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Factors That Influence 7- and 30-day Readmissions After Heart Failure Hospitalization

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Factors That Influence 7- and 30-day Readmissions After Heart Failure Hospitalization

by

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Abstract

Patients with heart failure (HF) frequently return to hospital within days of discharge, yet contributing factors have not been fully explored. Hospitalizations place stress on the patient, family, and healthcare system, and require closer examination to determine potential avoidability and targets for intervention. Thus, current factors that influence readmissions after HF hospitalization in Alberta were examined.

A two-phased case-control design was used to compare patients who were readmitted and not readmitted after hospitalization for HF. In Phase One, an 8-year period of hospital discharge abstract data was analyzed. The rate of unplanned all-cause readmission was 6% and 18% within 7 and 30 days respectively after discharge. After risk adjustment for age, sex, and year, all-cause readmission within 7 days after discharge was associated with having kidney disease, and readmission within 30 days was associated with having cancer, pulmonary, liver, and kidney disease. At both time intervals, discharge with homecare services was associated with increased risk of readmission, and discharge from a hospital with HF services was associated with lower risk of readmission.

In Phase Two, a health record audit was undertaken for a more detailed examination of factors associated with readmission within 7 days of discharge and potential avoidability. Matched pairs of patients discharged from Calgary hospitals were identified from the Phase One sample. Patients who were frail or had a specialist as attending physician were more likely to be readmitted. Patients who were instructed to see a physician within 1 week of discharge were less likely to be readmitted. Common reasons for readmission included HF then gastrointestinal, other cardiac, and respiratory diagnoses. Almost 60% of readmissions were deemed potentially avoidable based on explicit criteria developed from past research.

Several factors were associated with readmission within the 2 time intervals studied. Despite care by specialists and referral to HF clinics, complex frail patients were discharged with unresolved symptoms or inadequate community support. It is important that criteria be developed to screen for frailty, discharge readiness, and to determine avoidability.

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Dedication

To my daughters, Rachel and Claire, who lived along side me during this project, and faithfully encouraged me to move forward. May they dream big and set out to reach their goals as they grow.

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CHAPTER ONE: INTRODUCTION

Heart failure (HF) is a chronic, progressive condition that can result when there is injury to the heart muscle (e.g. after a heart attack). Approximately 500,000 Canadians are affected by this condition, with 50,000 new cases diagnosed each year in Canada (Ross et al., 2006). This usually older population often requires frequent and costly hospitalizations to treat the troubling symptoms (e.g, shortness of breath, fatigue, edema). In fact, HF is the most common reason for hospital admissions in patients over 80 years of age and the third most common reason for admission for patients 60-79 years of age (Canadian Institute for Health Information, 2013). Further, the more frequently a person requires hospitalization for HF symptoms, the greater the strain on the patient and family, and the poorer their outlook for recovery (Giamouzis et al., 2011; Jha, Orav, & Epstein, 2009; Lee et al., 2009; Lum, Studenski, Degenholtz, & Hardy, 2012).

As the Canadian population ages and people live longer after cardiac events, HF hospitalizations are expected to increase. This will undoubtedly add further strain to the healthcare budget (Johansen, Strauss, Arnold, Moe, & Liu, 2003). Based on 2008-2009 data, there were 26,668 admissions for HF in Canada (Canadian Institute for Health Information, 2013). With an average length of stay over 8 days and a cost of over $7400 (CAN) per admission in Alberta, HF presents a significant economic burden. International policy makers assert that reducing readmission rates will indicate that in-hospital care is improved which, in turn, will help contain healthcare costs (Jencks, Williams, & Coleman, 2009).

Heart Failure

Heart failure is a clinical syndrome that develops in response to injury to the myocardium, resulting in worsening of the heart function over time. Heart function declines due

to the ongoing interaction between the dysfunctional myocardial cells and the pathophysiologic and neurohormonal mechanisms that become activated (Paul, 2012). As heart function worsens, patients may experience reduced energy, difficulty breathing, and at times swelling or chest pain. These symptoms can interfere with patients' ability to work or attend to activities of daily living (e.g. lifting, walking stairs, moving quickly). When symptoms progress to include shortness of breath on minimal exertion or talking, orthopnea, and/or paroxysmal nocturnal dyspnea, hospitalization is required. Frequent hospitalizations, especially readmissions within 30 days, signal a greater risk of death and potentially, a need for advanced therapies or palliative services.

Treatment guidelines for HF aim to slow disease progression and improve symptom management to minimize hospitalizations and risk of death. To reach these goals, researchers have identified that quality patient care includes four actions from their healthcare providers: a) a thorough assessment of reason for admission and etiology of HF; b) optimization of medical treatment; c) continuity of care between inpatient and outpatient services (including community-based monitoring and treatment); and d) education for self-care (Fonarow et al., 1997; Hernandez et al., 2010; Jovicic, Holroyd-Leduc, & Straus, 2006; Patel et al., 2010; Riegel, Jaarsma, & Stromberg, 2012). Interventions by health care workers such as these need to be evaluated to assure quality and to develop strategies to reduce rates of readmission (Howlett et al., 2010).

Healthcare providers' adherence to evidence-based guidelines must be evaluated before assuming the patient's behaviour has triggered the recurrent hospitalization. Once this has been established, then the patient's behaviour should be examined. The patient's role in slowing the disease and managing symptoms involves adhering to medical recommendations about medications, diet and activity; self-monitoring for recurrence of symptoms; and taking action to

resolve changes in symptoms (Riegel & Dickson, 2008). It is important for researchers to scrutinize both patient and provider-based factors contributing to readmission after HF hospitalization.

Readmission

For highly prevalent chronic illness conditions like HF, readmission to hospital within 30 days of discharge is an internationally used outcome to provide a measure of both disease severity and healthcare quality. Readmission is defined as the next subsequent unplanned admission of a patient within a defined interval from a previous (index) discharge (Ashton & Wray, 1996). Readmission is commonly considered an indicator of quality of healthcare provided to patients. Using readmission as an indicator of healthcare quality involves the assumptions that provided the patient was fully treated while admitted, was stable when discharged, and had access to outpatient treatment and resources, the readmission would not occur, and hence be avoidable (Rumball-Smith & Hider, 2009). Outcomes, such as morbidity and mortality, are consistently used to evaluate both disease severity and quality of healthcare. Unlike mortality that is measured by death, morbidity or the amount of disease present, is less finite. Surrogate measures are required to capture disease severity and response to treatment that make up the outcome (Hasan, 2001). Hence, unplanned early re-hospitalization (i.e. readmissions) is an accepted indicator of morbidity that may also reflect the quality of healthcare.

The time interval used to measure readmissions is commonly 30 days after discharge, yet a large portion of these readmissions occurs within 7 to 14 days after discharge. Measuring readmission to hospital within 30 days of discharge has been important for two reasons: (1) to evaluate trends across populations using a consistent time frame, and (2) to provide an indication

of the patient's response to both inpatient and subsequent outpatient services (Joynt & Jha, 2012; Rumball-Smith & Hider, 2009). However, within 30 days of discharge, many patient and community factors over which hospitals have little control, can affect a patient's health (Joynt & Jha, 2012) and may not be modifiable (Desai & Stevenson, 2012; Hernandez et al., 2010; van Walraven, Bennett, Jennings, Austin, & Forster, 2011). Thus, these clinicians call for a greater focus on the 7-day post-discharge period considering nearly half of HF readmissions occur before the first ambulatory visit usually scheduled within that timeframe. As such, arguments are growing to measure readmissions within 7 days for the following reasons: (1) to provide a more accurate reflection of the quality of in-hospital care, (2) to provide timely reporting that may be more likely to motivate clinicians to feel more responsible for the readmission event (Joynt & Jha, 2012), and (3) 7-day readmissions are considered more avoidable (Clarke, 1990; van Walraven, Bennett, et al., 2011).

Avoidability

One of the factors that should be taken into account when measuring readmission is the concept of avoidability. Even though there is general agreement that most readmissions result from the natural worsening of HF or events outside the control of healthcare providers rather than from healthcare errors, researchers contend that identifying, measuring, and reporting avoidable readmissions may result in a more meaningful measure of quality of care (van Walraven, Austin, & Forster, 2012). No studies to date have focused on the one-week post-discharge period nor have attempted to clarify avoidability of readmissions after hospitalization in the HF population, but rather have focused on general medical-surgical populations (Clarke, 1990; van Walraven, Jennings, Taljaard, et al., 2011; Yam, Wong, Chan, Leung, et al., 2010).

While many readmissions to hospital may be necessary and unavoidable, for developing quality improvement strategies, it is important to distinguish those readmissions that may be avoidable.

Problem Statement

As the population ages, increasing numbers of patients live with chronic HF. A significant personal and economic burden results when 15-20% of these patients are being readmitted to hospital within 30 days. Readmission after HF hospitalization has been the focus of many studies, yet two gaps in the literature exist. First, the difference between patients readmitted within 7 or 30 days is not clear. Clarifying patient characteristics and treatment received within the different timeframes is important to determine risk factors leading to readmission. These factors may be related to the inpatient care, outpatient care, or the patient's self-care and need closer examination. Secondly, while considered most avoidable, the subgroup of patients readmitted within 7 days has not been well studied. Detailed examination of this subgroup is important to describe the quality of inpatient care, transitional care, or patient self-care immediately after discharge. Subsequently, clinical strategies aimed at reducing potentially avoidable readmissions can be designed and tested.

Study Aim

The aim of this study was to determine factors contributing to readmission to hospital after HF hospitalization. This information will be used to develop strategies to reduce readmissions. Ultimately, with a better understanding of what contributes to patients being readmitted, this work will contribute to healthcare quality by improving interventions aimed at saving healthcare dollars (efficiency) and improving the well-being of patients and their families (effectiveness).

Research Questions

The overarching research question is: What factors contribute to readmission after HF hospitalization? The secondary questions are: What were the characteristics of patients who were readmitted within 7 and 30 days post-discharge in Alberta between 2004/05 to 2011/12? How do people who were readmitted within 7 and 30 days differ from those not readmitted within 7 and 30 days? What proportion of readmissions occurring within 7 days of discharge is avoidable?

Study Design

To answer these questions and determine the factors contributing to readmission after HF hospitalization, a two-phase retrospective descriptive case-control study was undertaken. Phase One involved analysis of hospital discharge abstract administrative data between 2002-2012 to characterize the sample and determine factors that contribute to or reduce the risk of readmission after hospitalization for HF. A comparison of the risk factors for readmission within 7 days and 30 days was conducted and reported. In Phase Two, a health record audit was undertaken for detailed description and comparison of documented clinical profiles and process-related factors of patients readmitted and not readmitted within 7 days of discharge after hospitalization for HF. Avoidability of the readmissions was determined. Patterns and qualitative description of the factors contributing to readmission was reported.

CHAPTER TWO: LITERATURE REVIEW

Heart Failure

Historical Overview

There has been extensive progress in research on the physiologic mechanisms, as well as the chronic and acute management of HF. Yet, patients with HF have frequent hospitalizations and a shortened life expectancy (Yeung et al., 2012). Heart failure remains a leading cause of death and disability, specifically for those over 65 years of age (Go et al., 2014).

To address the poor morbidity and mortality associated with HF, considerable research was undertaken in the 1980s and 1990s whereby researchers linked neurohormonal mechanisms triggered by injury to the heart muscle to HF symptoms. This major breakthrough in understanding HF pathophysiology occurred when researchers found that when heart muscle cells die (apoptosis) and cardiac output is decreased, a neurohormonal cascade of events resulted in structural remodeling of the heart (Cohn, 1995; Shah, Ali, Lamba, & Abraham, 2001). Remodeling is the change in muscle size, shape, and thickness as the heart attempts to compensate for the regions of damaged muscle (Cohn, Ferrari, & Sharpe, 2000). With this new information, researchers then focused on strategies to slow and reverse heart muscle damage. Researchers studied medications that interrupted this neurohormonal cascade of events and subsequently balanced circulating fluid volume and improved heart function. A series of large clinical trials, such as SOLVD, COPERNICUS, and Val-HeFT, were undertaken to test medications aimed at reducing the deleterious compensatory responses of the renin-angiotensin aldosterone system and the sympathetic nervous systems (Cohn, Tognoni, & Valsartan Heart Failure Trial Investigators, 2001; Packer et al., 2002; The SOLVD Investigators, 1991). As evidence grew, it became the standard of care to prescribe an oral diuretic, an angiotensin

converting enzyme (ACE) inhibitor or an angiotensin receptor blocker (ARB), and a beta blocker for chronic HF management (Arnold et al., 2007).

Throughout the same time period, researchers also focused on establishing essential components of patient assessment to determine HF type and severity. To promote evidence-based practice decisions, authors of clinical practice guidelines (CPGs) for treatment of patients with reduced left ventricular function then advocated for thorough assessment and documentation of: a) etiology (ischemic or non-ischemic), b) degree of heart dysfunction as determined by echocardiogram and other tests, and c) factors leading to the acute symptoms of breathlessness, weakness, or edema (e.g. infection, heart rhythm disturbance, medication or diet non-adherence) (Hunt et al., 2005).

Once it became evident that HF was a chronic and progressive disease that could potentially be reversed or slowed, clinical researchers focused their efforts less on managing acute episodes of symptoms, and more on monitoring symptoms through outpatient care (Fonarow et al., 1997; Lee, Tkacs, & Riegel, 2009). With more specific CPGs for outpatient pharmacological and non-pharmacological treatment of HF with reduced Ejection Fraction (HFrEF), researchers focused on refining and evaluating processes of care to reduce morbidity, mortality, and cost of care (Fonarow et al., 2007). Some of these processes of care included methods for improving continuity of care, inpatient and outpatient up-titration of medications, education for self-care, and supporting patients with monitoring their symptoms. This combination of treatments is known as disease management. Fonarow et al. (1997) reported that a comprehensive HF disease management program, that included optimization of medications and intensive patient education, improved functional status (New York Heart Association (NYHA) class) and decreased hospitalizations by 85% for 214 pre-transplant candidates

discharged after transplant evaluation. This sentinel study prompted HF clinicians and researchers to design outpatient care models aimed at improving outcomes such the frequency of hospitalizations. Still, in the last decade, 30-day all-cause readmission rates after discharge for HF remained as high as 28% (Cujec, Jin, Quan, & Johnson, 2004; Jin, Quan, Cujec, & Johnson, 2003; Joynt & Jha, 2011; Yeung et al., 2012).

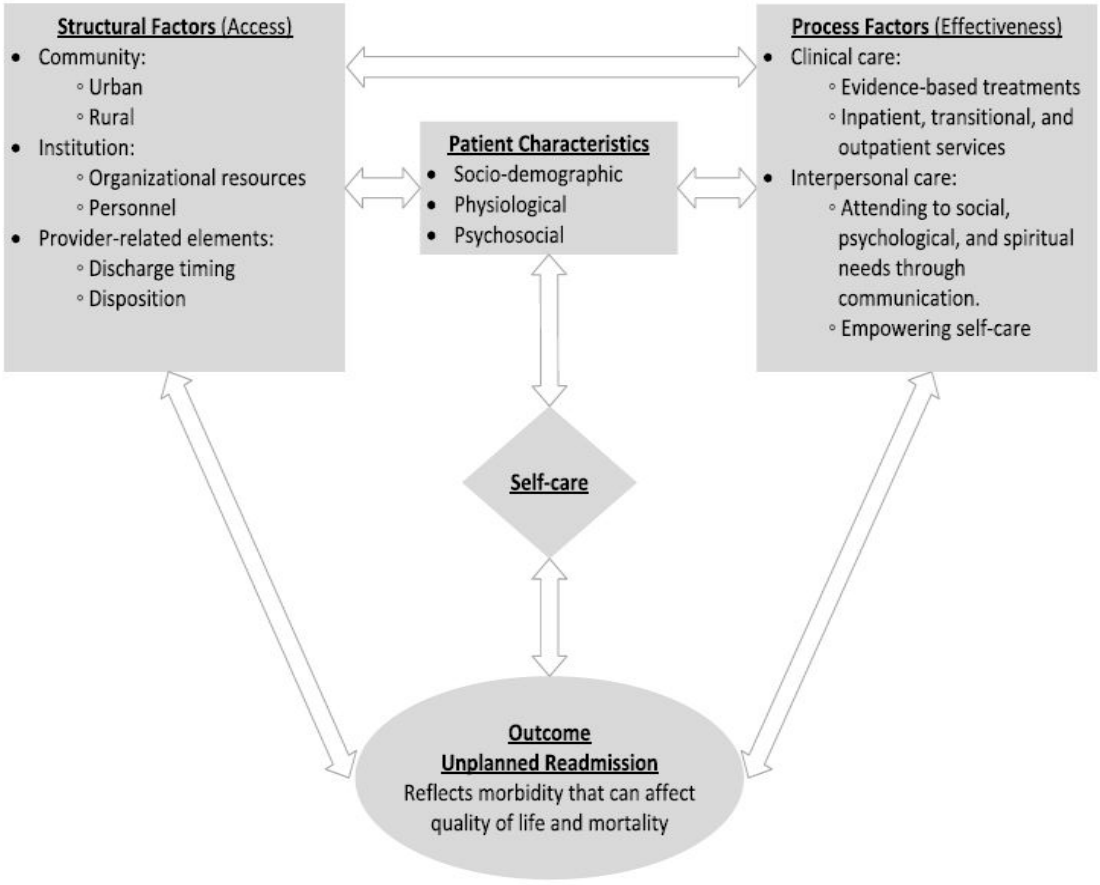
While continuing research for better treatments, researchers also concentrated on tracking and improving HF outcomes by examining (a) risk for hospitalizations (morbidity), and (b) risk for death (mortality). Patients who survived a first hospitalization with HF had a 16% risk-adjusted likelihood of being readmitted to hospital and a 10% likelihood of dying within 30 days of discharge (Yeung et al., 2012). Researchers also recognized the ominous association between number of hospitalizations for acute HF symptoms and an increased risk of mortality (Chun et al., 2012; Joynt & Jha, 2011). Of 7572 patients, repeat hospitalizations for HF symptoms were strongly associated with a greater risk of dying, even after adjustment for predictors of death at baseline (Solomon et al., 2007). Evidence gained from large clinical registry projects in the United States revealed modest improvement in morbidity and mortality which were largely associated with a steady increase in use of guidelines-based therapies for hospitalized HF patients (Fonarow et al., 2007). Given that development of clinical registries have not taken place in Canada, periodic evaluation of outcomes such as readmission rates and the factors contributing to readmission after HF hospitalization, are crucial for assuring healthcare quality (Howlett et al., 2010).

Readmissions and Heart Failure

Given the multi-dimensional nature of factors that lead to HF patients' readmission to hospital, a framework based on established concepts for assessing and monitoring healthcare

quality and utilization was adopted to describe relevant factors (Figure 1) (Brien & Ghali, 2008; Campbell, Roland, & Buetow, 2000; Donabedian, 1978; Phillips, Morrison, Andersen, & Aday, 1998).

Figure 1 Factors contributing to readmission



Recent research on readmission after HF hospitalization has focused on identifying associations among readmissions and various factors including patient characteristics, processes of care, healthcare structures or environment, provider-related factors, and the role of self-care. This framework illustrates the complexity of factors associated with readmission after HF hospitalization. Patient characteristics associated with readmission include the socio-demographic, physiological, and psychological elements of *who* is the recipient of care. Processes elements include *how* clinical and interpersonal care is delivered. Clinical care is the application of knowledge, technology, and actions aimed at effectively addressing health issues. Interpersonal care includes psychosocial interactions for communication, connection, and empowerment (Campbell et al., 2000). Structural, also labeled environmental elements, involve *where* and *who* is involved in providing healthcare, as well as access to and organization of human and system-wide resources (Phillips et al., 1998). Phillips et al. (1998) identified provider-related factors to include aspects of patient care influenced by providers like discharge disposition and access to specialty programs. Finally, self-care is the work of living with a chronic illness and thought to strongly influence outcomes including readmissions (Jovicic et al., 2006).

As indicated by the arrows, all components of this framework are interrelated and potentially contribute toward readmission. For example, processes of care vary given the structural support systems for care delivery (e.g. urban versus rural location). As well, patient characteristics impact treatment options and the range of services accessed. Patient characteristics also influence the level of interpersonal intervention required for supporting self-care practices. For instance, frequent episodes of pulmonary edema alerts practitioners to pay greater attention to a patient's sodium intake. Further, engagement in self-care can enhance

physiologic stability, such as stable fluid balance as evidenced by stable weight. This is an example of the two-way relationship between patient characteristics and self-care behaviours that can be associated with the frequency of readmission to hospital.

Patient Characteristics Associated with Readmission After Heart Failure Hospitalization

A wide range of patient characteristics has been associated with a greater or lesser risk of readmission after HF hospitalization. Table 1 includes a comprehensive list of these characteristics; some of which are described in detail below.

Table 1. Factors related to readmissions in the heart failure population

Factors associated with increased risk of readmission	Factors associated with decreased risk of readmission	Factors with mixed or insufficient evidence
Patient		
Advanced age	Patient education	Race/ethnicity
Social or economic factors related to poverty influencing adherence to treatment (e.g. cost of medications)	Adherence to evidence-based pharmacotherapy	NYHA class/ functional status
Rural dwelling	Living with a partner or married	Low systolic blood pressure
Living alone/lack of social support	Above average self-management	High systolic blood pressure (low and high blood pressure have been associated with more readmissions)
Comorbidities (chronic obstructive pulmonary disease, renal disease, diabetes, coronary artery disease, heart valve disease, idiopathic cardiomyopathy, prior cardiac surgery)		Depression
New onset anemia		Presence of congestion at discharge
Higher symptom severity; Chronic disability		
History of one or more hospitalizations for HF		
Longer length of stay		
Elevated serum B-type natriuretic peptide, cardiac troponin, serum creatinine on admission; persistent hyponatremia		
New medical problem; Old problem worsens; Addiction issues; Language/cultural barriers		
Atrial fibrillation; Low ejection fraction		
Severe anxiety		
Inadequate self-care		
Limited health literacy		
Poor sense of life purpose		

Provider Poor adherence practice guidelines by cardiologists and primary care physicians Laboratory tests not followed-up properly Inappropriate timing of discharge	Beta blocker use Angiotensin converting enzyme inhibitor use Cardiologist involvement	
System Discharged on Friday Lapse in communication with primary care physician Inadequate patient education Medication errors Lack of timely follow-up Discharged home with home health services Inadequate or lapse in home health services	Disease management systems Home follow-up by nurse practitioner Follow-up arranged early after discharge Timely communication of discharge summary to primary care Multidisciplinary teams Post discharge care	Higher hospital scores on performance indicators

Note. NYHA = New York Heart Association classification score

Socio-demographic Characteristics

Several socio-demographic characteristics have been linked with higher rates of readmission after hospitalization for HF. However, the evidence is not always clear. For example, advanced age has been associated with more frequent readmission after HF hospitalization (Anderson et al., 2006; Giamouzis et al., 2011; Hamner & Ellison, 2005; Philbin & DiSalvo, 1999; Ross et al., 2008). Yet, in other studies, the proportion of readmissions is similar across age groups (Lee et al., 2004). The sex of patients has not been consistently associated with readmissions (Howie-Esquivel & Dracup, 2007; Ross et al., 2008). Likewise, the relationship between race and readmission is not clear. For example, African-American or Hispanic race has been associated with higher readmission rates (Evangelista, Dracup, & Doering, 2002; Howie-Esquivel & Dracup, 2007; Philbin & DiSalvo, 1999; Rodriguez, Joynt, Lopez, Saldana, & Jha, 2011). However, few other racial groups have been studied. Researchers examined associations between readmission rates, race, hospital location, and socioeconomic status, and determined that residing in lower socioeconomic regions may be the

stronger factor for readmission rather than race (Giamouzis et al., 2011; Philbin & DiSalvo, 1999; Rodriguez et al., 2011). Readmissions were also higher for patients from rural regions than urban region (Jin et al., 2003). While there is little known about race, socio-economic status, and place of residence in relation to readmissions, age is a strong potentially confounding variable and must be included in studies of readmissions.

