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Effects of a Hospital-Wide Quality Improvement Initiative on 30-day Readmissions for Patients with Heart Failure

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on 30-day Readmissions for Patients with Heart Failure

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Abstract

BACKGROUND: As readmissions have commonly been attributed to quality of care, federal law has required the Center for Medicare and Medicaid Services to implement a program penalizing hospitals with 30-day Heart Failure (HF) readmissions in excess of the national average. This has resulted in widespread implementation of hospital quality improvement (QI) initiatives to reduce readmissions. Little data exists on the effects of hospital wide efforts to reduce HF readmissions.

OBJECTIVES: To describe how a QI initiative aimed at reducing 30-day HF readmissions can affect the overall HF patient population. To describe the factors that differed between readmitted and non-readmitted patients before and after a QI initiative. To identify characteristics of patients who are less likely to respond to a QI initiative and the significance of these characteristics. To identify any changes to the major predictors of readmission after a QI initiative.

METHODS: All heart failure discharges from the year prior to (2008) and after (2011) full implementation of a QI initiative were reviewed and data from the medical record were abstracted. Analyses were performed comparing discharges between 2008 and 2011 for patients with and without readmission to identify changes in the HF population. Sub-analyses of each year were performed to determine factors associated with readmission in each year.

RESULTS: Compared with 2008, patients admitted for HF in 2011 had a 4% absolute increase in ejection fraction, 13% more were on a beta blocker on admission, 12% less were on an angiotensin receptor blocker, 9% less were on aldosterone. Significantly fewer patients admitted in 2011 presented with hyponatremia (2.4% vs. 11.1%). Seven-day follow-up after discharge occurred 2.5 times more frequently in 2011. Factors that differed between readmitted and not readmitted patients changed after the QI initiative. In 2008 readmitted patients were more often diabetic, on aldosterone at initial presentation, and were discharged to a SNF after index hospitalization. In 2011 readmitted patients more often had dementia, a lower initial creatinine (mean 1.37 vs. 1.63), and had more often had a 7-day follow-up visit. Patients readmitted despite the QI initiative had received more follow up visits before readmission and were discharged on more medications (absolute increase in mean by 2 medications) after readmission in 2011. By logistic regression, the variables most associated with readmission in 2008 were the number of medications on initial admission, total outpatient visits 30-days after index discharge, discharge destination, aldosterone on initial admission, and diabetes; in 2011 variables associated with readmission were dementia and 7-day follow up visit.

CONCLUSIONS: Hospital wide QI initiatives can significantly decrease the rate of readmission and lead to significant changes in the overall HF population. Factors associated with readmission prior to a QI initiative may represent modifiable risks. This study showed that after a QI initiative there may be fewer known variables associated with readmission as efforts from the initiative may have successfully removed well-established factors from contributing to readmission. Patients readmitted despite QI initiatives may be affected by more severe disease and readmission in these patients may not be avoidable.

Introduction

One in four patients hospitalized for heart failure are rehospitalized within thirty days of discharge. This unacceptable rate of readmission has gained the attention of many hospitals, researchers, and policy makers in attempts to create a solution to this problem. With changes to federal law, hospitals across the United States are now reacting by implementing initiatives to reduce rehospitalizations for heart failure patients. As there is little known about the effects that these initiatives will have, this report will include an analysis on the changes in readmission rate and patient characteristics among the heart failure population at a single institution after implementation of a hospital-wide program aimed at reducing 30-day readmissions. A review of the background surrounding this issue is provided below prior to this analysis.

Overview

Readmissions within 30 days after a hospitalization for Heart Failure (HF) occurred at a rate of 24.7% for Medicare patients discharged in 2008-2011.[1] For patients discharged in 2003-2004, this rate was 26.9%.[2] Little improvement in readmission rates have been seen despite evidence showing that many readmissions may be preventable. Hospital readmissions have been a target of quality measurement and performance-based incentives as some readmissions are presumed to be associated with substandard care, such as poor resolution of the main problem and inadequate discharge planning, during the initial hospitalization.[3,4] Furthermore, as many as 12% to 75% of hospital readmissions have been prevented in controlled trials using quality improvement interventions.[4]

Hospital readmissions were first described in the Medicare population over 25 years ago when a review of discharges between 1974 and 1977 found a 22% readmission rate in the 60 day post discharge period for all Medicare beneficiary hospitalizations.[5] By 2003 this rate was 31.1%, reflecting a relative increase in the readmission rates over time, two-thirds (19.6%) of which occurred in the first 30 days.[2]

The most frequent diagnosis at initial discharge that results in readmission is HF. A study in 1985 found that 36% of HF patients were readmitted within a 6 month period.[6] From October 1 2003 to September 30 2004, 7.6% of all patients with 30-day readmissions had been initially discharged with a diagnosis of HF.[2] Moreover, HF was responsible for 20% more readmissions in this time period than the second most frequent cause, pneumonia, which was the condition at initial discharge for 6.3% of all readmissions.

In a 2008 report to Congress, the Medicare Payment Advisory Commission (MedPAC) regarded the Medicare program as fiscally unsustainable over the long term.[7] Readmission reductions were a strong focus of the report to address this concern. A subsequent study found that in 2004 approximately $17.4 billion of the $102.6 billion in hospital payments from Medicare was spent on readmissions for all conditions on index discharge.[2] The Congressional Budget Office estimates that Medicare spending for hospital inpatient care will reach $234.9 billion in 2019.[8] Because of the high costs and frequency of readmissions, reductions in their occurrence could help address concerns over the escalating costs of healthcare and the difficulties in achieving cost reductions.[3]

In addition, preventing readmissions has direct benefits for patients. Readmissions are potential life threatening events and median survival has been shown to decrease progressively after each hospitalization. The average hospital stay on readmission has been shown to be 13.2% longer (0.6 days) than that of a patient with the same Diagnosis Related Group (DRG) who has not been hospitalized in the previous six months.[2] Controlled studies have found higher quality of life scores among those not readmitted and evidence that many readmissions are preventable, thus suggesting that decreased readmissions are an indicator of better quality of care.

Much of the purpose behind identifying the proportion of avoidable readmissions has been to determine the appropriateness of using readmissions as a measure of quality of care. For all cause readmissions, one systematic review found that the median proportion of readmissions deemed avoidable was 27.1%.[9] However, it was also shown that among studies assessing the proportion of avoidable readmissions, there was wide variability in the data which made for a difficult assessment of the number of preventable readmissions. A prior analysis from MedPAC reported that 76% of readmissions are preventable.[10] Although the variation in estimates of this proportion may reflect differences in the quality of care, it is also a result of subjective criteria used to define an avoidable readmission.[9] Nevertheless, if a high proportion of readmissions are in fact avoidable, then there may be a strong association between readmission and quality of care. However, this relationship would be weakened if the proportion was instead low, a phenomenon which may be seen as hospital initiatives to reduce readmissions take effect.[9]

Most studies have included all diseases in their analyses and therefore the proportion of avoidable readmissions specific to HF cannot be determined with certainty. Whether or not an actual proportion is known, there is an accumulation of evidence that suggests that rates of readmission can be improved.

Patients with HF are known to have a response to intensified care; and transitional care interventions have shown decreased readmissions through several strategies, including reengineered hospital discharge programs.[11] Among HF patients readmitted within 30 days in 2003, 52% were found not to have had a visit to a physician's office between discharge and readmission.[12,2] The wide variations in readmission rate among states also suggest that patients with the same disease process may be more likely to be readmitted in one hospital system than another and that there is room for improvement on a national scale.[2]

With evidence supporting the ability to lower readmission rates, the Centers for Medicare and Medicaid Services have implemented hospital penalties for readmissions. For patients with an index admission of HF, pneumonia, and heart attack, all unplanned readmissions are analyzed to determine hospital penalties. This initiative was the result of MedPAC recommendations and policies from the Patient Protection and Affordable Care Act that took effect on October 1 2012. About 67% of 3,282 hospitals studied will be penalized as a result of their readmission rates this year. [13] To avoid penalties hospitals must try and prevent as many readmissions as possible and most are implementing initiatives adopted from proven interventions which have lowered readmissions in controlled trials.

Risk Predictors

To clarify the determinants and to be able to prevent readmissions, researchers have collected considerable amounts of data from Medicare claims and retrospective reviews to identify risks associated with increased likelihood of readmission. Patients with a prior hospitalization for HF are most frequently readmitted for heart failure (37.0%), pneumonia (5.1%), renal failure (3.9%) and nutrition-related or metabolic issues (3.1%).[2] Acute myocardial infarction, chronic obstructive pulmonary disease, arrhythmias, circulatory disorders, gastrointestinal bleeding, and gastrointestinal problems make up 14.0% of readmission diagnoses. Other less frequent causes comprise the remaining 36.9% of readmissions. It has also been estimated that after an index hospitalization for heart failure, approximately 10% of readmissions are planned. Although readmission diagnoses provide insight into the factors that result in readmission, Medicare penalties do not depend on readmission diagnoses. Therefore, most data are focused on patient and care-related factors at index admission that result in all cause readmissions.

One study found that the most influential factors associated with readmission include reason for the index hospitalization (e.g., HF), the number of previous hospitalizations, and the length of stay; these had more influence on readmission than demographic factors.[2] For example, three or more readmissions in the prior six months led to a hazard ratio of 2.504 (95% CI 2.495-2.513); for a single readmission alone the hazard ratio was 1.378 (95% CI 1.374-1.383). In comparison, the risk of readmission related to age was greatest for those 85-89 years, with a hazard ratio of 1.123 (95% CI 1.111-1.136); although significant, the risk is much less than associated with recent readmissions.

