



REVIEW

Strategies to Reduce Heart Failure Hospitalizations and Readmissions: How Low Can We Go?

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Abstract

It is estimated that more than one million heart failure hospitalizations occur each year. Systolic heart failure and heart failure with preserved ejection fraction contribute equally to heart failure hospitalizations. Heart failure readmission rates continue to be about 25%. Strategies to reduce heart failure readmission are key to reducing hospitalization rates. The strategies to reduce heart failure hospitalization are as follows: (1) During hospitalization, diuresis to the euvolemic state is essential. Fifty percent of discharged heart failure patients have minimal weight loss during the hospitalization, representing minimal diuresis, but still fluid overload. (2) During hospitalization, interrogate the defibrillator or biventricular pacemaker (if applicable) to ensure that there is no right ventricular pacing and there is appropriate biventricular pacing. Interrogation of devices can identify arrhythmia or suboptimal biventricular pacing, which can contribute to decompensation. (3) Before discharge, identify the reason for decompensation, such as atrial fibrillation, infection, pulmonary embolism, or noncompliance. (4) Before discharge a multidisciplinary team is needed to educate the patient on diet, medications, fluid weight surveillance, and exercise. (5) A postdischarge visit should occur within 10 days and with emphasis on uptitration of neurohormonal blockers and continued congestion management. Such interventions conducted by a multidisciplinary team have the potential to reduce heart failure hospitalization rates.

Keywords: heart failure; readmissions; strategies

Introduction

Despite reductions in mortality related to the management of heart failure (HF), HF admissions continue to be significant and consume resources of the HF community [1, 2]. It is estimated that six million Americans have HF. Annual hospital discharges now exceed one million per year, with an associated 6.5 million hospital days in the United States annually [3, 4]. As expected, the cost related to HF

hospitalizations is significant, with some data suggesting the cost exceeds \$39.2 billion per year [5]. The estimated cost of HF per patient is \$110,000 per year, with most of that cost consumed by inpatient care [6]. Thirty-day readmission rates after HF patient discharge are about 25%. Readmission rates are such a concern that the Affordable Care Act established the hospital Readmissions Reduction Program that reduces Medicare inpatient payments to those hospitals with high 30-day readmission rates.

Over the last 10 years, the typical HF patient and their related hospitalization have changed. HF is the most common cause of hospitalization in patients older than 65 years [4]. Almost half of

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all HF hospitalizations are related to patients who have HF with preserved ejection fraction (HFpEF) [7]. These two patient populations (age greater than 65 years and HFpEF) are very complex patients with multiple comorbid conditions that contribute to HF readmission rates. Much work and review of clinical workflows have been performed to look at how to reduce hospital readmission rates. It is clear that the transition from inpatient HF management to outpatient management is an important vulnerable period for which both inpatient and outpatient issues must be addressed.

The purpose of this article is to review the typical HF patient hospitalization, identify risk factors for readmission rates, and discuss strategies for both inpatients and outpatients to reduce HF readmission rates.

The Heart Failure Admission

It is estimated that there are about 1.1 million HF admissions per year in the United States [3, 4]. Fifteen percent of these admissions are because of de novo diagnosis of HF, and 80% are for worsening HF of chronic duration [8]. The average length of stay is about 6 days, and the most common presentation is congestion and not low cardiac output. There are two large registries that have prospectively collected data on patients admitted with acute HF and their related in-hospital outcomes up to discharge (Figure 1) [7, 9]. Combined, the Acute Decompensated Failure National Registry (ADHERE) and the Organized Program to Initiate Lifesaving Treatment in Hospitalized Patients with Heart Failure (OPTIMIZE-HF) provide clinical data on more than 200,000 patients admitted for HF. The average HF patient is in his or her mid-70s, almost 50% of HF patients are male, and half have ischemic heart disease. Thirty percent have atrial fibrillation and about half have an ejection fraction of more than 40% or HFpEF. Average systolic blood pressure is more than 140 mmHg, which confirms that congestion and not low cardiac output is the main reason for congestion. In-hospital mortality is 2–7% but may increase with renal impairment [10]. Clinical markers that can affect prognosis during the HF admission include systolic blood pressure less than 120 mmHg, elevated heart rate, hyponatremia,