Living alone has been associated with higher readmissions while being married has been identified as protective (Anderson et al., 2006; Chung et al., 2009; Giamouzis et al., 2011; Hamner & Ellison, 2005). One study revealed patients hospitalized for HF who were living without a partner had 1.8 times greater risk of readmission within 90 days than those who were married (Howie-Esquivel & Spicer, 2012). In addition, social isolation and lack of social support are associated with increased risk of re-hospitalization (Krumholz et al., 1998; Moser, 2002; Rodriguez-Artalejo et al., 2006). Therefore, the relationship between habitation and readmission is worthy of closer study.

Physiological Characteristics

Some physiological characteristics, particularly comorbid conditions such as renal or lung disease, are associated with increased readmission risk (Giamouzis et al., 2011). Specifically, prior myocardial infarction or underlying ischemic heart disease, renal failure, and chronic pulmonary disease exhibit the strongest links to hospital readmission (Chun et al., 2012; Ross et al., 2008). Evidence has been consistent that the greater number of comorbid conditions, as often measured by the Charlson comorbidity index score (Quan et al., 2011), is associated with increased risk of readmission in the HF population (Anderson et al., 2006; Giamouzis et al., 2011; Philbin & DiSalvo, 1999). Other comorbid conditions, such as atrial fibrillation, diabetes, anemia, depression, and alcoholism, have been shown in some studies to be associated with

readmission to hospital but with less consistent evidence (Anderson et al., 2006; Giamouzis et al., 2011; Ross et al., 2008). While the Charlson comorbid index is a strong predictor of readmission risk, when used as a proxy measure for symptom severity, NYHA functional score is not a good predictor of readmission risk and is not consistently documented (Ross et al., 2008). Lastly, left ventricular ejection fraction or a description of left ventricular function is inconsistently associated with readmission risk, though it is an important measure of cardiac function and a proxy for disease severity.

While the greater number of comorbid conditions increases the risk of readmission, the actual presenting symptoms that trigger return to hospital have not been well documented. Some authors claim that the majority of readmissions to hospital are due to exacerbation of HF symptoms (Giamouzis et al., 2011). Yet, research reveals only one fifth of readmissions are due to HF symptoms (Yeung et al., 2012). In another study patients and caregivers most frequently reported worsening HF as the contributing factor for readmission, while providers reported comorbidity, non-adherence, or non-optimal medications as the most important contributing factors (Annema, Luttik, & Jaarsma, 2009). Patients and providers agreed on the underlying reason for the readmission in only 34% of cases. Differing viewpoints highlight the need for further study of presenting symptoms and precipitating factors.

Various other physiological characteristics and biomarkers have been associated with increased risk of readmission after HF hospitalization. Though not frequently tested in Canada, B-type natriuretic peptide (BNP) measured at the time of index admission may be a promising biomarker as it has been shown to be strongly associated with risk of readmission (Cheng et al., 2001; Ross et al., 2008). Although not as strong an association, readmissions have been linked

with elevated serum creatinine and cardiac troponin at time of discharge after HF hospitalization (Hillege et al., 2006; Ross et al., 2008).

Other physical signs such as low and high systolic blood pressure on admission have been correlated with readmission (Felker et al., 2004). Although there is lack of agreement about measurement, determining the presence of pulmonary congestion (e.g. dyspnea, crackles) at time of index discharge is an emerging indicator of HF severity and risk of readmission (Anderson, 2010). Clusters of symptoms have been described as acute HF syndromes (e.g. warm and wet, cold and wet, cold and dry) at the time of admission, and have not yet been examined as risk factors for readmission (Nohria, Mielniczuk, & Stevenson, 2005). These syndromes indicate levels of disease severity and may illuminate patterns for readmission.

Frailty is a geriatric syndrome that can occur when multiple body system impairments lead to decreased reserve and resilience to stressors, and is identified to some degree by the presence of multiple comorbid conditions, dependency and assistance with activities of daily living (Afilalo, Karunananthan, Eisenberg, Alexander, & Bergman, 2009). Frailty is strongly associated with cardiovascular disease and disability (Buck & Riegel, 2011) and can be a marker of disease severity and risk of poor outcomes. More than 50% of older patients with HF are frail (Afilalo et al., 2009). While consensus on an operational definition is still under development, criteria for frailty include many of the deficits experienced by HF patients, such as exhaustion, inactivity, weight loss, cognitive impairment, reduced gait velocity and grip strength. Hence, frailty may be a risk factor for readmission for HF patients. Also, the frail are less likely to be able to live alone, have a greater need for home support services, and have a greater risk of institutionalization in acute or long-term care (Rockwood et al., 2004). As such, associations

between readmission, frailty, and disposition (e.g., to home, homecare, long-term care) or access to HF services remain unknown.

In general, research focused on physiologic characteristics has been hampered by lack of replication as different variables are often reported in the various studies. Fewer researchers have studied physiological characteristics given that data can only be captured in clinical registries, prospective trials, or laborious health record audits.

Psychological Characteristics

There is limited understanding of the extent to which psychological characteristics contribute to readmission patterns of HF patients. Researchers who have examined predictors for readmission have rarely included psychosocial factors in their examination (Betihavas et al., 2012). In a few studies, poor perceived quality of life (Howie-Esquivel & Dracup, 2007; O'Loughlin et al., 2010), a poor sense of life purpose (Hodges, 2009), and severe anxiety (Volz et al., 2011), were associated with greater risk of readmission. In addition, psychosocial factors such as self-efficacy, coping, spirituality, and social support were also independently predictive of morbidity in patients with HF (Clark & Thompson, 2008; Moser, 2002). Psychosocial characteristics are not readily available in administrative data files or health records and often require prospective study designs.

The role of social support for the prevention of readmissions is not yet clear although data on marital status (a proxy of social support) is readily available in health records. Volz et al. (2011) reported no significant relationship between social support and readmission risk. Yet, self-care has been determined an independent predictor of readmission, and the presence of social support predicts strong self-care maintenance behaviours (Salyer, Schubert, & Chiaranai,

2012). Thus, marital status is likely worthy of further study in relation to readmission patterns in this population.

Process Factors

The relationships between readmissions after HF hospitalization and various clinical and interpersonal care processes have been studied. The following categories have been examined: diagnostics, treatment, patient education, self-management, and monitoring of disease status (Bonow et al., 2006). These categories involve interventions during inpatient care, at time of transition from hospital to the community, and during outpatient care.

Inpatient Care

Care processes advocated by consensus guidelines for the treatment of acute HF include: a) identifying the underlying cause of the exacerbation; b) evaluating left ventricular function; c) assessing and treating fluid imbalance; d) optimizing medications including prescription of ACE inhibitor after stabilization (Arnold et al., 2007; The SOLVD Investigators, 1991); and e) attending to psychosocial/family needs (Arnold et al., 2006; McKelvie et al., 2013). The assumption is that when patients are treated based on these guidelines; a portion of early readmissions should be avoidable. While there has been improvement in uptake of consensus recommendations by practitioners over time, it has been slow and patients are not consistently receiving evidence-based treatment (Shahian et al., 2012).

Given that many patients who are readmitted after HF hospitalization have advanced stages of the disease and are often older, another recommended inpatient process of care is discussion and documentation of the goal of care (Howlett et al., 2010). Recommendations include documentation of: a) a personal directive; b) discussion of resuscitation preferences; and c) review and revision of the goal of care (Howlett et al., 2010). These processes of care have

not been well studied in relation to outcomes, such as readmission to hospital. As well, the frequencies of hospitalizations of HF patients who are referred to palliative care or hospice services have not been well studied. Given the difficulties with prognostication for advanced HF, these end-of-life processes of care are not consistently implemented despite strong recommendations (Goodlin, 2009).

Inpatient Processes of Care and Measuring Quality

No agreement has been reached on which processes of care have the greatest association with readmission; hence, Pan-Canadian quality indicators remain under development for HF (Abrahamyan, Boom, Donovan, Tu, & Canadian Cardiovascular Society Quality Indicators Steering Committee, 2012; Johnstone, Buller, & National Steering Committees on Quality Indicators and Data Definitions of the Canadian Cardiovascular Society, 2012). In the United States, the frequency of implementation of several HF processes of care is publicly reported to reflect the quality of hospital care and to trigger quality improvement. Some HF processes of care chosen as performance indicators used by the Centers for Medicare and Medicaid (CMS) and The Joint Commission for Hospital Accreditation from the United States include: a) prescription of ACE inhibitor or ARB for left ventricular systolic (LVS) dysfunction; b) evaluation of LVS function; c) smoking cessation counseling; and d) discharge instructions (Schopfer, Whooley, & Stamos, 2012).

The evidence is inconsistent regarding the relationship between hospital scores on the CMS required processes of care and readmission rates. For example, Schopfer et al. (2012) analyzed the individual measures within the CMS data for 3655 hospitals and found that of the four processes of care, only evaluation of LV function and smoking cessation counseling documentation were associated with lower readmission rates. Similarly, Jha et al. (2009) found

no association between documentation of discharge instructions and lower readmissions rates. Further, Kociol et al. (2012) analyzed survey data from 100 hospitals participating in 'Get With The Guidelines', which is a collection of process improvement tools initiated by the American Heart Association. They reported that inpatient processes were not associated with lower 30-day readmissions, but hospitals with the lowest readmission rates had modestly higher scores on discharge and transitional processes of care. Despite the lack of consensus, Canadian clinical practice guidelines for acute care of the HF patient include recommendations for consistent application of acute care processes which include the medications prescribed at discharge, left ventricular function evaluation, documentation of patient education, and referral for specialized outpatient follow-up (Howlett et al., 2010).

Transitional Practices and Outpatient Disease Management

Even when patients receive evidence-based in-hospital care for HF, ongoing medical attention and patient adherence to medical regimens can be challenging once they return to the community (Riegel et al., 2009). Clinical practices at the time of transition from hospital to community and as well as immediate post-discharge interventions can influence the risk of readmission (Malcom et al., 2008; Paul, 2012; Phillips et al., 2004). For example, timely transfers of discharge summaries to the outpatient physician (van Walraven, Seth, Austin, & Laupacis, 2002) and the type of outpatient specialist as treating physician have been associated with readmissions (Ezekowitz, van Walraven, McAlister, Armstrong, & Kaul, 2005). For example Ezekowitz et al. (2005) reported readmissions occurred less often when cardiologists were a part of outpatient follow-up. As well, researchers reported reduced readmissions when patients received follow-up with a physician within 7 days of discharge (Hernandez et al., 2010). Notifying the family physician of the admission to hospital, informing the patient to schedule an

appointment with his/her family practice physician within one week of discharge, and referring the patient to a cardiologist are supported in clinical practice guidelines (Howlett et al., 2010).

Transition to a HF disease management program is also associated with reduced readmissions (Krumholz et al., 2002; McAlister, Stewart, Ferrua, & McMurray, 2004; Riegel et al., 2009). Disease management includes coordinated heath care interventions and communication whereby medications are optimized, symptoms are closely monitored, and patient self-care is supported (Paul, 2012). Sufficient evidence exists that there is a strong association between enrolment in disease management programs and reduced hospitalizations that enrolment in disease management programs is recognized as Class I, Level A evidence in clinical practice guidelines for HF (Howlett et al., 2010). For example, the findings of an RCT revealed patients who attended a multidisciplinary HF clinic for 6 months, were readmitted to hospital significantly less than those who did not (35% v. 57%, HR 0.59, 95% CI 0.38-0.92) (McAlister et al., 2004). Similarly, specific disease management interventions like home visits and telephone monitoring have also been linked with reduced readmissions (Ducharme, Doyon, White, Rouleau, & Brophy, 2005; Inglis et al., 2010).

Structural Factors

Structural factors that make up the context of care have been associated with risk of readmission. Structural elements include factors associated with resource utilization across the health services continuum from hospital to home (Anderson et al., 2006; Brien & Ghali, 2008; Phillips et al., 1998). For example, frequency of hospitalizations and length of stay make up the context of care. Multiple hospitalizations, usually specified as more than one in previous 6-12 months (Rodriguez-Artalejo et al., 2006; van Walraven, Oake, Jennings, & Forster, 2010), and longer lengths of stay during index admission (Au et al., 2012; van Walraven, Bennett, et al.,

2011; van Walraven et al., 2010) have been associated with increased risk of readmission after hospitalization for HF. Discharge timing and disposition after discharges are also contributing factors for readmissions. For example, discharges on Fridays have been related to higher HF readmissions (van Walraven & Bell, 2002). Discharge disposition has been associated with readmission risk such that patients discharged to home with home health services have been more likely to be readmitted, while patients in long-term care settings less likely to be readmitted following a hospitalization for HF (Hamner & Ellison, 2005; Howie-Esquivel & Spicer, 2012).

Self-care

Self-care is the work of living with a chronic illness (Granger, Sandelowski, Tahshjain, Swedberg, & Ekman, 2009). While living with HF, patient self-care involves self-maintenance behaviours (e.g., adhering to recommended diet, medications), monitoring for bodily changes (i.e., self-monitoring), and evaluating and acting on bodily changes (i.e., self-management) (Riegel et al., 2012). Researchers have reported that many readmissions after HF hospitalization are attributed to inadequate self-care (Ditewig, Blok, Havers, & van Veenendaal, 2010; Lee, Moser, Lennie, & Riegel, 2011; Moser et al., 2012). For example, after controlling for 15 confounders, of 195 NYHA class III-IV patients, those who engaged in above average self-management were less likely to be readmitted (HR 0.44, 95% CI 0.22-0.88) (Lee et al., 2011). Other researchers identified difficulties with self-care (e.g. non-adherence medications and diet; delay to seek medical care) have been strongly associated with increased risk of readmission after hospitalization for HF (Annema et al., 2009; Lee et al., 2011; Moser et al., 2012; Rich et al., 1993). Patients with strong social support and access to care had enhanced self-care practices and fewer readmissions after hospitalization for HF (Krumholz et al., 1998; Riegel et al., 2012; Rodriguez-Artalejo et al., 2006; Salyer et al., 2012). Riegel et al. (2012) found self-care ability

to be partially innate and partially modifiable with support from caregivers (family or professional) and access to health resources.

Avoidability of Readmissions

Some unplanned readmissions may be necessary, yet some may be avoidable. Avoidable and preventable are used synonymously in the literature. Identifying the potential avoidability of readmissions to hospital has been deemed important if hospital readmission rates are to be used to reflect the quality of care (Goldfield, 2011; van Walraven, Jennings, & Forster, 2011). Further, quality improvement efforts have a greater chance of success if aimed at the subset of potentially avoidable readmissions.

There is some degree of agreement among researchers regarding what constitutes avoidable readmissions. Readmission is deemed avoidable if:

1) it is clinically related to the first admission, that is, returning with the same diagnoses;

2) quality of inpatient care did not meet practice standards;

3) adverse event related to hospital care;

4) inadequate discharge planning including palliative care;

5) inadequate outpatient follow-up

6) gaps in communication between inpatient and outpatient healthcare providers (Clarke, 1990; Goldfield et al., 2008; Halfon et al., 2002; Oddone et al., 1996; van Walraven, Jennings, Taljaard, et al., 2011; Yam, Wong, Chan, Leung, et al., 2010).

Research involving evaluation for potential avoidability of readmissions to hospital presents several challenges and gaps: subjectivity of the avoidability criteria, health record reviews are laborious, historically judgement of avoidability has been limited to physician panels, and avoidability has only been studied in general medical/surgical populations. First, the

more subjective the criteria for avoidability, the less reproducible are the results. For example, subjective terms like 'inadequate discharge planning', or 'premature discharge' are not specific enough to be replicated by other reviewers or to indicate the change that must take place to prevent a readmission (Goldfield, 2011; Halfon et al., 2002; Yam, Wong, Chan, Leung, et al., 2010). Hence, concrete descriptive criteria for avoidable and not avoidable readmissions is needed that could be used in screening tools to determine readiness for discharge.

Next, attempts have been made to determine avoidability of readmissions using administrative discharge abstract data (Goldfield et al., 2008; Halfon et al., 2002; Walker, Teare, Hogan, Lewis, & Maxwell, 2009). Administrative data can readily reveal if the readmission was for the same diagnosis as the index admission (which is considered avoidable), but does not include clinical care or patient factors. Goldfield later comments that diagnosis codes alone are not enough to determine avoidability (Goldfield, 2011). Only a few researchers have undertaken the laborious task of reviewing multiple health records and assembling panels of physician reviewers, which to date has been the gold standard for determining avoidability of readmissions (Clarke, 1990; Oddone et al., 1996; van Walraven, Jennings, Taljaard, et al., 2011; Yam, Wong, Chan, Leung, et al., 2010). Lastly, medical and surgical populations as a whole have been studied, not disease-specific populations. Studying high readmission populations like HF might reveal important patterns for refining criteria to judge avoidability, and ultimately aid in strategies to prevent potentially avoidable readmissions.

Conclusion

Over time researchers have focused on refining clinical processes and evaluating the delivery of services to improve outcomes (e.g., morbidity) as measured by readmission status after hospitalization for HF. Without large clinical registries in Canada, factors that contribute to

readmission have not been well examined. As organized within a framework, several clusters of patient, process, structural, and self-care factors require further study. While there are extensive research reports focusing on factors contributing to readmission after hospitalization for HF, detailed examination of hospitalized patients in Alberta, Canada will enhance understanding of this multidimensional construct. Strategies to reduce unplanned avoidable readmissions will be clearer with further study of avoidability of these readmissions in the HF population.

CHAPTER THREE: DESIGN AND METHODOLOGY

Research Design

A two-phased descriptive case-control study was undertaken to examine factors that contribute to readmission after hospitalization for HF in Alberta. Phase One involved a population-based analysis to identify factors associated with risk of all-cause and HF-specific readmissions within 7 and 30 days of hospital discharge. Phase Two involved a health record audit to examine the socio-demographic, clinical, and health system factors associated with risk of all-cause readmissions within 7 days post-hospital discharge in the city of Calgary, Alberta only.

Phase One

We conducted this population-based study to identify factors associated with risk of all-cause and HF-specific readmissions within 7 and 30 days of hospital discharge[1]. We hypothesized that factors associated with readmission within 7 and 30 days are different. Risk of readmission for patients with HF may be lessened with appropriate disposition (i.e., to home, homecare, long-term care, or left against medical advice) and/or access to specialized HF services.

Administrative Data

This study included de-identified inpatient discharges from the Discharge Abstract Database (DAD) for the province of Alberta linked with the Alberta Health Insurance Plan Registry file. While DAD data have been rigorously collected, there are several potential issues with using discharge abstract data. The primary issue is that validity of administrative data is dependent upon the quality of physician documentation and coding consistency. Further,

[1] Phase One of this dissertation has been previously published (Eastwood et al., 2014)

validity studies have not included all variables (e.g. discharge disposition, most responsible physician) and researchers have only reported the validity of diagnoses, comorbid conditions, and procedures (Canadian Institute for Health Information, 2012).

Despite these potential issues, DAD is a strong data source for research purposes. The DAD includes complete data and the data quality is maintained by procedures required for submission of the data to the national database (Canadian Institute for Health Information, 2009). As well, strong face validity of the Alberta DAD has been determined with a high level of consistency among coders for diagnoses, procedures, and complications (Hennessy, Quan, Faris, & Beck, 2010).

The DAD includes a field for most responsible diagnosis and up to 24 secondary diagnosis fields that are coded using International Classification of Disease-10 (ICD-10) (Quan et al., 2008). ICD-10 code I50 has been validated in the Alberta database and captures the majority of HF cases with accuracy determined by a chart audit comparison (Quan et al., 2008).

Study Cohort

We extracted all hospital separations with the most responsible diagnosis field coded I50.x of the ICD-10 between April 1, 2002 and March 31, 2012. We excluded separations meeting any of the following criteria: 1) not an Alberta resident or service not provided in an Alberta facility; 2) age < 19 or > 105 years; 3) in-hospital death or death within 30 days after discharge; 4) discharged to another acute care facility; and 5) any duplicated separations in subsequent study years if repeated separations occurred. To increase the likelihood that incident HF cases were identified, we performed a washout whereby we excluded patients hospitalized with a primary or secondary diagnosis of HF (ICD-10 I50) during the two years before 2004. After exclusions, each patient had one index HF discharge.

Outcome Variables

All patients were followed to April 30, 2012 to ensure a minimum of 30 days for follow-up by linking admissions in the DAD to determine readmission to any acute care hospital in Alberta within 7 days and 30 days following discharge. We included non-elective readmissions and grouped readmissions into four categories: 7-day readmission for all causes, 7-day readmission for HF, 30-day readmission for all-causes, and 30-day readmission for HF. These categories were not mutually exclusive. Reason for admission was defined based on the most responsible diagnosis of I50.x.

Independent Variables

We defined sex, age at time of admission, and Charlson comorbid conditions within 24 secondary diagnoses fields of the DAD for the index HF hospitalization using validated coding algorithms to define the comorbidities (Quan et al., 2005). The Charlson comorbid index, as a proxy of disease severity, exhibits good-to-excellent prediction of mortality, and has been validated for accuracy of coding for the HF population in the Alberta DAD (Quan et al., 2011; Yeung et al., 2012). As another proxy severity indicator for the index HF hospitalization, length of stay (LOS) was calculated as days between admission and discharge dates, and included time spent at both hospitals for patients transferred between institutions (Eapen et al., 2013). Discharge was attributed to the last hospital in the transfer chain.

Discharge disposition was identified in the DAD. Disposition categories included discharged home, discharged with homecare (e.g. home health services, senior's assisted living, homemaking), discharged to long-term care (including inpatient or outpatient continuing care for rehabilitation, psychiatric, or palliative services, and nursing home discharges), or discharged against medical advice.

While physicians discharging patients from all Alberta hospitals can refer to any outpatient HF program, specialized HF services were offered in 13 centers: 11 hospitals had onsite access to specialized disease management, while 2 hospitals provided access via telemedicine (Alberta Health Services, 2012). These services included HF-specific discharge teaching and referral of new HF patients to outpatient programs for optimizing medical management and promoting self-care practices. Generally, these hospitals reported the highest volume of HF admissions and had critical care services. Each hospital was assigned a unique numeric identifier. Index hospitals were thus categorized as with or without specialized HF services. The attending physician at time of discharge was used to define attending physician specialty as primary care physician, cardiologist or internal medicine physician, or other specialist.

Statistical Analysis

We described patient characteristics and tested differences between patients readmitted or not within 7 or 30 days using Chi-square tests for categorical variables and *t*-tests for the continuous variables.

Logistic regression models were used to determine odds ratios for each variable within readmission categories. Full logistic regression models including all variables were fit to identify significant factors contributing to readmission for each outcome. Parsimonious models including age, sex, and only the significant variables were then fit using a stepwise method to determine the strong readmission predictors for each outcome. All statistics and modeling were done in Stata (Version 11.2) (Stata Corp, Texas, 2009) and the level of significance was defined as $p < 0.05$.

Phase Two

A health record audit was undertaken to examine the socio-demographic, clinical, and health system factors associated with risk of all-cause readmissions within 7 days post-hospital discharge. We hypothesized that patients who are readmitted within 7 days of discharge have particular characteristics that may predict their readmission. We also hypothesized that certain readmissions are potentially avoidable. Health records of patients discharged from 3 Calgary, Alberta hospitals were reviewed. The 3 hospitals are large, tertiary care facilities with cardiovascular services. All 3 settings admit a high volume of HF patients annually and offer outpatient services for HF. We explored patient characteristics (i.e. socio-demographic and physiologic), structural elements (i.e. provider type), and process elements (e.g. prescribed medications, patient education, referrals to outpatient services) occurring in the index health record at admission and discharge, and readmission health record at admission and discharge. We also explored events leading to readmission for patterns and potential avoidability. While some early readmissions may be necessary and unavoidable, the risk of early readmission for patients with HF may be lessened with evidence-based therapy, clinical stability at discharge, and appropriate disposition and/or access to specialized HF services. Therefore, this phase of the study included a thorough examination the patient characteristics and processes of care for the readmitted and not readmitted groups.