Validated readmission risk prediction models have been designed, each with unique discriminative abilities. One of these, a multivariate model based on a retrospective review of Medicare beneficiaries with heart failure in Connecticut hospitals, found that of 32 patient and clinical factors, four were significant predictors of readmission in six months.[14] These factors included prior admission within one year, prior heart failure, diabetes and creatinine level >2.5mg/dL (indicating renal disease) at discharge.[14] While the validation cohort patients with 1-2 predictors had a 48% rate of readmissions, those with 3-4 predictors had a 59% rate of readmission. This study pointed out the difficulty in identifying patients at low risk for all cause readmissions since having no predictors still resulted in a 26% readmission rate.

When the same patient sample was used to analyze administrative data, important predictors were identified including male gender, prior hospitalization, higher comorbidity score, treatment in a tertiary care hospital and prolonged length of stay during the index hospitaliziton.[15,16]

A study using administrative records from a New York state research database on heart failure patients found that more predictors could be identified if focus was geared only on readmissions which were also for HF. This study similarly found that the comorbid illnesses, diabetes and renal disease, were both predictors of readmission.[16] Other predictors identified included black race, Medicare insurance, Medicaid insurance, home health care services after discharge, ischemic heart disease, valvular heart disease, chronic lung disease, idiopathic cardiomyopathy, prior cardiac surgery and use of telemetry monitoring during index hospitalization; these were all labeled as higher risk predictors. Four lower risk predictors identified included treatment in a rural hospital, discharge to a skilled nursing facility, performance of echocardiogram during the index admission and performance of cardiac catheterization during the index admission. A simple scoring system was then created by subtracting the number of lower risk predictors from the number of higher risk predictors. Lower risk predictors had the effect of reducing readmission rates. A readmission rate of approximately 27% could be achieved by having 4 higher risk factors, or 7 higher risk factors and 3 lower risk factors. The regression model for readmission with each patient's simple risk score had a c statistic of 0.60 ($p<.001$), which indicated modest predictive ability. Compared to the previous study, this study did not include data on prior hospitalizations or heart failure history. Furthermore, except for chronic lung disease, the predictors in this study were not included in the previous study. However, chronic lung disease was not found to have a significant statistical relationship to readmission of HF patients and was not included in the regression analysis.[14]

Data available in electronic medical records (EMRs) have been shown to have reasonable predictive ability on 30-day readmission (C statistic 0.72) in another model.[17] This model combined both clinical and non-clinical factors found in the EMR. The Tabak mortality score was integrated into the model for clinical variables, since it has been previously demonstrated to perform modestly well in predicting readmission (c-statistic 0.61). The Tabak mortality score includes age in addition to the worst value within the first 24 hours of hospital presentation for 17 laboratory and vital sign variables: albumin, total bilirubin, creatine kinase, creatinine, sodium, blood urea nitrogen, partial pressure of carbon dioxide, white blood cell count, troponin-I, glucose, internationalized normalized ratio, brain natriuretic peptide, pH, temperature, pulse, diastolic blood pressure, and systolic blood pressure. Additional demographic, health behavior, and healthcare utilization factors which were found to be significant predictors of readmission in the multivariate analysis included single status, male status, Medicare, number of home address changes, history of depression or anxiety, history of confirmed cocaine use, number of prior inpatient admissions, and presentation time between 6 AM – 6 PM. Weakly significant factors in the multivariate analysis were residence in a census tract of the lowest socioeconomic quintile (p=0.08), history of missed clinic visit (p=0.06), and use of a health system pharmacy (p=0.08), were retained in the model for their conceptual significance. The addition of all of these variables and the Tabak mortality score in the 30-day readmission prediction model produced a C-statistic of 0.72, an increase from 0.61 for the Tabak mortality score alone. This model showed the utility of including the social, behavioral, and economic circumstances of the patient when calculating readmission risk. In addition, the variables used in this model were all found in the EMR which, unlike claims data, is available early in the course of hospitalization and therefore is of more practical use. Of note in this study, patients in the lowest risk group for readmission were identified as having an 8-12% readmission rate. For Medicare beneficiaries alone the lowest risk group may carry a risk greater than this value as they have been shown to have increased risk over the general population.

Differences in risk factors arise when readmissions are examined at different time points. A Swiss study found that hospital readmission or death at 90 days was best predicted by history of coronary artery disease, prior MI, charlson score, elevated jugular venous pressure, lung rales, prior abdominal surgery, age, and geriatric depression scale score; whereas at 30 days these outcomes were best predicted by angina, lower systolic blood pressure, anemia, edema, higher creatinine levels and dry cough.[18]

There are clearly several factors which influence readmission risk, some modifiable and others not. Patient factors in the above mentioned studies were mostly of unmodifiable risk indicators, typically due to comorbid illness. However, there may be other factors which were not included in these studies which have better predictive ability. A systematic review of 117 studies found that patient characteristics are weak predictors of readmission.[19] Furthermore, no consistent predictors emerged from the review, although it did reveal significant heterogeneity among the studies including such factors as follow up periods, which ranged from 14 days to 4 years. One possibility from this data is that other patient and hospital factors may have more influence on readmission risk. Additionally, such factors, including education to improve compliance, appropriate relay of information by hospitals to outpatient providers, and medical errors, may be modifiable. These risk factors are central to efforts to reduce readmissions since they may be both modifiable and contain a better ability to predict readmissions.

Efforts to Reduce Readmissions

A variety of unique approaches to prevent hospitalizations and subsequent readmissions have been investigated. Outpatient disease management programs are among the earliest efforts to show reductions in hospitalizations for HF. However, the generalizability of findings from these interventions is difficult to determine as many different types of interventions have been tried. Additionally, the evaluators and developers of these programs are often the same which has raised questions about the validity of this evidence.[28] Meta-analyses have grouped disease management programs into three categories and suggest the following conclusions: (1) in-person specialized multidisciplinary follow-up either at home or in clinic reduced HF hospitalizations (RR 0.74) and all-cause hospitalizations (RR 0.81); (2) long-term patient self-care activities with frequent reinforcement reduced HF hospitalizations (RR 0.44-0.66) and all-cause hospitalizations (RR 0.59-0.80); and (3) studies that employed structured telephone support with a nurse reduced HF hospitalizations (RR 0.75-0.78) but not all-cause hospitalizations.[28] Of note, data on the success of outpatient disease management programs are based on all HF hospitalizations over different time periods, often 1 year, but do not provide information on the influence of these programs specifically on 30-day HF readmissions. Additionally, large randomized clinical trials of disease management programs including Medicare Health Support pilot programs and the

COACH trial found no benefit on readmission rates. However, both the Medicare and COACH studies mentioned above were designed for care over a long term and neither was aimed specifically at reducing 30-day readmissions.[29,30]

Telemonitoring disease management programs utilize methods including the remote intermittent transmission of blood pressures and weight. Two large randomized trials have shown that as a sole intervention, telemonitoring has no benefit on 6-month HF readmission.[31,32] Data from outpatient disease management programs therefore suggest that features of effective programs include frequent in person contact with clinicians and formal self-care education and support rather than telephone contact or telemonitoring alone.[28]

The focus of inpatient initiatives has been on adhering to evidenced based heart failure care such as CORE measures, improving the discharge process, and ensuring a safer transition from hospital to home through established early follow up appointments and timely communication with outpatient physicians. Adherence to clinical process measures for inpatients with HF, including prescribing an angiotensin-converting enzyme inhibitor or angiotensin receptor blocker, prescribing a beta blocker, providing smoking cessation counseling, and documenting the ejection fraction, have been associated with small (0.2%) reductions in 30-day readmissions.[33] Larger reductions have been seen with transitional and coordinated care interventions.

A meta-analysis of discharge planning and post discharge support interventions found a significant reduction in all-cause readmissions (RR 0.75).[34] This involved readmissions which occurred between 3-12 months after index discharge. Interventions included medication counseling, education, dietary counseling, social work consultations, home visits, telephone follow-up, and more. Despite the risk reduction, the intervention group still had a mean readmission rate of 34.9%. Still, the significant reduction supports the routine use of comprehensive discharge planning and post discharge support, although the analysis also shows that additional measures are needed to reduce readmissions to a more acceptable rate.

Follow up with a physician within seven days after discharge to review medications, examine the patient (including reassessment of fluid status), and provide patient education has been recommended. A large study found that 7-day follow ups were associated with a 3% lower rate of 30-day readmissions in some hospitals.[35]

Coordinated care models, which provide interdisciplinary care coordination to patients across multiple settings and different degrees of ongoing support to implement a plan of care, have seen positive results in readmission reductions. However, these were not geared only to patients with HF.

The Transitional Care Model (TCM), Care Transitions Initiative (CTI), and Project RED share four main components. They coordinate care between hospital and post-hospital providers, educate patient and families, provide monitoring of a patient's health status post-discharge, and employ a coach or team to manage clinical, social, rehabilitative, nutritional, and pharmacy needs after discharge.[39]

The TCM institutes a multidisciplinary team led by a transitional care nurse and targets high-risk older adults.[39,43] This model provides seven-days per-week telephone support along with regular home visits. The duration of the intervention ranges from one to three months and subsequently access to continuing services such as palliative care, hospice care, and chronic case management is facilitated. A random controlled trial of HF patients showed that the intervention TCM group had fewer readmissions in one year following discharge. Additionally, cost of care during the year post-discharge was reduced by 39% per patient.[43]

In the CTI program a nurse transition coach saw the patient in the hospital to perform medication reconciliation, provide education and ensure follow up plans.[28,44] This transition coach then visited the patient's home during the 7-day post discharge period and made two phone calls within 30-days after discharge. However, only 20% of the patients in the trial had HF; 30-day readmission rates decreased from 11.9% to 8.3%, but it is difficult to determine the impact on HF patients alone. The benefit of the CTI is that it is a low cost four-week program that can easily be adopted by any hospital.

