;22(1):p. 25.

Figure 2: American College of Cardiology/American Heart Association Stages of Heart Failure

Stage	Description	Example
A	High risk, no symptoms	Hypertension, coronary artery disease, diabetes mellitus
B	Structural heart disease, no symptoms	Left ventricular hypertrophy, asymptomatic left ventricular systolic dysfunction
C	Structural heart disease, previous or current symptoms	Dyspnoea or fatigue due to heart failure
D	Structural heart disease, refractory symptoms	Patients with end stage heart failure

Abbreviations: ACC = American College of Cardiology, **AHA** = American Heart Association

Source:
Mosterd A, Hoes AW. Clinical epidemiology of heart failure. Heart. 2007;93:p.1139.

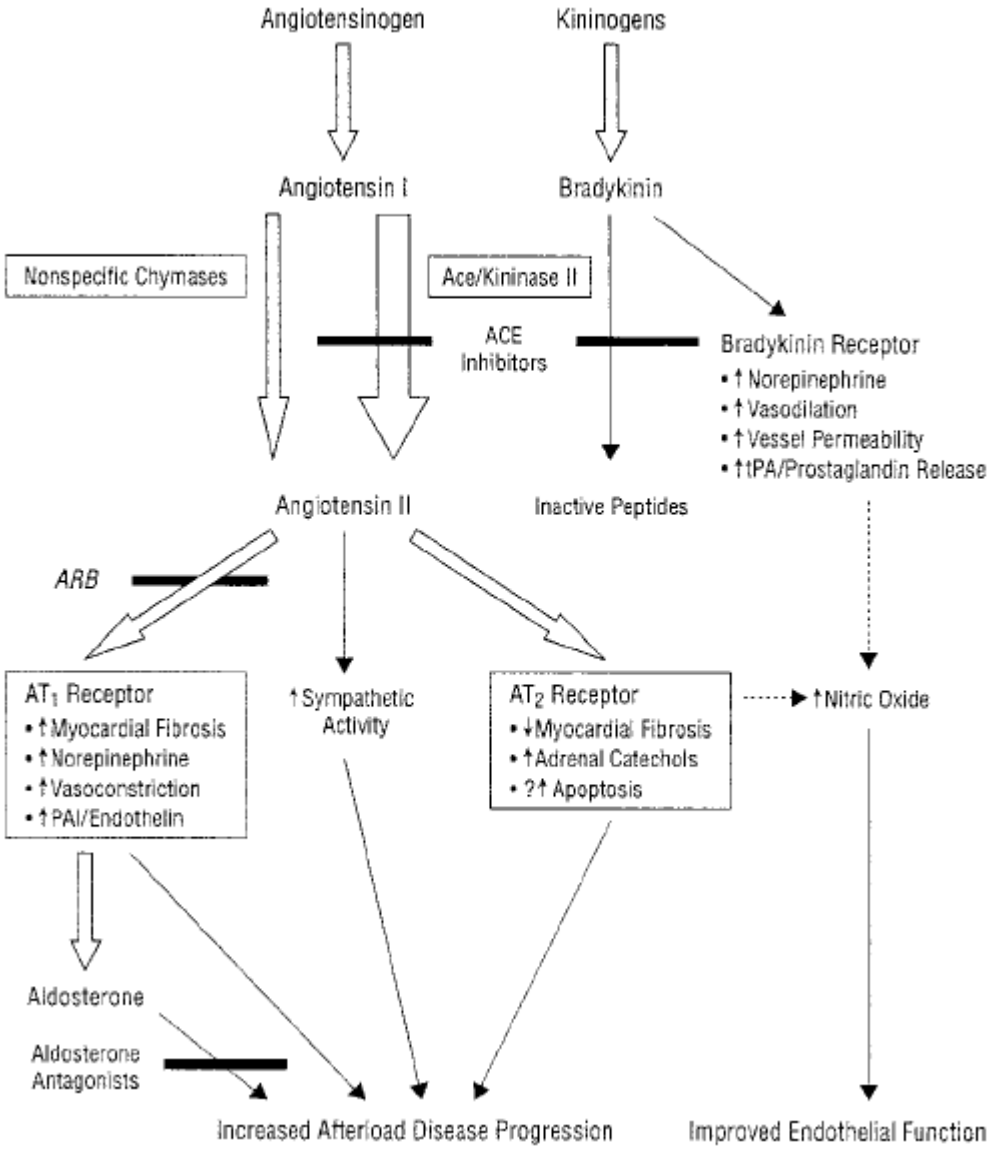
APPENDIX C: Heart Failure Pathophysiology

Figure 1: Effects of Aging on the Cardiovascular System

Increased vascular "stiffness," impedance to ejection, and pulse wave velocity
Impaired left ventricular early diastolic relaxation and mid-to-late diastolic compliance
Diminished responsiveness to neurohumoral stimuli, esp. β1 and β2 adrenergic stimulation
Altered myocardial energy metabolism and reduced mitochondrial ATP-production capacity
Reduced number of sinus node pacemaker cells and impaired sinoatrial function

Source:
Rich MW. Heart failure in the 21st century: a cardiogeriatric syndrome. J Gerontol. 2001;56A(2):p. M89.

Figure 2: The Renin-Angiotensin-Aldosterone System: Targets of ACE inhibitor, ARB and AA Therapies



Abbreviations: AA = Aldosterone Antagonist, **ACE** = Angiotensin Converting Enzyme, **ARB** = Angiotensin Receptor Blocker, **AT** = Angiotensin, **RAA** = Renin-Angiotensin-Aldosterone

Source:
Eisenberg MJ, Gioia LC. Angiotensin II receptor blockers in congestive heart failure. Cardiol in Rev. 2006;14(1):p. 27.

Figure 3: Angiotensin II Production and Neurohormonal Activation in Heart Failure

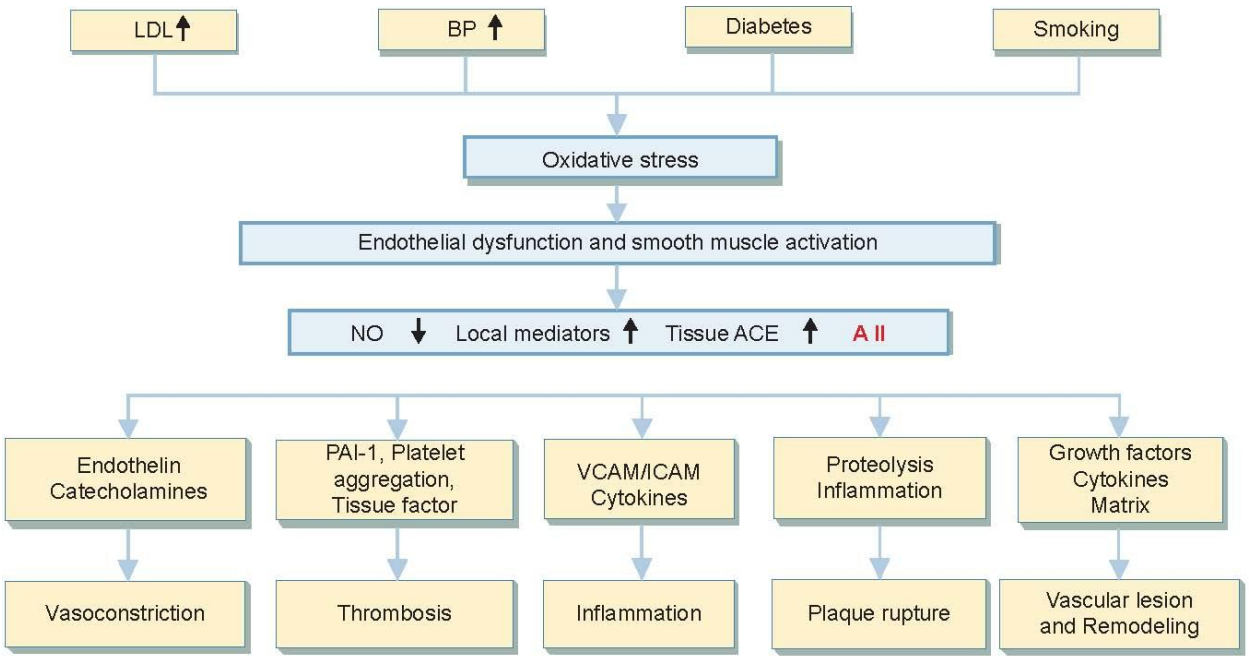


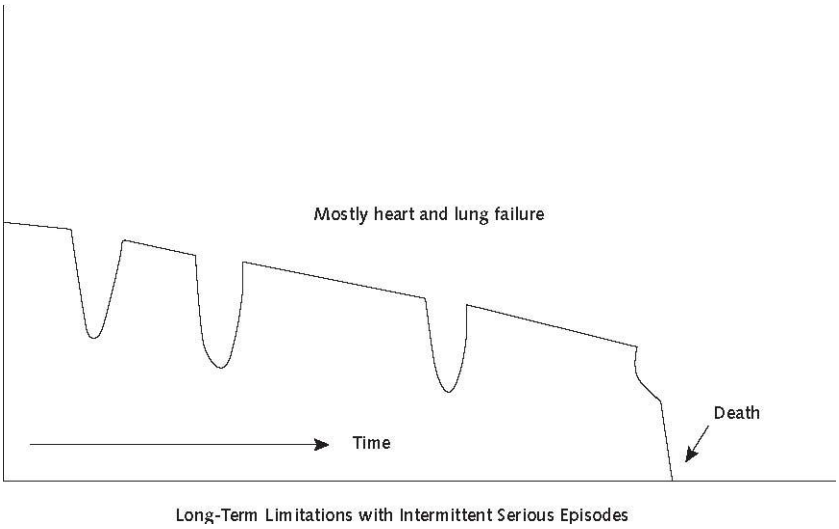
Figure 1 The role of the renin angiotensin aldosterone system in vascular disease. Angiotensin II (AII) is an important mediator of vascular damage that promotes the development of atherothrombosis and the complications of atherosclerosis.

Abbreviations: ACE = Angiotensin Converting Enzyme, **BP** = Blood Pressure, **CAM** = Vascular Cell Adhesion Molecule, **LDL** = Low-Density Lipoprotein, **NO** = Nitric Oxide, **VCAM** = Vascular Cell Adhesion Molecule

Source:
Fitchett D. Results of ONTARGET and TRANSCEND studies: an update and discussion. Vasc Health Risk Manage. 2009;5:p. 22.

APPENDIX D: Heart Failure in Later Life

Figure 1: Trajectory of Late-Life Illness with Heart Failure



Source:
Lorenz KA, Lynn J, Dy SM, Shugarman LR, Wilkinson A, Mularski RA, et al. Evidence for improving palliative care at the end of life: a systematic review. Ann Intern Med. 2008;148(2):p. W-28.

APPENDIX E: Management of Heart Failure

Figure 1: Pharmacotherapies Useful in the Treatment of Heart Failure

Drug	Stage A	Stage B	Stage C
ACE inhibitors			
Benazepril	H	...	...
Captopril	H, DN	Post MI	HF
Enalapril	H, DN	Asymptomatic LVSD	HF
Fosinopril	H	...	HF
Lisinopril	H, DN	Post MI	HF
Moexipril	H	...	...
Perindopril	H, CV Risk	...	...
Quinapril	H	...	HF
Ramipril	H, CV Risk	Post MI	Post MI
Trandolapril	H	Post MI	Post MI
Angiotensin receptor blockers			
Candesartan	H	...	HF
Eprosartan	H	...	...
Irbesartan	H, DN	...	...
Losartan	H, DN	CV Risk	...
Olmesartan	H	...	...
Telmisartan	H	...	...
Valsartan	H, DN	Post MI	Post MI, HF
Adosterone blockers			
Eplerenone	H	Post MI	Post MI
Spironolactone	H	...	HF
Beta-blockers			
Acebutolol	H	...	...
Atenolol	H	Post MI	...
Betaxolol	H	...	...
Bisoprolol	H	...	HF
Carteolol	H	...	...
Carvedilol	H	Post MI	HF, Post MI
Labetalol	H	...	...
Metoprolol succinate	H	...	HF
Metoprolol tartrate	H	Post MI	...
Nadolol	H	...	...
Penbutolol	H	...	...
Pindolol	H	...	...
Propranolol	H	Post MI	...
Timolol	H	Post MI	...
Digoxin	...	...	HF

*See Figure for explanation of stages of heart failure.
Asymptomatic LVSD indicates Asymptomatic left ventricular systolic dysfunction; CV Risk, reduction in future cardiovascular events; DN, diabetic nephropathy; H, hypertension; HF, heart failure and asymptomatic left ventricular dysfunction; Post MI, reduction in heart failure or other cardiac events following myocardial infarction.