Study Cohort

A cohort of patients readmitted within 7 days and patients not readmitted within 7 days was identified from the same DAD administrative data set as used in Phase One. We identified hospital separations with the most responsible diagnosis field coded I50.x of the ICD-10 between April 1, 2004 and March 31, 2012. The index hospitalization was defined as the first occurring

admission to any hospital with a most responsible diagnosis of HF as coded after discharge as ICD-10CA code I50. The corresponding readmission within 7 days of discharge, if present, was also identified. Based on Phase One data, we estimated approximately 200 health records would fit the inclusion criteria based on the frequency of readmissions to Calgary hospitals within 7 days of discharge.

Inclusion Criteria

Patients were included if they were discharged alive from any of the 3 Calgary, AB hospitals. Patients readmitted and not readmitted were matched by sex, by 5-year categories of age (e.g. 60-64 years), and by discharge date within the same fiscal year. Two lists of patient records were generated from the administrative data used in Phase One that included: a) index admission records of all patients readmitted within 7 days with the corresponding readmission record, and b) the index admission records of the matched set of patients not readmitted within 7 days. We included only non-elective readmission occurrences.

Exclusion Criteria

As in Phase One, we excluded separations meeting any of the following criteria: 1) not an Alberta resident or service not provided in Alberta facility; 2) age < 19 or > 105 years; 3) in-hospital death; and 4) discharged to another acute care facility. However, if repeated separations occurred and were followed by readmission within 7 days, the file was included to capture the maximum number of readmissions occurring within 7 days of discharge.

Ethical Considerations

The Conjoint Health Research Ethics Board granted ethics approval and a Research Agreement with Alberta Health Services was signed prior to initiation of the study (Appendix A). Approval was also obtained from the department of Health Information/Records

Management for Calgary and Area of Alberta Health Services (Appendix A). The specifications for confidentiality were respected by assigning a unique study code number to each health record. Only the code number appeared on the data collection forms and no identifying patient information was collected. Master lists with health record numbers and data collection forms were kept in separate locations during data collection. This study involved existing data and posed very low risk to participants. Thus, no consent was obtained from patients.

Instrumentation

Health record data collection forms were created to compile pertinent health record data. The data for the index admission and subsequent readmission of the case group was compiled on one form (Appendix B). The data for the index admissions of the control group (not readmitted) was compiled onto another form. The data collected for the index admission of both groups was the same. The data collection forms included data definitions and information on where to locate the data.

Variables were captured from both the index and readmission records when appropriate. Electronic- and paper-based data were collected as the Calgary, AB hospitals use a hybrid health record system. Using health record data for research can pose challenges largely due to the potential for missing data when there is inconsistent clinical care and documentation (e.g. echocardiogram reports may not be available on all patients). Nonetheless, this retrospective health record audit was advantageous in that health records of large numbers of study subjects were examined enhancing the statistical power and generalizability of the findings. Also, a health record audit, as such, results in an authentic representation of real-life or usual clinical care, not necessarily possible in prospective study designs (Anderson, 2010).

Reliability and Validity of Health Record Data

Reliability of health record data is dependent upon the quality of documentation. Variability in chart quality may occur given the subjectivity of clinical variables (e.g. rales in the lungs) and documentation by multiple clinicians. Health records included information that was required for this study, which was not available from other sources. While the validity of health record data cannot be determined given there is no 'gold standard' for comparison, health record data were valuable for this type of research (Iezzoni, 2003). Health record data are considered the 'gold standard' by which to validate administrative data (So et al., 2010).

Age, sex, admission, discharge dates, and fiscal year were generated using the DAD and have a high degree of completeness and accuracy (Hennessy et al., 2010). As in Phase One, the most responsible diagnosis and the Charlson comorbid conditions were also derived from the DAD. Both the most responsible diagnosis of HF (ICD-10CA I50) and presence or absence of a non-elective readmission to hospital within 7 days of discharge was verified within each health record.

Health record data sources included the emergency department admission forms, history and physical documents, interdisciplinary progress notes, laboratory and diagnostic reports, and discharge summaries. While documentation can vary in degrees of completeness, health record data have been considered important and highly accurate. For example, nursing admission notes have been found to be valuable chart components when scored for quality and quantity (Paans, Sermeus, Nieweg, & van der Schans, 2010).

The investigator and 2 research assistants evaluated index and readmission health record quality and assigned a score on a scale of 1 to 10. A high score was assigned for a very helpful and thorough health record when all variables were readily located. Lower scores were assigned

when information was missing (e.g. the discharge summary was sparse, weights or patient education were not documented).

Establishing Inter-rater Reliability of Data Collection

To enhance the reliability and validity of the study, each item on the data collection form included a definition of the variable and where to locate the data in the health record (Appendix B). The research assistants (senior nursing trainees) underwent extensive training with the investigator regarding data definitions.

Initially, each member of the reviewer group audited 5 different health records. This experience enabled further clarification of the variable definitions and improvements to the data collection forms. Then, data collection proceeded to establish initial inter-rater reliability. To accomplish this, each reviewer abstracted data from the same 7 health records. Agreement between reviewers was examined. A kappa statistic of 0.61–0.80 suggests substantial agreement, and 0.81–1.0 suggests almost perfect agreement (Kunac, Reith, Kennedy, Austin, & Williams, 2006). The mean kappa statistic of this first check was 0.85 (range: 0.62-1.0). Discrepancies between the reviewers were discussed until consensus was reached and the variable definitions were refined. Then, each team member reviewed 3 additional health records to test the agreement again and achieved almost perfect agreement (mean: 0.89; range: 0.50 – 1.0) and data collection proceeded. Upon commencing record review at the second and third hospital, inter-rater reliability checks were completed on 5 more records at each site by all 3 team members with almost perfect agreement (mean 0.86; range 0.6-1.0, and mean 0.92; range 0.66-1.0).

Data Management

Anonymity was maintained. For identification, only the last 3 digits of the medical record numbers were recorded on the data collection forms. All study documents were securely

transported from the hospital sites to the University of Calgary. Completed data collection forms were kept under locked storage in the research offices of Kathryn King-Shier in the Faculty of Nursing, University of Calgary. Upon completion of data collection, data were transferred to one electronic file for analysis. This file was password protected. All hard copy forms will be held securely for 7 years.

Study Variables in the Index Health Records

Socio-demographic Patient Characteristics

Variables such as age and sex were identified from the DAD with the patient list. Marital status and habitation were identified from the patient admission data form.

Physiologic Patient Characteristics

Some physiologic variables (e.g. weight, comorbid conditions, type of HF, blood pressure, serum creatinine, congestion on chest x-ray) were collected to determine the patient's status at the time of index admission and index discharge. Body weight increases with fluid retention. Typically, if there is evidence of congestion in the lungs or edema in the legs at admission, after diuresis, weight loss is achieved. We identified each patient's weight at admission and at or nearest discharge. We grouped results by those who lost weight compared with those who gained or did not lose weight.

Clinical instability, especially within the last 48 hours prior to discharge has been identified as a predictor of death or readmission (Brook, Kahn, & Kosecoff, 1992; Halfon et al., 2002). Documentation of signs and symptoms of congestion within 48 hours before discharge was identified to determine the patient's clinical status. These data were located in medical and nursing assessment notes.

Left ventricular function was determined by the presence of a documented ejection fraction (percent). All cardiac tests were reviewed (e.g. echocardiogram, heart catheterization, cardiac MRI). In the absence of a percentage, a clinical description of left ventricular function was converted to 2 severity categories commonly used in clinical settings (> 40 % when described as mild left ventricular dysfunction and ≤ 40 % when described as moderate to severe left ventricular dysfunction).

Possible reasons for HF exacerbation were identified from the literature and were used as predetermined categories. These reasons included:

- Ischemic acute coronary syndrome including angina or myocardial infarction
- Cardiac rhythm disturbance including atrial fibrillation or flutter, bradycardia, heart block, ventricular arrhythmia
- Medication-induced exacerbation including digoxin toxicity, new non-steroidal anti-inflammatory drug or steroid added
- Patient self-care issue/ non-adherence including documentation that the patient acted against recommended treatment for medications or diet
- Undertreated or mistreated lung condition including description of treatment with antibiotics and/or steroids prior to this admission for pneumonia or chronic obstructive pulmonary disease (COPD)
- Progressive HF including history of HF; exacerbation without other causes
- Other (i.e. does not fit a category)
- Unable to determine

A direct and documented link between the physiologic change or behaviour and the exacerbation of HF symptoms was required for the researchers to choose a category, otherwise 'unable to determine' was chosen.

Frailty

Frailty was included as a marker of severity. Frailty involves impairment in multiple body systems affecting reserve and resiliency (Afilalo et al., 2009). Frailty is associated with advanced age and age > 75 has been used in risk scoring tools (Ng, Feng, Nyunt, Larbi, & Yap, 2014). Patients >75 years of age exhibited a significantly greater likelihood of 30-day readmission in Phase One, making this age bracket important to explore further. Frailty is interrelated with comorbidity and disability, and is evidenced by dependency on others for activities of daily living (Afilalo et al., 2009). This is especially true for elderly patients when afflicted with HF that can affect strength, gait, endurance, and cognition. HF combined with other comorbid conditions increases the risk of readmission (Kossovsky et al., 2000) and frailty (Ng et al., 2014). The presence of 3 or more comorbid conditions has been a significant predictor of 30-day readmission in HF and general medical populations (Halfon et al., 2002; Kossovsky et al., 2000). Specifically, risk scoring tools for frailty include greater weighting for the greater number of comorbid conditions (Ng et al., 2014).

To evaluate frailty, measures have included hand grip strength, gait speed, and other biometric measures (Ng et al., 2014). However, collection of these data requires specific assessment and these data are not routinely available in health records. Thus, to account for disease severity, we defined frailty as >75 years of age, > 3 comorbid conditions, and requiring assistance with activities of daily living (e.g. used walker or cane; depended on family or others for meals or personal care).

Process Elements

Some variables that captured processes of care, meaning how care was delivered, were included. For example patient education was considered completed if there was documentation of education on any of the key HF topics (i.e. medications, low sodium diet, symptoms to monitor, daily weight). Provider-related processes of care variables are actions dependent upon provider decisions. All process of care variables were among those recommended in clinical practice guidelines for HF (Howlett et al., 2010; McKelvie et al., 2011; McKelvie et al., 2013). These variables included evaluation of left ventricular function, referrals to specialty services, discharge disposition, and specific medications prescribed at discharge. We also examined the health records for documentation of a goal of care level (i.e. the amount of medical care with or without resuscitation or intensive care admission), end-of-life discussions (e.g. discussion of prognosis, quality versus quantity of life, or shifting to symptom management versus aggressive intervention), and the presence or absence of a personal directive for healthcare.

Study Variables in the Readmission Health Records

Variables of interest in the readmission health records focused on physiologic status at the time of readmission and if the same or different processes of care took place compared with the index admission. The principle diagnosis in the discharge summary was located and compared with the index principle diagnosis. For each readmission, we captured the extent of description regarding returning to hospital (i.e. events leading to readmission or limited to presenting signs and symptoms). We identified vital signs at admission (i.e. weight, blood pressure), and if a visit had been made to a clinic or emergency department between hospitalizations. We identified signs of dehydration, symptomatic hypotension, and signs or symptoms of congestion (e.g. lung crackles, leg edema, dyspnea). If the readmission was for

HF, the acute HF type was determined based on specific definitions from the literature (Nohria et al., 2005):

Wet/ Warm: BP > 100 mmHg systolic and congestion on x-ray and/or signs and symptoms of congestion.

Wet/ Cold: BP < 100 mmHg systolic plus at least one of the following: congestion on x-ray and/or signs and symptoms of congestion; renal insufficiency; altered level of consciousness; syncope; postural drop in systolic BP of ≥10 mmHg; shock.

Dry/ Cold: BP < 100 mmHg systolic plus at least one of the following: no congestion on x-ray and/or signs and symptoms; renal insufficiency; altered level of consciousness; syncope; postural drop in systolic BP of ≥10 mmHg; shock.

Dry/ Warm: BP > 100 mmHg systolic; no congestion on x-ray and/or signs and symptoms of congestion.

Similar processes of care as the index admission were identified in the readmission record (i.e. goal of care level, end-of-life discussion, personal directive, referrals, disposition, education). Data were collected on whether or not the patient was referred to a greater number of services than during the index admission.

Qualitative Data

The investigator and 2 research assistants identified as much description as possible of the main factors and events contributing to readmission from the readmission health record. The researchers located the chief complaint and the discharge diagnoses listed in the emergency department notes, history and physical, and discharge summary. Along with the presenting symptoms, the researchers noted actions taken by the patient or family in response to the symptoms, and the actions taken by healthcare providers in response to the symptoms prior to

readmission and upon hospitalization. Narrative summaries of what occurred prior to the readmissions were written on the data collection forms in as much detail as possible. These summaries became qualitative text.

Data Screening and Preparation

Data were screened and prepared for analysis. To check for completeness and internal consistency, data screening programs within Stata11 were used to assess for accuracy in data entry, missing values, outliers, normality, and linearity as outlined by Tabachnick and Fidell (2013). The presence of any missing data was checked for each variable. The investigator and research assistants retrieved the missing data from the patient health record. Once data were determined to be as complete as possible, univariate descriptive statistics were run to identify accuracy of data entry. We looked for out-of-range values for categorical variables and plausible minimum and maximum values, means, and standard deviations. If values fell outside of the range of possible scores for a particular variable, we identified errors by comparing the data with the data collection forms. Errors resulting from data entry were corrected. To test normality and linearity of the data, we checked skewness and kurtosis of continuous variables using box plots. Some continuous variables were then recoded into categories for inclusion in logistic regression analysis (e.g. Charlson Index score, serum creatinine).

Quantitative Data Analysis

Socio-demographic, physiologic, and structural variables of the index admissions for both readmitted and non-readmitted groups were characterized using descriptive statistics. Means and standard deviations were computed to summarize the continuous variables (e.g. Charlson Index, blood pressure) using Student's *t*-tests. Using Chi-square tests, frequencies and proportions were computed to summarize the nominal level data (e.g. marital status, comorbid conditions). We

then computed the statistical significance of the difference between the paired cases and controls (p values) using paired *t*-tests for continuous variables and McNemar Chi-square tests for categorical variables.

Simple logistic regression was run for independent variables to identify crude associations with readmission. Variables were selected for inclusion in conditional multiple logistic regression models based on their significance in univariate analysis ($p < 0.05$) or their clinical importance. Statistical significance was set at $p < 0.05$. Stata (Version 11.2) (Stata Corp, Texas, 2009) was used for all statistics and modeling. Given the matched-pair study design, all models implicitly included adjustment for age, sex, and fiscal year of discharge. In a forward step-wise fashion, 6 variables (frailty, provider type, physician follow-up in one week, end-of-life discussion, referral to heart function clinic or cardiologist at index discharge, and no weight loss) were fit in order of strength of association with readmission in univariate analysis, into multivariate models using conditional logistic regression analysis. In Phase One, discharge from hospitals with specialized HF services was strongly associated with reduced likelihood of readmission within 7 or 30 days, therefore justifying inclusion in the model. Lastly, the variable of no weight loss during index admission was added as it neared univariate significance and provided a marker of clinical stability at the time of index discharge. Other markers of clinical stability at discharge, such as signs or symptoms of congestion at discharge, were not significant in univariate analysis and were not brought forward into the multivariate models.

Qualitative Data Collection and Analysis

The narrative summaries of what occurred prior to the readmissions were entered into Microsoft Office Excel 2011 (Microsoft, 2011) as written on the Data Collection Form. Some quantitative data were retained in each line of data, such as age, sex, implicit avoidability score,

chief complaint, and principal diagnosis for the readmission. Qualitative data included description of the patient's health status since index discharge, symptoms upon presentation to hospital, and description of events that led up to the readmission.

The investigator and research assistant (a cardiology nurse) analyzed the data using conventional content analysis strategies (Hsieh & Shannon, 2005). The intention was to cluster and summarize the main reasons for readmission and factors/processes/events in plain language with minimal interpretation. The purpose was to describe what was happening when patients required readmission using an inductive approach, that is, without preconceived categories (Elo & Kyngäs, 2008). The research team members read the text for each readmission individually to gain a sense of the similarities and differences in the documented descriptions. Then, key words and phrases were noted that best described the readmission episode (Hsieh & Shannon, 2005). Each team member made notes identifying initial thoughts and prominent key words. These data were grouped into clusters or categories and were given labels (coded). Key words could fall into more than one category at this stage.

Then, these codes were clustered further into larger categories, which were determined after discussion and consensus was reached between the two researchers. The larger categories were named: presenting pathology (e.g. diagnoses) and contributing factors (e.g. continuing symptoms not resolved at discharge, medication related). Subcategories, like these examples, were noted under these larger headings. Text and subcategory groups were read again to ensure the most prominent factor was identified and one subgroup was assigned for each case. To ensure agreement on each larger category and subgroup, the researchers jointly reviewed all 191 readmission cases and reached consensus when discrepancies were present.

At this stage, literature was consulted. Some of our labels for categories were similar to published reasons for rehospitalization (Clarke, 1990; Yam, Wong, Chan, Leung, et al., 2010) but labels were kept as they emerged inductively during coding.

Categories were prepared for presentation based on the proportion of participants whose case histories were represented by each code. Exemplars of categories are presented in the results section to describe the identified groupings. These exemplars form the rigor of this process (Sandelowski, 1986).

Scoring Avoidability

The potential avoidability of each readmission was evaluated using 2 methods: implicit and explicit review (Brook & Appel, 1973). Implicit review involves the opinion of each judge based on no predetermined criteria. This method of review has been used to evaluate causation and preventability of adverse events and readmissions after hospitalization for general medical and surgical diagnoses (Baker et al., 2004; van Walraven, Jennings, Taljaard, et al., 2011). Judgment using implicit review is based upon the expertise and professional opinion of the reviewers. Explicit review involves judgments based on predetermined criteria developed with group agreement (Brook & Appel, 1973). Each professional determines if the case fits the criteria assigned to each score. Where possible, multiple reviewers are recommended for both methods of review.

During the data collection phase of this study, the investigator and 2 research assistants (senior nursing students) evaluated avoidability of the readmissions using implicit review of the health record using a 6-point scale (Table 2).

While refining the data tool during the pilot phase of data collection, inter-rater reliability scores between the 3 researchers using this 6-point scale initially varied by 1-4 points, when no

description of the criteria for each avoidability level was provided. This implicit method of judging avoidability produced great variation. After inclusion of minimal wording: low avoidability (1-3) is when a new problem occurs; high avoidability (4-6) is when the patient

Table 2 Implicit avoidability scale from the data collection tool

Avoidability After consideration of the clinical details of this patient's medical chart, rate your confidence in the evidence for avoidability of re-hospitalization.
1. Virtually no evidence of avoidability
2. Slight to modest evidence of avoidability
3. Avoidability not likely (less than 50/50)
4. Avoidability likely (more than 50/50)
5. Strong evidence of avoidability
6. Virtually certain evidence of avoidability

returns for the same problem (Halfon et al., 2002), scores between researchers varied by only 1 point and were satisfactory. Each team member ranked a set of health records for avoidability with the periodic checks for inter-rater reliability as described earlier in this chapter.

During the qualitative data analysis phase, when factors contributing to readmission were examined, implicit ranking of avoidability did not adequately fit with what was happening in many cases (i.e. avoidability seemed ranked too low). Subcategory descriptions for low and high avoidability became evident to the research team members. The literature was consulted for more explicit descriptions of avoidability categories for readmissions. Other researchers have determined readmissions were highly avoidable if: the symptoms upon readmission were the same as those not resolved at the time of index discharge; there was evidence of discussion of palliation during the index admission but no addition of palliative services; there was a high

degree of disability during the index admission but no engagement of home health services; a self-care issue (e.g. misinterpretation of a medication prescription) occurred; or an adverse event (i.e. poor outcome due to clinical care) occurred (Clarke, 1990; Oddone et al., 1996; Yam, Wong, Chan, Leung, et al., 2010).

Drawing from this past research that involved scoring avoidability of general medical and surgical readmissions (Clarke, 1990; Halfon et al., 2002; Landrum & Weinrich, 2006; Oddone et al., 1996; Yam, Wong, Chan, Wong, et al., 2010) we developed explicit criteria for low avoidability and high avoidability of readmissions for this HF sample. An attempt was made to reduce the subjective wording (e.g. premature discharge; inadequate palliative care) (Yam, Wong, Chan, Leung, et al., 2010). The investigator and research assistant (cardiology nurse) then scored avoidability again using the explicit criteria (Table 3).

Some cases were very difficult to score. Avoidability was scored a 3 if some of the criteria for low avoidability were present but avoidability was deemed not likely (<50/50). Avoidability was scored a 4 if some of the criteria for high avoidability were present and avoidability was deemed likely but not certain (>50/50).

While not planned a priori, this second evaluation for avoidability was undertaken to compare implicit versus explicit review. Upon commencing the study, no explicit review criteria were available for judging avoidability of unplanned readmission after HF hospitalization. Past studies included a mixture of surgical index admissions and elective and non-elective readmissions making the criteria not fully relevant to HF-specific populations (Halfon et al., 2002; Oddone et al., 1996). Past studies involved panels of 1 (Halfon et al., 2002) to 10 or more

Table 3 Explicit criteria for judging avoidability

Low Avoidability Score of 1 to 3
• New, unforeseen problem not related to HF or a condition present during index admission • Refusal of care; left against medical advice • Same signs and symptoms as during index admission but stable at discharge • Services provided but not enough (e.g. homecare but went on to need hospice or long-term care)
High Avoidability Score of 4 to 6
• Presence of the same signs and symptoms not resolved at discharge • Discussion of palliation but no added palliative services, hospice, or change in goal of care • High disability but no extra home services or increased level of disposition to long-term care, etc. • Social or self-care issue not addressed with extra services • Adverse event related to clinical care during index admission

(Oddone et al., 1996; van Walraven, Jennings, Taljaard, et al., 2011) physicians for determination of avoidability. We posited that with explicit criteria, other health professionals could make the determination.

Rigor of Qualitative Process

Credible qualitative findings include descriptions that are recognizable and make sense to readers (Sandelowski, 1986). We reported symptoms, events, and quotes with minimal interpretation. For accuracy, we trained team members on treatment of HF, and each person spent 30 to 60 minutes per health record gathering details of what happened at the time of readmission.

Dependability is the stability of the findings after review by other researchers (Lincoln & Guba, 1985). We enhanced dependability by independently reviewing and coding the narrative text before results were compared and discussed. As well, we let time pass before reviewing the data and codes again to gauge stability over time. Codes and categories were compared with published studies.

Confirmability refers to repeatability of findings when clear description of the method is reported in an audit trail (Sandelowski, 1986). The data collection tools provide evidence of how the data was collected. The audit trail included spreadsheets with narrative text, analysis instructions, early and later coding schemes, and larger categories.