Project RED utilized a discharge advocate to coordinate discharge support and led to lower combined hospital and ED utilization (incidence rate ratio 0.70).[11,28] This model included pharmacist medication reviews, which identified a number of medication errors and may have contributed to the decrease in readmissions. The proportion of patients with an index hospitalization for HF was not provided.

A limitation of initiating these coordinated care models nationwide is that they are not always cost effective. For example, although one nurse-led program was able to reduce 30-day readmissions by 48% for HF patients, there was little impact on direct costs to the healthcare system in the 60 days following discharge.[28,45] Additionally, it had a negative impact on hospital revenue under the reimbursement system prior to the start of the Hospital Readmissions Reduction Program.

Preventable Readmissions

For hospital planning it would be ideal to be able to predict the patients in which a 30-day readmissions reduction initiative would be successful. However, the evaluation of hospital readmissions is complex because even with optimal care many readmissions are not preventable. An understanding of risk factors helps identify patients likely to be readmitted but does not necessarily identify those for whom readmission can be avoided. Moreover, there is no clear understanding of whether early intervention is more efficacious in preventing readmission in patients with numerous risk factors versus those with fewer. In some cases, early readmission may be due to suboptimal care,[9] whereas in other instances it results from a non-preventable progression of the disease or from an entirely new disease process.[4] As predictors of readmission are established, it is critical that interventions designed to prevent readmission carefully consider whether the risk indicators selected are indeed modifiable factors.[4] Strong evidence for the existence of modifiable risk factors is evidenced by geographic variability between states as rates of readmission within 30 days after discharge are as low as 13.3% in some states and as high as 23.2% in others.[2]

The term potentially preventable readmission (PPR) was established to identify readmissions that may have been prevented by the provision of quality care in the initial hospitalization, adequate discharge planning, adequate post discharge follow up, or improved coordination between inpatient and outpatient health care teams.[20] To be considered a PPR, the readmission must be clinically related to the index hospitalization. The authors conceptualize PPRs as fitting into one of five categories, three of which are for medical readmissions: (1) a readmission for a continuation or recurrence of the reason for the initial admissions or for a closely related condition, (2) a readmission for an acute decompensation of a chronic problem that was not the reason for the initial admission but was plausibly related to care either during or immediately after the initial admission, (3) a readmission for an acute medical complication plausibly related to care during the initial admission. Admissions that are excluded from being considered a PPR which may occur in individuals admitted for HF include those associated with major or metastatic malignancies, obstetrical admissions and admissions with a discharge status of left against medical advice. With these criteria in mind a panel of physicians examined all possible admission and readmission combinations of the 314 All Patient Refined Diagnosis Related Groups (DRGs) to determine whether two hospitalizations are clinically related. Using a Florida inpatient hospital data source of 2005-2006 hospitalizations, the researchers reviewed 120,062 HF index admissions and 21,694 15-day readmissions, of which 14.4% were found to be unrelated to the index admission based on the readmission DRG and approximately 85.7% of readmissions were considered a PPR. Although this method does identify some readmissions which are not preventable, an accumulation of evidence suggests that far fewer than the 85.7% of PPRs for HF are in fact preventable.

Most studies have used subjective criteria to determine whether readmissions are preventable, resulting in the proportion of readmission determined to be avoidable to vary widely between studies (5-79%, median 27.1).[9] A meta-analysis determined that the most notable studies used criteria with several qualifiers provided to define "avoidable"—along with multiple categories for avoidable readmissions.[9] Among these was a retrospective study of patients on a geriatric unit with a readmission rate of 25%.[21] A total of 48% of readmissions were deemed avoidable due to inadequate medical management, social problems or inadequate rehabilitation. However, the interval between index discharge and readmission was 12 months and only one reviewer was used. Another study on 30-day readmissions found only 9% to be preventable, as determined by three reviewers with strong inter-reviewer reliability ($k=0.78$, $p<0.001$).[22] Reasons for readmissions included medical system failures, an unfulfilled hope that the patient would improve after discharge, or suboptimal judgments in evaluation or treatment. Data from successful interventions to reduce readmissions support the finding that some proportion of readmissions are preventable, but more data is needed to understand the factors in an index hospitalization which are associated with a preventable readmission.

Few studies have examined preventable readmissions in HF readmissions alone. A prospective study of patients receiving home care services after a prior hospitalization with a primary or secondary diagnosis of HF found that 73.3% of 90-day readmissions were not preventable.[23] The proportion of preventable readmissions in those with a primary HF diagnosis is not provided. Additional limitations were that there was no mention of the reasoning behind labeling a readmission as preventable and that preventability was based solely on the opinion of the treating home care nurse. Another study of 90-day HF readmissions found that up to 50% were preventable, 38% were possibly preventable and 15% were probably preventable.[24] Subjective assessment was used to determine the degree to which certain factors contributed to readmission including noncompliance with medications (15%) or diet (18%), inadequate discharge planning (15%) or follow up (20%), failed social support system (21%), and failure to seek medical attention promptly when symptoms recurred (20%).

It has been shown that the proportion of readmissions deemed avoidable decreases significantly with time from discharge.[25] This suggests that readmissions occurring soon after discharge are more likely to be avoidable than those which occur months to a year after discharge. It may also explain some of the variation between the estimated proportions of avoidable readmission. A meta-analysis from 2011 of 16 studies found that 23.1% of 30-day hospital readmissions were classified as avoidable.[26] Of the identified studies, none assessed avoidable readmissions in HF patients alone. The weighted proportion of 23.1% may in fact in itself contain significant variation depending on the number of days until readmission within the first month. An earlier study classified 32% of readmissions occurring 0-6 days after discharge and only 6% occurring at 21-27 days as avoidable.[27]

Readmissions as a Measure of Quality of Health Care

The success of some transitional care interventions and improved discharge planning efforts indicate that better care can decrease readmission rates. Furthermore, the presence of preventable readmissions suggests that these readmissions may be associated with inappropriate care during or after the index admission.[4] This intuitive relationship between readmission rate and quality of care has led to its use as a quality marker and as a basis for hospital reimbursement penalties. In addition, the ease at which readmission data are available to payers such as Medicare has made their use appealing as a quality indicator. However the evidence linking readmission and quality of care on initial hospitalization is mixed.

A retrospective study of patients at Veterans Affairs hospitals with HF and readmitted within 14-days post discharge was performed reviewing quality measures at admission, during the course of hospitalization, and at discharge.[41] A significant association was found only with the quality of care at discharge measured by a 10-point readiness for discharge score. This included the 10 following criteria: (1) Substantial improvement has occurred in symptoms and signs, (2) Weight stable or decreasing, (3) Temperature less than 37.8 C for 24 hours, (4) Blood urea nitrogen and serum creatinine stable or decreasing, (5) No cardiac medication changes for 24 hours, (6) Digoxin level less than 2.6 nmol/L, (7) Prothrombin time stable, (8,9) Documentation that patient or family understand the medication regimen and dietary regimen, (10) Plans for follow-up are documented. A multivariate analysis of the readiness for discharge score derived from the number of met criteria found that lower readiness for discharge scores were associated with a higher risk for readmission after controlling for demographic and severity of illness variables. Patients with one unmet criterion had an 18% increased odds of readmission. However, substandard care was defined by the authors as having a readiness for discharge score below the 25th percentile, which required more than three unmet criteria. Substandard care was responsible for 18.5% of readmissions. The authors conclude that readmissions are therefore associated with remediable deficiencies in the process of care, particularly the discharge process for patients with HF.

Four out of five HF patients in this study were readmitted despite receiving the standard of care. These findings more likely indicate that the association between substandard inpatient care and early readmission are weak or that that the methods for measuring the quality of inpatient care were inadequate.[41]

A subsequent study was unable to prove the hypothesis that poor quality of care during a hospitalization leads to increased readmission rates.[42] Medicare claims data was used to create and validate a model to predict readmission risk for HF patients which had a c-statistic of 0.56. Data containing the results of quality reviews for Medicare inpatient hospitalizations examined by a Medicare Peer Review Organization were obtained and the model was applied to these patients. The resulting risk probabilities were used along with observed readmission outcomes to compare risk-adjusted readmission rates for cases that had acceptable quality care ratings and for cases whose quality of care was considered poor. There was no significant difference between the observed to expected readmission risk ratio between those patients in the acceptable quality group and those in the poor quality group for HF (p-value 0.252). Although the c statistic in this model was low, it represents similar predictive ability as the model currently used by CMS (c statistic 0.60). Since the purpose of this study was to determine the validity of using readmission rates as a measure of quality of care, for comparison it is beneficial that the model used in this study was similar to the current model used to profile hospital performance.

Despite the fact that the literature appears to show that quality of care is weakly or not associated with readmissions, a widely held opinion of the converse still persists. Although the validity of readmission rates as an indicator of quality of care is uncertain, readmissions naturally raise concern among health care providers and they endorse efforts to reduce readmissions..[4] Still, however, the lack of uniform findings of an association has led many to question the appropriateness of measures to penalize hospitals based on high readmission rates.