Source:

Hunt SA; American College of Cardiology, American Heart Association Task Force on Practice Guidelines. ACC/AHA 2005 guideline update for the diagnosis and management of chronic heart failure in the adult: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Circulation. 2005;112:p.e169.

Figure 2: Components of Chronic Disease Management Education Programs for Heart Failure

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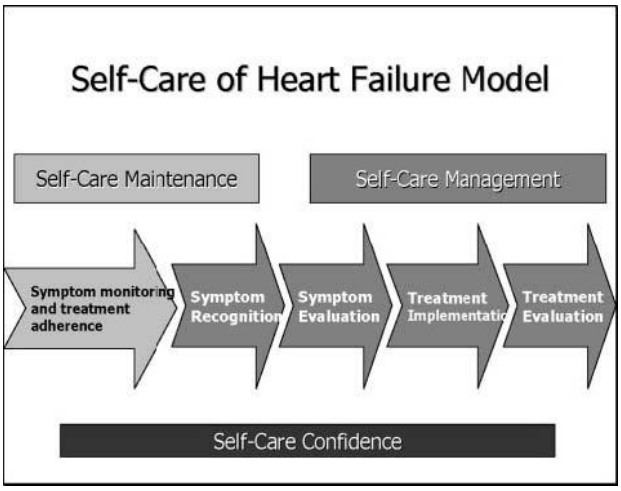
Definition: What is heart failure?
Etiology: What causes heart failure?
Symptoms and signs
Diagnostic assessment: How is heart failure diagnosed? What tests are used?
Treatment
- Diet
- Medications
- Physical activity
- Smoking cessation
- Alcohol use
- Daily weights
- Adherence to treatment

Followup
- Telephone
- Office or clinic appointments
- Symptomatic deterioration: When should I call the doctor or nurse?
- Contact information: Who should I call with questions or problems?

Abbreviations: CDM = Chronic Disease Management

Source:
Rich MW. Management of heart failure in the older. Heart Fail Rev. 2002;7:p.91.

Figure 3: Model of Self-Care for Heart Failure



Source:
Riegel B, Moser DK, Anker SD, Appel LJ, Dunbar SB, Grady KL, et al. State of the science: promoting self-care in persons with heart failure: a scientific statement from the American Heart Association. Circulation. 2009;120(12):p. 1143.

APPENDIX F: Treatment Guidelines for Heart Failure Pharmacotherapy

Table 1: Summary of Canadian, American and European Guidelines for Treatment of Heart Failure

	Canadian Guidelines 2006[1]	American Guidelines 2005[2]	European Guidelines 2008[3]
ACE inhibitor use	**Class I:** 1) all patients as soon as safe following MI; continued indefinitely if LVEF < 40% or acute HF is complicated by MI 2) all asymptomatic patients with LVEF below 35% 3) all patients with HF symptoms and LVEF < 40% *** 2009 guideline update[4]** **Class I:** 1) patients older than 80 years with BP above 160/90 mmHg to reduce risk of HF depending on comorbidity and patient preference 2) in patients with vascular disease or diabetes with end organ damage to reduce risk of HF development	**Class I:** 1) all patients with post-MI regardless of EF or with HF in combination with β-blocker therapy 2) all asymptomatic patients with LVEF < 40%, even without MI 3) all patients with current or prior symptoms of HF and reduced LVEF unless contraindicated **Class IIa:** 1) patients at high risk for HF development (history of atherosclerotic vascular disease, diabetes, hypertension + associated risk factors) 2) asymptomatic patients with hypertension and LV hypertrophy **Class IIb:** 1) symptom control in patients with HFPEF and controlled hypertension	**Class I:** 1) all patients with symptomatic HF and LVEF < 40% <u>Who Should get ACE inhibitors</u>: • patients with LVEF < 40% irrespective of symptoms, based on RCTs
β-Blocker use	**Class I:** 1) all HF patients with LVEF ≤ 40% (evidence-based β-blockers) 2) NYHA class IV symptomatic patients with NYHA class IV, stabilized HF 3) initiated therapy at low dose and titrate to target dose from trials, or maximum tolerated dose	**Class I:** 1) with ACE inhibitors in patients with recent MI despite EF or presence of HF 2) asymptomatic patients with LVEF < 40% 3) bisoprolol, carvedilol and metoprolol recommended for all stable patients with current or prior HF symptoms and LVEF < 40% with no contraindications	**Class I:** 1) all patients with symptomatic HF and LVEF < 40%, unless contraindicated or not tolerated <u>Who Should get β-Blocker:</u> • LVEF < 0.40

	Canadian Guidelines 2006[1]	American Guidelines 2005[2]	European Guidelines 2008[3]
β-Blocker use	**Class I:** 4) not for use in patients with symptomatic hypotension despite adjustment of other therapies, severe airway disease, symptomatic bradycardia or significant AV block without permanent pacemaker (stable COPD is not a contraindication)	**Class IIb:** 1) symptom control in patients with HF and normal LVEF with controlled hypertension	<u>Who Should get β-Blocker:</u> • NYHA class II-IV patients with asymptomatic systolic dysfunction post- MI (in combination with optimal dose of ACE inhibitor and ARB) • clinically stable patients
ARB use	**Class I:** 1) patients intolerant to ACE inhibitor 2) added to ACE inhibitor therapy for patients with persistent HF symptoms at increased risk of HF hospitalization despite optimal treatment with other drugs 3) considered instead of ACE inhibitor therapy for patients with acute MI with acute HF or LVEF < 40% **Class IIa:** 1) adjunctive therapy to ACE inhibitors when β-blockers are contraindicated or not tolerated *** 2009 guideline update[4]** **Class I:** 1) in patients with vascular disease or diabetes with end organ damage to reduce risk of HF development	**Class I:** 1) all patients post-MI without HF with intolerance to ACE inhibitors and LVEF < 40% 2) evidence-based therapy (valsartan and candesartan) recommended in patients with current or prior HF symptoms, LVEF < 40% and ACE inhibitor intolerance **Class IIa:** 1) preventatively in high risk patients (atherosclerotic vascular disease, diabetes, hypertension + associated risk factors) 2) asymptomatic patients with hypertension and LV hypertrophy 3) as alternatives to ACE inhibitors as first-line therapy in mild to moderate HF with LVEF < 40% **Class IIb:** 1) symptomatic patients with LVEF < 40% receiving conventional therapy	**Class I:** 1) alternative to ACE inhibitor therapy in patients who are intolerant <u>Who Should get ARB:</u> • LVEF< 40% as alternate to ACE inhibitor in those with intolerance • LVEF< 40% in patients with persisting symptoms on ACE inhibitor therapy

	Canadian Guidelines 2006[1]	American Guidelines 2005[2]	European Guidelines 2008[3]
ARB use		**Class IIb:** 2) to minimize symptoms in patients with HF, normal LVEF and controlled hypertension	
AA use	**Class I:** 1) considered in patients with LVEF < 30% and severe symptomatic chronic HF despite optimization of other recommended treatments **Class IIa:** 1) patients with acute HF and LVEF < 30% following acute MI (if serum creatinine is less than 200μmol/L and potassium is less than 5.2 mmol/L)	**Class I:** 1) in select patients with moderate to severe HF symptoms and reduced LVEF who can be carefully monitored for renal function and potassium levels **Class III:** 2) not recommended with ACE inhibitors and ARB for patients with current or prior symptoms of HF and LVEF < 40%	**Class I:** 1) considered at low dose in patients with LVEF < 35% and symptomatic HF (NYHA III-IV), unless contraindicated or not tolerated <u>Who Should get AA:</u> • LVEF < 35% • NYHA III-IV • those with optimal dose of β-blocker, ARB and/or ACE inhibitor
Digoxin use	**Class I:** 1) patients in sinus rhythm with persistent symptoms despite optimized HF pharmacotherapy **Class IIa:** 1) patients with chronic AF and poor control of ventricular rate despite β-blocker therapy, or when β-blocker cannot be used 2) measure serum potassium and creatinine when increasing digoxin or diuretic dose	**Class IIa:** 1) patients with current or prior symptoms of HF and reduced LVEF to decrease hospitalizations for HF **Class IIb:** 1) symptom control in HF patients with normal LVEF is not established **Class III:** 1) should not be used in asymptomatic patients with low EF and sinus rhythm	**Class IIa:** 1) consider in patients with symptomatic HF and AF <u>Who Should get Digoxin:</u> • patients with AF • patients with sinus rhythm and LVEF < 40%, NYHA II-IV, on optimal dose of ACE inhibitor/ARB and β-blocker

	Canadian Guidelines 2006[1]	American Guidelines 2005[2]	European Guidelines 2008[3]
Hydralazine and Isosorbide dinitrate use	**Class IIa:** 1) considered in addition to standard therapy for African-Americans with LVEF < 40% **Class IIb:** 2) may be considered for other HF patients unable to tolerate other standard recommended therapy	**Class IIa:** 1) patients with LVEF < 40% on ACE inhibitor and β-blocker therapy for HF with persisting symptoms **Class IIb:** 1) patients with current or prior symptoms of HF and reduced LVEF with intolerance to ACE inhibitors or ARBs, hypotension or renal insufficiency	**Class IIa:** 1) symptomatic patients with LVEF < 40% as alternative to both ACE inhibitor and ARB if intolerant Who Should get H-ISDN: • those intolerant to ACE inhibitor/ARB therapy • with ACE inhibitors if ARB or AA intolerant

Abbreviations: AA = Aldosterone Antagonist, **ACE** = Angiotensin Converting Enzyme, **AF** = Atrial Fibrillation, **ARB** = Angiotensin Receptor Blocker, **β-Blocker** = β-Adrenergic Receptor Blocker, **BP** = Blood Pressure, **bpm** = beats per minute, **HF** = Heart Failure, **HFPEF** = Heart Failure with Preserved Ejection Fraction, **LV** = Left Ventricle, **LVEF** = Left Ventricular Ejection Fraction, **MI** = Myocardial Infarction, **NYHA** = New York Heart Association (functional classification), **RCT**= Randomized Controlled Trials
Class I Recommendation: Evidence or general agreement that a given procedure or treatment is beneficial, useful and effective.
Class II Recommendation: Conflicting evidence/ divergence of opinion about usefulness or efficacy of procedure or treatment.
Class IIa Recommendation: Weight of evidence is in favour of usefulness or efficacy.
Class IIb Recommendation: Usefulness or efficacy is less well established by evidence or opinion.
Class III Recommendation: Evidence or general agreement that the procedure or treatment is not useful or effective and may be harmful.

Sources:

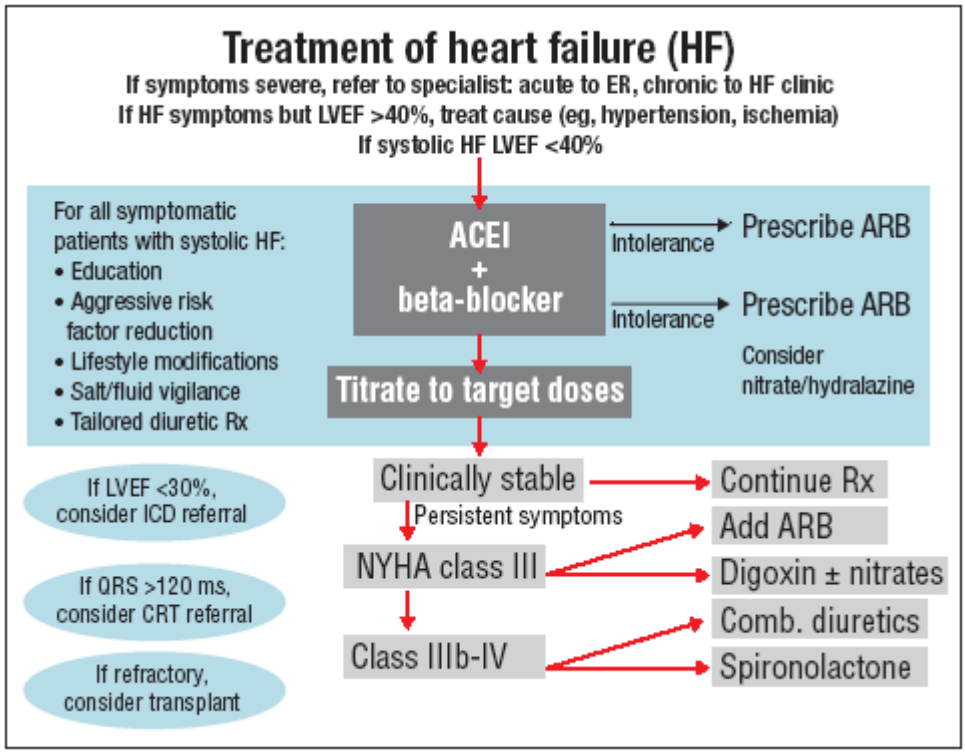
[1] Arnold JMO, Liu P, Demers C, Dorian P, Giannetti N, Haddad H, et al. Canadian Cardiovascular Society consensus conference recommendations on heart failure 2006: Diagnosis and management. Can J Cardiol. 2006;22(1):23-45.