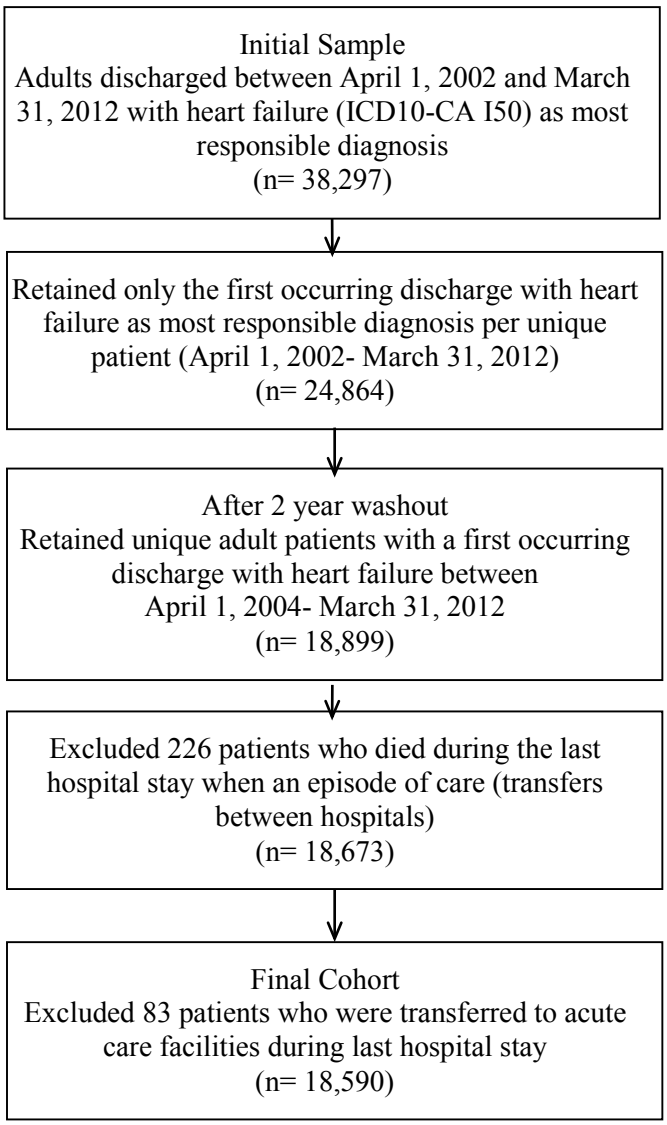
Transferability refers to the "ability of others to see utility of the results in other contexts" (King, McFetridge-Durdle, LeBlanc, Anzarut, & Tsuyuki, 2009, p. 117). Our findings are most applicable to other large urban centers but given the prevalence of the problem of readmission internationally, readers may find our results highly relevant. Transferability was enhanced with a thorough and representative sample that included all HF patients who were readmitted within 7 days of discharge during the years of interest, with minimal exclusion criteria.

CHAPTER FOUR: FINDINGS

Phase One: Administrative Data Analysis

From April 1, 2002 to March 31, 2012 there were 38,297 discharges with a most responsible diagnosis of HF in Alberta. These discharges involved 24,864 unique patients. After applying our exclusion criteria, our study population consisted of 18,590 patients with incident HF hospitalizations within the 8-year study period (Figure 2) (Eastwood et al., 2014).

Figure 2 Flow diagram of study population



Of the final cohort of 18,590 patients, 50.2% were male, mean age was 76.4 years, and 62.9% were 75 years or older (Table 4). The most frequent comorbid conditions were diabetes, atrial fibrillation, chronic pulmonary disease, renal disease, and prior myocardial infarction. The length of stay of the index admission was between 1 to 7 days for just over half of the patients, and 8-14 days for one-third of the patients. The majority of patients were discharged home without support services from hospitals with HF services. One quarter of patients were discharged with homecare services and one third had cardiologists or internal medicine specialists as attending physicians.

Table 4 Characteristics of Alberta adults surviving a first hospitalization for HF 2004-2012

Characteristics	n=18,590
Male (%)	9,329 (50.2)
Age (years)	
Mean/ Median	76.4 (79)
Age in years (%)	
20-49	623 (3.4)
50-64	2,520 (13.6)
65-74	3,751 (20.2)
≥75	11,696 (62.9)
Charlson Index	
Mean score (SD)	2.6 (1.63)
Median score (IQR)	2 (1, 3)
Prior myocardial infarction	2,558 (13.8)
Peripheral vascular disease	706 (3.8)
Cerebrovascular disease	498 (2.7)
Dementia	1,253 (6.7)
Pulmonary disease	4,846 (26.1)
Diabetes	6,328 (34.0)
Renal disease	2,680 (14.4)
Cancer	829 (4.5)
Atrial fibrillation	6,315 (34.0)
Transferred in to index admission	3,815 (20.5)
Length of stay	
Median (IQR)	7 (4,13)
1-7 days	9,546 (51.4)
8-14 days	5,131 (27.6)
15-29 days	2,654 (14.3)
≥30 days	1,259 (6.8)

Disposition	
Home	12,044 (64.8)
Home with homecare	4,615 (24.8)
Long-term care	1,718 (9.2)
Left against medical advice	213 (1.2)
Attending physician specialty	
Primary care physician	11,085 (59.6)
Cardiologist or internal medicine	6,942 (37.3)
Other specialist	563 (3.0)
Discharged from hospital with HF services	12,143 (65.3)

(Eastwood et al., 2014)

During the 8-year period studied, there was an average of 2,324 annual discharges with HF as most responsible diagnosis. The all-cause readmission rate was 5.6% at 7 days and 18.0% at 30 days post-discharge (Table 5). These readmissions rates represent 129 patients who experienced all-cause 7-day readmissions per year studied, and 417 patients who experienced all-cause 30-day readmissions per year studied. Women and men were readmitted at an equal rate. Rate of all-cause readmission within 7 days of discharge (but not HF-specific) varied significantly between age groups in that there was a slightly higher rate of readmission among the youngest and oldest age groups. The all-cause and HF-specific readmission rates within 30 days of discharge also varied significantly but rose steadily with increased age.

All-cause 7-day readmission rate was significantly greater for patients with a history of renal disease, were transferred in to the index facility, were discharged with homecare, left against medical advice, or had a primary care physician as attending physician (Table 5). HF-specific 7-day readmission rate was significantly greater only for patients discharged home with homecare or left against medical advice. Patients readmitted within 7 days for all causes had a 17.8% readmission rate but this accounted for only 38 cases, compared to the 312 patients

Table 5 Readmission rate (%) by characteristics of patients discharged alive after a first hospitalization with a most responsible diagnosis of heart failure in Alberta 2004-2012

Characteristics	Number of patients N	Within 7 days for all cause n (%)	*P* value	Within 7 days for HF n (%)	*P* value	Within 30 days for all cause n (%)	*P* value	Within 30 days for HF n (%)	*P* value
Overall	18,590	1,033 (5.6)		378 (2.0)		3,340 (18.0)		1,237 (6.7)	
Readmission Rate by Characteristic									
Male	9,329	508 (5.6)	0.506	191 (2.1)	0.892	1,657 (17.8)	0.465	611 (6.6)	0.758
Female	9,261	525 (5.7)		187 (2.0)		1,683 (18.2)		626 (6.7)	
By Age Group									
20-49	623	34 (5.5)	0.034	14 (2.3)	0.202	90 (14.5)	<0.001	34 (5.5)	<0.001
50-64	2,520	114 (4.5)		39 (1.6)		401 (15.9)		128 (5.1)	
65-74	3,751	195 (5.2)		71 (1.9)		636 (17.0)		215 (7.4)	
≥75	11,696	690 (5.9)		254 (2.2)		2,213 (18.9)		860 (12.0)	
Myocardial infarction									
Yes	2,558	133 (5.2)	0.396	59 (2.3)	0.292	450 (17.6)	0.595	182 (7.1)	0.314
No	16,032	900 (5.6)		319 (2.0)		2,890 (18.0)		1,185 (6.6)	
Peripheral vascular disease									
Yes	706	38 (5.4)	0.837	11 (1.6)	0.362	131 (18.6)	0.678	52 (7.4)	0.439
No	17,884	995 (5.6)		367 (2.1)		3,209(17.9)		2,035 (11.8)	
Cerebrovascular disease									
Yes	498	26 (5.2)	0.74	8 (1.6)	0.494	69 (13.9)	0.015	22 (4.4)	0.042
No	18,092	1,007 (5.6)		370 (2.1)		3,271 (18.1)		1,215 (6.7)	
Dementia									
Yes	1,253	60 (4.8)	0.219	17 (1.4)	0.079	207 (16.5)	0.167	66 (5.3)	0.041
No	17,337	973 (5.6)		361 (2.1)		3,133 (18.1)		1,171 (6.8)	
Pulmonary disease									
Yes	4,846	292 (6.0)	0.098	99 (2.0)	0.956	950 (19.6)	0.001	317 (6.5)	0.714
No	13,744	741 (5.4)		279 (2.0)		2,390 (17.4)		920 (6.7)	
Diabetes									
Yes	6,328	341 (5.4)	0.473	124 (2.0)	0.609	1,122(17.7)	0.547	421 (6.7)	0.996
No	12,262	692 (5.6)		254 (2.1)		2,218 (18.1)		816 (6.7)	

Renal disease									
Yes	2,680	172 (6.4)	0.035	60 (2.2)	0.415	581 (21.7)	<0.001	232 (8.7)	<0.001
No	15,910	861 (5.4)		318 (2.0)		2,759 (17.3)		1,005 (6.3)	
Cancer									
Yes	829	55 (6.6)	0.166	14 (1.7)	0.472	185 (22.3)	0.001	67 (8.1)	0.091
No	17,761	978 (5.5)		364 (2.1)		3,155 (17.8)		1,170 (6.6)	
Atrial Fibrillation									
Yes	6,315	339 (5.4)	0.421	121 (1.9)	0.416	1,142 (18.1)	0.765	458 (7.3)	0.019
No	12,275	694 (5.7)		257 (2.1)		2,198 (17.9)		779 (6.5)	
Transferred in									
Yes	3,815	244 (6.4)	0.011	78 (2.0)	0.956	763 (20.0)	<0.001	252 (6.6)	0.893
No	14,775	789 (5.3)		300 (2.0)		2,577 (17.4)		985 (6.7)	
Length of stay									
1-7 days	9,546	543 (5.7)	0.016	205 (2.2)	0.389	1,716 (18.0)	0.106	649(6.8)	0.796
8-14 days	5,131	289 (5.6)		103 (2.0)		926 (18.0)		338(6.6)	
15-29 days	2,654	156 (5.9)		52 (2.0)		501 (18.9)		173(6.5)	
≥30 days	1,259	45 (3.6)		18 (1.4)		197 (15.7)		77 (6.1)	
Disposition									
Home	12,044	612 (5.1)	<0.001	225 (1.9)	<0.001	2,030 (16.9)	<0.001	761 (6.3)	<0.001
To home with homecare	4,615	312 (6.8)		110 (2.4)		998 (21.6)		362 (7.8)	
To long-term care	1,718	71 (4.1)		27 (1.6)		234 (13.6)		80 (4.7)	
Left against medical advice	213	38 (17.8)		16 (7.5)		78 (36.6)		34 (16.0)	
Attending physician									
Primary care physician	11,085	665 (6.0)	0.006	236 (2.1)	0.467	2,084 (18.8)	0.001	744 (6.7)	0.437
Cardiologist/Internal medicine	6,942	341 (5.2)		133 (1.9)		1,159 (16.7)		463 6.7)	
Other specialist	563	27 (4.8)		9 (1.6)		97 (17.2)		30 (5.3)	
Index hospital									
Without HF services	6,447	446 (6.9)	<0.001	164 (2.5)	<0.001	1,341 (20.8)	<0.001	470 (7.3)	0.011
With HF services	12,143	587 (4.8)		214 (1.8)		1,999 (16.5)		767 (6.3)	

Note. Readmission rates equal number readmitted in category divided by total number with characteristic. P-value is for statistical difference of the readmission rate between categories of the characteristic. For example, difference in readmission rate for males and females within 7 days. (Eastwood et al., 2014).

discharged with homecare for a readmission rate of 6.8%. All-cause 7-day readmission rate was significantly less for patients with an index length of stay ≥ 30 days or when patients were discharged from hospitals with specialty HF services. The 7-day HF-specific readmission rate was also lower for patients discharged from hospitals with HF services, but no other variables were significant.

The all-cause 30-day readmission rate was significantly related to many more variables. There was a greater 30-day all-cause rate of readmission among patients who had pulmonary disease, renal disease, cancer, transferred in to the index facility, discharged home with homecare, left against medical advice, or had a primary care attending physician. The frequency was small for cancer with only 185 readmissions that occurred with a history of cancer over the 8-year period, yet a statistically significant difference was evident. The all-cause 30-day readmission rate was lower for patients with cerebrovascular disease (including stroke) or if patients were discharged from a hospital with specialty HF services.

Lastly, the HF-specific 30-day readmission rate was significantly higher for patients with renal disease, atrial fibrillation, and the same 2 discharge dispositions - homecare and left against medical advice. The HF-specific 30-day readmission rate was significantly lower for patients with cerebrovascular disease, dementia, and if patients were discharged from a hospital with HF services. Table 5 values are crude values before risk adjustment.

After risk adjustment for age, sex, fiscal year, and step-wise removal of non-significant variables (in univariate analysis) (Table 6), the characteristics of patients associated with increased risk of 7-day readmissions were renal disease, transferred in to the index facility, discharged requiring homecare services, and discharged against medical advice. Factors associated with reduced risk of 7-day readmission were very long index LOS (30 days or longer)

Table 6. Risk adjusted models for non-elective readmission for patients discharged alive after a first hospitalization with a most responsible diagnosis of heart failure (HF)

n= 18,590 Outcome	Readmission within 7 days for all causes		Readmission within 7 days for HF		Readmission within 30 days for all causes		Readmission within 30 days for HF	
Variable	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Male	0.97	[0.85, 1.10]	1.03	[0.84, 1.27]	0.98	[0.90, 1.06]	1.04	[0.92, 1.17]
Age								
20-49	Reference		Reference		Reference		Reference	
50-64	0.85	[0.57, 1.27]	0.71	[0.38, 1.33]	1.12	[0.87, 1.44]	0.94	[0.64, 1.39]
65-74	0.99	[0.68, 1.45]	0.90	[0.50, 1.61]	1.19	[0.94, 1.52]	1.07	[0.74, 1.56]
≥75	1.12	[0.78, 1.61]	1.05	[0.60, 1.83]	1.36	[1.08, 1.72]	1.43	[1.00, 2.05]
Admission year	--		--		--		--	
Myocardial infarction	--		--		--		--	
Peripheral vascular disease	--		--		--		--	
Cerebrovascular disease	--		--		0.73	[0.56, 0.94]	0.64	[0.42, 0.99]
Dementia	--		--		--		--	
Pulmonary disease	--		--		1.14	[1.05, 1.24]	--	
Liver disease	--		--		1.41	[1.07, 1.85]	--	
Diabetes	--		--		--		--	
Renal disease	1.28	[1.08, 1.53]	--		1.37	[1.24, 1.52]	1.43	[1.23, 1.67]
Cancer	--		--		1.31	[1.10, 1.55]	--	
Atrial Fibrillation	--		--		--		1.14	[1.01, 1.29]
Transferred in	1.22	[1.02, 1.46]	--		1.21	[1.09, 1.35]	--	
Length of stay								
1-7 days	Reference		--		--		--	
8-14 days	1.03	[0.89, 1.20]						
15-29 days	1.04	[0.86, 1.26]						
≥30 days	0.65	[0.47, 0.90]						
Disposition								
Home	Reference				Reference		Reference	
Homecare	1.26	[1.07, 1.49]	1.28	[1.01, 1.63]	1.23	[1.11, 1.35]	1.17	[1.02, 1.34]
Long-term care	0.77	[0.57, 1.04]	0.81	[0.54, 1.22]	0.66	[0.56, 0.78]	0.65	[0.51, 0.83]
Left AMA	4.47	[3.10, 6.46]	4.60	[2.70, 7.86]	3.10	[2.33, 4.13]	3.16	[2.16, 4.61]
Attending physician specialty	--		--		--		--	
Hospital with HF services	0.65	[0.57, 0.74]	0.67	[0.54, 0.82]	0.71	[0.65, 0.77]	0.81	[0.72, 0.92]

Note. OR = odds ratio; CI = confidence interval; AMA = against medical advice; Non-significant variables from the full models were not included in the parsimonious models and are denoted by - -. (Eastwood et al., 2014)

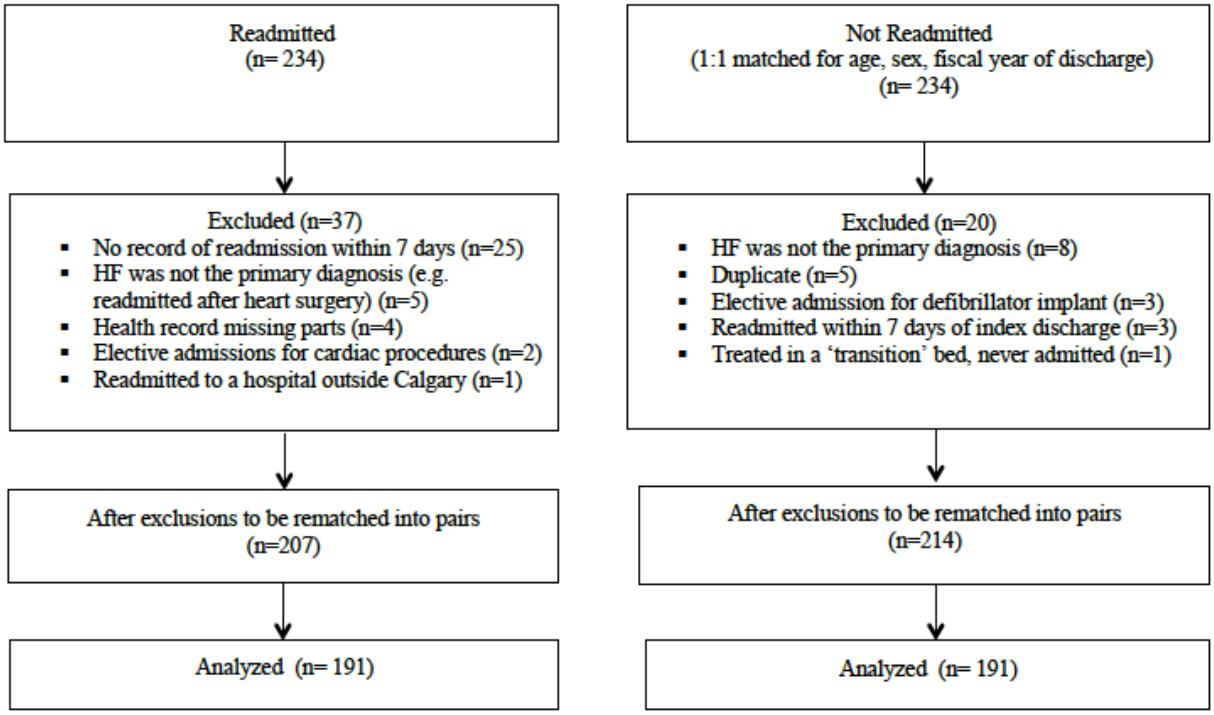
and being discharged from hospitals with specialized HF services. The characteristics of patients associated with increased risk of all-cause readmission within 30 days were age over 75 years, liver disease, renal disease, cancer, chronic pulmonary disease, transferred in, discharged requiring homecare services, and discharged against medical advice. Factors associated with reduced risk of 30-day readmission included being discharged to long-term care and from hospitals with HF services.

In summary, after following 18,590 patients (equal numbers of men and women, primarily elderly) discharged from Alberta hospitals with HF as most responsible diagnosis, several physiologic and health system factors were linked with increased and decreased rate of readmission within 7 or 30 days. One third of the 18% (3,340) patients readmitted within 30 days for all causes were readmitted within the first 7 days after discharge, representing 1,033 patients during this 8-year study period. Renal disease, discharge home with homecare services, and left against medical advice were variables consistently associated with greater likelihood of readmission within 7 or 30 days of discharge. Discharge from hospitals with HF specialty services was consistently associated with reduced likelihood of all-cause or HF-specific readmission within 7 or 30 days of discharge.

Phase Two: Health Record Audit

Of the 18,590 Alberta patients identified in Phase One, 234 Calgary, AB patients were readmitted within 7 days of discharge. Of that sample, 191 matched pairs (readmitted and not readmitted; cases and controls) were retained in the sample for analysis (Figure 3). Using ICD-10CM I-50 for the case definition for HF, 13 records were excluded because HF was not listed the most responsible diagnosis after review of the health record. The positive predictive value for ICD-10CM I-50 to identify HF cases in Calgary administrative health data was high (97.2%).

Figure 3 Flow diagram of sample of adults discharged from Calgary, AB hospitals between April 1, 2004 and March 31, 2012 with heart failure that were readmitted and not readmitted within 7 days of discharge



Some significant differences were identified between patients who were readmitted and not readmitted within 7 days of discharge (Table 7). Readmitted patients more frequently had a cardiologist or other specialist as attending physician, were more often frail, had pulmonary edema or pleural effusion on the first chest x-ray, and did not lose weight (fluid) during the index admission.

Characteristics of patients readmitted and not readmitted were also identified at the time of index hospital discharge. Readmitted patients were more often referred to a HF clinic or cardiologist upon index discharge and had documentation of end-of-life discussions in the health record (Table 8). A note to follow-up with a physician within 1 week of discharge was found less often in records of patients who were readmitted than those not readmitted.

Table 7 Characteristics at index hospital admission for heart failure

Patient Characteristics (frequency/percent)		Readmitted (n=191)	Not readmitted (n=191)	P-value
Marital status	Married/Common law	83 (46.6)	88 (52.8)	0.656
	Separated/Divorced	12 (6.7)	14 (8.24)	
	Widowed	64 (36.0)	52 (30.6)	
	Single	19 (10.7)	16 (9.4)	
	Missing data	13	21	
Habitation	With spouse	72 (38.7)	70 (37.2)	0.950
	Alone	48 (25.8)	53 (28.2)	
	With children	17 (9.1)	20 (10.6)	
	With spouse and children	6 (3.2)	5 (2.7)	
	Care facility	43 (23.1)	40 (21.3)	
	Missing data	8	3	
Physiologic Characteristics				
	History of myocardial infarction	26 (13.6)	26 (13.6)	1.0
	Peripheral vascular disease	5 (2.6)	8 (4.2)	0.581
	Cerebrovascular disease	5 (2.6)	8 (4.2)	0.588
	Dementia	16 (8.4)	18 (9.4)	0.715
	Chronic Pulmonary Disease	48 (25.1)	41 (21.5)	0.392
	Diabetes	67 (35.1)	72 (37.7)	0.583
	Renal Failure	34 (17.8)	25 (13.1)	0.199
	Cancer	11 (5.8)	7 (3.7)	0.481
	Liver disease	7 (3.7)	1 (0.5)	0.070
	Atrial Fibrillation	72 (37.7)	70 (36.7)	0.829
Charlson Index (mean/standard deviation, SD)		2.9 (1.8)	2.7 (1.7)	0.244
Newly diagnosed with heart failure		80 (41.9)	82 (42.9)	0.843
Type of heart failure	Ischemic	68 (35.6)	72 (37.7)	0.673
	Non-ischemic	123 (64.4)	119 (62.3)	
Reason for HF exacerbation for index admission (may be more than one)	Ischemic	42 (22.0)	42 (22.0)	1.0
	Cardiac rhythm disturbance	56 (29.3)	39 (20.4)	0.050
	Medication induced	10 (5.2)	12 (6.3)	0.655
	Non-adherence	24 (12.6)	25 (13.1)	0.873
	Treated for lung disease/pneumonia but was HF	26 (13.6)	16 (8.4)	0.114
	Progressive heart failure	65 (34.0)	58 (30.4)	0.419
	Other	20 (10.5)	13 (6.8)	0.223
	Unable to determine	8 (4.2)	23 (12.0)	0.004
Frailty		81 (42.4)	54 (28.3)	0.003
Systolic BP upon index admission (mmHg)(mean/SD)		138 (30.5)	141 (26.8)	0.349
Weight upon index admission (kg) (mean/SD)		72.8 (18.6)	78.7 (21.6)	0.069
First creatinine at index admission (micromol/L)		129 (96.7)	113 (74.4)	0.043

(mean/SD)				
First chest x-ray showed pulmonary edema or pleural effusion	Yes	157 (82.2)	150 (78.5)	<0.0001

Note. Frailty = >75 years, >3 comorbid conditions, needing assistance with activities of daily living.