Risk Standardized Readmission Rate

Medicare claims data have been used to create a readmission prediction model validated against a medical record model containing clinical data, and this prediction model is now being utilized by CMS to profile hospital performance.[36] The purpose of the model is to account for differences across hospitals in patient demographic and clinical characteristics that might be related to readmission but are unrelated to quality of care, a process known as risk adjustment or risk standardization.[37] This model was not devised to predict outcomes for individual patients, but rather to identify high performing or low performing hospitals due to differences in quality or other factors associated with various hospital systems. The predictive ability of the model for individual patients is therefore modest, as established predictors of 30-day readmission such as complications during hospitalization, patient race, socioeconomic status and discharge disposition were excluded to avoid controlling for factors that can highlight important quality differences.[38] Risk Standardized Readmission Rates (RSRR) allow for a comparison of a particular hospital's performance given its case mix to an average hospital's performance with the same case mix. Hospitals that perform better than average can then be considered to be of better quality and those with higher than expected readmissions are considered of worse quality.[37]

The model contains 37 variables which include 9 cardiovascular, 26 comorbidity and 2 demographic variables (age and sex). Claims data prior to the index hospitalization is required for risk adjustment. CMS uses this model to calculate an excess readmission ratio, which is the ratio of the predicted readmission rate to the expected readmission rate. Predicted readmissions are those that occur within 30 days predicted on the basis of the hospital's performance with its observed case mix (determined by the hospital's patient mix and its own hospital-specific intercept as determined by the logistic regression model). Expected readmissions are those that occur within 30 days and that are expected based on the nation's performance with that hospital's case mix;[37,1] they are determined by the hospital's patient mix and the average hospital-specific intercept based on all eligible hospitals.[38] Excess readmission ratios are used to determine payment adjustments for each eligible hospital.

The RSRR is the product of a hospital's excess readmission ratio and the nationwide unadjusted 30-day readmission rate. Based on this rate, and the claims data used for adjustment, hospital performance is publicly reported on the hospital compare webpage (www.hospitalcompare.org) and hospital reimbursement penalties are determined.[1]

Clinical data such as physiological data, laboratory results, and diagnostic test results are not included in the current prediction model to standardize risk.[38] One study found that adding certain clinical variables to a claims-based model did not meaningfully change the ability of the model to discriminate between high and low risk patients, improve concordance between predicted probabilities and observed outcomes, or improve the model's ability to account for observed variance in the HF population. Clinical variables considered included ejection fraction, heart rate, hemoglobin, serum creatinine, serum sodium, systolic blood pressure, and weight. Among these only hemoglobin, serum creatinine, serum sodium and systolic blood pressure were significantly related to readmission. However, including these variables with a claims-based model had little effect on prediction of readmission. It is possible that this finding was due to the ability of claims data to include patient level risk that is inherently contained in the claims data and represented by the clinical data, or that the addition of these clinical data did not adequately characterize patient level risk.[38] The latter could be the result of the selection criteria for this study. Although the selected variables represent multiple clinical domains, it is still possible that other clinical variables may be of significance.

The current risk standardization method has been critiqued as it does not account for non-clinical variables such as a patient's support system or socioeconomic status (SES).[13] This concern stems from the belief that SES can affect a patient's ability to eat properly, pay for medications, obtain transportation to doctor appointments, and more, all of which can influence readmission status. One study found evidence that major teaching hospitals and safety net hospitals were more likely to have higher than predicted rates of readmission.[13] The authors suggest that this finding may relate to the fact that the risk standardization method used does not completely account for case mix (medical complexity) and also excludes socioeconomic status. The authors themselves, in describing limitations of their study, note that there is no single method to determine which hospitals care for the sickest patients or for more patients of low socioeconomic status. Additionally, their conclusions are based on a single year's predictions; further research is needed to determine how well the current risk standardization model performs over time.

Hospital Readmissions Reduction Program

The Patient Protection and Affordable Care Act of 2010 (PPACA) implemented the Hospital Readmissions Reduction Program, a Medicare program aimed at reducing hospital readmissions through financial incentives. Through the program hospitals are penalized for readmissions in excess of the national average for heart failure, acute myocardial infarction (AMI) and pneumonia (PNA). The CMS risk standardization determines the average hospital performance with a given hospital's case mix. Hospitals with higher-than-predicted readmission rates are then penalized based on their frequency of excess readmissions.

For example, a hospital with an expected HF 30-day risk standardized readmission rate of 25% would be penalized based on the degree to which this rate was exceeded. If the hospital's readmission rate was 26% it would be 4% (1/25) over expected. The hospital would then be assigned a penalty of 4% of all payments for HF hospitalizations. The maximum penalty allowed under the HRRP is 1% of total Medicare reimbursements for fiscal year 2013, 2% in FY 2014 and 3% in subsequent years. If 25% of the hospital's income was from HF, then this 4% can be collected back by assigning a 1% penalty to all hospital payments. If the hospital made 12.5% of its income from HF, then a 0.5% penalty for all hospital payments would result in the same fine being collected. If the hospital made more than 25% of its income from HF, in this example the hospital would not be penalized the full 4% of payments for HF, because this would require greater than a 1% penalty to be applied to all hospital payments. Therefore, the 1% maximum penalty would be applied. Similarly, if this hospital had a readmission rate greater than 26% and the hospital again made 25% of its income from HF, then a penalty greater than 1% would have to be applied to all hospital payments; in this case, the maximum 1% penalty would apply again regardless of the percentage of readmissions over expected.

The sum of all calculated penalties for HF, AMI, and PNA is used to determine whether a hospital has exceeded the maximum penalty. Therefore, the previous example assumes that for AMI and PNA there were no readmissions over expected.

As described in the example, the HRRP requires that all Medicare payments be reduced by a percentage, which allows for a hospital to be fined the full penalty over a one-year period. If a hospital's calculated penalty is over the maximum allowed, then the hospital's payments are reduced by the capped maximum (i.e., 1% in 2013). The new payment structure as described in the PPACA can be summarized as follows:

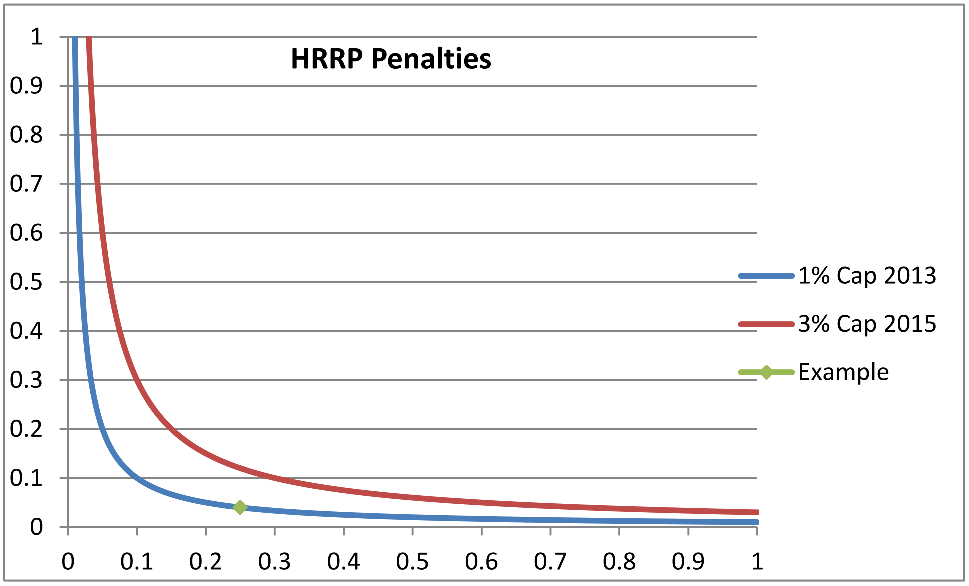
- New payments to hospitals is an amount = (Base DRG payment) X (Adjustment factor)
- Adjustment factor = Greater of A or B

  (A) Ratio = 1 – (Aggregate Payments for excess readmissions / Aggregate payments for all discharges)

  (B) Floor adjustment Factor = .99 for 2013
- Aggregate Payments for excess readmissions = (Base DRG Payment) x (Number of Admissions) x (excess readmission ratio - 1) + X_2 (AMI) + X_3 (PNA)
- Aggregate payments for all discharges = (Sum of all base DRG payments for all conditions)
- Excess Readmission Ratio = (risk adjusted readmissions) / (risk adjusted expected readmissions)
- Note: Excess readmissions do not include readmissions for which there are less than a minimum number of discharges.

In summary, for all hospital payments the base DRG amount will be multiplied by an adjustment factor no less than 0.97 by FY 2015, which would result in a 3% maximum penalty. For a hospital to be penalized less, base DRG payments for excess readmissions should be no more than 3% of all base DRG payments in a given year. This can be depicted in Figure 1.

Figure 1. Hospital Readmission Reduction Program Penalties



Note: X axis: Proportion of HF base DRG payments to sum of all base DRG payments. Y axis: Proportion over the expected HF risk standardized readmission rate. Hospitals plotted on or above the line would receive the maximum penalty. Those plotted below the line would receive a lesser penalty based on their readmission rate. The example point (.25, .04) represents a hospital receiving 25% of its income from HF which is 4% over the expected readmission rate (i.e., 26% RSRR with expected rate of 25%). This figure assumes zero excess readmissions for Acute Myocardial Infarction or Pneumonia.

Methods[46, 47]

Most methods used in this study are the same as those described in other studies[46,47] analyzing this patient population and QI initiative; these have not yet been published.

Setting

The UConn Health Center's John Dempsey Hospital is a 229-bed, acute-care hospital located in Farmington, Connecticut. The hospital offers cardiac services including primary angioplasty and cardiac surgery (not including heart transplant or left ventricular assist devices). Part of the University of Connecticut Health Center, the hospital is largely staffed by salaried faculty physicians as well as fellows, residents, and students. A small minority of patients receive care from private practitioners.

Patient Data Collection

For the subset of patients readmitted to the UConn Health Center, demographic and clinical variables were obtained through chart abstraction. A focused training session using an abstraction tool designed for this study was provided prior to data collection. After the review of five sample charts, results were compared to those of the primary investigator, Dr. Jason Ryan. Any discrepancies were addressed before proceeding to analyze additional patient charts. In order to validate the interobserver agreement, a random sample of 10% of the records was reviewed independently. For binary variables, data were compared with Cohen's kappa coefficient. Agreement is usually considered excellent for kappa >0.9 and very good for kappa 0.6 to 0.9. For the majority of demographic variables, kappa was excellent at 1.0. The lowest kappa was 0.79. For vital signs, interobserver agreement was 100%. For admission labs, agreement was 95%.