[2] Hunt SA; American College of Cardiology, American Heart Association Task Force on Practice Guidelines. ACC/AHA 2005 guideline update for the diagnosis and management of chronic heart failure in the adult: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Circulation. 2005;112:e154-e235.

[3] Dickstein K, Cohen-Solal A, Filippatos G, McMurray JJV, Ponikowski P, Poole-Wilson PA, et al. European Society of Cardiology guidelines for the dignosis and treatment of acute and chronic heart failure 2008. Eur J Heart Fail 2008; 10: 933-89.

[4] Howlett JG, McKelvie RS, Arnold JMO, Costigan J, Dorian P, Ducharme A, et al. Canadian Cardiovascular Society consensus conference guidelines on heart failure, update 2009: Diagnosis and management of right-sided heart failure, myocarditis, device therapy and recent important clinical trials. Can J Cardiol. 2009;25(2):85-105.

Figure 1: Canadian Cardiovascular Society Treatment Guidelines for Heart Failure with Reduced Ejection Fraction

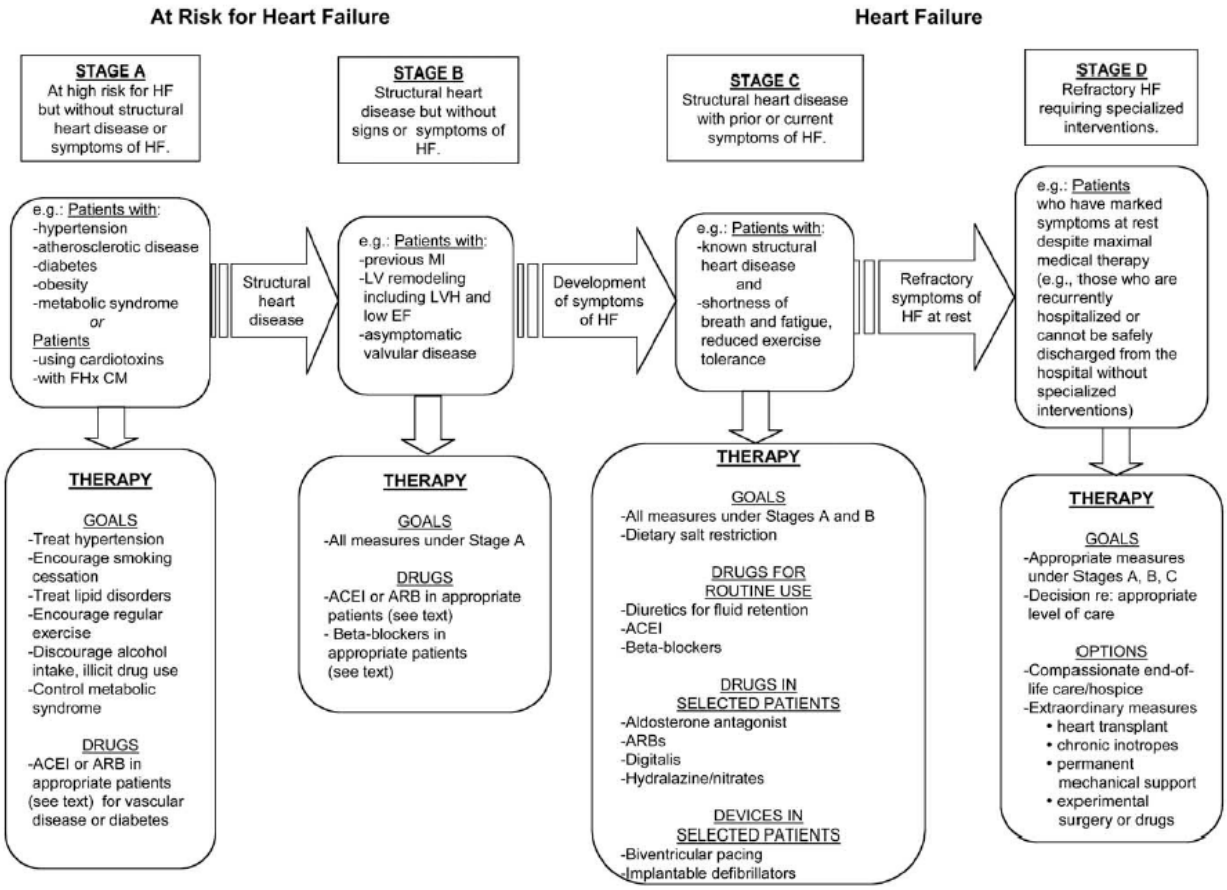


Abbreviations: ACEI = Angiotensin Converting Enzyme Inhibitor, **ARB** = Angiotensin Receptor Blocker, **CCS** =Canadian Cardiovascular Society, **CRT** = Cardiac Resynchronization Therapy, **EF** = Ejection Fraction, **ER** = Emergency Room, **HF** = Heart Failure, **LVEF** = Left Ventricular Ejection Fraction, **NYHA** = New York Heart Association (functional classification), **QRS** = Cardiac QRS representing ventricular depolarization

Source:

Arnold JM, Liu P, Demers C, Dorian P, Giannetti N, Haddad H, et al. Canadian Cardiovascular Society consensus conference recommendations on heart failure 2006: diagnosis and management. Can J Cardiol. 2006;22(1):p. 28.

Figure 2: American Heart Association/American College of Cardiology Treatment Guidelines for Heart Failure with Reduced Ejection Fraction



Abbreviations: ACC = American College of Cardiology, **ACEi** = Angiotensin Converting Enzyme Inhibitor, **AHA** = American Heart Association, **ARB** = Angiotensin Receptor Blocker, **EF** = Ejection Fraction, **HF** = Heart Failure

Source:

Hunt SA; American College of Cardiology, American Heart Association Task Force on Practice Guidelines. ACC/AHA 2005 guideline update for the diagnosis and management of chronic heart failure in the adult: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Circulation. 2005;112:p.e161.

APPENDIX G: Treatment of Heart Failure with Reduced Ejection Fraction

Table 1: Summary of ACE inhibitor Randomized Controlled Trials

Study	Description	Sample	Outcome(s)	Results
Captopril Multicenter Research Group Captopril Multicenter Research Group, 1983.	- captopril or placebo in patients on digoxin and diuretic therapy - 13 US centers - 12 week follow-up	- n = 92 - NYHA class II-IV - mean age = 57 years - over 90% male	1) clinical improvement, improvement in NYHA class, exercise tolerance, EF effects	- captopril improved NYHA class, exercise tolerance, and LVEF over placebo
CONSENSUS – Cooperative North Scandinavian Enalapril Survival Study Consensus Trial Study Group, 1987.	- enalapril or placebo in patients on digoxin and diuretics - 35 Scandinavian centers - 188 day follow-up	- n = 253 - NYHA class IV - mean age = 71 years - 70% male	1) prognosis of severe HF (mortality, NYHA class)	- enalapril reduced 1-year mortality by 31%, significantly improved NYHA class and reduced need for other HF medications
Captopril-Digoxin Multicenter Research Group Captopril Digoxin Multicenter Research Group, 1988.	- captopril or digoxin plus diuretic therapy - 19 US centers - 6 month follow-up	- n = 300 - NYHA class I-IV - LVEF < 40% - mean age = 57 years - 83% male	1) exercise tolerance 2) changes in LVEF and NYHA class, frequency of ventricular premature beats, diuretic requirements, ED use and hospitalizations	- captopril improved exercise time, NYHA class and reduced premature beats - digoxin increased LVEF - both therapies reduced need for diuretic therapy and hospitalizations
SOLVD – Studies of Left Ventricular Dysfunction The SOLVD Investigators, 1991.	- enalapril or placebo - 23 centers in US, Canada and Belgium - 41.4 month follow up	- n = 2,569 - NYHA class I-IV - LVEF < 35% - mean age = 61 years - 80% male	1) all-cause mortality 2) HF hospitalizations, MI incidence, specific cause mortality, combined mortality and morbidity	- enalapril reduced mortality by 16% and reduced the combined endpoint of mortality or hospitalizations

Study	Description	Sample	Outcome(s)	Results
SOLVD-Prevention – Studies of Left Ventricular Dysfunction – Prevention Trial The SOLVD Investigators, 1992.	- enalapril or placebo in asymptomatic patients - 23 centres in the US, Canada and Belgium - 37.4 month follow-up	- n = 4,228 - NYHA class I-II - LVEF < 35 % - mean age = 59 years - 89% male	1) mortality 2) HF incidence 3) hospitalizations	- enalapril reduced deaths in those with incident HF, mortality or hospitalizations and delayed HF progression
SAVE – Survival and Ventricular Enlargement Trial Pfeffer et al., 1992.	- captopril or placebo post-MI - 45 centres in the US and Canada - 42 month follow-up	- n = 2,231 - 3-16 days post-MI - LVEF < 40% - mean age = 59 years - 83% male	1) mortality 2) deterioration in cardiac performance 3) clinical deterioration 4) hospitalizations	- captopril reduced all-cause and CV mortality, clinical deterioration, hospitalizations and risk of non-fatal MI by 25%
AIRE - Acute Infarction Ramipril Efficacy The AIRE Study Investigators, 1993.	- ramipril or placebo post-MI - 144 centers in 14 countries - 6 month follow-up	- n = 1,986 - 3-10 days post MI - mean age = 65 years - 74% male	1) all-case, all-cause mortality 2) adverse events	- ramipril reduced all-cause mortality by 27% and reduced death, reinfarction, and strokes
SMILE – Survival of Myocardial Infarction Long-Term Evaluation Study Ambrosioni et al., 1995.	- zofenopril or placebo post-MI - 154 Italian centers - 6 week follow-up	- n = 1,556 - 24 hours post-MI - mean age = 64 years - 73% male	1) mortality or severe congestive HF 2) effect on clinical signs, recurrent MI, angina, cumulative 1-year mortality	- zofenopril reduced risk of death or severe HF by 34 % and 1-year mortality by 29 %

Study	Description	Sample	Outcome(s)	Results
TRACE – Trandolapril Cardiac Evaluation Study Kober et al., 1995.	- trandolapril or placebo post-MI - 27 centers in Denmark - 24-50 month follow-up	- n = 1,749 - 2-6 days post-MI - EF < 35% - mean age = 67 years - 72% male	1) all-cause mortality 2) cardiovascular death, sudden death, recurrent MI, progression to severe HF	- trandolapril reduced all-cause and CV mortality and HF progression - no reduction in recurrent MI

Abbreviations: CV = Cardiovascular, **ED** = Emergency Department, **EF** = Ejection Fraction, **HF** = Heart Failure, **MI** = Myocardial Infarction, **LVEF** = Left Ventricular Ejection Fraction, **NYHA** = New York Heart Association, **US** = United States