Table 8 Characteristics at index hospital discharge

Physiologic characteristics (frequency/percent)	Readmitted (n=191)	Not Readmitted (n=191)	P-value
Systolic BP (mmHg) (mean/SD)	119 (23.8)	122 (21.2)	0.185
Systolic BP >140 mmHg at index discharge	43 (22.5)	33 (17.3)	0.204
Signs or symptoms of congestion within 48 hours before discharge	123 (65.4)	115 (61.8)	0.666
No weight loss during index admission	46 (34.3)	40 (27.0)	0.040
Last creatinine during index admission (micromol/L) (mean/SD)	122 (76.6)	118 (74.5)	0.664
Chest x-ray within 48 hours before discharge with pulmonary edema or pleural effusion No	18 (9.4)	21 (11.0)	0.824
Yes	78 (40.8)	71 (37.2)	
Not done	95 (49.7)	99 (51.8)	
Structural Elements			
Provider Type Primary care physician	94 (49.2)	119 (62.3)	0.007
Cardiologist, internal medicine, or other specialist	97 (50.8)	72 (37.7)	
Process Elements			
Beta blocker prescribed	137 (71.7)	144 (77.4)	0.425
Angiotensin converting enzyme inhibitor or angiotensin receptor blocker prescribed	153 (80.1)	146 (76.4)	0.385
Calcium channel blocker prescribed	51 (26.7)	41 (21.5)	0.232
Left ventricular function evaluated during index admission	117 (61.3)	125 (65.5)	0.394
Ejection fraction value on chart	41 (21.5)	38 (19.9)	0.701
Referrals for follow-up after discharge			
No referrals	39 (20.4)	54 (28.3)	0.067
Heart function clinic or cardiologist	95 (49.7)	75 (39.3)	0.041
Heart failure liaison nurse	17 (8.9)	20 (10.5)	0.563
Cardiac rehabilitation/ wellness	8 (4.2)	8 (4.2)	1.0
Anticoagulation	15 (7.9)	18 (9.4)	0.578
Diabetes clinic	6 (3.1)	3 (1.6)	0.508
Other	87 (45.6)	85 (44.5)	0.842
Communication with family physician			
Note to follow-up with physician	169 (88.5)	171 (89.5)	0.752

Note to see physician within 1 week		101 (52.9)	126 (66.0)	0.009
Heart failure patient education was documented		104 (54.5)	124 (64.9)	0.052
Goal of care levels	R	70 (36.7)	73 (38.2)	0.957
	M	74 (38.7)	70 (36.7)	
	C	3 (1.6)	4 (2.1)	
	Not documented	44 (23.0)	44 (23.0)	
End-of-life discussion documented		31 (16.2)	15 (7.9)	0.008
Discharge disposition	Home without support	63 (33.7)	84 (44.0)	0.284
	Continuing care	17 (9.1)	12 (6.3)	
	Home with Homecare	82 (43.9)	69 (36.1)	
	Assisted living	20 (10.5)	20 (10.5)	
	Home with palliative care or to hospice	5 (2.7)	6 (3.1)	

Note. Goal of care levels: R = medical care including resuscitation and intensive care unit admission, M= medical care excluding resuscitation and intensive care unit admission, C = focus on comfort; symptom management only.

When using conditional multivariate logistic regression modeling with forward stepwise addition of the significant variables found in the univariate analysis (Table 9, 10), frailty and having a specialist as provider (attending physician) remained significantly associated with increased likelihood of readmission. Documented instructions to follow-up with a physician within 1 week of discharge remained significantly associated with reduced likelihood of readmission (Table 11).

Several variables did not remain significantly associated with readmission despite significance in univariate analysis (Table 11). Documentation of end-of-life discussions and referral to a HF clinic or cardiologist were less associated with readmission once adjusted for the other variables. The variable ‘no weight loss’ was added as a measure of severity but also lost significance against the other 4 variables.

Table 9 Univariate conditional logistic regression analysis of characteristics at index hospital admission associated with readmission within 7 days of discharge

Patient Characteristics			OR 95% CI
Marital status		Married/common-law versus Alone (single, divorced, widowed)	0.82 [0.65, 1.04]
Habitation	With spouse, children or a care facility versus alone		1.16 [0.81, 1.67]
Physiologic Characteristics			
		Myocardial Infarction	1.00 [0.55, 1.83]
		Peripheral vascular disease	0.65 [0.20, 1.91]
		Cerebrovascular disease	0.63 [0.20, 1.91]
		Dementia	0.87 [0.43, 1.79]
		Chronic Pulmonary Disease	1.23 [0.76, 2.00]
		Diabetes	0.88 [0.58, 1.36]
		Renal Failure	1.45 [0.82, 2.56]
		Cancer	1.57 [0.61, 4.05]
		Liver disease	7.00 [0.86, 56.9]
		Atrial Fibrillation	1.05 [0.69, 1.60]
Charlson Index		Score >3	1.44 [0.92, 2.26]
Newly diagnosed heart failure			0.96 [0.65, 1.42]
Type of heart failure	Ischemic compared with non-ischemic		1.09 [0.72. 1.65]
Most prominent reason for decompensation of HF		Ischemic	Reference
		Cardiac rhythm disturbance	1.28 [0.67, 2.47]
		Medication induced	0.83 [0.28, 2.46]
		Non-adherence	0.97 [0.42, 2.22]
	Treated for lung disease/pneumonia but really was HF		1.37 [0.57, 3.34]
		Progressive HF	1.28 [0.67, 2.43]
		Other	2.19 [0.87, 5.52]
		Unable to determine	0.37 [0.13, 1.05]
Frailty			2.00 [1.26, 3.17]
First creatinine at index admission by categories		0-133 micromol/L	Reference
		134-177 micromol/L	1.81 [0.99, 3.31]
		178-243 micromol/L	1.45 [0.63, 3.35]
		> 243 micromol/L	2.02 [0.67, 6.11]
First chest x-ray with pulmonary edema/ pleural effusion			1.25 [0.69, 2.25]

Note. OR – odds ratio; CI = confidence interval; Frailty= >75 years, >3 comorbid conditions, needed assistance with activities of daily living.

Table 10 Univariate conditional logistic regression analysis of characteristics at index hospital discharge associated with readmission within 7 days of discharge

Physiologic Characteristics		OR	95% CI
Chest x-ray within 48 hours before discharge showing pulmonary edema or pleural effusion		0.98	[0.81, 1.18]
Last systolic blood pressure >140 mmHg		1.38	[0.84, 2.29]
Signs or symptoms of congestion within 48 hours before discharge		1.03	[0.73, 1.46]
No weight loss during index admission		1.19	[1.00, 1.41]
Structural Elements			
Provider type: Cardiologist, internal medicine, or other specialist versus primary care physician		1.83	[1.18, 2.86]
Process Elements			
Beta blocker prescribed		0.83	[0.53, 1.31]
Angiotensin converting enzyme inhibitor or angiotensin receptor blocker prescribed		1.24	[0.76, 2.02]
Calcium channel blocker prescribed		1.33	[0.83, 2.14]
Left ventricular function evaluated during index admission		0.83	[0.55, 1.27]
Ejection fraction value or clinical description of left ventricular function documented		1.05	[0.68, 1.62]
Referrals for follow-up after discharge	No referrals	0.63	[0.39, 1.04]
	Heart function clinic or cardiologist	1.53	[1.01, 2.30]
	Heart failure liaison nurse	0.80	[0.37, 1.71]
	Cardiac rehabilitation/ wellness	1.00	[0.35, 2.85]
	Anticoagulation	0.81	[0.39, 1.69]
	Diabetes clinic	2.00	[0.50, 8.00]
	Other	1.04	[0.70, 1.54]
More than one referral		1.38	[0.90, 2.13]
Communication with family physician at index discharge			
	Note to follow-up with physician	0.90	[0.49, 1.68]
	Note to see physician within 1 week	0.57	[0.37, 0.87]
Heart failure patient education was documented		0.68	[0.46, 1.01]
Goal of care level documented		1.00	[0.59, 1.70]
Goal of care levels condensed	R		Reference
	M or C	1.02	[0.83, 1.24]
End-of-life discussion documented		2.60	[1.25, 5.39]
Personal directive on chart		0.72	[0.29, 1.81]
Discharge disposition condensed	Home without support		Reference
	Home with palliative care, hospice, left against medical advice, to continuing care	1.58	[0.87, 2.86]
	Home with home care services	1.59	[1.00, 2.55]

Note. OR – odds ratio; CI = confidence interval; Goal of care levels: R = medical care including resuscitation and intensive care unit admission, M= medical care excluding resuscitation and intensive care unit admission, C = focus on comfort; symptom management only.

Table 11 Multivariate conditional logistic regression analysis of factors associated with readmission within 7 days of discharge

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
	OR 95% CI	OR 95% CI	OR 95% CI	OR 95% CI	OR 95% CI
Frailty	2.30 [1.41, 3.76]	2.20 [1.35, 3.67]	2.00 [1.18, 3.32]	2.00 [1.21, 3.46]	2.00 [1.20, 3.46]
Provider type (specialist)	2.10 [1.32, 3.42]	2.20 [1.37, 3.63]	2.20 [1.36, 3.62]	2.00 [1.22, 3.36]	2.10 [1.26, 3.54]
Note to see physician within 1 week of discharge		0.56 [0.36, 0.88]	0.55 [0.35, 0.87]	0.53 [0.33, 0.85]	0.53 [0.33, 0.86]
End-of-life discussion documented			2.10 [0.97, 4.71]	2.10 [0.93, 4.53]	2.20 [0.97, 4.81]
Referral to heart function clinic or cardiologist after index discharge				1.40 [0.91, 2.28]	1.40 [0.88, 2.23]
No weight loss during index admission					1.20 [0.99, 1.44]

Data from the Readmission Records

Of the readmitted patients, 10% sought medical attention at an emergency department or medical office during their out of hospital time (Table 12). Upon presenting to a Calgary hospital, 54% (103) of the patients were readmitted for cardiac symptoms, 77% (79 patients) of which presented with HF as primary diagnosis. Eighty-one percent of patients were readmitted with warm and wet acute HF. There was a high frequency of signs of congestion and symptoms of congestion in the readmitted patients, although HF was not always the primary diagnosis. New evaluations of left ventricular function (e.g. echocardiogram, nuclear scan) were done on 23% of the readmitted patients but only 17% of patients had an ejection fraction value documented in the health records (including older test results).

Table 12 Characteristics and processes of care for patients readmitted within 7 days of discharge from the readmission records

Variable frequency (percent)		Readmitted (n=191)
Same principal diagnosis for index admission and readmission (HF)		79 (41)
Cardiovascular diagnosis other than HF as reason for readmission		24 (13)
Events surrounding readmission documented		89 (46.6)
Only symptoms at time of readmission documented		102 (53.4)
Visited emergency or outpatient setting in the 1 week before readmission		19 (10.0)
Ejection fraction documented in readmission record		33 (17.3)
New evaluation of left ventricular function done during readmission		45 (23.6)
Pulmonary edema or pleural effusion on first chest x-ray	No	49 (25.7)
	Yes	112 (58.6)
	Not done	30 (15.7)
Signs of congestion upon readmission		135 (70.7)
Symptoms of congestion upon readmission		115 (60.2)
Acute heart failure type (n = 79)	Warm/ wet	64 (81.0)
	Wet/ cold	12 (15.2)
	Dry/ cold	3 (3.8)
	Not applicable/ not HF	112
Referrals at time of readmission discharge	No referrals	66 (34.6)
	HFC or cardiologist	64 (33.5)
	HF liaison nurse	11 (5.8)
	Cardiac rehab/ wellness	6 (3.1)
	Anticoagulation clinic	10 (5.2)
	Diabetes clinic	4 (2.1)
	Other	82 (42.9)
HF-specific patient education was documented in readmission record		71 (37.2)
Change in goal of care from index admission to readmission		
	Up by 1-3 levels (more aggressive intervention)	9 (4.7)
	No change	85 (44.5)
	Down by >1-3 levels (less aggressive intervention/comfort care)	37 (19.4)
	Missing/ not documented	60 (31.4)
End-of-life/ palliative discussion documented in readmission record		45 (23.6)
Disposition after readmission	Home without support	44 (23.0)
	Continuing care	26 (13.6)
	Home care	68 (35.6)
	Left against medical advice	3 (1.6)
	Assisted living	11 (5.8)
	Home with palliative services or to hospice	9 (4.7)
	Died in hospital	28 (14.7)
	Transferred to another acute care hospital	2 (1.1)

Despite being readmitted within 7 days of discharge, 35% of patients were not referred to any support services at their second discharge. This number excludes patients who died or were transferred to another acute care facility. One third of the readmitted patients were referred to a heart function clinic or cardiologist after discharge but very few patients were referred to other types of outpatient clinics. Of note, only 71 of the 191 readmitted patients' records included HF-specific patient education documentation.

For patients who were readmitted, some differences between index and readmission hospitalizations appeared in several processes of care. The goal of care was documented at the same frequency (78%) in the index and readmission records. There was no change in the goal of care level among 44.5% of the readmitted patients while very few patients had a higher level of care (i.e. more intervention), and one third had a lower level of care (i.e. less intervention, more comfort measures). End-of-life discussions were documented slightly (23.6%) more often in the readmission health records than in the index health records (16.2%) of the readmitted cohort. Twenty-eight of the readmitted patients (14.7%) died during the re-hospitalization. Comparing disposition of the index admission and readmission, after readmission fewer patients went home without support or with homecare services, and more patients were transferred to continuing care facilities. Slightly more (2.1%) patients were discharged with palliative or hospice services than during the index admission.

Qualitative Description of Factors Leading to Readmission and Avoidability

A wide variety of factors contributed to readmission within 7 days of discharge. Qualitative review of descriptive text gathered from the emergency admission notes, history and physical, discharge summary, and multidisciplinary communications for each readmission was

undertaken. Analysis included determination of the presenting pathology, the primary factor contributing to readmission, and the degree of avoidability.

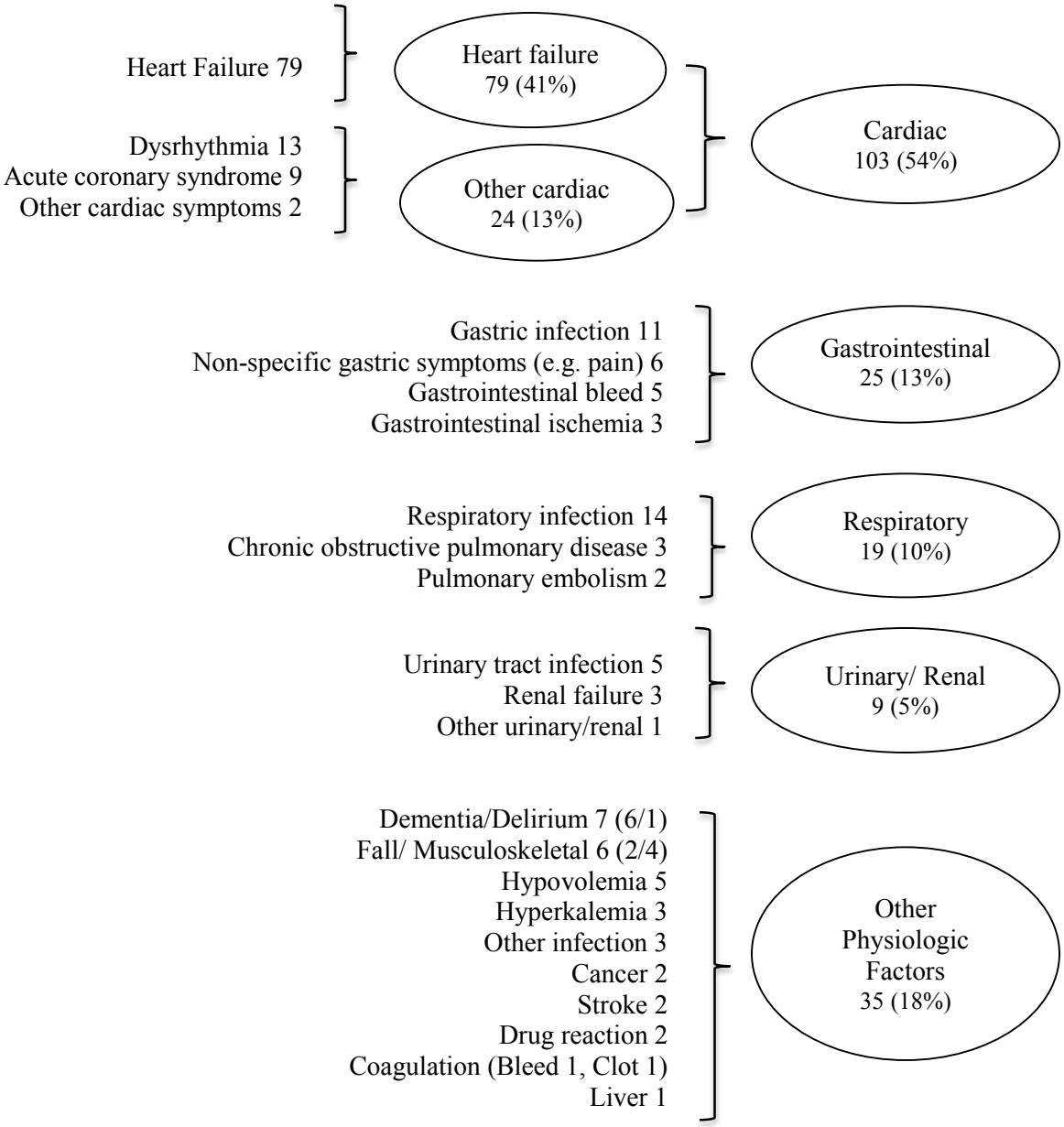
Presenting Pathology at time of Readmission

The pathologic conditions that brought patients back to hospital varied greatly, though clusters appeared. The majority of patients presented to the hospitals with symptoms other than HF (Figure 4). Other cardiac conditions such as atrial fibrillation, bradycardia, and chest pain were also common. Gastrointestinal (GI) disorders included diarrhea, GI bleed, ischemic bowel, and other GI disorders such as undiagnosed abdominal pain. Respiratory issues were commonly pneumonia or upper respiratory infections. Urinary and renal issues were predominantly infections. Other conditions included altered mental status, mobility issues, electrolyte or metabolic imbalances, other infections (e.g. cellulitis), cancer, stroke, coagulation issues, and liver disease (e.g. hepatic encephalopathy). Two patients presented with systemic reactions to oral medications.

Factors Contributing to the Readmission

When possible, we identified what process or event may have triggered the symptoms and related pathology that required readmission (Table 13). Sixty percent of the readmission records had symptoms documented but minimal or no description of what may have precipitated the symptoms. Of this subgroup, a large portion (42%) of readmissions was due to continuing symptoms from the index admission. Some examples of continuing symptom descriptions include: “short of breath since discharge”, or “throbbing headache since discharge”, or “exacerbation related to recent MI and resulting pericarditis”, or “readmitted for abdominal pain, continuous since discharge yesterday”. Another portion (18%) of readmissions were due to new health conditions such as gastrointestinal bleeds, bradycardia, confusion, or falls. Of these two

Figure 4 Presenting pathology at the time of readmission within 7 days of discharge



subgroups, there was not enough information to discern what may have contributed to the development of the symptoms.

The other 40% of the records had an identifiable underlying factor. When multiple factors were evident, we identified the primary factor for each case. We did this by independently reviewing the description of patient health status at index discharge, symptoms at readmission, events related to readmission (e.g. what happened at home), and diagnosis list in the readmission history and physical. When team members determined a different primary factor contributing to readmission, discussion took place, and consensus was reached.

Of these cases where more detail was documented, health system processes potentially contributed to 20% of the readmissions. These cases involved medications (e.g. digoxin toxicity or no HF medications prescribed), inappropriate placement (e.g. discharged home with severe immobility or dementia), hospital-related complications (e.g. "cellulitis related to intravenous") or healthcare provider error (e.g. "oxygen tank ran out in long-term care facility"). In one case, the documentation included "discharged yesterday post pacemaker implantation. Awoke very short of breath, called EMS, oxygen saturation 60-88%". The documented diagnosis was "pulmonary embolus related to the prior medical procedure". In cases where palliative care was the focus, hospice or home-based palliative services may have been more suitable than an acute care readmission, thus categorized as a health system not a patient-related factor.

Patient-related factors (19%) included self-care issues such as non-adherence to the prescribed regimen, misunderstanding the care plan, and self-harm. Patient factors also included the refusal of care, or a swift decline in function in elderly patients described as "failure to thrive".

Table 13 Principal factors contributing to readmission

Factors (n=191)	Description and examples
Continuing symptoms not resolved at discharge 80 (42%)	HF symptoms (e.g. dyspnea, edema) Other symptoms present during index admission (e.g. dysrhythmia, epistaxis, COPD, pneumonia, pulmonary fibrosis, knee pain, diarrhea)
New health condition 35 (18%)	New symptoms, no link to prior admission (e.g. "came to ED with abdominal pain and nausea", chest pain, "found confused by daughter, had fallen twice, bradycardia, low glucose", cardiac arrest, hyperkalemia)
Medication-related – 20 (10%)	Adverse drug reaction (e.g. hives from antibiotic) Over medicated (e.g. digoxin toxicity, fell out of bed after taking sleeping pill) Under-medicated (e.g. no HF meds prescribed)
Self-care issue – 16 (8%)	Patient non-adherence to prescribed regimen (e.g. CPAP not worn, prescriptions not filled by family, patient stopped self-care due to mood disorder, patient stopped medications due to feeling well) Misunderstanding the care plan (e.g. excessive fluid intake, ate high sodium soups, used old medication list) Self-harm (e.g. overdose of 10 Tylenol #4 tablets)
Refusal of care -10 (5%)	Left against medical advice Declined homecare or long-term care Refused functional or cognitive assessment
Potentially inappropriate placement- 9 (5%)	Mobility issues (e.g. unable to get off toilet) Increased confusion/dementia (e.g. combative at home) Current services not enough (e.g. "difficulty coping despite current maximum homecare"); spouses couldn't manage patient at home any more (e.g. patients had metastatic cancer, somnolence, dyspnea and anxiety too great to cope at home)
Failure to thrive – 11 (6%)	Weakness, gradual functional decline (e.g. dehydration from poor oral intake, not eating or drinking for days, high risk for falls with unsteady gait, severe lethargy and/or weakness, progressive dementia) Decline in status despite added services
Hospital-related – 5 (3%)	Complication of recent procedure or therapy (e.g. arm cellulitis secondary to intravenous trauma, nosocomial pneumonia, clostridium difficile colitis, pulmonary embolus post pacemaker insertion)
Palliative – 4 (2%)	Active dying (e.g. unable to eat/drink and died in hospice 4 days post readmission, advanced age with severe multisystem symptoms, advanced cancer, died during readmission)
Healthcare provider error – 1 (<1%)	Poor standard of community care (e.g. nursing home let oxygen tank run out and patient became hypoxic)

Note. One category was determined for each readmission; COPD = chronic obstructive pulmonary disease; ED = emergency department; CPAP = continuous positive airway pressures

Avoidability

Avoidability was scored using 2 approaches: implicit review by 3 team members (i.e. the investigator and 2 senior nursing students), and explicit review by 2 team members (i.e. the investigator and practicing registered nurse) (Table 14). Implicit review involved using professional judgment to determine a score for avoidability on a 6-point scale with minimal predetermined criteria. Explicit review involved development of criteria for a 6-point rating scale after examining the data, the literature, and reaching agreement among team members.