Determination of Readmission Rate

The Connecticut Hospital Association (CHA) Chimedata database was used to determine 30-day all-cause readmission rates. This database contains all hospitalizations within the state of Connecticut for all-payers. This allowed quantification of readmissions to our own institution as well as other hospitals in Connecticut.

Patients were eligible if they were discharged from John Dempsey Hospital with a primary diagnosis of heart failure during the pre-initiative period (January 1, 2008 through December 31, 2008) and the post-initiative period (January 1, 2011 through December 31, 2011). Patients were considered to have a primary diagnosis of heart failure if the principle ICD-9-CM diagnosis code for their admission was one of the following: 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 428.0, 428.1, 428.20, 428.21, 428.22, 428.23, 428.30, 428.31, 428.32, 428.33, 428.40, 428.41, 428.42, 428.43, and 428.9. We excluded patients who were transferred to another acute care hospital, who expired in the hospital, or who left against medical advice. These are the same inclusions and exclusions used by the Centers for Medicaid and Medicare Services (CMS) to determine readmission rates for the Hospital Compare website. A readmission was defined as a hospitalization for any reason within 30 days of discharge after the index hospitalization. For patients with multiple readmissions during the 30-day window, only the first readmission was counted, consistent with guidelines from CMS.

Analysis

Statistical analysis was performed using SAS 9.3 (Cary North Carolina). For continuous variables, equality of the means was tested using a two-sample t-test assuming unequal variances. For categorical variables, equality of the proportions was tested using a chi-square test. For data elements with small sample sizes, p-values were obtained using the Fisher’s exact method. Means and proportions for all variables were compared between readmitted and not readmitted patients and the p-values from this comparison were rank ordered prior to logistic regression. A multivariate logistic regression was then performed independently for 2008 and 2011. Variables with greater than 10% of missing data elements were removed prior to this analysis. If convergence criteria were not satisfied, then the variable with the largest rank ordered p-value was removed and the model fitting was attempted again. This procedure was repeated until convergence criteria were satisfied for both the 2008 and 2011 regression models. The remaining variables were considered potential covariates, and variable selection was subsequently performed with these covariates using a backward elimination regression method with alpha=0.01.

Description of Quality Improvement Initiative

In 2009 the UCONN Health Center created the Heart Quality Team (HQT) to improve the transition of care from the hospital to home and lower the 30-day all-cause readmission rate. The HQT also joined a state-wide effort in February 2010 led by Qualidigm, the state's Medicare Quality Improvement Organization (QIO), and the CHA to reduce heart failure readmissions. As part of this collaborative, HQT members attended seminars and received quarterly feedback on the hospital's progress in lowering rates of readmission.

The HQT identified hospitalized heart failure patients at JDH on a daily basis using a computer-generated list of inpatients receiving diuretics.[6] This technique pared down the hospital population to a manageable list of 20 to 30 patients who were likely to have heart failure. Charts for each of these patients were reviewed to identify those individuals listed by a physician as having a primary diagnosis of heart failure. A daily email of the entire hospital population of heart failure patients was created to notify nurse managers, social workers, physicians, and other key staff members.

Targeted interventions to improve care were provided to each heart failure patient. Floor nurses received specific training to provide heart failure teaching (low salt eating, daily weights, medication compliance). A heart failure nurse practitioner evaluated many of the inpatients and supplemented the HF education they were receiving from nurses. Staff members from nutrition, pharmacy, and social work met with each patient. A 7-day follow-up appointment was scheduled prior to discharge for most patients, often with the same physician or nurse practitioner who cared for the patient in the hospital. For some weekend discharges, the follow-up appointment was scheduled on Monday and the patient received a phone call for notification. Follow-up phone calls were conducted 48 to 72 hours after discharge.

As part of the initiative, a team of community service providers that cared for the hospital patients after discharge, including skilled nursing facilities (SNFs) and visiting nurse associations (VNAs), was formed. This team met monthly to discuss care transitions. Topics included communication between community providers and physicians as well as standardized teaching tools for heart failure education.

The HQT began its work in April of 2009. It took over a year to train nursing staff and engage community providers. Mandatory 7-day follow-ups began in late 2010. Thus, 2008 represents the last full calendar year prior to the program; 2011 represents the first full calendar year after its complete implementation.

Results

In the results data are compared between 2008 and 2011 patients to identify changes in the overall Heart Failure patient population hospitalized at the UConn Health Center's John Dempsey Hospital. Additional comparisons are performed to identify differences between the 2008 and 2011 readmitted patients at their initial (index) hospitalization, which may exist due to the start of the Quality Improvement Initiative between these years. Differences between readmitted patients and not readmitted patients are used to identify variables which are associated with readmission; to determine further whether these variables are independent of one another, results from a backward elimination logistic regression analysis are shown below.

Comparison of Eligible Discharges in 2008 vs. 2011

The 2008 study sample contained 206 patients. The Connecticut Hospital Association determined 189 to be eligible discharges. For 2011 these numbers were 224 and 209, respectively. The mean age of eligible discharges was 80.5 in 2008 and 79.9 in 2011; 45% and 51.2%, respectively, were of male gender. There were no statistically significant differences in these demographics (Table 1).

Table 1. Demographic Variables from Eligible Discharges

	2008 (N=189)	2011 (N=209)	P-Value
Age	80.5	79.9	0.633
Male (%)	45.0	51.2	0.215

Systolic heart failure was present in 51.1% of patients in 2008 and 48.8% in 2011, with the remaining patients classified as having diastolic heart failure. A statistical difference was found in ejection fraction, with a lower mean in those admitted in 2008 (Table 2).

Table 2. Heart Failure Disease Specific Variables

	N	2008	N	2011	P-Value
Systolic HF (%)	188	51.1	208	48.8	.099
Ejection Fraction	186	42.7	208	46.8	.029

The mean time of admission was 16:04 in 2008 and 20:24 in 2011, with no statistical difference observed. There were no statistical differences between admission or discharge days of week between years (Table 3). The mean length of stay was longer in 2011, 5.3 vs. 4.6 days, although this difference was not statistically significant (p=0.198).

Table 3. Comparison of Admission and Discharge Days of Week among Eligible Discharges

	2008 (N=189)	2011 (N=209)	2008 (N=189)	2011 (N=209)
	Admission (%)	Admission (%)	Discharge (%)	Discharge (%)
Sunday	16.4	8.13	13.2	8.1
Monday	12.7	16.8	19.1	16.8
Tuesday	15.9	18.2	13.8	18.2
Wednesday	16.9	17.7	17.5	17.7
Thursday	13.2	13.9	13.2	13.9
Friday	14.8	16.3	15,3	16.3
Saturday	10.1	9.1	7.9	9.1
	P-Value=0.292		P-Value=0.249	

The proportions of patients with certain comorbidities were similar in 2008 and 2011. Over three-fourths of patients admitted had a prior history of heart failure in both years (Table 4).

Table 4. Comorbidities of Eligible Discharges

	2008 (N=189)	2011 (N=209)	P-Value
Diabetes Mellitus (%)	36.5	34.5	0.668
Dementia (%)	11.7	10.1	0.596
Prior Heart Failure	77.7	82.8	0.200
COPD (%)	24.5	18.2	0.126

COPD= Chronic Obstructive Pulmonary Disease. N=188 for Dementia, Prior Heart Failure and COPD in 2008; for all other values N is as specified.

The mean number of medications on admission was roughly 8.5 in both years (Table 5). Significantly fewer patients with systolic HF in 2008 were admitted on a Beta Blocker. Significantly more patients with diastolic HF in 2008 were admitted on an Angiotensin Receptor

Blocker (ARB). Significantly more patients in 2008 with systolic HF were admitted on Aldosterone. Significantly more patients in 2008 were admitted on Coumadin. A non-significant trend was observed with more patients in 2008 admitted on Digoxin. Among patients on Furosemide, 94 had a documented dosage in 2008, with a daily average of 57.7mg; in 2011, this average was 55.9mg for 125 documented dosages. Admission medications were not documented for 5 patients in 2008 and 3 patients in 2011.

Table 5. Admission Medications from Index Hospitalization among Eligible Discharges

	2008 (N=184)	2011 (N=206)	P-value
No. of Meds on Admission	8.6	8.5	0.780
Beta Blocker (%)	62.5	75.2	0.007
Beta Blocker (%) Systolic HF	54.8	76.1	0.003
Beta Blocker (%) Diastolic HF	70.0	58.0	0.486
ACE Inhibitor (%)	40.0	39.8	0.564
ARB (%)	24.5	16.0	0.038
ARB (%) Systolic HF	26.9	21.6	0.407
ARB (%) Diastolic HF	22.2	12.0	0.048
Aspirin (%)	54.9	57.8	0.568
Statin (%)	58.2	50.5	0.129
Digoxin (%)	20.1	13.1	0.062
Nitrate (%)	11.4	9.2	0.477
Aldosterone (%)	21.2	12.14	0.016
Aldosterone (%) Systolic HF	30.11	15.91	0.024
Aldosterone (%) Diastolic HF	12.2	9.4	0.514
Metolazone (%)	5.4	3.4	0.325
Coumadin (%)	37.0	26.2	0.023
Loop Diuretic (%)	71.3	68.0	0.480

ACE= Angiotensin Converting Enzyme; ARB= Angiotensin Receptor Blocker.
N=181 for Loop Diuretic in 2008; for all other values N is as specified.