	ADHERE	OPTIMIZE-HF
N	159,168	48,418
Age (years)	72.4	73
Male (%)	48.4	(-48)
Atrial Fibrillation (%)	30.9	31
Coronary Artery Disease (%)	57.5	46
History of Heart Failure (%)	75.6	–
Ejection Fraction > 40 (%)	50	51
Congestion (X-ray) (%)	75	–
Ejection Fraction (%)	37.8	39
Systolic Blood Pressure (mmHg)	143.9	142
Creatinine (mg/dL)	1	1.8
BUN (mg/dL)	32	12
Na (mmol/L)	138	136

Figure 1 Heart Failure Hospitalizations: Baseline Characteristics in ADHERE (Acute Decompensate Heart Failure National Registry) and OPTIMIZE-HF (Organized Program to Initiate Life saving Treatment in Hospitalized Patients With Heart Failure). BUN (Blood Urea Nitrogen). Ejection fraction (%) is mean ejection fraction.

troponin release, renal impairment, and presence of ventricular dyssynchrony with QRS interval of more than 120 ms [8]. HF patients with a systolic blood pressure less than 115 mmHg and serum creatinine levels greater than 2.75 mg/dL can have an in-hospital mortality rate of more than 20% [11]. HF patients with these risk factors may need special attention after discharge or may need to be considered for advanced therapies.

More than half of HF admissions involve patients with HFpEF [7]. There are limited data and information on outcomes in this patient population. HF patients with preserved ventricular function tend to be older, more obese, and more often women [12]. They tend to have more comorbid conditions, such as hypertension, atrial fibrillation, and coronary artery disease. Patients with HFpEF have lower in-hospital mortality, but their need for hospitalization is similar to that of HF patients with systolic HF. Despite limited data on medical therapy regarding morbidity and mortality [13], many of the evidence-based therapies for chronic systolic HF are used for HFpEF without proven data to support their use [13]. Because of this, the American College of Cardiology and the American Heart Association recommend aggressive management of comorbid conditions such as reduction in blood pressure, heart rate control, revascularization, and maintenance of normal sinus rhythm [4].

Strategies to Reduce Heart Failure Readmission Rates

There are several interventions that are supported by evidence-based data that can reduce HF readmission rates. For the best results and outcomes, a multidisciplinary team (HF cardiologist, nurse, dietician, and social worker) is required to execute these strategies to reduce HF readmission rates.

The first recommendation to reduce future HF readmission rates begins with the initial HF admission. It is essential that the HF patient be diuresis to their euvolemic state. It is estimated that more than 50% of patients have little or no weight loss during their hospitalization for HF, and thus have minimal fluid removal [14]. Patients discharged with elevated filling pressures or excess volume have a worse prognosis and a greater number of hospitalizations [15, 16].

It is important to understand the HF patient, their symptoms, and their volume status lie under what is called the iceberg phenomenon. The tip of the iceberg (what you see above the water) represents clear congestion, fluid overload, and symptoms. This is what makes the patient come to the hospital. However, what is more dangerous is the part of the iceberg you do not see below the water. In the HF patient this represents subclinical congestion, volume overload that does not produce symptoms. Many patients after discharge may have subclinical elevated left ventricular filling pressures that contribute to progression of HF, alteration of left ventricular geometry, and further progression of mitral regurgitation and activation of the renin-angiotensin-aldosterone system [8]. In summary, subclinical elevated filling pressure increases days to weeks before the development of symptoms and subsequent hospitalization. Therefore, proper diuresis should eliminate symptoms and further eliminate subclinical elevated filling pressures.

One of the main limitations for appropriate diuresis in a decompensated HF patient is renal impairment. Renal failure in the hospitalized HF patients has a worse prognosis, greater mortality rate, and is associated with higher readmission rates [17–19]. Worsening renal function occurs in 20–30% of HF patients [17–20]. It is important to understand two fundamental principles when it comes to diuresis in

HF patients and the corresponding changes in renal function (cardiorenal syndrome).

In the absence of intrinsic disease, changes in renal function are not because of low output but are because of high central venous pressure [21]. The concept of renal venous hypertension is related to high right atrial pressure and its effect on liver and kidney congestion. Renal venous congestion causes increased interstitial pressure, tissue hypoxemia, vasoconstriction, and release of vasoactive cytokines [22]. This response leads to a decreased glomerular filtration rate and thus renal impairment. Data suggest lowering right atrial pressure will improve kidney function. Reduction of central venous pressure will decongest the kidney and reverse multiple factors that are contributing to renal impairment. The second concept that must be reviewed is that of the plasma refill rate [23]. During administration of diuretics, patients lose sodium, which decreases venous pressure and thus intravascular volume. Decreased hydrostatic pressure plus interstitial pressure plus oncotic pressure drives fluid from the extracellular environment to the intravascular environment. This is how edema, ascites, and effusions are reduced and reabsorbed. This rate of fluid absorption is called the plasma refill rate. If the diuresis rate exceeds the plasma refill rate, then there is potential for renal impairment. Thus, in the presence of fluid overload and a rising creatinine concentration, the diuresis rate should be decreased to allow the plasma refill rate to catch up. This is a common problem that is sometimes not recognized and which leads to ineffective diuresis due to worsening renal failure at discharge and thus increased readmission rates.