Table 2: Summary of ARB Randomized Controlled Trials

Study	Description	Sample	Outcome(s)	Results
Val-HeFT – Valsartan in Heart Failure Trial Cohn et al., 2001.	- valsartan or placebo - 302 centers in 16 countries - 23 month follow-up	- n = 5,010 - NYHA class II-IV - LVEF < 40% - mean age = 62 years - 80% male	1) mortality 2) combined mortality and morbidity	- mortality similar between groups - losartan reduced combined endpoint of mortality and morbidity
OPTIMAAL – Optimal Trial in Myocardial Infarction with the Angiotensin II Antagonist Losartan Dickstein et al., 2002.	- losartan (ARB) or captopril (ACE inhibitor) post-MI -329 centers in Europe - 2.7 year follow-up	- n = 5,477 - 1-10 days post-MI - LVEF < 35% - mean age = 67.4 years - 71% male	1) total mortality 2) sudden CV death or resuscitated cardiac arrest 3) fatal or not-fatal MI	- losartan therapy was better tolerated and associated with a trend towards reduced mortality
VALIANT – Valsartan in Acute Myocardial Infarction Trial Pfeffer et al., 2003.	- valsartan, captopril or both post-MI - 931 centers in 24 countries - 25 month follow-up	- n = 14,808 - 0.5-10 days post-MI - LVEF < 40% - mean age = 65 years - 70% male	1) all-cause mortality 2) specific cause mortality 3) CV death, recurrent MI, or HF hospitalization	- no difference in all-cause mortality between three groups - more adverse drug-related events in combination group
CHARM-Alternative - Candesartan in Heart failure Assessment of Reduction in Mortality and morbidity-Alternative Trial Granger et al., 2003.	- candesartan or placebo in HF patients with ACE inhibitor intolerance - 618 centers in 26 countries - 33.7 month follow-up	- n = 2,028 - NYHA class II-IV - LVEF < 40% - mean age = 67 years - 68% male	1) CV death or unplanned HF hospitalization 2) CV death, CV or HF hospitalization, MI, development of new diabetes	- candesartan reduced CV death or unplanned HF hospitalizations - similar discontinuation rates

Study	Description	Sample	Outcome(s)	Results
CHARM-Added – Candesartan in Heart failure Assessment of Reduction in Mortality and morbidity- Added Trial McMurray et al., 2003.	- candesartan or placebo in patients on ACE inhibitor therapy - 618 centers in 26 countries - 41 month follow-up	- n = 2,548 - NYHA class II-IV - LVEF < 40% - mean age = 64 years - 79% male	1) CV death or unplanned HF hospitalization 2) CV events or HF hospitalization	- candesartan reduced CV deaths or unplanned HF hospitalizations, improved CV events and HF hospitalization

Abbreviations: ACE = Angiotensin Converting Enzyme, **ARB** = Angiotensin Receptor Blocker, **CV** = Cardiovascular, **HF** = Heart Failure, **MI** = Myocardial Infarction, **LVEF** = Left Ventricular Ejection Fraction, **NYHA** = New York Heart Association,

Table 3: Summary of β-Blocker Randomized Controlled Trials

Study	Description	Sample	Outcome(s)	Results
COMET – Carvedilol or Metoprolol European Trial Poole-Wilson et al., 2003.	- carvedilol or metoprolol in chronic HF - 15 European countries - 58 month follow-up	- n = 3,029 - NYHA class II-IV - LVEF < 35% - mean age = 62 years - 80% male	1) all-cause mortality 2) all-cause mortality or hospitalizations	- carvedilol improves mortality beyond metoprolol (seen by 6 months) - no differences in all-cause hospitalizations
MDC – Metoprolol in Dilated Cardiomyopathy Waagstein et al., 1993.	- metoprolol or placebo in patients with symptomatic idiopathic dilated cardiomyopathy - 33 centers in North America and Europe - 12 -18 month follow-up	- n = 383 - LVEF < 40% - mean age = 49 years - 73% male	1) all-cause mortality or clinical deterioration (need for cardiac transplantation) 2) effects on CV function, exercise capacity, quality of life, hospitalizations or ED visits for HF	- metoprolol reduced all-cause mortality by 34%, prevented clinical deterioration, and improved symptoms, LVEF, quality of life and exercise capacity
RESOLVD – Randomized Evaluation of Strategies for Left Ventricular Dysfunction Pilot Study The RESOLVD Investigators, 2000.	- metoprolol-CR with candesartan (ARB), enalapril (ACE inhibitor) or both in patients with ischemic and dilated cardiomyopathy - multiple centers in Europe and Canada - 24 week follow-up	- n = 426 - NYHA class II-IV - LVEF < 40% - mean age = 62 years - 83% male	1) efficacy and safety of metoprolol CR use in addition to standard therapy 2) effects of metoprolol-CR with standard therapy on ventricular volumes and function, NYHA class and quality of life	- metoprolol-CR added to ACE inhibitor and/or ARB therapy improves LVEF, reduces RAA activation, and reduces mortality - no changes in exercise capacity, quality of life scores, NYHA class or systolic or diastolic BP

Study	Description	Sample	Outcome(s)	Results
MERIT-HF – Metoprolol CR/XL Randomized Intervention Trial in Congestive Heart Failure Hjalmarson et al, 2000.	- metoprolol-CR/XL or placebo - 313 centers in 14 countries - 1 year follow-up	- n = 3,991 - NYHA class II-IV - LVEF < 40% - mean age = 64 years - 77% male	1) total mortality 2) total mortality or HF hospitalization 2) substudy examined quality of life	- metoprolol-CR/XL improved survival, NYHA class, HF hospitalizations, patient well-being and reduced total mortality or all-cause hospitalizations by 19%
CIBIS- Cardiac Insufficiency Bisoprolol Study CIBIS Investigators and Committees, 1994.	- bisoprolol or placebo - multiple centers in Europe - 1.9 year follow-up	- n = 961 - NYHA class III - IV - LVEF < 40% - mean age = 60 years - 83% male	1) mortality 2) tolerability of bisoprolol and analysis of all critical events	- bisoprolol reduced HF progression - no significant reduction in mortality or mode of death
CIBIS II – Cardiac Insufficiency Bisoprolol Study II CIBIS-II Investigators and Committees, 1999.	- bisoprolol or placebo - 18 European countries - 1.3 year follow-up	- n = 2,647 - NYHA III - IV - LVEF < 35% - mean age = 61 years - 80% male	1) all-cause mortality 2) all-cause hospitalizations, all CV deaths, permanent treatment withdrawals	- bisoprolol reduced all-cause mortality, CV mortality and hospitalizations
CIBIS III – Cardiac Insufficiency Bisoprolol Study III Dobre et al., 2008	- bisoprolol or enalapril (ACE inhibitor) monotherapy prior to combination - multi-center in Europe - 5.4 month follow-up	- n = 1,010 - NYHA II and III - LVEF < 35% - mean age = 72 years (all were 65+ years) - 68% male	1) all-cause mortality or hospitalization 2) HF hospitalizations	- bisoprolol showed trend to lower mortality - similar rates of CV hospitalizations, but more HF-related hospitalizations
COPERNICUS – Carvedilol Prospective Randomized Cumulative Survival Packer et al., 2001.	- carvedilol or placebo in severe chronic HF - 334 centres in 21 countries - 10.4 month follow-up	- n = 2,289 - LVEF < 25% - mean age = 63 years - 80% male	1) all-cause mortality 2) mortality or HF hospitalization	- carvedilol therapy reduced mortality by 35%, and mortality or hospitalization by 24%

Study	Description	Sample	Outcome(s)	Results
PRECISE – Prospective Randomized Evaluation of Carvedilol on Symptoms and Exercise Packer et al., 1996.	- carvedilol or placebo - 31 centers in the US - 12 month follow-up	- n = 278 - NYHA class II-IV - LVEF < 35% - mean age = 62 years - 80% male	1) exercise tolerance 2) changes in NYHA class, LVEF, quality of life 3) CV hospitalizations	- carvediol improved NYHA class, LVEF and morbidity and mortality risk, but not exercise tolerance or qualtity of life
US Carvedilol Heart Failure Study Group Colucci et al., 1996. Packer et al., 1996. Cohn et al., 1997.	- carvedilol or placebo - 54 centers in the US - 12 month follow-up	- n = 366 - NYHA II-IV - LVEF < 35% - mean 60 = years - 70% male	1) HF death or hospitalization, need to increase HF meds 2) LVEF, NYHA class, quality of life, exercise tolerance and heart size	- carvedilol reduced clinical progression by 21% , reduced all-cause mortality, and improved NYHA class and HF symptoms
MOCHA – Multicenter Oral Carvedilol Heart Failure Assessment Bristow et al., 1996.	- carvedilol or placebo in symptomatic patients on stable doses of diuretics and ACE inhibitors before entry - multiple US centers - 6 month follow-up	- n = 345 - NYHA II – III - LVEF < 35% - mean age = 60 years - 83% male	1) exercise tolerance 2) changes in quality of life, NYHA class, LVEF, hospitalizations, and signs/symptoms of HF	- dose-related improvements in LV function, mortality and hospitalizations with carvedilol, but no change in exercise tolerance
CAPRICORN – Carvedilol Post-Infarct Survival Control in Left Ventricular Dysfunction Dargie et al., 2001.	- carvedilol or placebo post-MI - 163 centers in 17 countries - 1.3 year follow-up	- n = 1,959 - LVEF < 40% post-MI - mean age = 63 years - 74% male	1) all-cause mortality or CV hospitalization 2) sudden death and HF hospitalization	- no difference in combined primary endpoint - carvedilol reduced all-cause mortality, CV hospitalization and combined endpoint

Abbreviations: ACE = Angiotensin Converting Enzyme, **ARB** = Angiotensin Receptor Blocker, **BP** = Blood Pressure, **CV** = Cardiovascular, **ED** = Emergency Department, **HF** = Heart Failure, **MI** = Myocardial Infarction, **LV** = Left Ventricle, **LVEF** = Left Ventricular Ejection Fraction, **NYHA** = New York Heart Association, **RAA** = Renin-Angiotensin-Aldosterone system, **US** = United States

Table 4: Summary of AA Randomized Controlled Trials

Study	Description	Sample	Outcome(s)	Results
RALES – Randomized Aldactone Evaluation Study Pitt et al., 1999.	- spironolactone or placebo with ACE inhibitors and diuretics in severe HF - 195 centres in 15 countries - 24 month follow-up	- n = 1,663 - NYHA class III - IV - LVEF < 35% - mean age = 65 years - 73% male	1) all-cause mortality 2) CV death, CV hospitalizations, combined CV death or hospitalization and change in NYHA class	- spironolactone reduced all-cause mortality by 30%, CV death by 31%, and risk of CV hospitalization by 30 % and improved NYHA class
EPHESUS – Eplerenone Post-Acute Myocardial Infarction Heart Failure Efficacy and Survival Study Pitt et al., 2003.	- eplerenone or placebo with optimal pharmacotherapy post-MI - multiple centers internationally - 16 month follow-up	- n= 6,642 - 3-14 days post-MI - LVEF < 40% - mean age = 64 years ~70% male	1) all-cause mortality, CV mortality and hospitalizations 2) CV mortality, CV hospitalizations, all-cause mortality and hospitalizations	- eplerenone reduced all-cause mortality and CV mortality or hospitalization (overall reduction in mortality and morbidity)

Abbreviations: ACE = Angiotensin Converting Enzyme, **CV** = Cardiovascular, **HF** = Heart Failure, **MI** = Myocardial Infarction, **LVEF** = Left Ventricular Ejection Fraction, **NYHA** = New York Heart Association

Table 5: Summary of Digoxin Randomized Controlled Trials

Study	Description	Sample	Outcome(s)	Results
PROVED – Prospective Randomized Study of Ventricular Failure and the Efficacy of Digoxin Uretsky et al., 1993.	- digoxin or placebo in stable HF - 29 centers in the US - 3 month follow-up	- n = 88 - NYHA II-III - LVEF < 35% - mean age = 64 years - 80% male	1) exercise performance, treatment failure, time to treatment failure 2) HF progression, changes in HF signs/ symptoms, LVEF, vital signs, body weight	- digoxin improved exercise performance, treatment failure, time to treatment failure, LVEF and lowered HR and body weight
RADIANCE – Randomized Assessment of Digoxin on Inhibitors of Angiotensin Converting Enzyme Trial Packer et al., 1993.	- digoxin or placebo with ACE inhibitors - 43 centers in the US and Canada - 12 week follow-up	- n = 178 - NYHA II-III - LVEF <35% - mean age = 60 years - 68% male	1) withdrawal rate for worsening HF, time to withdrawal, exercise tolerance 2) effects on HF symptoms and progression, quality of life, NYHA class and cardiac dimensions	- remaining on digoxin therapy associated with stable HF, stable exercise tolerance, slower HF progression, better quality of life - switch from digoxin to placebo reduced quality of life, increased HR and body weight
DIG – Digitalis Investigation Group Trial Digitalis Investigation Group 1997.	- digoxin or placebo - 302 centers in the US and Canada - 37 month follow-up	- n= 7,788 - NYHA I-IV - LVEF below 45% - mean age = 63 years - 78% male	1) all-cause mortality 2) HF hospitalizations	- digoxin therapy did not improve mortality, but showed trend towards lower HF mortality, fewer hospitalizations and lower combined outcome of HF death or hospitalization