The mean number of medications on discharge was roughly 9 in both years (Table 6). Of note, discharge medications were not documented for 17 patients in 2008; in 2011 only 3 patients did not have documented medications at discharge. Proportions of patients discharged on the charted medications were similar in both years with the exception of aldosterone, with significantly more patients discharged on this drug in 2008; this relationship was the same as on admission. All other significant medication differences which existed on admission between years were not significant upon discharge. The non-significant trend of more patients on digoxin in 2008 was maintained at discharge.

Table 6. Discharge Medications from Index Hospitalization among Eligible Discharges

	2008 (N=172)	2011 (N=206)	P-value
No. of Meds on Discharge	8.8	9	0.559
Beta Blocker (%)	73.8	79.6	0.184
ACE Inhibitor (%)	41.0	44.9	0.453
ARB (%)	22.5	17.0	0.174
Aspirin (%)	65.9	68.0	0.670
Statin (%)	59.0	57.3	0.742
Digoxin (%)	17.9	11.2	0.061
Nitrate (%)	12.1	8.7	0.278
Aldosterone (%)	23.7	12.1	0.003
Metolazone (%)	5.2	4.9	0.877
Coumadin (%)	31.8	30.1	0.722
Loop Diuretic (%)	88.4	86.9	0.664

ACE= Angiotensin Converting Enzyme; ARB= Angiotensin Receptor Blocker.
N=173 for all medications in 2008 except loop diuretic; for all other values N is as specified.

Vital signs obtained on admission were similar in 2008 and 2011 (Table 7). Except for serum sodium, laboratory data also were similar upon admission in the two years (Table 8). The mean serum sodium value was lower in 2008, 136.4meq/L vs. 138meq/L in 2011; this difference was statistically significant. Significantly more patients had serum sodium of less than 130meq/L on admission in 2008.

Table 7. Vital Signs on Admission (Means) among Eligible Discharges

	N	2008	N	2011	P-Value
Systolic Blood Pressure (mmHg)	188	137.5	195	139.1	0.585
Diastolic Blood Pressure (mmHg)	188	73.1	195	73.4	0.870
Heart Rate (bpm)	187	84.5	196	86.0	0.508
Respiratory Rate (rpm)	179	23.0	192	22.6	0.611

Table 8. Laboratory Data on Admission among Eligible Discharges

	2008 (N=189)	2011 (N=208)	P-Value
Serum Sodium (meq/L)	136.4	138.0	<.001
Blood Urea Nitrogen (mg/dl)	30.7	29.2	0.436
Creatinine (mg/dl)	1.55	1.60	0.635
Glucose (mg/dl)	146.9	138.5	0.184
Hematocrit (%)	35.0	34.8	0.658
Serum Sodium < 130 (%)	11.1	2.4	<.001
Creatinine >1.5 (%)	31.8	34.6	0.545
Creatinine > 2.0 (%)	14.3	15.4	0.759

For Hematocrit N=188 in 2008 and N=206 in 2011; for all other values N is as specified. Hematocrit is described as the mean percentage; values for Serum Sodium<130, Creatinine>1.5, and Creatinine>2.0 represent the percentage of patients that met this criteria.

Proportions of patients discharged to destinations of home with no services, home with VNA services and skilled nursing facilities were roughly even in 2008 (Table 9). In 2011 the largest proportion of patients were discharged to skilled nursing facilities (37.9%), followed by home with VNA services (33.3%) and home with no services (26.8%). Although this trend was seen in 2008, the differences were less noticeable. Few patients were discharged to hospice care in both years. Discharge destination was not documented for 4 patients in 2008 and 11 patients in 2011. A comparison of discharge destinations between years yielded no significant differences.

Table 9. Discharge Destination after Index Hospitalization among Eligible Discharges

	2008 (N=185)	2011 (N=198)
Home no Services (%)	31.9	26.8
Home with VNA services (%)	33.0	33.3
Skilled Nursing Facility (%)	33.5	37.9
Hospice (%)	1.6	1.9
	P-Value=0.693	

The frequency of follow up visits after discharge increased significantly in 2011 compared to 2008. UConn follow up visits within 7 days of discharge increased from 19.6% in 2008 to 46.9% in 2011. In 2011, significantly more patients had two or more UConn follow up visits in the 30-day post discharge period, and significantly fewer patients had no UConn follow up during this period (Table 10).

Table 10. Follow Up Visits Among Eligible Discharges

	2008 (N=189)	2011 (N=209)	P-Value
0 outpatient visits 30-days (%)	52.8	29.2	<0.001
1 outpatient visit 30-days (%)	19.4	24.9	0.200
2+ outpatient visits 30-days (%)	27.2	45.9	<0.001
Mean outpatient visits 30-days	1.0	1.6	<0.001
7 Day Follow Up UConn (%)	19.6	46.9	<0.001

Comparison of All-Cause Readmissions in 2008 vs. 2011

The 30-day all-cause hospital readmission rate decreased significantly from 25.4% (n=48) in 2008 to 18.2% (n=38) in 2011. In 2008 these included 4 planned readmissions, 40 unplanned readmissions, and 4 readmissions to an outside institution. In 2011 these numbers were 3, 23, and 12, respectively (Table 11).

Table 11. Readmissions among Eligible Discharges

	2008 (N=189)	2011 (N=209)	P-Value
All Readmissions	48(25.4%)	38(18.2%)	0.040
UConn Unplanned Readmissions	40 (21.2%)	23 (11.0%)	<0.001
Planned Readmissions	4 (2.1%)	3 (1.4%)	1.0
Outside Institution Readmissions	4 (2.1%)	12 (5.7%)	

Comparison of Unplanned Readmissions 2008 vs. 2011

Among the 30-day all cause readmissions, 83.3% in 2008 and 60.5% in 2011 were unplanned readmissions to UConn. The mean age of patients with unplanned readmissions was 81.4 in 2008 and 82.6 in 2011; 35% and 39.1%, respectively, were of male gender. There were no statistically significant differences in these demographics (Table 12).

Table 12. Demographic Variables of Readmitted Patients

	2008 (N=40)	2011 (N=23)	P-Value
Age	81.4	82.6	0.665
Male (%)	35.0	39.1	0.743

Systolic heart failure was present in 47.5% of patients with unplanned readmissions in 2008 and 47.8% in 2011; the rest of the patients were classified as having diastolic heart failure (Table 13). A statistical difference was not observed in the mean left ventricular ejection fraction (LVEF) for readmitted patients between years; however, as described above, a difference was observed in mean LVEF between years for all discharged patients.

Table 13. Heart Failure Disease Specific Variables of Readmitted Patients

	N	2008	N	2011	P-Value
Systolic HF (%)	40	47.5	23	47.8	.980
Ejection Fraction	37	42.7	23	46.5	.420

The mean time of index admission was 9:07 for unplanned readmissions in 2008 and 18:43 in 2011; this difference was not statistically significant. The mean length of stay on index admission was similar for both groups, 5.0 days in 2008 and 4.8 days in 2011. The mean number of days between admission and readmission was 13.8 in 2008 and 14.9 in 2011 (Table 14).

Table 14. Time Related Factors of Readmissions

	2008 (N=40)	2011 (N=23)	P-Value
Sunday (%)	17.5	13.0	
Monday (%)	12.5	13.0	
Tuesday (%)	17.5	21.7	
Wednesday (%)	22.5	17.4	
Thursday (%)	15	17.4	
Friday (%)	10	13.0	
Saturday (%)	5	4.4	
Length of Stay Index Hospitalization	5.0	4.8	0.8376
Days until readmission	13.8	14.9	0.5735

A significantly larger proportion of patients with unplanned readmissions had dementia in 2011 compared to 2008 (Table 15). The proportions of patients with the other charted comorbidities were similar in both years among patients with unplanned readmissions. The index hospitalization was the first episode of HF for only two readmitted patients in 2008 and one in 2011.

Table 15. Comorbidities of Readmitted Patients

	2008 (N=40)	2011 (N=23)	P-Value
Diabetes Mellitus (%)	50.0	34.8	0.242
Dementia (%)	12.5	34.8	0.035
Prior Heart Failure (%)	95.0	95.7	1.0
COPD (%)	20.0	13.0	0.484

COPD= Chronic Obstructive Pulmonary Disease. Prior Heart Failure represents a history prior to the index admission.

The mean number of medications on readmission was 9.1 in 2008 and 9.7 in 2011; both means were greater than the mean for all eligible discharges, which were roughly 8.5 in both years. Moreover, no significant differences were observed in the proportion of patients on each of the listed cardiac related medications between years (Table 16). There is a greater use of beta blockers and ACE inhibitors in 2011 than in 2008, although not statistically significant, as well as greater use of Coumadin. There was lower use of other drugs in 2011 than in 2008. Loop diuretic usage included Furosemide, Bumetadine, Torsemide and Ethacrynic Acid; Furosemide was most frequently observed. Among patients readmitted on Furosemide, 27 had a documented dosage in 2008, with a daily average of 57.2mg; in 2011 this average was 74.2mg for 17 documented dosages. The difference between the two years was not statistically significant.

Table 16. Medications Upon Readmission

	2008 (N=40)	2011 (N=23)	P-value
No. of Meds on Admission	9.1	9.7	0.524
Beta Blocker (%)	77.5	91.3	0.165
ACE Inhibitor (%)	35.0	52.2	0.183
ARB (%)	32.5	21.7	0.363
Aspirin (%)	70.0	69.6	0.971
Statin (%)	72.5	65.2	0.544
Digoxin (%)	22.5	17.4	0.630
Nitrate (%)	7.5	13.0	0.660
Aldosterone (%)	37.5	30.4	0.571
Metolazone (%)	2.5	13.0	0.134
Coumadin (%)	30.0	43.5	0.280
Loop Diuretic (%)	77.5	87.0	0.357

ACE= Angiotensin Converting Enzyme; ARB= Angiotensin Receptor Blocker.