The second strategy that can be used to lower readmission rates involves the evaluation of the HF patient's cardiac device. Although the incidence of internal cardiac defibrillators (ICDs) and cardiac resynchronization therapy (CRT) devices in acute HF hospitalized patients is unknown, hospitalized HF patients with chronic HF frequently have these devices. It is well known that ICDs provide a mortality benefit by reducing sudden death, whereas CRT lowers hospitalization rates and improves quality of life while reducing mortality as it corrects ventricular dyssynchrony [24–26]. However, these devices if not programmed directly can worsen HF symptoms [27]. Right ventricular

pacing, ICD shocks, and suboptimal biventricular pacing in the presence of a wide QRS interval on the electrocardiogram can worsen ventricular function and symptoms. Although the HF patient may have decompensated for a variety of reasons, the HF admission offers the opportunity to interrogate the cardiac device in those patients who have an implant. Interrogation of the CRT device and/or the ICD can confirm the presence of ventricular arrhythmia or episodes of atrial fibrillation, which can contribute to decompensation. The devices should be programmed to avoid right ventricular pacing in the setting of low ejection fraction and provide appropriate CRT in those who have a wide QRS interval and ventricular dyssynchrony. Data suggest that CRT devices require appropriate management after implantation and that suboptimal programming, such as atrioventricular delay, less than 90% biventricular pacing, or suboptimal left ventricular lead position or dislodgement can affect device function and outcomes [28]. At least one study suggests that CRT optimization algorithms can reduce readmission rates [29].

The third strategy that can reduce readmissions for HF involves a multidisciplinary team before discharge. As patients are approaching the euvolemic state, evidence-based therapies such as renin-angiotensin-aldosterone blocker and beta blocker therapy should be optimized [30, 31]. Education on diet, salt intake, fluid restriction, and medications should be reviewed [4]. Discharge education for 1 h before discharge has been shown to reduce readmission rates [32]. All intravenous medication should be converted to oral medication at least 24 h before discharge. A “heart failure 001” prescription should be generated for the patient that covers diet, exercise, medication, and instructions on diuretic management if significant weight gain occurs secondary to fluid buildup. It is important to recognize that many patients discharged have enough fluid removal to have no symptoms at rest. However, they may have subclinical elevated pressures that will manifest themselves on minimal exertion. This may explain why the patient’s brain natriuretic peptide concentration has not decreased. So, euvolemic status is essential. Finally, on discharge, a comprehensive assessment of why the HF patient decompensates should have been performed. Common reasons or

risk factors for HF decompensation include atrial fibrillation, ventricular arrhythmias, ischemia, underlying infection, pulmonary embolism, and noncompliance. Addressing the reasons for the HF decompensation can go a long way to reducing rates. The three most common risk factors for readmission of HF patients are renal impairment, diabetes, and chronic obstructive pulmonary disease [33]. Therefore, as part of this HF syndrome, comorbid conditions should be addressed, as they also contribute to readmission rates.

The final aspect of reducing HF readmission rates involves the postdischarge period. This period has been considered a vulnerable phase in HF patient factors such as kidney function, congestion, neurohormonal disbalance, and unrecognized issues related to the original decompensation influence on the readmission rate. It has been recommended that an early postdischarge visit be made within 10 days of discharge [34]. HF patients who are discharged from hospital with an early follow-up period have lower 30-day readmission rates [35]. Initial outpatient management should focus on optimization of neurohormonal blockers, reevaluation of diuretic strategies, and reevaluation of education on signs of congestion. The creation of multidisciplinary HF clinics is supported by the Heart Failure Society of America and can impact HF outcomes [36, 37]. Despite data supporting short-term postdischarge visits, more than 50% of HF Medicare patients readmitted for HF have not seen a physician within 30 days of discharge [34].