Abbreviations: ACE = Angiotensin Converting Enzyme, **HF** = Heart Failure, **HR** = Heart Rate, **LVEF** = Left Ventricular Ejection Fraction, **NYHA** = New York Heart Association, **US** = United States

APPENDIX H: Treatment of Heart Failure with Preserved Ejection Fraction

Table 1: Summary of Studies of Therapies for Heart Failure with Preserved Ejection Fraction

Study	Description	Sample	Outcome(s)	Results
Ezekowitz et al., 2008.	- prospective cohort, HF post-discharge - ACE inhibitor, β-blocker, digoxin, spironolactone, and ARB therapy - 103 Ontario hospitals - 1 year follow-up	- n=9,943 - any NYHA class - any LVEF - mean age = 76 years - 36% male (HFPEF)	1) 1-year mortality or HF readmission	- no difference in survival with ACE inhibitor, β-blocker, spironolactone, digoxin or ARB therapy
I-PRESERVE: Irbesartan in Patients with Heart Failure and PRESERVEd Ejection Fraction Massie et al., 2008.	- irbesartan (ARB) or placebo in HFPEF - 293 sites in Europe, North and South America, South Africa, and Australia - 49.5 month follow-up	- n = 4,563 - NYHA class II-IV - LVEF > 45% - mean age = 72 years - 60% female	1) all-cause mortality or CV hospitalization 2) HF death or hospitalization, all-cause or CV mortality, quality of life	- irbesartan did not improve primary or secondary outcomes
CHARM-Preserved – Candesartan in Heart Failure Assessment of Reduction in Mortality Preserved Yusuf et al., 2003.	- candesartan (ARB) or placebo in HFPEF - 618 centers in 28 countries - 36.6 month follow-up	- n = 3,023 - NYHA class II-IV - LVEF > 40% - mean age = 67 years - 60% male	1) CV death or HF hospitalization	- candesartan did not improve primary outcome, but moderately reduced HF hospitalizations
PEP-CHF – Perindopril in Older People with Chronic Heart Failure Cleland et al., 2006.	- perindopril (ACE inhibitor) or placebo in HFPEF with diuretic therapy - 53 centers in Europe - 2.1 year follow-up	- n = 850 - NYHA class I-IV - LVEF > 40% - mean age = 76 years - 55% female	1) all-cause mortality or unplanned HF hospitalization	- insufficient power, but perindopril therapy showed a trend towards improved symptoms, exercise capacity and hospitalizations

Study	Description	Sample	Outcome(s)	Results
DIG – Digitalis Investigation Group Trial Ahmed et al., 2006.	- digoxin or placebo (subset with HFPEF) - 302 centers in the US and Canada - 37 month follow-up	- n= 988 - NYHA class I-IV - LVEF > 45% - mean age = 65 years - 60% male	1) HF mortality or hospitalization 2) cause-specific mortality or hospitalization	- digoxin did not improve primary or secondary endpoints - showed towards reduced HF hospitalizations
SENIORS - Study of the Effects of Nebivolol Intervention on Outcomes and Rehospitalization in Seniors with heart failure Flather et al., 2005.	- nebivolol (β-blocker) or placebo - 11 European countries - 21 month follow-up	- n = 2,128 - NYHA class I-IV - 35% enrolled with LVEF > 35% - mean age = 76 years - 36% female	1) all-cause mortality or CV hospitalization 2) all-cause mortality or hospital admissions, all-cause hospital admissions, CV hospitalizations and mortality, exercise tolerance	- nebivolol therapy achieved modest reduction in primary endpoints, reduced all-cause mortality or hospitalizations - similar findings in subgroup analysis of those HFPEF
Aronow and Kronzon, 1993.	- enalapril (ACE inhibitor) or placebo in HF post- MI - one US center - 3 month follow-up	- n = 21 - NYHA class III - LVEF > 50% - mean age = 80 years - 86% women	1) NYHA class, BP, exercise time and LVEF	- enalapril improved NYHA class, BP, exercise time and LVEF
Parthasarathy et al., 2009	- valsartan (ARB)or placebo - multiple centers in Finland - 14 week follow-up	- n = 152 - LVEF > 40% - mean age = 62 years - 50% male	1) exercise time 2) echocardiography results, quality of life scores, exertion	- valsartan did not improve primary outcome, but improved peak exercise systolic BP and perceived exertion

Abbreviations: ACE = Angiotensin Converting Enzyme, **ARB** = Angiotensin Receptor Blocker, **β-blocker =** β-Adrenergic Receptor Blocker, **BP** = Blood Pressure, **CV** = Cardiovascular, **HF** = Heart Failure, **HFPEF** = Heart Failure with Preserved Ejection Fraction, **MI** = Myocardial Infarction, **LVEF** = Left Ventricular Ejection Fraction, **NYHA** = New York Heart Association, **US** = United States

APPENDIX I: Ontario Drug Benefit Formulary

Table 1: Heart Failure Medications Included in the Ontario Drug Benefit Formulary

Medication Class	Generic Drug Name	Exceptions to Coverage
ACE inhibitor	benazepril	None
	captopril	Capoten not covered
	cilazapril	None
	enalapril	Only Vasotec is covered (2.5, 5, 10 and 20 mg)
	fosinopril	None
	lisinopril	20mg lisinopril with 25 mg HCTZ (combination with diuretic) not covered
	perindopril	Generic (apo-perindopril 8 mg) not covered
	quinapril	None
	ramipril	15 mg not covered (Apo/Ratio-ramipril or Altace)
	trandolapril	None
β-blocker	acebutolol	Monitan not covered (100, 200 and 400 mg)
	atenolol	None
	bisoprolol	None
	carvedilol	Coreg not covered (3.125, 6.25, 12.5 and 25 mg)
	metoprolol	None
	nadolol	Corgard not covered (40m 80 and 160 mg)
	propranolol	Inderal not covered (10, 20, 40, 80, 120 mg)
ARB[a]	candesartan	None
	eprosartan	None
	irbesartan	None
	losartan	None
	telmisartan	None
	valsartan	None

Abbreviations: ACE = Angiotensin Converting Enzyme, **ARB** = Angiotensin Receptor Blocker, **β-blocker** = β-Adrenergic Receptor Blocker, **HCTZ** = Hydrochlorothiazide

[a] ARB therapies are all under patent, no interchangeable medications are available

Source:

Ontario Ministry of Health and Long-Term Care. Ontario public drug programs: Formulary [Internet]. Toronto: MOHLTC; 2009 [cited 2009 Oct 21]. Available from: http://www.health.gov.on.ca/english/providers/program/drugs/odbf_mn.html

APPENDIX J: Supplementary Information from Chapter 6.0

Table 1: Comparison of Baseline Characteristics among Older Home Care Clients with Heart Failure by Time between Assessments, Ontario 2005-2007 (N=115,755)

		Assessment Gap Between 60-270 days N = 68,017	Assessment Gap Not Between 60-270 days N = 47,738	*p value*
		% (n)	% (n)	
HF[a]		14.1 (9,283)	12.9 (6,162)	
Sociodemographic Characteristics				
Age	65-74 years	19.7 (13,423)	20.0 (33,728)	
	75 – 84 years	46.1 (31,368)	47.6 (22,711)	<0.0001
	85+ years	34.2 (23,226)	32.5 (15,494)	
Gender	Female	68.7 (46,737)	70.7 (33,728	<0.0001
Living Alone		38.7 (25,995)	38.2 (18,472)	0.10
Clinical Characteristics				
ADL Hierarchy Scale score[b]	0	71.2 (48,405)	72.1 (34,406)	
	1-2	20.3 (13,833)	19.2 (9,150)	0.08
	3+	8.5 (5,759)	8.7 (4,164)	
IADL Capacity Scale score[c]	0	3.9 (2,654)	4.5 (2,167)	
	1-2	24.2 (16,438)	24.9 (11,885)	<0.0001
	3+	71.9 (48,920)	70.6 (4,164)	
CPS score[d]	0	51.5 (35,015)	53.6 (25,595)	
	1-2	39.2 (26,641)	38.5 (18,354)	<0.0001
	3+	9.4 (6,360)	7.9 (3,779)	
CHESS Scale score[e]	0	33.1 (22,525)	35.5 (16,959)	
	1-2	56.9 (38,705)	55.6 (26,509)	<0.0001
	3+	10.0 (6,777)	8.9 (4,248)	
MAPLe Algorithm score[f]	1	24.6 (16,755)	25.7 (12,275)	
	2-3	44.8 (30,454)	46.1 (21,990)	<0.0001
	4-5	30.6 (20,808)	28.2 (13,473)	
Falls CAP[g]	0	69.4 (47,184)	70.0 (33,417)	
	1	18.2 (12,371)	17.8 (8,500)	0.07
	2	12.4 (8,460)	12.2 (5,814)	
Mood CAP[h]	0	67.7 (46,035)	66.5 (31,716)	
	1	21.1 (14,339)	21.8 (10,383)	<0.0001
	2	11.2 (7,618)	11.7 (5,601)	
Number of Comorbid Conditions[i]	0,1	10.3 (6,985)	11.2 (5,338)	
	2-4	62.4 (42,443)	62.1 (29,638)	<0.0001
	5+	27.3 (18,589)	26.7 (12,762)	
Pharmacotherapy				
Number of Medications[j]	1-4	17.5 (11,923)	18.1 (8,648)	
	5-8	36.5 (24,790)	36.9 (17,625)	<0.0001
	9+	46.0 (31,304)	45.0 (21,465)	

Pharmacotherapy			
Any ACE inhibitor use	36.0 (24,453)	36.0 (17,168)	0.97
Any ARB use	9.4 (6,419)	9.6 (4,586)	0.33
Any β-blocker use	28.1 (19,128)	28.7 (13,703)	0.03

Abbreviations: ACE = Angiotensin Converting Enzyme, **ADL** = Activities of Daily Living, **ARB** = Angiotensin Receptor Blocker, **β-blocker** = β-Adrenergic Receptor Blocker, **CAP** = Clinical Assessment Protocol, **CHESS** = Changes in Health, End-stage disease and Signs and Symptoms, **CPS** = Cognitive Performance Scale, **HF** = Heart Failure, **IADL** = Instrumental Activities of Daily Living, **MAPLe** = Method for Assigning Priority Levels

[a] excludes new and inconsistent HF (n = 4,348)

[b] 0 = no impairment; 1-2 = some functional impairment; 3+ = severe functional impairment

[c] 0 = no difficulty; 1-2 = some difficulty; 3+ = great difficulty

[d] 0 = cognitively intact; 1-2 = mild cognitive impairment; 3+ = cognitively impaired

[e] 0 = no health instability; 1-2 = some health instability; 3+ = moderate to high health instability

[f] 1 = low priority; 2-3 = mild/moderate priority; 4-5 = high priority

[g] 0 = no prior falls; 1 – 1 prior fall; 2 – multiple prior falls

[h] 0 = no indicators of depression; 1-2 = some indicators of depression; 3+ = indicators of probable depression

[i] excludes HF

[j] excludes ACE inhibitor, β-blocker and ARB therapies

Table 2: Summary of Bivariate Analyses for Mortality within 90 days among Older Home Care Clients with Heart Failure, Ontario 2005-2007 (N=9,283)