The mean number of medications upon rehospitalization discharge was significantly more in 2011, 10.6 vs. 8.6 (Table 17). A significantly larger proportion of rehospitalized patients were discharged on an Angiotensin Converting Enzyme (ACE) Inhibitor in 2011 compared to 2008 (25.8% vs. 57.9). A non-significant trend was observed with rehospitalized patients discharged less frequently on Aldosterone in 2011 (38.7% vs. 15.79%; p=0.086). Proportions of rehospitalized patients discharged on all other listed medications were similar in both years. Among rehospitalized patients discharged on Furosemide, the most frequently observed loop diuretic upon discharge, 24 had a documented dosage in 2008, with a daily average of 67.9mg, compared to 53.6mg for 14 documented dosages in 2011, a difference that was not statistically significant. Discharge medications were not documented for five patients in 2008; the remaining differences in N are due to deaths prior to discharge.

Table 17. Discharge Medications of Rehospitalized Patients

	2008 (N=31)	2011 (N=19)	P-value
No. of Meds on Discharge	8.6	10.6	0.043
Beta Blocker (%)	74.2	84.2	0.407
ACE Inhibitor (%)	25.8	57.9	0.023
ARB (%)	32.3	26.3	0.656
Aspirin (%)	58.1	73.7	0.264
Statin (%)	70.1	68.4	0.849
Digoxin (%)	29.0	15.8	0.287
Nitrate (%)	9.7	10.5	1.0
Aldosterone (%)	38.7	15.8	0.086
Metolazone (%)	9.7	5.3	1.0
Coumadin (%)	27.6	36.8	0.499
Loop Diuretic (%)	83.9	94.7	0.39

ACE= Angiotensin Converting Enzyme; ARB= Angiotensin Receptor Blocker.
For Coumadin in 2008 N=29; for all other values N is as specified.

Most vital signs obtained for unplanned readmissions were similar in both years (Table 18), although respiratory rates were lower on presentation for 2011 readmissions. No statistically significant differences in laboratory data were observed upon readmission between years (Table 19). Although significantly lower serum sodium values were seen during the index hospitalization in 2008 compared with 2011, they were not observed during the readmission.

Table 18. Vital Signs on Readmission (Means)

	2008 (N=40)	2011 (N=23)	P-Value
Systolic Blood Pressure (mmHg)	123.7	127.4	0.655
Diastolic Blood Pressure (mmHg)	64.3	69.0	0.331
Heart Rate (bpm)	87.6	85.9	0.780
Respiratory Rate (rpm)	21.8	19.1	0.030

For Respiratory Rate in 2008 N=39; for all other values N is as specified.

Table 19. Laboratory Data on Readmission

	2008 (N=40)	2011 (N=23)	P-Value
Serum Sodium (meq/L)	135.0	136.7	0.137
Blood Urea Nitrogen (mg/dl)	43.2	35.8	0.190
Creatinine (mg/dl)	1.94	1.62	0.314
Glucose (mg/dl)	147.1	162.7	0.385
Hematocrit (%)	33.7	33.6	0.896
Serum Sodium < 130 (%)	12.5	4.35	0.402
Creatinine >1.5 (%)	47.5	34.8	0.326
Creatinine > 2.0 (%)	27.5	17.4	0.364

Hematocrit is described as the mean percentage; values for Serum Sodium<130, Creatinine>1.5, and Creatinine>2.0 represent the percentage of patients that met this criteria.

In 2008, most readmitted patients (50%) had been discharged to a skilled nursing facility after their index hospitalization. In 2011, most readmitted patients (54.6%) had been discharged home with VNA services. In both years discharge home with no services after index hospitalization was least frequent among readmitted patients. No statistically significant differences in 2008 vs. 2011 discharge destinations for unplanned readmissions after index hospitalization were observed (Table 20).

Table 20. Discharge Destination after Index Hospitalization of Readmitted Patients

	2008 (N=40)	2011 (N=23)
Home no Services (%)	17.5	9.1
Home with VNA services (%)	32.5	54.6
Skilled Nursing Facility (%)	50.0	36.7
	P-Value=0.2246	

A larger proportion of readmitted patients were discharged home with no services after rehospitalization in 2008 than in 2011 (Table 21). The greatest proportions of rehospitalized patients were discharged to a skilled nursing facility in 2008 and home with VNA services in 2011. In 2008, 10% of rehospitalized patients were discharged to hospice, whereas no rehospitalized patients were discharged to hospice in 2011. Finally, a larger proportion of patients died during rehospitalization in 2011 compared to 2008.

Table 21. Discharge Destination after Rehospitalization among Readmitted Patients

	2008 (N=40)	2011 (N=23)
Home no Services (%)	22.5	8.7
Home with VNA services (%)	22.5	47.8
Skilled Nursing Facility (%)	35.0	26.1
Hospice (%)	10.0	0
Died (%)	10.0	17.39

On average, unplanned readmissions received twice as much follow up prior to rehospitalization in 2011 than in 2008 (1.1 days vs. 0.5 days). UConn follow up visits within seven days after index discharge were significantly more frequent among 2011 readmissions (60.0% vs. 22.7%). Significantly fewer patients in 2011 had no UConn outpatient follow up by the time of readmission (30.4% vs. 65.8). Another trend observed, but not statistically significant, was that more readmitted patients received seven-day follow up after rehospitalization in 2011 compared to 2008 (Table 22).

Table 22. Follow Up Visits Among Readmitted Patients

	2008 (N=40)	2011 (N=23)	P-Value
0 outpatient visits until readmissions (%)	65.8	30.4	0.008
1 outpatient visit until readmission (%)	23.7	43.5	0.106
2+ outpatient visits until readmission (%)	10.5	26.1	0.112
Mean Number of Outpatient Visits	0.5	1.13	0.012
7 Day Follow Up UConn Index Admission	22.7	60.0	0.022
7 Day Follow Up UConn Readmission (%)	32.3	57.9	0.062

Comparison of Eligible Discharges, Unplanned Readmissions and Not Readmitted Patients in 2008 and 2011

Eligible discharges contain the three subgroups of unplanned readmissions, not readmitted patients and planned readmissions. Unplanned readmissions are sometimes referred to as readmitted patients in this section. Not readmitted patients in this analysis include those who were not readmitted as well as any readmissions to an outside institution. As previously stated, the majority of all readmissions are unplanned. P-values measure differences between unplanned readmissions and not readmitted patients (planned readmissions were excluded). All means and proportions presented are in reference to data obtained from the index hospitalization; that is, data representing patients with unplanned readmissions are from the hospitalization prior to the readmission occurring. Means and/or proportions for not readmitted patients are not provided below.

Readmitted patients in 2008 were 0.9 years older on average than all eligible discharges; in 2011, readmitted patients were 2.7 years older on average (Table 23). This difference was relatively more significant in 2011 than 2008 (p= 0.197 vs. 0.610). There were also fewer male than female readmissions in both years, and the difference was similarly significant in both years (p= 0.074 vs. 0.095).

Table 13. Demographic Variables: Eligible Discharge (ED) vs. Unplanned Readmission (UR)

	2008 (N=189) ED	2008 (N=40) UR	P-Value	2011 (N=209) ED	2011 (N=23) UR	P-Value
Age	80.5	81.4	0.610	79.9	82.6	0.197
Male (%)	45.0	35.0	0.074	51.2	39.1	0.095

Eligible discharges and unplanned readmissions had a similar proportion of systolic heart failure in 2008 and in 2011. This similarity was also observed with ejection fraction. Among eligible discharges, no significant differences in either variable were observed between not readmitted and readmitted patients in either year (Table 24).

Table 14. Heart Failure Disease Specific Variables: Eligible Discharge (ED) vs. Unplanned Readmission (UR)

	2008 ED	2008 UR	P-Value	2011 ED	2011 UR	P-Value
Systolic HF (%)	51.1	47.5	0.838	48.8	47.8	0.411
Ejection Fraction	42.7	42.7	0.875	46.8	46.5	0.884

For Systolic HF in 2008, N=188 for Eligible Discharges and N=40 for UR; for Ejection Fraction in 2008, N=186 for Eligible Discharges and N=37 for UR; for 2011 Eligible Discharges and UR, N=208 and 23 respectively for both variables.

The mean length of stay on index admission was within 0.5 days comparing eligible discharges and unplanned readmission; this was the case in both 2008 and 2011 (Table 25).

Table 15. Length of Stay of Index Hospitalization

	2008 ED (N=189)	2008 UR (N=40)	P-value	2011 ED (N=209)	2011 UR (N=23)	P-Value
Length of Stay Index Hospitalization	4.6	5.0	0.463	5.3	4.8	0.412

Diabetes was more prevalent among readmitted patients in 2008 than among all eligible discharges. This difference is attributable to more patients with an unplanned readmission having diabetes than those not readmitted ($p=0.046$). This difference was not observed among readmissions in 2011. Dementia was more prevalent among readmitted patients in 2011 than among all eligible discharges; this difference was also attributable to more patients with an unplanned readmission having dementia than those not readmitted ($p<0.001$). This was not observed in 2008. The index hospitalization was the first episode of HF for 95% of readmitted patients in 2008 and 99.7% in 2011, vs. 77.7% and 82.8% among eligible discharges in respective years. However, no statistical difference was observed between unplanned readmissions and. not readmitted patients in either year for prior history of heart failure (Table 26).

Table 16. Comorbidities of Eligible Discharges (ED) vs. Unplanned Readmission (UR)

	2008 ED (N=189)	2008 UR (N=40)	P-Value	2011 ED (N=209)	2011 UR (N=23)	P-Value
Diabetes Mellitus (%)	36.5	50%	0.046	34.5	34.8	0.972
Dementia (%)	11.7	12.5	0.137	10.1	34.8	<0.001
Prior Heart Failure (%)	77.7	95	0.649	82.8	95.7	0.574
COPD (%)	24.5	20	0.359	18.2	13.0	0.498

COPD= Chronic Obstructive Pulmonary Disease. Prior Heart Failure represents a history prior to the index admission.