Finally, about 5% of patients admitted for HF have an advanced decompensation state. This specific population has class IV HF, a 6-min walk test result of less than 300 m, and cardiac cachexia and tends to be cold and wet. Readmission strategies that have been discussed may not be sufficient to keep these patients out of the hospital. Signs of significant hyponatremia, discontinuation of use of neurohormonal blockers because of hypotension, persistent elevated brain natriuretic peptide levels, and the need for high-dose diuretics or inotropes are associated with poor outcomes. Therefore, referral for advanced therapies such as heart transplantation or left ventricular assist devices is indicated. If the patient is not a candidate for these therapies, end-of-life issues and hospice care should be discussed.

New Strategies to Reduce Hospitalization Rates

Over the last 10 years, the reduction of HF mortality has plateaued for patients receiving “triple therapy” with ACE inhibitors, beta blockers, and aldosterone antagonists [38]. The 2-year mortality rate for patients receiving these drugs is about 40% [38]. The 2-year mortality rate after one HF readmission is about 40% [39]. Recently, new neurohormonal and heart rate-lowering agents have been developed that improve prognosis. Ivabradine (a specific inhibitor of the I_f current in the sinoatrial node) has been shown to reduce hospital admission rates and death from HF in the Systolic Heart Failure Treatment with the I_f Inhibitor Ivabradine Trial (SHIFT) [40]. By reducing heart rate with no effect on myocardial contractility or intracardiac conduction, ivabradine demonstrated the effect known from beta blockers trial regarding the relationship between magnitude of heart rate reduction and outcome.

As mentioned by Richard Conti in this issue, LCZ696 was approved by the Food and Drug Administration for the management of HF. LCZ696 consists of the neprilysin inhibitor sacubitril and the angiotensin-receptor blocker valsartan. Neprilysin, which is a neutral endopeptidase, degrades several endogenous vasoactive peptides, such as natriuretic peptides, bradykinin, and adrenomedullin. LCZ696 was superior to enalapril in reducing the risk of death and the risk of hospitalization for HF [41]. Both of these new neurohormonal blockers will

provide new medical regimen alternatives to reduce HF hospitalization rates.

Finally, the concept of remote home telemonitoring has now evolved. The multidisciplinary HF care has traditionally provided in-person follow-up visits to address congestion, titration of medications, and assessment of hemodynamic profiles. The concept of home remote telemonitoring provides telephone contact between the HF team and the patient and transfer of physiologic data by remote access technology via external or implantable electronic devices. Meta-analysis of remote telemonitoring data suggests an effect in reducing mortality and hospitalization rates [42]. Recently, the CardioMEMS wireless pulmonary artery sensor was approved in the United States for monitoring of chronic HF. The CardioMEMS Heart Sensor Allows Monitoring of Pressure to Improve Outcomes in NYHA Class III Heart Failure Patients (CHAMPION) trial demonstrated that access to pulmonary artery pressures provided by a wireless pulmonary sensor implanted percutaneously via a right-sided heart catheterization approach provided a 37% reduction in the HF-related hospitalization rate compared with no access to the data by the HF team in control patients who had the wireless sensor [43]. The key to home remote telemonitoring is to have an infrastructure and personnel in place not only to identify the patients who might benefit from this technology but also to use and track the data and make appropriate changes in medications on the basis of the physiologic data.

KEY STRATEGIES TO LOWER HF READMISSION RATES	
✓	During initial HF hospitalization diuresis to euvolemic state
✓	Interrogate ICD or CRT pacemaker to identify arrhythmias, right ventricular pacing, or suboptimal CRT
✓	Identify reason for HF decompensation (anemia, infection, arrhythmias, ischemia, pulmonary embolism, noncompliance)
✓	Discharge education on diet, exercise, medications, weight monitoring, diuretic titration for congestion
✓	Post-discharge early follow-up within ten days.

Figure 2 Key Strategies to Lower Heart Failure (HF) Admission Rates. CRT, cardiac resynchronization therapy; ICD, internal cardiac defibrillator.

Conclusion and Take-Home Message

The HF patient regardless of the cause of HF or ventricular function presents a unique challenge to our medical society. It is clear that an HF hospitalization is a life-altering event that affects morbidity and mortality. HF admission requires several strategies to provide appropriate diuresis, identify the cause of decompensation, and address factors that can and could contribute to further decompensations (Figure 2). A multidisciplinary team that is familiar with these processes and other current clinical strategies is essential for effective HF management and reduction of HF admission rates.

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Conflict of Interest

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