	Point Estimate (SE)	OR (95% CI)	*p value*
Sociodemographic Characteristics			
Age	0.10 (0.03)	1.11 (1.04, 1.18)	0.002
Female	-0.57 (0.05)	0.57 (0.52, 0.62)	<0.0001
Married	0.17 (0.02)	1.42 (1.30, 1.55)	<0.0001
Living Alone	-0.55 (0.05)	0.58 (0.53, 0.64)	<0.0001
Caregiver Stress	0.41 (0.06)	1.51 (1.34,1.70)	<0.0001
Clinical Characteristics			
ADL Hierarchy Scale score	0.32 (0.01)	1.38 (1.35,1.42)	<0.0001
IADL Capacity Scale score	0.31 (0.02)	1.37 (1.32, 1.42)	<0.0001
CPS score	0.21 (0.02)	1.24 (1.20, 1.28)	<0.0001
CHESS Scale score	0.30 (0.02)	1.35 (1.30, 1.41)	<0.0001
MAPLe Algorithm score	0.27 (0.02)	1.31 (1.26, 1.36)	<0.0001
Behavioural Symptoms	0.55 (0.09)	1.74 (1.46, 2.08)	<0.0001
Impairment with Stairs	0.58 (0.05)	1.79 (1.61, 1.99)	<0.0001
Incontinence	0.09 (0.04)	1.10 (1.01, 1.20)	0.03
Falls CAP	0.07 (0.03)	1.07 (1.01, 1.15)	0.03
Mood CAP	0.10 (0.03)	1.11 (1.04, 1.18)	0.001
Number of Comorbid Conditions[a]	-0.15 (0.10)	0.86 (0.70, 1.04)	0.12
Diagnoses			
Hypertension	-0.33 (0.05)	0.72 (0.66, 0.78)	<0.0001
Arthritis	-0.36 (0.05)	0.70 (0.64, 0.76)	<0.0001
CAD	-0.03 (0.04)	0.97 (0.89, 1.05)	0.44
Diabetes Mellitus	0.08 (0.05)	1.09 (0.99, 1.19)	0.08
Airway Disease[b]	0.27 (0.05)	1.30 (1.19, 1.43)	<0.0001
Osteoporosis	-0.20 (0.06)	0.82 (0.73, 0.91)	0.0002
Stroke	0.03 (0.05)	1.03 (0.93, 1.15)	0.53
Any Dementia	0.28 (0.06)	1.33 (1.17, 1.50)	<0.0001
Cancer	0.35 (0.06)	1.43 (1.26, 1.61)	<0.0001
Pharmacotherapy			
Number of Medications[c]	-0.004 (0.01)	1.00 (0.98, 1.01)	0.57
Impaired Medication Management	0.60 (0.05)	1.82 (1.66, 2.00)	<0.0001
Medication Non-Adherence[d]	-0.27 (0.27)	0.77 (0.46, 1.29)	0.32
Any ACE inhibitor use	-0.02 (0.04)	0.98 (0.90, 1.07)	0.69
Any ARB use	-0.32 (0.07)	0.73 (0.63, 0.84)	<0.0001
Any β-blocker use	-0.09 (0.05)	0.91 (0.83, 0.99)	0.04
Continuous ACE inhibitor or ARB use[e]	-0.11 (0.04)	0.90 (0.82, 0.98)	0.01
Continuous β-blocker use[f]	-0.13 (0.05)	0.88 (0.81, 0.96)	0.004
Continuous ACE inhibitor, ARB or β-blocker use[g]	-0.16 (0.05)	0.86 (0.78, 0.94)	0.002

	Point Estimate (SE)	OR (95% CI)	*p value*
Service Use			
Any Nursing[h]	0.44 (0.05)	1.56 (1.43, 1.70)	<0.0001
Any Homemaking[h]	-0.19 (0.04)	0.83 (0.76, 0.90)	<0.0001
Any Physiotherapy[h]	-0.21 (0.11)	0.81 (0.66, 0.99)	0.04
Any Home Help[h]	0.11 (0.06)	1.12 (1.00, 1.24)	0.05
Weekly Cost of HC services[i]	0.07 (0.01)	1.07 (1.05, 1.10)	<0.0001
Any previous ED visit[j]	0.11 (0.04)	1.11 (1.03, 1.21)	0.008
Any previous Hospitalization[j]	0.17 (0.04)	1.18 (1.10, 1.27)	<0.0001

Abbreviations: ACE = Angiotensin Converting Enzyme, **ADL** = Activities of Daily Living, **ARB** = Angiotensin Receptor Blocker, **β-blocker** = β-Adrenergic Receptor Blocker, **CAD** = Coronary Artery Disease, **CAP** = Clinical Assessment Protocol, **CHESS** = Changes in Health, End-stage disease and Signs and Symptoms, **CI** = Confidence Interval, **CPS** = Cognitive Performance Scale, **ED** = Emergency Department, **HC** = Home Care, **HF** = Heart Failure, **IADL** = Instrumental Activities of Daily Living, **MAPLe** = Method for Assigning Priority Levels, **OR** = Odds Ratio, **SE** = Standard Error

[a] excludes HF

[b] includes chronic obstructive pulmonary disease (COPD), emphysema and asthma

[c] excludes ACE inhibitor, β- blocker and ARB therapies

[d] adherent less than 80% of the time

[e] ACE inhibitor or ARB use recorded at every assessment

[f] β-blocker use recorded at every assessment

[g] ACE inhibitor, ARB or β-blocker use recorded at every assessment

[h] measured in 7 days prior to assessment

[i] measured in increments of $100

[j] measured in 90 days prior to assessment

Table 3: Summary of Bivariate Analyses for Long-Term Care Admission within 90 days among Older Home Care Clients with Heart Failure, Ontario 2005-2007 (N=9,283)

	Point Estimate (SE)	OR (95% CI)	*p value*
Sociodemographic Characteristics			
Age	0.60 (0.05)	1.83 (1.67, 2.00)	<0.0001
Female	-0.03 (0.06)	0.98 (0.87, 1.10)	0.67
Married	-0.01 (0.03)	0.98 (0.87, 1.10)	0.73
Living Alone	-0.23 (0.06)	0.79 (0.71, 0.89)	<0.0001
Caregiver Stress	0.86 (0.07)	2.38 (2.09, 2.70)	<0.0001
Clinical Characteristics			
ADL Hierarchy Scale score	0.21 (0.02)	1.24 (1.19, 1.28)	<0.0001
IADL Capacity Scale score	0.35 (0.02)	1.42 (1.36, 1.49)	<0.0001
CPS score	0.39 (0.02)	1.48 (1.42, 1.53)	<0.0001
CHESS Scale score	0.19 (0.03)	1.21 (1.15, 1.27)	<0.0001
MAPLe Algorithm score	0.56 (0.03)	1.76 (1.67, 1.85)	<0.0001
Behavioural Symptoms	1.25 (0.09)	3.48 (2.93, 4.14)	<0.0001
Impairment with Stairs	0.71 (0.07)	2.03 (1.77, 2.32)	<0.0001
Incontinence	0.53 (0.06)	1.71 (1.53, 1.90)	<0.0001
Falls CAP	0.40 (0.04)	1.50 (1.40, 1.60)	<0.0001
Mood CAP	0.31 (0.04)	1.36 (1.27, 1.46)	<0.0001
Number of Comorbid Conditions[a]	-0.20 (0.12)	0.82 (0.65, 1.05)	0.11
Diagnoses			
Hypertension	-0.09 (0.06)	0.92 (0.82, 1.03)	0.13
Arthritis	-0.27 (0.06)	0.76 (0.68, 0.85)	<0.0001
CAD	-0.19 (0.06)	0.82 (0.74, 0.92)	0.001
Diabetes Mellitus	-0.35 (0.06)	0.70 (0.62, 0.80)	<0.0001
Airway Disease[b]	-0.36 (0.07)	0.70 (0.61, 0.79)	<0.0001
Osteoporosis	0.05 (0.06)	1.05 (0.92, 1.19)	0.48
Stroke	0.01 (0.07)	1.01 (0.88, 1.15)	0.93
Any Dementia	1.14 (0.06)	3.13 (2.77, 3.54)	<0.0001
Cancer	-0.18 (0.09)	0.84 (0.70, 1.01)	0.06
Pharmacotherapy			
Number of Medications[c]	-0.05 (0.01)	0.95 (0.93, 0.96)	<0.0001
Impaired Medication Management	1.14 (0.07)	3.11 (2.72, 3.56)	<0.0001
Medication Non-Adherence[d]	0.97 (0.20)	2.63 (1.78, 3.87)	<0.0001
Any ACE inhibitor use	-0.13 (0.06)	0.88 (0.79, 0.98)	0.021
Any ARB use	-0.19 (0.09)	0.83 (0.70, 0.99)	0.03
Any β-blocker use	-0.19 (0.06)	0.83 (0.74, 0.92)	0.001
Continuous ACE inhibitor or ARB use[e]	-0.18 (0.06)	0.84 (0.75, 0.93)	0.001
Continuous β-blocker use[f]	-0.17 (0.06)	0.85 (0.76, 0.95)	0.003
Continuous ACE inhibitor, ARB or β-blocker use[g]	-0.23 (0.07)	0.80 (0.71, 0.89)	0.0001

	Point Estimate (SE)	OR (95% CI)	*p value*
Service Use			
Any Nursing[h]	0.13 (0.06)	1.14 (1.02, 1.28)	0.02
Any Homemaking[h]	0.26 (0.06)	1.30 (1.16, 1.45)	<0.0001
Any Physiotherapy[h]	-0.04 (0.12)	0.96 (0.75, 1.22)	0.73
Any Home Help[h]	0.09 (0.07)	1.10 (0.96, 1.26)	0.17
Weekly Cost of HC services[i]	0.01 (0.003)	1.01 (1.00, 1.01)	0.08
Any previous ED visit[j]	0.15 (0.05)	1.17 (1.06, 1.29)	0.002
Any previous Hospitalization[j]	-0.10 (0.05)	0.91 (0.82, 1.00)	0.06

Abbreviations: ACE = Angiotensin Converting Enzyme, **ADL** = Activities of Daily Living, **ARB** = Angiotensin Receptor Blocker, **β-blocker** = β-Adrenergic Receptor Blocker, **CAD** = Coronary Artery Disease, **CAP** = Clinical Assessment Protocol, **CHESS** = Changes in Health, End-stage disease and Signs and Symptoms, **CI** = Confidence Interval, **CPS** = Cognitive Performance Scale, **ED** = Emergency Department, **HC** = Home Care, **HF** = Heart Failure, **IADL** = Instrumental Activities of Daily Living, **MAPLe** = Method for Assigning Priority Levels, **OR** = Odds Ratio, **SE** = Standard Error

[a] excludes HF

[b] includes chronic obstructive pulmonary disease (COPD), emphysema and asthma

[c] excludes ACE inhibitor, β- blocker and ARB therapies

[d] adherent less than 80% of the time

[e] ACE inhibitor or ARB use recorded at every assessment

[f] β-blocker use recorded at every assessment

[g] ACE inhibitor, ARB or β-blocker use recorded at every assessment

[h] measured in 7 days prior to assessment

[i] measured in increments of $100

[j] measured in 90 days prior to assessment

Table 4: Summary of Bivariate Analyses for Hospitalization within 90 days among Older Home Care Clients with Heart Failure, Ontario 2005-2007 (N=9,283)

	Point Estimate (SE)	OR (95% CI)	*p value*
Sociodemographic Characteristics			
Age	-0.06 (0.03)	0.94(0.90, 0.99)	0.02
Female	-0.11 (0.04)	0.90 (0.84, 0.97)	0.006
Married	0.03 (0.02)	1.06 (0.98, 1.14)	0.15
Living Alone	0.002 (0.04)	1.00 (0.93, 1.08)	0.96
Caregiver Stress	0.08 (0.05)	1.08 (0.97, 1.20)	0.16
Clinical Characteristics			
ADL Hierarchy Scale score	0.03 (0.02)	1.03 (1.00, 1.06)	0.46
IADL Capacity Scale score	0.09 (0.01)	1.10 (1.07, 1.12)	<0.0001
CPS score	0.01 (0.02)	1.00 (0.97, 1.03)	0.74
CHESS Scale score	0.20 (0.02)	1.22 (1.18, 1.26)	<0.0001
MAPLe Algorithm score	0.14 (0.02)	1.15 (1.12, 1.19)	<0.0001
Behavioural Symptoms	-0.02 (0.09)	0.98 (0.82, 1.17)	0.80
Impairment with Stairs	0.35 (0.04)	1.42 (1.31, 1.54)	<0.0001
Incontinence	0.12 (0.04)	1.13 (1.05, 1.21)	0.0009
Falls CAP	0.18 (0.03)	1.19 (1.13, 1.25)	<0.0001
Mood CAP	0.12 (0.03)	1.13 (1.07, 1.18)	<0.0001
Number of Comorbid Conditions[a]	0.36 (0.10)	1.44 (1.18, 1.75)	0.0003
Diagnoses			
Hypertension	-0.02 (0.04)	0.99 (0.91, 1.06)	0.69
Arthritis	-0.02 (0.04)	0.98 (0.91, 1.06)	0.64
CAD	0.10 (0.04)	1.10 (1.03, 1.18)	0.008
Diabetes Mellitus	0.23 (0.04)	1.26 (1.17, 1.36)	<0.0001
Airway Disease[b]	0.22 (0.04)	1.25 (1.16, 1.35)	<0.0001
Osteoporosis	-0.006 (0.04)	0.99 (0.91, 1.08)	0.88
Stroke	0.05 (0.04)	1.05 (0.96, 1.14)	0.28
Any Dementia	-0.23 (0.06)	0.80 (0.71, 0.89)	0.0001
Cancer	0.19 (0.06)	1.20 (1.08, 1.34)	0.0007
Pharmacotherapy			
Number of Medications[c]	0.04 (0.005)	1.04 (1.03, 1.05)	<0.0001
Impaired Medication Management	0.21 (0.04)	1.23 (1.14, 1.32)	<0.0001
Medication Non-Adherence[d]	0.31 (0.17)	1.36 (0.97, 1.91)	0.08
Any ACE inhibitor use	-0.01 (0.04)	0.99 (0.92, 1.06)	0.80
Any ARB use	-0.08 (0.06)	0.92 (0.83, 1.03)	0.12
Any β-blocker use	-0.04 (0.04)	0.96 (0.89, 1.03)	0.27
Continuous ACE inhibitor or ARB use[e]	-0.10 (0.04)	0.91 (0.84, 0.97)	0.01
Continuous β-blocker use[f]	-0.03 (0.04)	0.98 (0.91, 1.05)	0.50
Continuous ACE inhibitor, ARB or β-blocker use[g]	-0.08 (0.04)	0.92 (0.85, 1.00)	0.04