Table 14 Potential avoidability of readmission scored using implicit and explicit criteria

Avoidability (frequency/percent)	Implicit	Explicit
1. Virtually no evidence of avoidability	33 (17.3)	7 (0.4)
2. Slight to modest evidence of avoidability	71 (37.2)	25 (13.0)
3. Avoidability not likely (less than 50/50)	39 (20.4)	52 (27.2)
4. Avoidability likely (more than 50/50)	33 (17.3)	29 (15.2)
5. Strong evidence of avoidability	15 (7.9)	78 (40.8)
6. Virtually certain evidence of avoidability	0	0

When avoidability was ranked using implicit criteria, the greatest numbers of cases (75%) were scored in the lower avoidability categories (score 1-3). When avoidability was ranked on a 6-point scale using explicit criteria, the largest cluster (56%) scored with strong evidence of avoidability (score 4-6). High avoidability was assigned to patients who returned with the same unresolved symptoms present during the index admission, were not provided with more post-discharge services when evidence of high disability, social issues were not addressed with added services, or an adverse event occurred related to clinical care during the index admission (Table 15). The other 44% cases were deemed less avoidable (score 1-3) due to a new unforeseen problem, stable at discharge but symptoms recurred, refusal of care, or provision of services yet problems still arose. Examples of new unforeseen problems included cardiac arrest,

chest pain, delirium, falls, or stroke. Even using the explicit criteria, many cases (42.4%) had less clear evidence of high or low avoidability and were assigned a score of 3 or 4 (Table 14).

Table 15 Description of reasons for potential low and high avoidability (explicit criteria)

Low Avoidability	84 (44%)
New unforeseen problem	39 (21%)
Continuing symptoms but stable at discharge	32 (17%)
Refusal of care	10 (5%)
Services provided but not enough	3 (2%)
High Avoidability	107 (56%)
Signs and symptoms present at discharge	42 (22%)
Adverse event related to clinical care	23 (12%)
Social or self-care issue not addressed with added services	20 (11%)
High disability but no added services	16 (8%)
Discussion of palliation but no added services	6 (3%)

Deaths During Readmission

Deaths occurred in 14.7% (28) of patients during readmission. Of those, 4 patients were described as terminal or palliative in the readmission history and physical notes. Other patients who died during the readmission were classified as "failure to thrive", exhibited continuing symptoms from the index admission, or had new unforeseen problems like a stroke.

Summary of Phase Two Findings

In summary, after review of 382 health records of patients discharged from Calgary hospitals with HF, half of whom were readmitted within 7 days of index discharge, age-, sex-, and year-matched with patients not readmitted within 7 days, several physiologic and health system factors were linked with increased and decreased likelihood of readmission. Frailty and provider type as specialist were associated with increased likelihood of readmission. Documented instructions for the patient to visit a physician within one week of discharge were associated with decreased likelihood of readmission.

The presenting pathology was cardiovascular for 54% of the readmitted patients, 77% of which were HF. Other common conditions included gastric, respiratory, and urinary infections. Factors contributing to readmission included continuing symptoms not resolved at index discharge, new problems, medication-related, self-care issue, refusal of care, potentially inappropriate placement, failure to thrive, hospital-related, palliative, and health-care provider error. Over half (56%) of the readmissions were scored as potentially avoidable using the more descriptive explicit criteria. Implicit review produced a more conservative number. Avoidable readmissions included patients with symptoms not resolved at index discharge, social or self-care issues not addressed, adverse events related to index admission clinical care, high disability or terminal illness with no added services. Less avoidable readmissions were due to new unforeseen health issues, recurring symptoms after being stable at index discharge, or refusal of care during the index admission.

Summary of Key Results

In Phase One, after analysis of 18,590 patients discharged with HF as most responsible diagnosis in Alberta, Canada, multiple physiologic factors were associated with increased likelihood of all-cause readmission within 30 days of discharge from hospital after risk adjustment. These factors included age >75 years, diabetes, atrial fibrillation, pulmonary disease, kidney disease and previous myocardial infarction. Also, patients discharged from hospitals with specialty HF services were less likely to be readmitted for all causes within 30 days. A history of kidney disease, transfer in to the index facility, discharge home with homecare services, and discharge against medical advice were the only variables significantly associated with increased likelihood of all-cause readmission within 7 days after discharge.

Discharge from hospitals with specialty HF services and long index length of stay remained strongly associated with decreased likelihood of readmission within 7 days after discharge.

In Phase Two, after an audit of 382 health records of patients readmitted and not readmitted within 7 days of discharge after hospitalization for HF in Calgary, AB, only 2 factors were significantly associated with increased likelihood of readmission within 7 days of discharge: frailty and provider as specialist. Decreased likelihood of readmission was associated with instructions to visit a physician within 7 days of discharge. Half of the patients presented with cardiovascular symptoms upon readmission. The other half presented with a variety of other health problems. Patients frequently (42%) were readmitted for symptoms continuing from the index admission. System factors (medication-related, hospital-related, inappropriate placement) and patient factors (self-care issues, refusal of care) also contributed to readmissions within 7 days. Using newly developed explicit criteria, 56% for the readmissions were deemed potentially avoidable.

CHAPTER FIVE: DISCUSSION

Phase One

Readmission Rates

We determined readmission rates and factors associated with readmission for HF patients using Alberta population-based data. We determined the non-elective readmission rate within 7 days (5.6% for all causes and 2.0% for HF) and within 30 days (18.0% for all causes and 6.7% for HF). The factors associated with increased readmission risk were similar at both 7 days and 30 days: discharged with the need for additional home health services (a potential proxy for frailty), left against medical advice, concomitant renal disease, and discharged from hospitals without specialized HF services. These factors remained independently associated with readmission risk even after adjustment for age, sex, and other comorbidities. These clusters of characteristics should alert clinical personnel to patients at increased risk of early readmission after HF hospitalization.

The 7-day all-cause readmission rate of 5.6% from our study was higher than published rates on (Mourad & Redelmeier, 2006; Westert, Lagoe, Keskimaki, Leyland, & Murphy, 2002). It is possible that this is due to differences in how readmissions have been defined. We included readmissions for all causes, patients with a history of any comorbid condition, and transfers into the index facility, which would account for the higher rate. Westert et al. (2002) included readmissions for a diagnosis related to the initial admission diagnosis and Mourad and Redelmeier (2006) included readmissions for HF as primary diagnosis while excluding cancer patients and transfers in to the index facility. These differing definitions rendered readmission rates between 1.7% and 3.8%.

The 30-day all-cause readmission rate of 18%, on the other hand, was similar to other reported rates in Canada, ranging from 15.9% in Ontario in 2007 (Yeung et al., 2012) to 17.5% in Alberta in 2009 (McAlister, Bakal, et al., 2013). Consistency between findings makes sense. The first occurring discharges with HF as most responsible diagnosis and similar exclusion criteria were used in these Canadian studies.

Risk Factors for Readmission

Physiologic Factors

Risk factors for readmission varied by duration of observation. The only condition associated with 7-day all-cause readmission was renal disease, while multiple conditions (including renal disease) were associated with 30-day all-cause readmission. While dementia was not associated with risk of readmission in this older HF population, other potential markers of frailty/disability (such as the need for homecare services) were. The validity of the coding for the comorbid conditions varied by condition; for example, dementia is under-coded compared to chart audit (sensitivity 66.9%), while cancer coding validity is high (sensitivity 80.8%) (Quan et al., 2008). Under coding may have masked the association between some comorbid conditions (such as dementia) and readmission.

Structural and Provider-Related Elements

Transfer from one hospital to the discharging acute care facility was a predictor of all-cause readmissions within 7 days and 30 days. Even though we adjusted for comorbidities, patients transferred from other acute facilities might be sicker, or might not have received as aggressive early treatment, rendering their conditions more complex. Those transferred in from other facilities may also have been more likely to live in rural settings with less access to

outpatient follow-up or specialty HF services after hospitalization, as described in other studies (Gamble et al., 2011; McAlister, Bakal, et al., 2013).

Using 1994 to 2000 Alberta administrative data, Cujec et al. reported that HF patients cared for by primary care physicians were less likely to be readmitted within 180-days after discharge (aOR 0.81 95% CI: 0.71–0.92) compared to specialist-treated patients (Cujec, Quan, Jin, & Johnson, 2005). Our more recent data show that while specialty of attending physician was not associated with readmission risk after adjustment for comorbidity burdens and patient demographic characteristics, patients discharged from hospitals with specialized HF services were at lower risk for readmission regardless of duration of observation (i.e. 7 days and 30 days) or reason for readmission (i.e. all causes or HF). Rich literature demonstrates that specially trained multidisciplinary teams optimize the use of proven efficacious therapies and clinical outcomes for patients with HF (Ezekowitz et al., 2005; Hernandez et al., 2010; Howlett et al., 2009; McAlister et al., 2004). In our sample, 13 hospitals had access to this type of specialized disease management, while two others provided access via telemedicine. While recognizing that referral patterns and programs vary, the immediate benefit of discharge teaching and early outpatient visits or telephone contact may have contributed to fewer early readmissions. This is consistent with recent data demonstrating that a system wide intervention to increase access to specialized HF services was associated with improvements in post-hospitalization outcomes in Alberta (McAlister, Bakal, et al., 2013).

Discharge disposition categories were strong predictors of readmission risk. Importantly, the 7-day and 30-day all-cause readmission rates were highest for the 24.8% of patients requiring homecare assistance after discharge (undoubtedly a marker for frailty). Chen et al. also reported that patients with HF who received homecare services after discharge are more likely to be

readmitted than those who did not receive the service (50% vs. 29%) (Chen, Khan, King, Hemmelgarn, & Quan, 2010). It is unclear if this simply reflects a higher level of comorbidity in these patients or if systemic characteristics of homecare delivery in this population allow for a higher likelihood of readmission. Our findings suggest an opportunity for further study, and potential development of interventions designed to reduce readmission rates in the homecare setting for HF patients.

Patients discharged to long-term care made up 9.2% of the study sample and had a 13.6% all-cause 30-day readmission rate. Research focused on Medicare beneficiaries with HF revealed 18-19% of patients were discharged to long-term care facilities (skilled nursing facilities) and had a 27% 30-day all-cause readmission rate (Allen et al., 2011; Bueno et al., 2010). The samples for these studies were comprised of older patients and had more women; possibly accounting for more discharges to long-term care.

Our finding that patients who left against medical advice had the highest rates of readmission has been reported in other settings (Coffey et al., 2012; Garland et al., 2013). When patients leave hospitals early, clinical care may be incomplete and the factors contributing to readmission may remain unaddressed. Hence it is not surprising that these patients return to hospital for further treatment. Discharge disposition categories, particularly discharged home with homecare services and discharged against medical advice, are important predictors of risk of readmission in the HF population.

Strengths and Limitations

Strengths of this study include the large sample size, representativeness of the sample, consistency of the method with prior studies, and novel comparison of 7- and 30-day readmissions. Large samples attained through hospital discharge abstract administrative data are

considered representative of patients for that geographic region when minimal exclusion criteria are applied, as in this study. Definitions for HF, comorbid conditions, and other variables such as discharge disposition, follow the same algorithms as other Canadian studies. This study updates and adds new information about readmissions in the HF population, which is valuable for clinicians and policy makers alike.

This study has some limitations. Administrative data lack detailed clinical information about cardiac severity such as ejection fraction or BNP levels. However, we adjusted for index hospital LOS and transfers from admitting hospital to discharging hospital as proxies for severity. Further, to adjust for comorbidity burdens we used the Charlson index, and the scores in our cohort (mean 2.6) are comparable to other Canadian reports (Yeung et al., 2012). Unlike the study by Yeung et al, we did not control for more cardiovascular comorbid conditions like hypertension or hyperlipidemia, which may have been useful variables to include. Discharge medications or teaching were not included as data to determine the quality of care. Further, while patients discharged from hospitals with specialized HF services exhibited lower risk of readmission at both 7 days and 30 days, we cannot be certain that all patients discharged from these hospitals received these services nor that the services provided over the 8-year study period were consistent within and between hospitals. Also, we did not adjust for day of discharge but a recent study from Alberta has shown that patients discharged on weekdays have lower readmission rates than those discharged on weekends or holidays (McAlister, Au, Majumdar, Youngson, & Padwal, 2013). While beyond the scope of this study, prior studies have also demonstrated that early outpatient follow-up, particularly with a physician familiar with the patient's case, is associated with reduced risk of readmission (Cujec et al., 2005; McAlister et al., 2004).

The most important limitation of our study is that we cannot determine if readmissions were avoidable – that determination requires a review of detailed clinical data and patient interviews (van Walraven, Bennett, et al., 2011). However, we examined the immediate 7-day post-discharge time frame that has been highlighted as the interval where avoidable readmissions are most common; a novel and important contribution of our study. In doing so, we identified several subgroups (e.g. advanced age, renal disease, discharged requiring homecare support, or left against medical advice) that should be targets for future interventions designed to reduce readmissions. Pan-Canadian cardiac health quality indicators are under development with HF as a specific category (Abrahamyan et al., 2012; Johnstone et al., 2012). Previous studies demonstrated that 30-day readmission rates correlate poorly with quality of inpatient care and discharge transition to the community (Hernandez et al., 2011; Horwitz et al., 2012). Measuring readmissions closer to discharge (i.e., readmission within 7 days) might be a more appropriate target for judging the adequacy of discharge transitions.

Finally, several risk factors (e.g. advanced age, comorbid conditions, and discharged requiring homecare services) are associated with increased risk of all-cause and HF readmissions within 7 days and 30 days. Patients discharged from hospitals with specialized HF services exhibit lower risks of all-cause readmissions and HF-specific readmissions than those discharged from other hospitals. Given the emphasis on reducing readmissions as a quality indicator (Abrahamyan et al., 2012), if transition procedures and inpatient quality of care are to be fully evaluated, we believe future research should focus on both 7-day as well as 30-day readmission rates to clarify risk factors and identify, develop, or test potentially effective reduction strategies.

Phase Two

Risk Factors For Readmission

We determined risk factors associated with readmission within 7 days of discharge using health record data. Only 2 characteristics were significantly associated with increased likelihood of readmission: frailty and provider type. The only variable associated with a reduced likelihood of readmission was documented instructions for the patient to follow up with a family physician within 1 week of discharge.

Physiologic Factors

Frailty

Patients identified as frail were twice as likely to be readmitted within 7 days of discharge - even after accounting for index admission provider type, weight change during index admission, and outpatient follow-up patterns. It is not known which comes first: HF or frailty. Frailty may predispose cardiovascular patients to a lower threshold for HF decompensation or the HF alone may trigger the physiologic changes of frailty that increase the risk readmission in HF patients (Afilalo et al., 2014). While it is not clear which comes first, evidence is building that frailty significantly contributes to poorer quality of life, morbidity, and mortality in patients with HF (Afilalo et al., 2014; Bergman et al., 2007; Buck et al., 2012; Chaudhry et al., 2013; McNallan, Singh, et al., 2013). Given that frailty is considered a manageable condition Morley et al. (2013) like HF, fewer readmissions may occur with screening and early intervention for both syndromes.

Though more detailed validated frailty measures exist, using simple 3-point criteria for identifying frailty had a major advantage. The data were readily identifiable in health records. As reported by Afilalo et al. (2014), there are over 20 tools available for frailty screening, yet

criteria that require no questionnaires or physiologic testing are more practical for screening for frailty in acute care settings. A simple 3-point tool may also be more readily adopted into admission intake processes for more regular screening of HF patients.

The rates of frailty in this study were similar to rates reported in other studies of HF patients. Thirty-five percent of the HF patients in our sample were frail, which aligns with 21-48% frailty rates in cardiovascular populations when more complex definitions of frailty were used (Afilalo et al., 2009; McNallan, Chamberlain, et al., 2013).

The 3 criteria included in this definition of frailty were useful and warrant further testing (i.e. age >75 years, >3 comorbid conditions, requiring assistance with ADLs). First, age >75 years as a cut-off needs further study. This age was included since frailty is most common in the elderly and it is associated with cumulative impairments that can occur with advanced age across multiple diagnosis categories (Bergman et al., 2007; Ng et al., 2014). Yet age > 75 years might exclude younger patients who are frail. A lower age cut-off could be considered, given that a recent consensus panel recommended that all patients >70 years be screened for frailty (Morley et al., 2013). Second, researchers have identified that frailty rarely occurs in the absence of chronic illness (Bergman et al., 2007) and is associated with greater numbers of comorbid conditions in cardiovascular patients (Morley, Malmstrom, & Miller, 2012; Rockwood, Hogan, & MacKnight, 2000). Yet, multi-morbidity alone does not indicate frailty (Morley et al., 2013). A cut-off of 3 comorbid conditions is often used to differentiate disease severity, hence inclusion of >3 comorbid conditions in this definition.

The third criterion, disability, an adverse outcome of frailty warrants inclusion in a measure of frailty as disability results from the characteristics of frailty (i.e. slowness, weakness, low physical activity, exhaustion, and muscle shrinking). It is understood that disability only

indirectly points to frailty and not all disabled people are frail (Morley et al., 2013). However, researchers have indicated the close link between frailty, disability, and readmission, making disability a valuable marker of frailty. For example, Anderson (2013) found that HF patients who required assistance with ADL such as toileting, bathing, or ambulating were over 10 times more likely to experience readmission within 60 days of discharge after admission for HF than those patients who did not require assistance with ADL. Researchers also reported increased hospitalization rates when elements of frailty such as slow gait and muscle weakness were present in HF patients (Chaudhry et al., 2013). Ability to carry out ADLs is routinely found in nursing documentation, whereas gait and muscle strength require specific testing and do not appear routinely in health records. With testing, this 3-point measure of frailty can offer an effective way to screen for frailty.

Despite frailty appearing more often in advanced stages of HF, signs of frailty are not necessarily only a reflection of advanced age or the disease, and it is possible to intervene. There is consensus that frailty is a manageable condition (Morley et al., 2013). Some evidence exists to support that interventions such as exercise therapy (resistance and aerobic), caloric and protein support, vitamin D, and reduction of polypharmacy may reduce frailty in medical-surgical patients (Morley et al., 2013). For example, exercise has been found to modify some components of frailty (e.g. muscle strength, muscle mass) (Belardinelli, Georgiou, Cianci, & Purcaro, 2012). In a randomized controlled trial, patients with HF who partook in a supervised exercise program to address their frailty improved their functional capacity and achieved a 36% reduced risk of readmission (Belardinelli et al., 2012). In summary, evidence of frailty in HF patients may signal high risk for readmission and the need for interventions targeting the physical frailty.

Other Physiologic Factors

Forty-one percent of patients in this study presented to the readmitting hospital within 7 days of discharge with HF symptoms. No other studies exist in which reasons for readmission within 7 days of discharge are documented. Other researchers have reported that 20 to 35% of readmissions within 30 days were for HF as the most responsible diagnosis (Dharmarajan et al., 2013; McAlister, Bakal, et al., 2013; Yeung et al., 2012). When examining readmissions over the greater time period of 30 versus 7 days, there is more time for a variety of illnesses to occur and problems to arise that likely diluted the number of readmissions attributed to HF. Of note, our study based admitting diagnosis on the primary symptoms reported in the emergency department coupled with the first occurring diagnosis on the history and physical examination. The majority of studies examining readmissions within 30 days base readmission diagnosis on administrative data that includes most resource intensive diagnosis during readmission and this may not necessarily be the same as the primary admitting diagnosis. We focused on the presenting problem to more precisely identify the reason for readmission to better address that factors that might have precipitated the symptoms. With our close examination of the 7-day post discharge period, the high percentage of patients presenting back to hospital with HF, reinforces the importance of ensuring aggressive and thorough treatment of HF symptoms before discharge to prevent early readmission.

In contrast to other studies including 30 and 60-day outcomes, early readmission in this cohort was not associated with other physiologic factors such as blood pressure (Felker et al., 2004), atrial fibrillation, history of myocardial infarction (Sherer, Crane, & Abel, 2011), or symptoms of congestion at discharge (Anderson, 2013). A history of renal failure has also been associated with risk of readmission within 30 days of discharge (Chun et al., 2012; Ross et al.,

2008). Interestingly, after closer examination of the 7-day period, patients did not often present to hospital with renal failure (e.g. elevated creatinine) although fluid retention and HF symptoms could have been related to renal failure. Acknowledging that different time periods were studied, use of admitting diagnosis versus a most responsible diagnosis coded after discharge may account for fewer diagnoses of renal failure.

One unique finding of our study is the high incidence of infection as the primary presenting problem that prompted readmission (i.e. 15.7% for pneumonia, gastric infections, and urinary tract infections in order of frequency). Only 50% of the readmitted and not readmitted groups received a chest x-ray within 48 hours of discharge. If more chest x-rays were ordered within close proximity to discharge, pneumonia may have been detected. As well, as recommended by (Ashton et al., 1994), a white cell count prior to discharge may have detected the urinary, gastric, or respiratory infections, and prompted further treatment rather than discharge.

System Factors

Provider Type

Patients under the care of a cardiologist, internist, or specialist had a greater likelihood of readmission within 7 days of discharge even after accounting for the 5 other variables in the multivariate models (i.e. frailty, note to see physician within 1 week after discharge, end-of-life discussion documented, referral to HF clinic or cardiologist, and no weight loss during index hospital admission). Yet, in Phase One, provider type was not a significant predictor of 7- or 30-day readmission. When examining 30- and 60-day readmissions, other researchers found no association between cardiologist care and readmission after HF hospitalization (Anderson, 2013) (Kociol et al., 2013). While in our 2 studies, the same administrative data were used to identify

provider, the conflicting results could be attributed to studying a sample from one city versus the entire province. One might expect specialists to provide more thorough treatment resulting in fewer readmissions. Alternatively, a greater number of readmissions may represent more intensive monitoring and more aggressive treatment by a specialist. We adjusted for disease severity by including frailty in the regression models, so patients under the care of specialists were not necessarily more ill. While not found in other studies, provider as specialist was significantly associated with greater likelihood of readmission within 7 days, possibly indicating more intensive monitoring and treatment.

Process Factors

Early Physician Follow-up

Documentation of instructions to follow-up with a physician within 7 days of discharge occurred in 59% of the sample and was strongly associated with reduced likelihood of readmission within 7 days. This frequency of instructions to follow-up with a physician within 1 week of discharge is high considering that the association between scheduling early follow-up before discharge and readmissions has only recently become clear. No other studies include findings on the value of instructing patients to follow-up with a physician, but researchers report on related topics. For example, Bradley et al. (2013) reported that arranging follow-up visits before discharge was significantly associated with reduced 30-day readmissions after HF hospitalization. Hernandez et al. (2010) reported lower 30-day readmission rates in hospitals with the highest level of follow-up appointments with any physician within 7 days of discharge after HF hospitalization. While they studied a different outcome time period, identified physician procedure codes versus documented instructions, and used hospital-level versus patient-level data, the benefit was similar – fewer readmissions occurred with early follow-up.

We identified instructions for follow-up on patients' charts and not actual follow-up appointments. We might assume that some form of communication with a physician's office staff took place - a phone call or office visit, within the 7 days after discharge. The health records did not include what form of contact occurred, but the contact may have involved sufficient clinical or social support to reduce the likelihood of readmission.

Other similar process-of-care variables studied were not associated with readmission during the 7-day post-discharge period (e.g. documentation for the patient to follow-up with a physician without a specific time noted or appointment made; communication of discharge summary to an outpatient physician). Almost all discharge summaries indicated a copy was sent to one or more physicians. Yet, no relationship appeared between discharge summary communications and reduced readmission, as shown in a study of acute medical hospitalizations by (van Walraven et al., 2002). The act of instructing patients to schedule a follow-up medical visit within 7 days of discharge after HF hospitalization had the greatest association with reduced risk of readmission.

End-of-life Discussion

The documentation of end-of-life discussions was significantly associated with greater risk of readmission within 7 days in univariate analyses. This variable did not remain significantly associated with readmission in the multivariate model, suggesting that frailty had a greater influence on readmission. In one of few studies focused on end-of-life discussions, Thurston, Wayne, Feinglass, and Sharma (2014) found that more end-of-life discussions, specifically about resuscitation status, took place for patients with higher severity of illness scores. Considering that end-of-life conversations may have occurred but were not recorded, documentation of these conversations in only 24% of our total sample's records is alarmingly

low when 35% of the sample was frail and the other portion exhibited highly complex health issues, including advanced HF.

Given the complex advanced health issues of our sample, and that most HF hospitalizations occur in the last 3 to 6 months before death (Chun et al., 2012), open discussions about prognosis and palliative/symptom management options need to take place; and more often than what appeared in our data. Advocates for thorough planning for patients with advanced HF recommend discussions about goals of care, quality versus quantity of life, and palliative options with every clinical encounter (Goodlin, 2009). The focus of care could then be on quality of life and potentially avert multiple admissions towards end-of-life (Desai, 2012).