	Point Estimate (SE)	OR (95% CI)	*p value*
Service Use			
Any Nursing[h]	0.40 (0.04)	1.49 (1.39, 1.60)	<0.0001
Any Homemaking[h]	-0.05 (0.04)	0.95 (0.89, 1.02)	0.17
Any Physiotherapy[h]	0.24 (0.07)	1.27 (1.10, 1.47)	0.001
Any Home Help[h]	0.14 (0.05)	1.15 (1.05, 1.25)	0.003
Weekly Cost of HC services[i]	0.06 (0.01)	1.06 (1.04, 1.09)	<0.0001
Any previous ED visit[j]	0.28 (0.03)	1.32 (1.24, 1.41)	<0.0001
Any previous Hospitalization[j]	0.37 (0.03)	1.44 (1.37, 1.53)	<0.0001

Abbreviations: ACE = Angiotensin Converting Enzyme, **ADL** = Activities of Daily Living, **ARB** = Angiotensin Receptor Blocker, **β-blocker** = β-Adrenergic Receptor Blocker, **CAD** = Coronary Artery Disease, **CAP** = Clinical Assessment Protocol, **CHESS** = Changes in Health, End-stage disease and Signs and Symptoms, **CI** = Confidence Interval, **CPS** = Cognitive Performance Scale, **ED** = Emergency Department, **HC** = Home Care, **HF** = Heart Failure, **IADL** = Instrumental Activities of Daily Living, **MAPLe** = Method for Assigning Priority Levels, **OR** = Odds Ratio, **SE** = Standard Error

[a] excludes HF

[b] includes chronic obstructive pulmonary disease (COPD), emphysema and asthma

[c] excludes ACE inhibitor, β- blocker and ARB therapies

[d] adherent less than 80% of the time

[e] ACE inhibitor or ARB use recorded at every assessment

[f] β-blocker use recorded at every assessment

[g] ACE inhibitor, ARB or β-blocker use recorded at every assessment

[h] measured in 7 days prior to assessment

[i] measured in increments of $100

[j] measured in 90 days prior to assessment

Table 5: Summary of Bivariate Analyses for New Functional Decline within 90 days among Home Care Clients with Heart Failure, Ontario 2005-2007 (N=9,283)

	Point Estimate (SE)	OR (95% CI)	*p value*
Sociodemographic Characteristics			
Age	0.16 (0.06)	1.18 (1.05, 1.32)	0.006
Female	-0.23 (0.08)	0.80 (0.68, 0.94)	0.006
Married	-0.16 (0.04)	0.73 (0.62, 0.86)	0.0001
Living Alone	-0.72 (0.09)	0.49 (0.41, 0.59)	<0.0001
Caregiver Stress	0.26 (0.11)	1.29 (1.04, 1.61)	0.02
Clinical Characteristics			
IADL Capacity Scale score	0.23 (0.03)	1.26 (1.19, 1.34)	<0.0001
CPS score	0.13 (0.03)	1.14 (1.07, 1.21)	<0.0001
CHESS Scale score	0.18 (0.04)	1.19 (1.11, 1.28)	<0.0001
MAPLe Algorithm score	0.25 (0.04)	1.29 (1.20, 1.38)	<0.0001
Behavioural Symptoms	0.20 (0.18)	1.22 (0.86, 1.73)	0.27
Impairment with Stairs	0.27 (0.09)	1.31 (1.10, 1.57)	0.003
Incontinence	0.20 (0.08)	1.22 (1.04, 1.42)	0.01
Falls CAP	0.22 (0.05)	1.24 (1.12, 1.38)	<0.0001
Mood CAP	-0.04 (0.06)	0.97 (0.86, 1.09)	0.56
Number of Comorbid Conditions[a]	-0.52 (0.35)	0.60 (0.30, 1.18)	0.14
Diagnoses			
Hypertension	-0.06 (0.08)	0.94 (0.80, 1.11)	0.48
Arthritis	-0.26 (0.08)	0.77 (0.66, 0.90)	0.001
CAD	-0.06 (0.08)	0.95 (0.81, 1.11)	0.48
Diabetes Mellitus	-0.03 (0.09)	0.97 (0.82, 1.15)	0.73
Airway Disease[b]	-0.15 (0.09)	0.86 (0.73, 1.03)	0.10
Osteoporosis	-0.11 (0.10)	0.90 (0.74, 1.09)	0.28
Stroke	-0.14 (0.10)	0.87 (0.72, 1.06)	0.18
Any Dementia	0.13 (0.11)	1.14 (0.91, 1.42)	0.25
Cancer	0.08 (0.12)	1.08 (0.85, 1.38)	0.53
Pharmacotherapy			
Number of Medications[c]	0.01 (0.01)	1.01 (0.99, 1.03)	0.18
Impaired Medication Management	0.48 (0.09)	1.61 (1.36, 1.91)	<0.0001
Medication Non-Adherence[d]	-0.27 (0.46)	0.77 (0.31, 1.87)	0.56
Any ACE inhibitor use	-0.04 (0.08)	0.96 (0.82, 1.13)	0.64
Any ARB use	-0.07 (0.13)	0.93 (0.72, 1.20)	0.57
Any β-blocker use	0.06 (0.08)	1.06 (0.90, 1.24)	0.49
Continuous ACE inhibitor or ARB use[e]	-0.30 (0.08)	0.74 (0.64, 0.87)	0.0002
Continuous β-blocker use[f]	-0.04 (0.08)	0.96 (0.82, 1.13)	0.65
Continuous ACE inhibitor, ARB or β-blocker use[g]	-0.28 (0.08)	0.76 (0.64, 0.89)	0.0009

	Point Estimate (SE)	**OR (95% CI)**	***p value***
Service Use			
Any Nursing[h]	0.11 (0.08)	1.11 (0.95, 1.31)	0.19
Any Homemaking[h]	-0.12 (0.08)	0.89 (0.76, 1.04)	0.14
Any Physiotherapy[h]	0.10 (0.15)	1.10 (0.81, 1.49)	0.54
Any Home Help[h]	-0.28 (0.09)	0.76 (0.64, 0.90)	0.001
Weekly Cost of HC services[i]	0.27 (0.07)	1.31 (1.16, 1.49)	<0.0001
Any previous ED visit[j]	0.18 (0.07)	1.20 (1.05, 1.37)	0.008
Any previous Hospitalization[j]	0.13 (0.06)	1.13 (1.00, 1.28)	0.047

Abbreviations: ACE = Angiotensin Converting Enzyme, **ADL** = Activities of Daily Living, **ARB** = Angiotensin Receptor Blocker, **β-blocker** = β-Adrenergic Receptor Blocker, **CAD** = Coronary Artery Disease, **CAP** = Clinical Assessment Protocol, **CHESS** = Changes in Health, End-stage disease and Signs and Symptoms, **CI** = Confidence Interval, **CPS** = Cognitive Performance Scale, **ED** = Emergency Department, **HC** = Home Care, **HF** = Heart Failure, **IADL** = Instrumental Activities of Daily Living, **MAPLe** = Method for Assigning Priority Levels, **OR** = Odds Ratio, **SE** = Standard Error

[a] excludes HF

[b] includes chronic obstructive pulmonary disease (COPD), emphysema and asthma

[c] excludes ACE inhibitor, β- blocker and ARB therapies

[d] adherent less than 80% of the time

[e] ACE inhibitor or ARB use recorded at every assessment

[f] β-blocker use recorded at every assessment

[g] ACE inhibitor, ARB or β-blocker use recorded at every assessment

[h] measured in 7 days prior to assessment

[i] measured in increments of $100

[j] measured in 90 days prior to assessment

Table 6: Summary of Bivariate Analyses for New Cognitive Decline within 90 days among Older Home Care Clients with Heart Failure, Ontario 2005-2007 (N=9,283)

	Point Estimate (SE)	OR (95% CI)	*p value*
Sociodemographic Characteristics			
Age	0.28 (0.05)	1.32 (1.20, 1.45)	<0.0001
Female	-0.18 (0.07)	0.83 (0.73, 0.95)	0.007
Married	-0.06 (0.03)	0.89 (0.78, 1.02)	0.09
Living Alone	-0.25 (0.07)	0.78 (0.68, 0.89)	0.0003
Caregiver Stress	0.27 (0.09)	1.30 (1.09, 1.56)	0.003
Clinical Characteristics			
ADL Hierarchy Scale score	0.06 (0.03)	1.06 (1.00, 1.11)	0.03
IADL Capacity Scale score	0.07 (0.02)	1.07 (1.03, 1.12)	0.001
CHESS Scale score	0.03 (0.03)	1.03 (0.97, 1.10)	0.32
MAPLe Algorithm score	0.02 (0.03)	1.02 (0.97, 1.08)	0.43
Behavioural Symptoms	0.34 (0.14)	1.41 (1.08, 1.84)	0.01
Impairment with Stairs	0.11 (0.07)	1.11 (0.97, 1.28)	0.13
Incontinence	0.07 (0.06)	1.07 (0.95, 1.22)	0.26
Falls CAP	0.22 (0.04)	1.25 (1.14, 1.36)	<0.0001
Mood CAP	0.05 (0.05)	1.05 (0.96, 1.15)	0.28
Number of Comorbid Conditions[a]	-0.26 (0.30)	0.78 (0.42, 1.44)`	0.42
Diagnoses			
Hypertension	-0.003 (0.07)	1.00 (0.87, 1.14)	0.97
Arthritis	-0.12 (0.07)	0.89 (0.78, 1.01)	0.07
CAD	-0.19 (0.07)	0.83 (0.73, 0.94)	0.003
Diabetes Mellitus	-0.08 (0.07)	0.92 (0.80, 1.06)	0.24
Airway Disease[b]	-0.11 (0.07)	0.90 (0.78, 1.03)	0.12
Osteoporosis	-0.05 (0.08)	0.96 (0.82, 1.12)	0.57
Stroke	-0.10 (0.08)	0.90 (0.77, 1.05)	0.19
Any Dementia	0.20 (0.09)	1.22 (1.02, 1.45)	0.03
Cancer	-0.14 (0.11)	0.87 (0.70, 1.07)	0.18
Pharmacotherapy			
Number of Medications[c]	-0.01 (0.01)	0.99 (0.98, 1.01)	0.29
Impaired Medication Management	0.40 (0.07)	1.49 (1.30, 1.71)	<0.0001
Medication Non-Adherence[d]	-0.01 (0.33)	0.99 (0.52, 1.87)	0.97
Any ACE inhibitor use	-0.04 (0.07)	0.96 (0.85, 1.09)	0.57
Any ARB use	-0.06 (0.10)	0.95 (0.77, 1.16)	0.59
Any β-blocker use	0.005 (0.07)	1.01 (0.88, 1.14)	0.94
Continuous ACE inhibitor or ARB use[e]	-0.16 (0.06)	0.85 (0.75, 0.97)	0.01
Continuous β-blocker use[f]	-0.06 (0.07)	0.94 (0.83, 1.08)	0.39
Continuous ACE inhibitor, ARB or β-blocker use[g]	-0.12 (0.07)	0.88 (0.77, 1.01)	0.07