Referral to Heart Function Clinic or Cardiologist

Using univariate analysis, patients who were referred to a HF clinic or cardiologist upon discharge were 1.5 times *more* likely to be readmitted within 7 days than the control group. Referral to HF clinic or cardiologist did not remain significant in multivariate analysis after accounting for frailty, provider as specialist, and documentation of end-of-life discussions. A referral to a HF clinic or cardiologist may indicate that a patient was referred to these services because they were more ill (e.g., being more likely frail), under the care of a specialist, and in need of added support. Yet, unless telephone contact or a clinic visit occurs within the 7 days post discharge, referral to HF specialty services would have little impact on the immediate post-discharge period.

Factors Contributing to Readmission

This is the first time that a detailed description of factors that contributed to readmission within 7 days of discharge after HF hospitalization has been completed. Readmissions occurred in response to a wide variety of situations. Researchers of medical/surgical 30-day readmissions

also found a great variety of causes and contexts (Oddone et al., 1996; van Walraven, Bennett, et al., 2011; Yam, Wong, Chan, Leung, et al., 2010).

Continuing symptoms precipitated 42% of readmissions; twice as often as new unforeseen health issues. Several researchers have reported similar findings. In a study including HF admissions, 45% were readmitted for a continuation or recurrence of HF within 15 days after discharge (Goldfield et al., 2008). As well, Halfon et al. (2002) and Yam, Wong, Chan, Leung, et al. (2010) found that 45% and 33% respectively of unforeseen 30-day readmissions after medical/surgical index admissions were for previously known conditions or the same principal diagnosis in both index and readmission episode. Despite slight differences in variable definitions, readmissions have been commonly related to a condition present during the index stay.

We found that patients were frequently discharged after exhibiting HF symptoms within 48 hours before discharge. Halfon et al. (2002) identified clinical instability within the last 2 days of hospitalization as a risk factor for readmission. In the HF population, (Anderson, 2013) found a significant association between dyspnea and crackles within 48 hours of discharge and readmission within 60 days after discharge. Interestingly, the variable 'signs or symptoms of HF within 48 hours of discharge' in our study was not associated with 7-day readmissions, perhaps due to the shorter time period or smaller sample. Still, after detailed review, the high proportion of readmissions for continuing symptoms not fully resolved at index discharge highlights the need for thorough and aggressive inpatient treatment and, if discharged with symptoms, immediate connection with home health or other outpatient services, specifically prepared to monitor and treat the continuing symptoms.

Health system processes fell into two categories: complications of hospital care and insufficient services to match the level of disability. Complications of hospital care included medication-related events and complications due to issues other than medications in 20% of the readmissions studied. Examples of gaps in health services included nosocomial infections, digoxin toxicity, or severe disability with no added services. (Yam, Wong, Chan, Leung, et al., 2010) reported that 7.8% of cases in a study of medical/surgical 30-day readmissions were due to hospital or medication-related events. The proportion of readmissions related to hospital complications may be higher in our study due to the shorter time interval studied. Further comparison of this finding to other studies is difficult given that some researchers reported causes of all readmissions and some reported only preventable readmissions. There is also great variation between definitions of categories in that some researchers reported adverse events, medical complications, surgical complications, nosocomial infections, premature discharge, suboptimal medical care, provider error, or system error (Oddone et al., 1996; van Walraven, Bennett, et al., 2011; Yam, Wong, Chan, Leung, et al., 2010). It was similarly difficult to compare findings regarding readmissions related to insufficient services. Other researchers included categories such as inadequate discharge planning, a need to transfer to convalescence, or unavailable nursing home care, as examples (Oddone et al., 1996; Yam, Wong, Chan, Leung, et al., 2010). Hospital system processes contributed to a substantial portion of readmissions and subcategories vary in related research.

Difficulty with self-care was attributed to only 8% of the readmissions in our study. Similarly, non-adherence to medical regimen contributed to 30-day readmissions in medical/surgical samples 4% of the time (Yam, Wong, Chan, Leung, et al., 2010). Again, great variation exists in the way that self-care is defined in research related to readmissions. Lee et al.

(2011) reported that above-average self-care practices reduce the risk of readmission or death. Therefore, discharge teaching and early outpatient contact to empower self-care plays a role in prevention of readmissions.

Lastly, 8% of readmissions within 7 days were attributed to failure to thrive or patients in palliative stages of HF. According to Go et al. (2013), advanced HF contributed to 1 in 9 deaths in the United States in 2009 yet, few HF studies report how often readmissions are associated with the cluster refractory symptoms that occur towards end-of-life, also known as Stage D HF (Yancy et al., 2013). A better understanding of patients with Stage D HF could enhance the quality of care that might include a palliative approach. Predicting prognosis is difficult with advanced HF and a major barrier to timing the shift to symptom management (Whellan et al., 2014). In the medical/surgical population, Yam, Wong, Chan, Leung, et al. (2010) reported 1.7% of readmissions studied were due to terminal care, but lacked a clear definition. More often, researchers report on individual risk factors such as age >80 years, NYHA Class IV functional status, comorbid conditions, or lab values as predictors of readmission in the HF population (Betihavas et al., 2012; Giamouzis et al., 2011). These individual variables may indicate severity of HF and potential readmission risk, but clusters of these variables might better indicate when readmissions are occurring due to refractory symptoms towards end-of-life, Stage D HF. Therefore, documentation of the stage of HF would provide a clearer understanding of the number of patients who are readmitted and may benefit from specialized interventions or a palliative approach.

Avoidability

Two different mechanisms were used to determine avoidability of the readmissions that resulted in two different sets of scores. Implicit criteria (professional opinion) suggested 25% of

the readmissions were moderately to highly avoidable, while the detailed explicit criteria suggested 74.8% were moderately to highly avoidable. Similarly, Brook and Appel (1973) found that evaluation of the quality of medical care was highly dependent upon the method used for measurement – implicit versus explicit review criteria. They described that when implicit criteria were used, the acceptability of medical care was judged more leniently and was more open to variation between judges than when explicit criteria were used.

Although physician panels have used implicit criteria to determine avoidability (van Walraven, Jennings, Taljaard, et al., 2011), it was not sufficient for our team (1 experienced nurse and 2 novice nurses) to consistently judge avoidability without more explicit criteria. Goldfield (2011) suggested clinicians within institutions, not just researchers with access to physician review panels, must be able to use reproducible methods to evaluate avoidability of readmissions to activate quality improvement initiatives. Researchers found explicit criteria useful to reduce the risk of misclassifying the avoidability of each readmission case (Witherington, Pirzada, & Avery, 2008). Further, van Walraven, Jennings, Taljaard, et al. (2011) stated that criteria for evaluating avoidability of readmissions has been non-specific resulting in great variation between reviewers opinions of avoidability. If HF readmissions rates are to be linked with hospital payment incentives, then our proposed explicit criteria may produce useful estimates of avoidable readmissions and warrants further testing.

Many researchers discuss the importance of identifying, acting on, and being penalized for avoidable readmissions in the HF population. However, a real-time prospective approach to prevention of avoidable readmissions is still needed. Ashton et al. (1994) developed explicit criteria for discharge readiness of HF patients that has not been further tested. Our avoidability

criteria, coupled with identification of frailty, could inform development of a screening tool for discharge readiness.

Strengths and Limitations

This study has strengths and limitations related to health record data. One strength is inclusion of patients from 3 different tertiary care hospitals that serve diverse urban and surrounding rural populations. As well, we undertook detailed health record reviews at each hospital that enabled validation of diagnoses and examination of clinical details versus analyzing only admitting or discharge diagnoses. Health record data are valuable in providing a real-life representation of patient populations and clinical care thus enhancing generalizability.

Another strength is that the quality of the health records data was high. By considering how 'helpful' the record was for locating all variables, our team members ranked the quality of documentation on a scale from 1 to 10. A low number was assigned if chart components were missing or documentation was scant in the discharge summary or progress notes. A score of 8 or higher was assigned for 73% of the health records. Only 4 records were ranked lower than 6 on the quality scale.

One limitation with any health record audit is that the quality of health record data is dependent upon the quality of documentation. As well, our data were limited to what was documented and may not fully represent actual practice. For example, end-of-life discussions were documented in 12% of the total records, and patient education was documented in 60% of the records when many more such discussions or education may have taken place.

The outcome of interest in this study was non-elective all-cause readmission within 7 days of discharge. We did not track or report patients who died within the first week after discharge. We consider readmission so near to discharge to closely reflect the clinical status at

discharge and the interventions at or near the time of transition to the community. If deaths occurred during this same time period, a closer examination of the same patient characteristics and process variables would be valuable.

Our findings support the recommendation of routine screening for frailty in HF patients (Howlett et al., 2010). Our frailty criteria were based on information readily available in health records and produced an estimate of frailty within the range of other HF populations (Afilalo et al., 2014; McNallan, Singh, et al., 2013). Yet, our criteria have not been validated against other frailty scoring tools. For greater precision, a tool could include age ≥ 70 years and requires assistance with ADLs, combined with a few other simple criteria from validated tools such as, presence of specific comorbidities such as HF, asthma/COPD, stroke, or depression, hearing impairment, visual impairment, low hemoglobin, and elevated white blood cell count. These items are also readily available in health records. Buck and Riegel (2011) also attempted to simplify a construct of frailty but still included measures that required patients to report symptom severity using Likert scales. They identified frailty using weighted measures for age, comorbidities, and severity of 3 symptoms- fatigue, dyspnea on exertion, and chest pain. Our definition and findings suggest identifying of frailty is possible using readily accessible clinical information.

Identifying principal pathologies and factors contributing to readmission, and judging avoidability were a challenge. In many cases, multiple disease processes were present (e.g. drooping mouth, left-sided weakness, and frank blood in stool). Also, some patients had multiple factors that may have contributed to the readmission. Given the amount known about factors contributing to readmission, explicit criteria need to be developed and used for analysis

of reasons for readmission. Explicit criteria will enhance reproducibility and comparability between studies.

Lastly, our study relied on retrospective review of documented data. Documentation was often limited to presenting symptoms at the time of readmission with minimal description of related events. A more thorough description of what happened could be obtained through patient, family, or health provider interviews about the events that lead up to readmission. Few qualitative studies have included patient, family, and provider perspectives on reasons for readmission after HF hospitalization (Annema et al., 2009; Hekmatpou, Mohammadi, Ahmadi, & Arefi, 2009). Patient and family perspectives could also strengthen patient-centered approaches to care. Our retrospective analyses yielded valuable patterns consistent with other research that can be used to refine treatment strategies.

Implications and Future Research

Implications for practice are many. In particular, these results reveal: a) the value of examining 7-day readmissions, b) the incomplete uptake of clinical practice guidelines for inpatient care of HF patients, c) the need to screen for frail patients who are vulnerable to readmission, d) the need for assessment of discharge readiness using criteria for potentially avoidable readmissions, e) the need for consistent scheduling of follow-up appointments within 7 days of discharge, f) the need for enhanced end-of-life discussions and services, and g) that clinical nurse specialists (CNS) could oversee evidence-based changes to practice.

A novel and important contribution of this study is the detailed examination of HF patients who were readmitted and patients who remained in the community during the first 7 days after discharge. When one-third of 30-day readmissions occur within the first 7 days after

discharge, studying this time frame enabled focused attention on factors more closely related to the clinical status of the patient when discharged and the transitional care processes. If hospital personnel tracked and reviewed readmissions occurring within 7 days of discharge, many potentially avoidable readmissions could be identified due to the greater likelihood of a "plausible clinical relation to the initial admission" (Goldfield et al., 2008, p. 89). Then, multidisciplinary clinical teams could activate quality improvement processes to improve care, and readmission rates should improve. Traditional measurement of 30-day readmissions captures greater numbers of readmissions, is commonly used for comparison between hospitals, and does allow for evaluation of the effect of outpatient services. However, multiple factors can lead to readmissions occurring within 30 days, making it difficult to target strategies for changes in practice. Such factors can include physiologic factors, self-care behaviours, and health services availability or utilization. For both practice and research, evaluation of events leading to readmission within 7 days of discharge limits confounding factors and reveals more tangible targets for improvement.

Our findings show that some well-established practices found in evidence-based guidelines were inconsistently applied. For example, while an admission chest x-ray report was routinely found, 50% of all cases had no chest x-ray within 48 hours of discharge to re-evaluate pulmonary status. In fact, many patients had no repeat chest x-ray during their stay. Though evaluation of left ventricular function took place approximately 60% of the time, documentation of an ejection fraction value in the index or readmission health records was found less than 20% of the time. Many HF interventions are based on the ejection fraction (e.g. prescription of ACE inhibitors; resynchronization pacemakers). Algorithms for clinical decision-making cannot be properly applied without a documented ejection fraction value. We acknowledge that the

identified index admissions in this study occurred over an 8-year period and guidelines have changed during that time. Yet, these clinical examples (assessment of lung status and left ventricular function) have been recommendations for practice since 2003 (Lee et al., 2003).

On the positive side, uptake of guidelines was seen with high prescription rates (70-80%) for essential HF mediations (i.e. ACE inhibitors and beta blockers). As well, referrals to heart function clinics or cardiologists occurred in approximately 50% of the sample. Referral to disease management programs and specialists have been promoted and linked to reduced readmissions since the early 2000's (Fonarow et al., 1997; Lee et al., 2003). While studies have not shown consistent associations between the uptake of clinical practice guidelines and reduced readmissions (Heidenreich et al., 2012; Kociol et al., 2012), practices recommended in guidelines have been established with expert consensus and provide important clinical direction.

There is enough evidence linking frailty to poor outcomes in cardiovascular populations to integrate routine screening for frailty into clinical practice. In 2006, assessment and treatment of the frail elderly HF patient was introduced into Canadian HF guidelines. Despite description of the frail in a way similar to the criteria used in this study (i.e. elderly, "high comorbid disease burden", "characterized by a progressively eroding ability to independently perform activities of daily living" (Arnold et al., 2006, p. 38), use of specific screening tools for frailty was not evident in the health records studied. The most recent Canadian HF guidelines include "assessment of frailty in hospitalized older adults in view of identifying those requiring development of a multidisciplinary care plan" as a critical performance objective to help guide development of performance indicators for HF care (Howlett et al., 2010, p. 197). With validation and potential adjustment of age, assessment using the 3-point criteria suggested here

would adhere to guideline recommendations and provide a means to identify frail patients, who are at high risk of readmission.

There is a need for refinement and uptake of tools to assess discharge readiness of acutely decompensated HF patients. Instruments including criteria associated with potentially avoidable readmissions have not yet been published. Such an instrument should include well-documented risk factors for early readmissions combined with factors that describe potentially avoidable readmissions (Ashton et al., 1994; Halfon et al., 2002). Kossovsky et al. (2000) used readiness-for-discharge criteria from the work of Ashton et al. (1994), and found that suboptimal preparation for discharge was associated with early unplanned readmission after HF hospitalization, while admission processes and treatment during the stay were not linked to readmission.

Based on findings within our study and the literature, a checklist for discharge readiness could be developed. Much work has gone into identifying predictors of readmission and death, yet few clinical tools have resulted, and outcomes could be dramatically improved. In one example, O'Connor et al. (2010) developed a risk model and method for discharge scoring based on secondary clinical trial data of an advanced HF sample. They aimed to identify patients at high risk for death after discharge for triage into clinical strategies (e.g. cardiac assist devises or transplantation). A similar tool to identify patients at high risk of readmission is needed based not on single clinical trials, but a synthesis of registry data, health record data, and population-based studies, to maximize real-world applicability. Use of such a tool before discharge could alert nurses and physicians to ensure medications are optimized, symptoms are managed, adverse events are prevented, and appropriate outpatient support is arranged.

Our findings highlight the need for consistent scheduling of follow-up appointments within 7 days of discharge. This practice is a simple intervention that was found to be highly associated with a lower risk of readmission within 7 days of discharge. Our findings align with other similar research on early physician follow-up post-discharge (Bradley et al., 2014; Hernandez et al., 2010). Scheduling an early follow-up visit within 7 to 14 days after discharge is recommended in HF clinical practice guidelines (Yancy et al., 2013), and needs to be updated in Canadian HF guidelines. Close follow-up may be required for more effective prevention of readmissions. A recommendation for enhancing follow-up appears in proposed performance measures for HF hospitalizations include tracking the percentage of patients whom a "follow-up appointment was scheduled and documented, including location, date, and time for a follow-up office visit or home healthcare visit" (Bonow et al., 2012, p. 2385). Arranging and documenting a follow-up visit within 7 days of discharge, as identified in this current study, is a simple process that could have great benefits for patients, families, and hospitals.

End-of-life discussions need to occur more regularly for patients admitted for acute decompensated HF, as stated in clinical practice guidelines and position papers (Arnold et al., 2006; Goodlin, 2009; McKelvie et al., 2011; Whellan et al., 2014). In addition, end-of-life discussions focused on symptom management, comfort measures, and change in code status, should be considered risk factors for readmission if no supportive care services are added. Only 3% of the total sample was referred to palliative care or hospice services during the index admission. During the index admission, only 12% of the sample received discussions about quality of life or symptom management, despite 35% of patients being frail and 14% of patients who were readmitted, died during the readmission. Palliative services need to be consulted earlier, particularly when patients are frail, symptoms are persistent or refractory to medication

changes, and multiple readmissions have occurred. Heart failure-specific home health, palliative, and hospice services need to become more accessible for a proactive focus on symptom control rather having patients and families endure unplanned urgent readmissions to acute care facilities. Of 156 hospices surveyed, only 9% of the patients had a primary diagnosis of HF when HF was a leading cause of death (Goodlin et al., 2005). Discussions about quality of life and end-of-life symptom management strategies need to occur earlier and more frequently for quality of care and prevention of acute care readmissions.

Lastly, the CNS role is greatly under used in the management of high cost, high volume populations like patients with HF. Clinical nurse specialists can specifically address gaps between evidence and practice by adding value to teams as clinical expert, educator, consultant, researcher, and quality improvement initiative leader (Colwill et al., 2014). Research, like that of Williams, Akroyd, and Burke (2010), linking the CNS role to improved outcomes such as readmissions, has been limited. However, a review of 20 studies of nurse-led transitional care programs, some of which involved CNS and HF samples, indicated improved quality of life, readmissions, and cost of care (Stamp, Machado, & Allen, 2014). Authors defend the role of CNS to address gaps in care processes, such as the under treatment of older women with HF (Schall & Flannery, 2004). Implementation of initiatives such as frailty screening and discharge readiness assessment tools involves clinical expertise and coordination. Healthcare teams can 'hard-wire' ejection fraction values into health records to be consistently available for clinical decisions. As a CNS, I worked with cardiologists, information technology personnel, and others to increase the documentation of ejection fraction values to over 90% for acute HF patients over a 6-month period. Effective and sustainable changes in processes of care require education of

and buy-in from multidisciplinary team members, as well as oversight, evaluation, and redesign, all of which can be led by a CNS (Finkelman, 2013).

When half of readmissions occurring within 7 days are potentially avoidable, as in this study, investment in these practice changes and CNS positions could greatly improve patients' readiness and stability at discharge, and ensure prompt follow-up immediately after discharge.

Future Research

Future research needs to focus less on descriptive studies of readmissions and more on screening for and altering the treatment of patients at high risk for avoidable readmission. Simple screening tools for frailty require testing in clinical settings. Also, discharge readiness tools that identify people at high risk for avoidable readmissions need to be tested before discharge to determine the impact on outcomes. Evidence from studies of these screening tools needs to be applied to refine the tools and then multi-site interventional studies need to take place.

As advocated by researchers, creative models of care need to be tested for patients in the later phases of HF (Desai, 2012; Dharmarajan & Krumholz, 2014). These creative models should include consultation of patients and families to develop patient/family-centred new models for disease management programs, and HF-specific palliative care and hospice services. An extensive agenda for research related to end-of-life care of HF patient has been set (Whellan et al., 2014).

Various disease management models need to be studied for the effect on reduction of early readmissions. This includes multidisciplinary HF disease management in primary care settings. Programs that employ multidisciplinary strategies in primary care (e.g. phone calls, education, close monitoring) are being tested (Khunti et al., 2007). Primary care teams need to

work in collaboration with cardiologists to titrate newly prescribed HF medications and aggressively manage HF symptoms to prevent re-hospitalization. Augmenting telephone and in-person monitoring with home-based tele-management devices, that transmit vitals signs and an ECG tracing to primary care centers, has been shown to reduce the risk of readmission (Giordano et al., 2009). Disease management programs that only focus on preventing HF admissions will not adequately address the multiple complex health issues that can precipitate readmission, like found in our study. The broad scope of primary care teams is well suited to monitor and support HF patients soon after discharge.

Lastly, a multi-site HF registry would be valuable to track the uptake of practice guidelines in Canada. Then, gaps between recommended and actual practice could be efficiently addressed to ensure the best possible patient outcomes.

Conclusion

Our description of the physiologic, health system, and patient factors that contribute to readmission within the first 7 days after discharge aligns with past research. Multiple conditions precipitate readmission affirming the necessity for holistic chronic disease management, not just disease-specific programs. Frailty can be identified using a simple 3-point definition, and emerged as an important risk factor for readmission. The simple act of arranging a physician follow-up visit within 1 week after discharge can greatly reduce readmissions. Healthcare teams, not only physician review panels, can evaluate avoidability of readmissions retrospectively. Use of both implicit and explicit criteria for judging avoidability pointed to the value of using and refining explicit criteria. It is time for more precise explicit criteria upon which to determine avoidability of readmissions after admission for HF. As well, our findings highlight the potential items for inclusion in a tool to evaluate readiness for discharge. Implications for practice are

many, including tracking 7-day readmissions, promotion and uptake of clinical practice guidelines, screening for frail patients, assessment of discharge readiness, consistent scheduling of follow-up appointments, enhanced end-of-life discussions and services, and utilization of CNSs to oversee changes to clinical practice. Research should focus on screening tools for frailty and discharge readiness, testing explicit avoidability criteria, evaluating end-of-life discussions and services, evaluating new disease management models, and evaluating actual versus recommended practice. The findings within this detailed health record review present many implications for practice and directions for future research, to identify and address avoidable readmissions after hospitalization for HF.

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APPENDIX A: APPROVAL DOCUMENTS

Included in this appendix are:

1. Research Agreement with Albert Health Services

2. Health Information/Records Management for Calgary and Area of Alberta Health Services approval letter

(not included for privacy)

APPENDIX B: DATA COLLECTION TOOLS

Included in this appendix are:

1. Data Collection Tool for Index Admission for Non-readmitted Control

2. Data Collection Tool for Index Admission for Readmitted Case

3. Data Collection Tool for Readmission Record

Last 3 digits of HRN _____

B.1. INDEX ADMISSION OF NON-READMITTED CONTROL

Abstractor initials: _____ **Date Completed _____**

Location/ Unit _____ **Age _____ Sex M=0 / F=1**

Index Admission Date _____/____/____ YYYY MM DD **Index Discharge Date** _____/____/____ YYYY MM DD

Admitted for Most Responsible Diagnosis of HF Yes___(1) No ___(0)
<u>Principle diagnosis</u> in discharge summary (First list diagnosis to validate against DAD data)
If NOT Heart failure or pulmonary edema or cardiomyopathy, DO NOT CONTINUE.

IF YES, READMITTED? Yes ____ (1) / No ____ (0)
If YES when in the Control group- STOP

Marital Status: (Face sheet; nursing admission form; first social worker note)
Married/Common law _____(1)
Separated/Divorced _____(2)
Widowed _____(3)
Single _____(4)
Missing _____(".")

Habitation: (History and physical; nursing admission form; first social worker note)
With spouse _____(1)
Alone _____(2)
With children _____(3)
With spouse and children _____(4)
Care facility _____(5) (includes lodge, assisted living, nursing home, rehab)
Missing _____(".")
Is HF newly diagnosed? Y ___(1) N ___(0) (Documented as first hospitalization for HF? NOT newly dx if worded as 'progressive', 'exacerbation' or 'worsening' HF) (H&P or d/c summary)

Check the Type of HF?
___ (1) **Ischemic** (hx of Coronary artery disease (CAD) or myocardial infarction (MI))
___ (0) **Non-ischemic** (no hx of CAD or MI)
If Non-ischemic, check the etiology (cause):
___ (1) **Valvular**
___ (2) **Hypertension** (history of hypertension without other heart disease issues; diastolic HF)
___ (3) **Tachycardia-induced/ Endocrine/Toxic** causes (e.g. thyroid; drug or alcohol abuse; chemotherapy)

___ (4) **Defined cardiomyopathy** (hypertrophic; restrictive)
___ (5) **Peripartum cardiomyopathy** (PPCM) (pregnancy-induced)
___ (6) **Idiopathic cardiomyopathy** (must be stated as idiopathic)
___ (7) **Not documented; unable to determine**
___ (8) **Other** _____0= ischemic/ not applicable_____

Documented **reason for admission** (from ED notes, or medical or nursing admission H&P, or DC summary). **What lead up to the ADMISSION? The STORY not just symptoms.**

Story = (1) Symptoms only = (0)

Reason for HF exacerbation for index admission (check all that apply). Must be clearly linked to the HF in the medical notes. STAR the most prominent reason.
___ (1) Ischemic (incident of acute coronary syndrome including angina of any type; MI)
___ (2) Cardiac rhythm disturbance (e.g. atrial fibrillation; atrial flutter; bradycardia- heart block; ventricular arrhythmia- PVCs; runs of VT; other)
___ (3) Medication induced (e.g. digoxin toxicity; new NSAID or steroid added)
___ (4) Patient self-care issue/ non-adherence (must see documentation of patient's failure to take meds or follow diet as recommended)
___ (5) Undertreated or mistreated lung condition (treated as pneumonia/COPD then dx as HF)
___ (6) Progressive HF (History of CHF, exacerbation without other of these causes)
___ (7) Other _____
___ (8) Unable to determine

Frailty Yes __(1) No __(0) **(>75 years; >3 comorbids; low functional status**- needing assistance with activities of daily living- check ED notes, nursing admission notes, H&P, and first day of nursing notes to determine how much help the patient required at home- check if used walker, cane, depended on family or others for meals, personal care) (Temporary weakness when otherwise manages well is not frail.)

BP at admission ___/___ mmHg (ED Triage BP only) missing= "."
BP – Last ___/___ mmHg (LAST in SCM only) missing= "."
BPSyst <125 = (0) BPSyst ≥125 (1)
Sbp <120=0, 120-139=1, 140-161=2, >161=3

Weight at or nearest admission _____ lbs/ kg (FIRST in SCM only) missing= "."
Weight –Last _____ lbs/ kg (LAST in SCM only) missing= "."
Weight change categories
Serum creatinine at admission ____ micromol/L (FIRST in SCM only) m= "."
Serum creatinine –last ____ micromol/L (LAST in SCM only) m= "."

Congestion on **FIRST** chest x-ray Y __(1) N __(2) Not done___(0) (Pulm edema or plural effusions)
Congestion on **LAST** chest x-ray Y __(1) N __(2) Not done___(0) (Pulm edema or plural effusions)

LV evaluation (echo or MRI) done this admission? Yes ___ (1) No ___ (0)

EF % documented in this chart? Yes ___ (1) No ___ (0)
If YES, EF%/ LV Evaluation Most Recent (Last) **Date** _____/____/____
YYYY MM DD

Ejection Fraction (EF) Value (by number value in chart)
>40% _____(1) Number or range: _____ 3= not on chart but echo done
≤40% _____(2) Number or range: _____ 0= no echo
none on chart _____(0)
EF_numcat (EF number categories)
No EF= 0, EF <or=20=1, EF 21-40=2, >41= 3
n/a, none on chart but echo done __(4)
EF based on clinical description on report only:
>40% _____(1) (mild LV dysfunction or mild hypokinesis)
≤40% _____(2) (moderate to severe LV dysfunction or hypokinesis)
Unable to determine _____(3)
No echo _____(4) EF value on chart so n/a = (5)
Describe heart function and structures from the most recent LV evaluation report or medical note.
CIRCLE test: Echo, cardiac MRI, MUGA, CT, cardiac catheterization, nuclear (thallium) test)
Description_____

_____

_____

Was fluid status documented in the medical or nursing notes within 48 hours of discharge?
(Physical assessment of heart and/or lung sounds, edema, JVD) ___ Yes (1) ___ No (0)

IF YES:
SIGNS of **congestion** on physical assessment in **medical** or **nursing** clinical notes **within last 48 hrs** (e.g. rales/crackles, elevated JVD, edema, ascites) ___ Yes (1) ___ No (0)

SYMPTOMS of **congestion** on physical assessment **within last 48 hrs** ___ Yes (1) ___ No (0)
(e.g. shortness of breath, fatigue, weakness, paroxysmal nocturnal dyspnea (PND), orthopnea, chest pain)

Documented evidence of HF patient education? Y____(1) N____(0)
(In **Medical, Nursing, or Pharmacy notes only.** Education must address any of these topics-medications, low sodium diet, daily weights, symptom monitoring or reporting). Yes if meds reviewed at discharge.

Referrals to services (check all that apply)

As found in Discharge Summary or Physician's Orders. Yes

No referrals ___(1)
Heart Function Clinic or Cardiologist (for OP follow-up) ___(2)
Heart Failure Liaison Nurse ___(3)
Cardiac Rehabilitation or Cardiac Wellness program ___(4)
Oral Anticoagulation Clinic ___(5)
Diabetes Clinic ___(6)
Other _____ ___(7) n/a=(0)
(e.g. Palliative care; Social worker consult, Transition Services, Pulmonary Wellness/Rehab.)
More than one referral made ___Yes (1) ___ No (0)

Note to follow up with family MD (d/c summary, pt d/c form, last prog note)___Yes (1) ___ No (0)
Note to follow up with family MD within 1 week of discharge ___Yes (1) ___ No (0)
Family MD notified of admission? (cc'd or faxed d/c summary) ___Yes (1) ___No (0)

Discharge disposition (check ONE) **found in the Discharge Summary or Orders in last 3 days.**

Home without support ___(1)
Continuing care ___(2) (long term care- e.g. Fanning center; rehab facility)
Home with homecare ___(3) (home oxygen or CPAP- does included monitoring)
Left AMA ___(4)
Assisted living ___(5) (Lodge)
Home with palliative care ___(6) (Any outpatient palliative services)
Admitted to hospice ___(7)

Medications prescribed at **discharge** (in discharge summary)
Beta blocker? Y____(1) N____(0)
ACE inhibitor OR ARB OR Nitrate + Hydralazine? Y____(1) N____(0)

Evidence of **non-recommended drugs** in **discharge list** (in discharge summary or patient list)
NSAIDS Y____(1) N____(0) Drug name or circle:

_____
(Not ECASA or ASA, Not Tylenol)- look for Alieve, Advil, toradol, clinoril, Celebrex, Indocin, naprosen, volteran)
Calcium channel blockers Y____(1) N____(0) Drug name or circle:

_____
(Norvasc-amlodipine, Diltiazem-cardizem, tiazac, Felodipine, nicardipine-cardene, nifedipine-adalat, verapamil).

Goal of Care status established in Index chart? (Look in paper or SCM Orders only)
Y ___(1) N ___ (0)

What is the Goal of Care status at time of discharge? Level I=R1, Level II=M1, Level III=C1
R1 ___(1) R2 ___(2) R3 ___(3) M1 ___(4) M2 ___(5) C1 ___(6) C2 ___(7) Not docu ____(".")

Was there any documentation of discussion of end-of-life/ palliative/ focus on symptom management only in this chart? (Notes of MD, Cardiologist, HF Liaison RN) Y ___ (1) N ___ (0)

Personal Directive on the index chart or prior admission? Y ___ (1) N ___ (0)

How helpful was the information in this chart? Overall quality? Circle: 1-2-3-4-5-6-7-8-9-10

Helpful is when all variables were fairly easy to find. 9 is usually max unless exceptionally good. Not helpful is when discharge summary is too brief, weights are missing, patient education missing, nursing or medical documentation of signs and symptoms is absent.

Last 3 digits of HRN _____

B.2. INDEX ADMISSION OF READMITTED CASE

Abstractor initials: _____ **Date Completed _____**

Location/ Unit _____ **Age _____ Sex M=0 / F=1**

Index Admission Date _____/____/____ **Index Discharge Date** _____/____/____
YYYY MM DD YYYY MM DD

Admitted for Most Responsible Diagnosis of HF Yes___(1) No ___(0)
<u>Principle diagnosis</u> in discharge summary (First list diagnosis to validate against DAD data)
If NOT Heart failure or pulmonary edema or cardiomyopathy, DO NOT CONTINUE.

IF YES, READMITTED? Yes ____ (1) / No ____ (0)
If NO when in the Readmission Index group- STOP

Marital Status: (Face sheet; nursing admission form; first social worker note)
Married/Common law _____(1)
Separated/Divorced _____(2)
Widowed _____(3)
Single _____(4)
Missing _____(".")

Habitation: (History and physical; nursing admission form; first social worker note)
With spouse _____(1)
Alone _____(2)
With children _____(3)
With spouse and children _____(4)
Care facility _____(5) (includes lodge, assisted living, nursing home, rehab)
Missing _____(".")
Is HF newly diagnosed? Y ___(1) N ___(0) (Documented as first hospitalization for HF? NOT newly dx if worded as 'progressive', 'exacerbation' or 'worsening' HF) (H&P or d/c summary)

Check the Type of HF?
___ (1) **Ischemic** (hx of Coronary artery disease (CAD) or myocardial infarction (MI))
___ (0) **Non-ischemic** (no hx of CAD or MI)
If Non-ischemic, check the etiology (cause):
___ (1) **Valvular**
___ (2) **Hypertension** (history of hypertension without other heart disease issues; diastolic HF)
___ (3) **Tachycardia-induced/ Endocrine/Toxic** causes (e.g. thyroid; drug or alcohol abuse; chemotherapy)
___ (4) **Defined cardiomyopathy** (hypertrophic; restrictive)

___ (5) **Peripartum cardiomyopathy** (PPCM) (pregnancy-induced)
___ (6) **Idiopathic cardiomyopathy** (must be stated as idiopathic)
___ (7) **Not documented; unable to determine**
___ (8) **Other** _____0= ischemic/ not applicable_____

Documented **reason for admission** (from ED notes, or medical or nursing admission H&P, or DC summary). **What lead up to the ADMISSION? The STORY not just symptoms.**

Story = (1) Symptoms only = (0)

Reason for HF exacerbation for index admission (check all that apply). Must be clearly linked to the HF in the medical notes. STAR the most prominent reason.
___ (1) Ischemic (incident of acute coronary syndrome including angina of any type; MI)
___ (2) Cardiac rhythm disturbance (e.g. atrial fibrillation; atrial flutter; bradycardia- heart block; ventricular arrhythmia- PVCs; runs of VT; other)
___ (3) Medication induced (e.g. digoxin toxicity; new NSAID or steroid added)
___ (4) Patient self-care issue/ non-adherence (must see documentation of patient's failure to take meds or follow diet as recommended)
___ (5) Undertreated or mistreated lung condition (treated as pneumonia/COPD then dx as HF)
___ (6) Progressive HF (History of CHF, exacerbation without other of these causes)
___ (7) Other _____
___ (8) Unable to determine

Frailty Yes __(1) No __(0) **(>75 years; >3 comorbids; low functional status**- needing assistance with ADLS- check ED notes, nursing admission notes, H&P, and first day of nursing notes to determine how much help the patient required at home- check if used walker, cane, depended on family or others for meals, personal care) (Temporary weakness when otherwise manages well is not frail.)

BP at admission ___/___ mmHg (ED Triage BP only) missing= "."
BP – Last ___/___ mmHg (LAST in SCM only) missing= "."
BPSyst <125 = (0) BPSyst ≥125 (1)
Sbp <120=0, 120-139=1, 140-161=2, >161=3

Weight at or nearest admission _____ lbs/ kg (FIRST in SCM only) missing= "."
Weight –Last _____ lbs/ kg (LAST in SCM only) missing= "."
Weight change categories
Serum creatinine at admission ____ micromol/L (FIRST in SCM only) m= "."
Serum creatinine –last ____ micromol/L (LAST in SCM only) m= "."

Congestion on **FIRST** chest xray Y __(1) N __(2) Not done___(0) (Pulm edema or plural effusions)
Congestion on **LAST** chest xray Y __(1) N __(2) Not done___(0) (Pulm edema or plural effusions)

LV evaluation (echo or MRI) done this admission? Yes ___ (1) No ___ (0)

EF % documented in this chart? Yes ___ (1) No ___ (0)
If YES, EF%/ LV Evaluation Most Recent (Last) **Date** _____/____/____
YYYY MM DD

Ejection Fraction (EF) Value (by number value in chart)
>40% _____(1) Number or range: _____ 3= not on chart but echo done
≤40% _____(2) Number or range: _____ 0= no echo
none on chart _____(0)
EF_numcat (EF number categories)
No EF= 0, EF <or=20=1, EF 21-40=2, >41= 3
n/a, none on chart but echo done __(4)
EF based on clinical description on report only:
>40% _____(1) (mild LV dysfunction or mild hypokinesis)
≤40% _____(2) (moderate to severe LV dysfunction or hypokinesis)
Unable to determine _____(3)
No echo _____(4) EF value on chart so n/a = (5)
Describe heart function and structures from the most recent LV evaluation report or medical note.
CIRCLE test: Echo, cardiac MRI, MUGA, CT, cardiac catheterization, nuclear (thallium) test)
Description_____

_____

_____

Was fluid status documented in the medical or nursing notes within 48 hours of discharge?
(Physical assessment of heart and/or lung sounds, edema, JVD) ___ Yes (1) ___ No (0)

IF YES:
SIGNS of **congestion** on physical assessment in **medical** or **nursing** clinical notes **within last 48 hrs** (e.g. rales/crackles, elevated JVD, edema, ascites) ___ Yes (1) ___ No (0)

SYMPTOMS of **congestion** on physical assessment **within last 48 hrs** ___ Yes (1) ___ No (0)
(e.g. shortness of breath, fatigue, weakness, paroxysmal nocturnal dyspnea (PND), orthopnea, chest pain)

Documented evidence of HF patient education? Y____(1) N____(0)
(In **Medical, Nursing, or Pharmacy notes only.** Education must address any of these topics- medications, low sodium diet, daily weights, symptom monitoring or reporting). Yes if meds reviewed at discharge.

Referrals to services (check all that apply)

As found in Discharge Summary or Physician's Orders.	Yes
No referrals	___(1)
Heart Function Clinic or Cardiologist (for OP follow-up)	___(2)
Heart Failure Liaison Nurse	___(3)
Cardiac Rehabilitation or Cardiac Wellness program	___(4)
Oral Anticoagulation Clinic	___(5)
Diabetes Clinic	___(6)
Other _____	___(7) n/a=(0)

(e.g. Palliative care; Social worker consult, Transition Services, Pulmonary Wellness/Rehab.)

More than one referral made ___Yes (1) ___ No (0)

Note to follow up with family MD (d/c summary, pt d/c form, last prog note)___Yes (1) __No (0)

Note to follow up with family MD within 1 week of discharge ___Yes (1) ___ No (0)

Family MD notified of admission? (cc'd or faxed d/c summary) ___Yes (1) ___No (0)

Discharge disposition (check ONE) **found in the Discharge Summary or Orders in last 3 days.**

Home without support	___(1)
Continuing care	___(2) (long term care- e.g. Fanning center; rehab facility)
Home with homecare	___(3) (home oxygen or CPAP- does included monitoring)
Left AMA	___(4)
Assisted living	___(5) (Lodge)
Home with palliative care	___(6) (Any outpatient palliative services)
Admitted to hospice	___(7)

Medications prescribed at **discharge** (in discharge summary)

Beta blocker? Y____(1) N____(0)

ACE inhibitor OR ARB OR Nitrate + Hydralazine? Y____(1) N____(0)

Evidence of **non-recommended drugs** in **discharge list** (in discharge summary or patient list)

NSAIDS Y____(1) N____(0) Drug name or circle:

_____

(Not ECASA or ASA, Not Tylenol)- look for Alieve, Advil, toradol, clinoril, Celebrex, Indocin, naprosen, volteran)

Calcium channel blockers Y____(1) N____(0) Drug name or circle:

_____

(Norvasc-amlodipine, Diltiazem-cardizem, tiazac, Felodipine, nicardipine-cardene, nifedipine-adalat, verapamil).

Goal of Care status established in Index chart? (Look in paper or SCM Orders only)

Y ___(1) N ___ (0)

What is the Goal of Care status at time of discharge? Level I=R1, Level II=M1, Level III=C1

R1 ___(1) R2 ___(2) R3 ___(3) M1 ___(4) M2 ___(5) C1 ___(6) C2 ___(7) Not docu ____(".")

Was there any documentation of discussion of end-of-life/ palliative/ focus on symptom management only in this chart? (Notes of MD, Cardiologist, HF Liaison RN) Y ___ (1) N ___ (0)

Personal Directive on the index chart or prior admission? Y ___ (1) N ___ (0)

How helpful was the information in this chart? Overall quality? Circle: 1-2-3-4-5-6-7-8-9-10

Helpful is when all variables were fairly easy to find. 9 is usually max unless exceptionally good. Not helpful is when discharge summary is too brief, weights are missing, patient education missing, nursing or medical documentation of signs and symptoms is absent.

B.3. READMISSION RECORD

Last 3 digits of HRN _____

Location/Unit _____

Readmission Admit Date_____/___/___ **yyyy /mm/dd**

Readmission D/C date _____/___/___ **yyyy/mm/ dd**

Documented complaint leading to readmission
WHY? Main problem as found in **ED notes** _____

Principle diagnosis in discharge summary _____

Same principal diagnosis for Index Admission and Readmission Yes ____(1) No____ (0)

WHY Readmitted? WHAT led up to readmission? (Look for a STORY. Not symptoms only)

_____

_____

_____

_____

REASON: **Story of what likely precipitated the symptoms described in ED notes or H&P**___(1)
Symptoms only ___(0)

Documented Clinic or ED visits before readmission? Y____(1) N____(0) (ED note or H&P)

WEIGHT on Re-admission: _____ lb/ kg m= "." **BP on Re-admission: ____/____mmHg**
WEIGHT at Discharge: _____ lb/ kg m= "." **BP on Discharge: ____/____ mmHg**

EF % documented in this chart Yes ___ (1) No ___ (0)
NEW LV evaluation (echo/ MRI) **done this admission** Yes ___ (1) No ___ (0)

NEW Ejection Fraction (EF) number value in chart
>40% _____(1)
≤40% _____(2)
NEW EF based on clinical description on report only:
>40% _____(1) (mild LV dysfunction or mild hypokinesis)
≤40% _____(2) (moderate to severe LV dysfunction or hypokinesis)
Unable to determine _____(3)
Describe heart function and structures from new echocardiogram/MRI report.

Description_____

Congestion on **FIRST** chest xray (**SCM**) Y __(1) N __(0) Not done__ (2) (Pulm edema/ plural effusions)

SIGNS of **congestion** on **FIRST physical assessment in ED NOTES or H&P if direct admission**
(e.g. rales/crackles, elevated JVD, edema, ascites) ___ Yes (1) ___ No (0)

SYMPTOMS of **congestion** on **FIRST** physical assessment ___ Yes (1) ___ No (0)
(e.g. shortness of breath, fatigue, weakness, paroxysmal nocturnal dyspnea (PND), orthopnea, pain)

DEHYDRATION stated on **FIRST** physical assessment ___ Yes (1) ___ No (0)

SYMPTOMATIC HYPOTENSION stated on **FIRST** assessment: ___ Yes (1) ___ No (0)

Purpose for Readmission: (check only one)
HF related Y ___(1) N____(0)
If YES HF related: Wet/Warm Y ___(1) Wet/ Cold Y ___(2) Dry/ Cold Y ___(3) NA=9

Wet/ Warm (congestion on xray and/or S&S; BP >100 systolic)
Wet/ Cold (congestion on xray and/or S&S; BP <100 systolic; with renal insufficiency; altered LOC; syncope; postural drop in syst BP of ≥10 mmHg; shock- low BP plus at least one of these)
Dry/ Cold (No congestion on xray and/or S&S; BP < 100 systolic; with renal insufficiency; altered LOC; syncope; postural drop in syst BP of ≥10 mmHg; shock- low BP plus at least one of these)

Re-admission Goal of Care status in readmission chart? (In SCM or paper Orders only)
Y ___(1) N ___ (0)
IF YES, Goal of Care level at time of discharge? Level I=R1, Level II=M1, Level III=C1
R1 ___(1) R2 ___(2) R3 ___(3) M1 ___(4) M2 ___(5) C1 ___(6) C2 ___(7) Not docu __(".")

Was there any documentation of discussion of <u>end-of-life/ palliative/ focus on symptom management only</u> in this chart? (Notes of MD, Cardiologist, HF Liaison RN)Y ___ (1) N ___ (0)

Personal Directive on the readmission chart? Y ___ (1) N ___ (0)

Referrals to services (check all that apply)
As found in Discharge Summary or Physician's Orders.

No referrals	___(1) YES
Heart Function Clinic or Cardiologist (for OP follow-up)	___(2)
Heart Failure Liaison Nurse	___(3)
Cardiac Rehabilitation or Cardiac Wellness program	___(4)
Oral Anticoagulation Clinic	___(5)
Diabetes Clinic	___(6)
Other _____	___(7)

(e.g. Palliative care; Social worker consult, Transition Services, Pulmonary Wellness/Rehab.)
More than one referral made ___Yes (1) ___ No (0)

Discharge disposition (check ONE) **found in the Discharge Summary or Orders in last 3 days.**

Home without support ___(1)
Continuing care ___(2) (long term care- e.g. Fanning center; rehab facility)
Home with homecare ___(3)
Left AMA ___(4)
Assisted living ___(5) (includes Lodge)
Home with palliative care ___(6) (any outpatient palliative services)
Admitted to hospice ___(7)
Died ___(8)
Transferred to another hosp ___(9)

Were a <u>greater number or different services or referrals</u> ordered than in the index chart?
Look in Orders list or Discharge Summary only. Y ___ (1) N ___ (0)

Was CHF patient education documented in readmission chart? Y ___ (1) N ___ (0)
(Review last 3 days of **Medical, Nursing, or Pharmacy notes only.** Education <u>must</u> address any of these topics- <u>medications, low sodium diet, daily weights, symptom monitoring or reporting. Yes if meds reviewed at discharge.</u>).

Avoidability _#_____ After consideration of the clinical details of this patient's medical chart, rate **your confidence in the evidence for avoidability of the re-hospitalization**: 1. Virtually no evidence of avoidability. 2. Slight to modest evidence of avoidability 3. Avoidability not quite likely (less than 50/50, but "close call") 4. Avoidability more than likely (more than 50/50 but "close call") 5. Strong evidence of avoidability 6. Virtually certain evidence of avoidability	Of the readmission chart: **How helpful is this chart for describing what lead up to readmission? (not just symptoms)** (To determine the root cause) **Circle** the number: 1- 2- 3- 4- 5- 6- 7- 8- 9- 10 Not Helpful Very Helpful

Rank avoidability 4 or greater if they return with the same signs or symptoms not fully resolved at first discharge.
If a new, unforeseen problem occurred (e.g. injury), rank avoidability as low.

Low avoidability
1 New unforeseen problems not related to HF or a condition already present
<u>2 Slight to modest evidence of avoidability</u>
3 Avoidability not quite likely, but too hard to call (less than 50/50)
<u>4 Avoidability more than likely, but too hard to call (> 50/50)</u>
5 Strong evidence of avoidability
Presence of same signs or symptoms not resolved at discharge
6 Virtually certain evidence of avoidability