	Point Estimate (SE)	OR (95% CI)	*p value*
Service Use			
Any Nursing[h]	-0.03 (0.07)	0.97 (0.85, 1.10)	0.63
Any Homemaking[h]	-0.19 (0.06)	0.83 (0.73, 0.94)	0.004
Any Physiotherapy[h]	0.18 (0.12)	1.20 (0.94, 1.52)	0.14
Any Home Help[h]	-0.30 (0.07)	0.74 (0.65, 0.85)	<0.0001
Weekly Cost of HC services[i]	0.17 (0.05)	1.18 (1.08, 1.30)	0.0005
Any previous ED visit[j]	0.17 (0.06)	1.19 (1.06, 1.32)	0.003
Any previous Hospitalization[j]	0.14 (0.05)	1.15 (1.04, 1.27)	0.006

Abbreviations: ACE = Angiotensin Converting Enzyme, **ADL** = Activities of Daily Living, **ARB** = Angiotensin Receptor Blocker, **β-blocker** = β-Adrenergic Receptor Blocker, **CAD** = Coronary Artery Disease, **CAP** = Clinical Assessment Protocol, **CHESS** = Changes in Health, End-stage disease and Signs and Symptoms, **CI** = Confidence Interval, **CPS** = Cognitive Performance Scale, **ED** = Emergency Department, **HC** = Home Care, **HF** = Heart Failure, **IADL** = Instrumental Activities of Daily Living, **MAPLe** = Method for Assigning Priority Levels, **OR** = Odds Ratio, **SE** = Standard Error

[a] excludes HF

[b] includes chronic obstructive pulmonary disease (COPD), emphysema and asthma

[c] excludes ACE inhibitor, β- blocker and ARB therapies

[d] adherent less than 80% of the time

[e] ACE inhibitor or ARB use recorded at every assessment

[f] β-blocker use recorded at every assessment

[g] ACE inhibitor, ARB or β-blocker use recorded at every assessment

[h] measured in 7 days prior to assessment

[i] measured in increments of $100

[j] measured in 90 days prior to assessment

Table 7: Proportional Hazards Regression Model of Time to Any Functional Decline among Older Home Care Clients with Heart Failure, Ontario 2005-2007 (N=9,283)

		Parameter Estimate (SE)	Hazard Ratio (95% CL)	*p value*
Sociodemographic Characteristics				
Age 75-84 years[a]		0.21 (0.10)	1.23 (1.01, 1.49)	0.04
Age 85+ years[a]		0.45 (0.10)	1.56 (1.29, 1.89)	<0.001
Female		-0.27 (0.06)	0.76 (0.67, 0.86)	<0.001
Living Alone		-0.51 (0.08)	0.60 (0.52, 0.70)	<0.001
Clinical Characteristics				
CHESS Scale score		0.08 (0.03)	1.08 (1.02, 1.14)	0.006
MAPLe Algorithm score		0.24 (0.03)	1.27 (1.19, 1.35)	<0.001
Falls CAP	1[b]	0.10 (0.08)	1.10 (0.94, 1.29)	0.24
	2[c]	0.40 (0.08)	1.50 (1.27, 1.76)	<0.001
Incontinence		0.16 (0.06)	1.17 (1.04, 1.32)	0.01
Pharmacotherapy				
Impaired Medication Management		0.34 (0.08)	1.41 (1.21, 1.65)	<0.001
Any ACE inhibitor use		-0.14 (0.06)	0.87 (0.77, 0.98)	0.02
Any ARB use		-0.04 (0.10)	0.96 (0.80, 1.16)	0.69
Any β-blocker use		-0.03 (0.06)	0.97 (0.86, 1.10)	0.67

Individuals were followed for 9 months following each assessment. 1,105 individuals experienced any functional decline. **Abbreviations: ACE** = Angiotensin Converting Enzyme, **ARB** = Angiotensin Receptor Blocker, **β–blocker** = β-Adrenergic Receptor Blocker, **CAP** = Clinical Assessment Protocol; **CHESS** = Changes in Health, End-stage Disease, Signs and Symptoms, **CL** = Confidence Limit, **MAPLe** = Method for Assigning Priority Levels, **SE** = Standard Error

[a] Reference Group: Age 65-74 years

[b] 1 prior fall: Reference Group = Level 0 (no prior falls)

[c] 2 or more prior falls: Reference Group = Level 0 (no prior falls)

Table 8: Proportional Hazards Regression Model of Time to Any Cognitive Decline among Older Home Care Clients with Heart Failure, Ontario 2005-2007 (N=9,283)

		Parameter Estimate (SE)	Hazard Ratio (95% CL)	*p value*
Sociodemographic Characteristics				
Age 75-84 years[a]		0.46 (0.10)	1.58 (1.29, 1.93)	<0.001
Age 85+ years[a]		0.60 (0.10)	1.83 (1.49, 2.23)	<0.001
Female		-0.18 (0.06)	0.83 (0.74, 0.94)	0.004
Living Alone		-0.22 (0.07)	0.81 (0.71, 0.92)	0.001
Clinical Characteristics				
ADL Hierarchy Scale score		0.05 (0.03)	1.06 (1.01, 1.11)	0.04
MAPLe Algorithm score		-0.10 (0.03)	0.90 (0.85, 0.96)	0.001
Mood CAP	1[b]	0.12 (0.07)	1.13 (0.98, 1.30)	0.10
	2[c]	0.34 (0.09)	1.40(1.18, 1.67)	<0.001
Diagnoses				
Any Dementia		0.21 (0.09)	1.23 (1.03, 1.47)	0.02
Pharmacotherapy				
Impaired Medication Management		0.34 (0.07)	1.41 (1.22, 1.63)	<0.001
Any ACE inhibitor use		-0.03 (0.06)	0.97 (0.86, 1.09)	0.57
Any ARB use		-0.05 (0.10)	0.95 (0.79, 1.14)	0.57
Any β-blocker use		-0.08 (0.06)	0.92 (0.82, 1.04)	0.17

Individuals were followed for 9 months following each assessment. 1,191 individuals experienced any cognitive decline. **Abbreviations: ACE** = Angiotensin Converting Enzyme, **ARB** = Angiotensin Receptor Blocker, **ADL** = Activities of Daily Living, **β–blocker** = β-Adrenergic Receptor Blocker, **CAP** = Clinical Assessment Protocol, **CHESS** = Changes in Health, End-stage disease, Signs and Symptoms, **CL** = Confidence Limit, **MAPLe** = Method for Assigning Priority Levels, **SE** = Standard Error

[a] Reference Group: Age 65-74 years

[b] Depression Rating Scale Score of 1-2, indicating some depressive symptoms: Reference Group = Level 0 (no depressive symptoms)

[c] Depression Rating Scale score of 3 or more, indicating probably depression: Reference Group = Level 0 (no depressive symptoms)

Table 9: Medication Use among Older Home Care Clients with Heart Failure Over Time (N=9,283)

	Assessment 1 n = 9,283	Assessment 2 n = 9,283	Assessment 3 n = 5,456	Assessment 4 n = 3,613
ACE inhibitor Therapy				
Continuous Use	4,541	4,156	2,328	1,455
Never Use	4,742	4,401	2,457	1,594
New Use	-	385	321	213
Discontinued Use	-	341	295	268
Mixed Use[a]	-	-	55	83
β-blocker Therapy				
Continuous Use	3,985	3,711	2,022	1,305
Never Use	5,298	4,951	2,847	1,840
New Use	-	274	227	162
Discontinued Use	-	347	218	239
Mixed Use[a]	-	-	42	26
ARB Therapy				
Continuous Use	1,118	1,000	557	369
Never Use	8,165	7,991	4,615	2,993
New Use	-	118	91	75
Discontinued Use	-	174	169	145
Mixed Use[a]	-	-	24	31

Abbreviations: ACE = Angiotensin Converting Enzyme, **ARB** = Angiotensin Receptor Blocker, **β-blocker** = β-Adrenergic Receptor Blocker

[a] use of pharmacotherapies was inconsistent over all assessments

Table 10: Outcomes by ACE inhibitor Use Over Time among Older Home Care Clients with Heart Failure

(**n**)	Death **(312)**	LTC Admission **(209)**	Hospitalized **(793)**	ADL Decline		CPS Decline	
				New **(429)**	Any **(1105)**	New **(680)**	Any **(1191)**
Continuous Users	139	72	320	167	438	280	503
Never Users	138	114	330	198	516	298	536
New Users	13	10	65	24	65	46	66
Discontinuers	22	12	67	36	74	49	76
(at last assessment)	(22)	(12)	(47)	(24)	(56)	(32)	(54)
Mixed Users[a]	-	1	11	4	12	7	11

Abbreviations: ACE = Angiotensin Converting Enzyme, **ADL** = Activities of Daily Living, **ARB** = Angiotensin Receptor Blocker, **β-blocker** = β-Adrenergic Receptor Blocker, **CPS** = Cognitive Performance Scale

[a] use of ACE inhibitor therapy was inconsistent over all assessments

Table 11: Long-Term Care Admission among Older Home Care Clients by ACE inhibitor Use, Ontario, 2005-2007 (N=9,283)

N (%) **Event n (%)**	**Assessment 2** 3,827 (100) **188 (100)**	**Assessment 3** 1,843 (100) **16 (100)**	**Assessment 4** 3,613 (100) **5 (100)**	**Totals** 9283 **209**
Continuous Users	66/1,666	5/782	1/1,455	72/3,903
(%)	(4.0)	(0.6)	(0)	(1.8)
Never Users	105/1,814	7/814	2/1,594	114/4,222
(%)	(5.8)	(0.9)	(0.1)	(2.7)
New Users	6/146	2/107	2/213	10/466
(%)	(4.1)	(1.9)	(0.9)	(2.1)
Discontinuers	11/201	1/109	0/268	12/578
(%)	(5.5)	(0.9)	-	(2.0)
at last assessment	(11/201)	(1/59)	(0/91)	12/351
(%)	(5.5)	(1.7)	-	(3.4)
Mixed Users[a]	-	1/21	0/83	1/104
(%)		(4.8)	-	(1.0)

[a] use of ACE inhibitor therapy was inconsistent over all assessments

Table 12: Any Functional Decline among Older Home Care Clients by ACE inhibitor Use, Ontario 2005-2007 (N=9,283)

	Assessment 2	**Assessment 3**	**Assessment 4**	**Totals**
N (%)	3,827 (100)	1,843 (100)	3,613 (100)	9283
Event n (%)	**642 (100)**	**221 (100)**	**242 (100)**	**1105**
Continuous Users	268/1,666	88/782	82/1,455	438/3,903
(%)	(16.1)	(11.3)	(5.6)	(11.2)
Never Users	306/1,814	101/814	109/1,594	516/4,222
(%)	(16.9)	(12.4)	(6.8)	(12.2)
New Users	27/146	16/107	22/213	65/466
(%)	(18.5)	(15.0)	(10.3)	(13.9)
Discontinuers	41/201	11/109	22/268	74/578
(%)	(20.4)	(10.1)	(8.2)	(12.6)
at last assessment	41/201	7/59	8/91	56/351
(%)	(20.4)	(11.9)	(8.8)	(16.0)
Mixed Users[a]	-	5/21	7/83	12/104
(%)		(23.8)	(8.4)	(11.5)

[a] use of ACE inhibitor therapy was inconsistent over all assessments

Table 13: New Functional Decline among Older Home Care Clients by ACE inhibitor Use, Ontario 2005-2007 (N=9,283)

	Assessment 2	Assessment 3	Assessment 4	**Totals**
N (%)	3,827 (100)	1,843 (100)	3,613 (100)	9283
Event n (%)	**642 (100)**	**221 (100)**	**242 (100)**	**429**
Continuous Users	112/1,666	32/782	23/1,455	167/3,903
(%)	(6.7)	(4.1)	(1.6)	(4.3)
Never Users	133/1,814	35/814	30/1,594	198/4,222
(%)	(7.3)	(4.3)	(1.9)	(4.7)
New Users	11/146	8/107	5/213	24/466
(%)	(7.5)	(7.5)	(2.3)	(5.2)
Discontinuers	18/201	4/109	14/268	36/578
(%)	(9.0)	(3.7)	(5.2)	(6.1)
at last assessment	18/201	1/59	5/91	24/351
(%)	(9.0)	(1.7)	(5.5)	(6.8)
Mixed Users[a]	-	1/21	3/83	4/104
(%)				(3.8)

[a] use of ACE inhibitor therapy was inconsistent over all assessments