On index admission readmitted patients were on more medications on average than eligible discharges (0.5 medications more in 2008 and 1.2 medications more in 2011). However, no statistically significant difference was observed for medication number on admission between readmitted and not readmitted patients (p= 0.878, 2008; p=0.972, 2011). In 2008 more patients with unplanned readmissions were on aldosterone at the time of their index admission compared to all eligible discharges. This difference was due to significantly more readmitted patients than not readmitted patients on aldosterone at index admission (p=0.003). No other statistically significant differences were observed between readmitted and not readmitted patients for admission medications (Table 27).

Table 17. Index Admission Medications for Eligible Discharges (ED) vs. Unplanned Readmissions (UR)

	2008 (N=184) ED	2008 (N=40) UR	P-Value	2011 (N=206) ED	2011 (N=23) UR	P-Value
No. of Meds on Admission	8.6	9.1	0.878	8.5	9.7	0.972
Beta Blocker (%)	62.5	66.7	0.545	75.2	73.9	0.875
ACE Inhibitor (%)	40.0	33.3	0.598	39.8	47.8	0.404
ARB (%)	24.5	33.3	0.146	16.0	17.4	0.849
Aspirin (%)	54.9	59.0	0.564	57.8	56.5	0.898
Statin (%)	58.2	66.7	0.225	50.5	60.9	0.291
Digoxin (%)	20.1	23.1	0.602	13.1	21.7	0.193
Nitrate (%)	11.4	15.4	0.380	9.2	8.7	0.926
Aldosterone (%)	21.2	38.5	0.003	12.14	8.7	0.592
Metolazone (%)	5.4	2.6	0.373	3.4	4.4	0.790
Coumadin (%)	37.0	28.2	0.202	26.2	30.4	0.625
Loop Diuretic (%)	71.3	63.2	0.214	68.0	65.2	0.765

ACE= Angiotensin Converting Enzyme; ARB= Angiotensin Receptor Blocker. N=181 for Loop Diuretic in 2008; for all other values N is as specified.

The mean number of medications upon discharge in 2011 was greater for readmitted patients by an absolute difference of 1.6 medications compared to eligible discharges. This difference was not due to a statistically significant difference in medication number between readmitted and not readmitted patients. No statistically significant discharge medication differences were observed from the index hospitalization between readmitted and not readmitted patients in either year (Table 28).

Table 18. Discharge Medications of Eligible Discharges (ED) vs. Unplanned Readmissions (UR)

	2008 ED (N=172)	2008 UR (N=40)	P-Value	2011 ED (N=206)	2011 UR (N=19)	P-Value
No. of Meds on Discharge	8.8	8.6	0.437	9	10.6	0.610
Beta Blocker (%)	73.8	77.5	0.547	79.6	82.6	0.705
ACE Inhibitor (%)	41.0	37.5	0.604	44.9	56.5	0.234
ARB (%)	22.5	32.5	0.086	17.0	17.4	0.957
Aspirin (%)	65.9	75.0	0.167	68.0	60.9	0.439
Statin (%)	59.0	70.0	0.106	57.3	69.6	0.206
Digoxin (%)	17.9	17.5	0.937	11.2	13.0	0.762
Nitrate (%)	12.1	15.0	0.527	8.7	8.7	0.994
Aldosterone (%)	23.7	32.5	0.136	12.1	17.4	0.413
Metolazone (%)	5.2	5.0	0.948	4.9	4.4	0.905
Coumadin (%)	31.8	27.5	0.506	30.1	34.8	0.603
Loop Diuretic (%)	88.4	87.2	0.792	86.9	91.3	0.506

ACE= Angiotensin Converting Enzyme; ARB= Angiotensin Receptor Blocker. For 2008 Eligible Discharges N=173 for all medications except Loop Diuretic. For 2008 Unplanned Readmissions N=39 for Loop Diuretic; for all other values N is as specified.

The mean systolic blood pressure was 5.4mmHg higher in 2008 for unplanned readmissions compared to eligible discharges. In 2011 this difference was only 1.7mmHg. Although the differences between systolic blood pressures for readmitted vs. not readmitted patients were relatively more significant in 2008, no statistically significant differences were observed in either year (p=0.265, 2008; p=0.716, 2009). Other vital signs were similar among unplanned readmissions and eligible discharges in both years (Table 29).

Table 19. Vital Signs (Means) of Eligible Discharges (ED) vs. Unplanned Readmissions (UR)

	2008 ED (N=188)	2008 UR (N=40)	P-Value	2011 ED (N=195)	2011 UR (N=21)	P-Value
Systolic Blood Pressure (mmHg)	137.5	142.9	0.265	139.1	140.8	0.716
Diastolic Blood Pressure (mmHg)	73.1	74.8	0.446	73.4	70.3	0.206
Heart Rate (bpm)	84.5	88.1	0.283	86	89.2	0.466
Respiratory Rate (rpm)	23.0	23.4	0.676	22.6	22.3	0.819

For 2008 Eligible Discharges N=187 for Heart Rate and N=179 for Respiratory Rate, for 2011 Eligible Discharges N=196 and 192 respectively for these variables. For 2008 Unplanned Readmissions N=39 for Respiratory Rate; for all other values N is as specified.

Table 30 below compares the laboratory data for both eligible discharges and unplanned readmissions. The mean creatinine was 1.37 for readmitted patients and 1.60 for eligible discharges in 2011. This difference was due to a statistically significant difference between readmitted and not readmitted patients (p=0.049). No such difference was observed in 2008 for creatinine. In 2011 creatinine levels greater than 1.5 or 2.0 were less frequent among unplanned readmissions than among eligible discharges. In 2008, these levels were more frequent among unplanned readmissions. Differences between creatinine levels greater than 1.5 or 2.0 were relatively more significant in 2011 than in 2008 for readmitted vs. not readmitted patients, but did not reach statistical significance. The proportion of unplanned readmissions with a serum sodium level less than 130 was 3.6 times that of eligible discharges in 2011; in 2008 this proportion was only 1.1 times that of eligible discharges. The relative significance of a serum sodium level less than 130 was greater in 2011 for readmitted vs. not readmitted patients (p=0.095) compared to 2008 (p=0.753). However, these differences did not reach statistical significance in either year.

Table 20. Laboratory Data of Eligible Discharges (ED) vs. Unplanned Readmissions (UR)

	2008 ED (N=189)	2008 UR (N=40)	P-Value	2011 ED (N=208)	2011 UR (N=23)	P-Value
Serum Sodium (meq/L)	136.4	135.7	0.323	138	136.5	0.155
Blood Urea Nitrogen (mg/dl)	30.7	34.0	0.297	29.2	26.6	0.321
Creatinine (mg/dl)	1.55	1.73	0.401	1.60	1.37	0.049
Glucose (mg/dl)	146.9	153.9	0.489	138.5	142.8	0.746
Hematocrit (%)	35.0	34.27	0.278	34.8	33.1	0.093
Serum Sodium < 130 (%)	11.1	12.5	0.753	2.4	8.7	0.095
Creatinine >1.5 (%)	31.8	35.0	0.619	34.6	21.7	0.169
Creatinine > 2.0 (%)	14.3	17.5	0.513	15.4	4.4	0.120

For Eligible Discharges, N=188 for Hematocrit in 2008 and N=206 in 2011; for all other values N is as specified. Hematocrit is described as the mean percentage; values for Serum Sodium<130, Creatinine>1.5, and Creatinine>2.0 represent the percentage of patients that met this criteria.

As shown in Table 31, a smaller proportion of readmitted patients had been discharged home with no services than eligible discharges (17.5% vs. 31.9%) in 2008; a larger proportion of readmitted patients had been discharged to a skilled nursing facility (50.0% vs. 33.5%). Both eligible discharges and unplanned readmissions had similar rates of discharge to home with VNA services in 2008 (33.0 and 32.5, respectively). Discharge destinations after initial hospitalization were significantly different between readmitted and not readmitted patients in 2008. In 2011, a smaller proportion of readmitted patients had also been discharged home with no services compared with eligible discharges (9.1% vs. 26.8%); a larger proportion of readmitted patients had been discharged home with VNA services (54.6% vs. 33.3%).

Table 21. Discharge Destination after Index Hospitalization of Eligible Discharges (ED) vs. Unplanned Readmissions (UR)

	2008 ED (N=185)	2008 UR (N=40)	2011 ED (N=198)	2011 UR (N=23)
Home no Services (%)	31.9	17.5	26.8	9.1
Home with VNA services (%)	33.0	32.5	33.3	54.6
Skilled Nursing Facility (%)	33.5	50.0	37.9	36.7
Hospice (%)	1.6	0	1.9	0
	P=0.004			

A similar proportion of eligible discharges and unplanned readmissions had a 7-day UConn follow up visit after discharge in 2008 (Table 32). No significant difference in the frequency of 7-day follow up visits existed between readmitted and not readmitted patients in 2008. In 2011, readmitted patients were more likely to have had a 7-day follow up than not readmitted patients (p=0.006).

Table 22. Follow up Visits of Eligible Discharges (ED) vs. Unplanned Readmissions (UR)

	2008 ED (N=189)	2008 UR (N=40)	P-Value	2011 ED (N=209)	2011 UR (N=23)	P-Value
7-Day Follow Up UConn Index Admission	19.6	22.7	0.108	46.9	60.0	0.006

Changes in characteristics of Unplanned Readmissions and Not Readmitted Patients in 2008 vs. 2011

As stated in the previous comparison, not readmitted patients include any planned readmissions and readmissions to an outside institution. As in the previous section, p-values compare differences between unplanned readmissions (readmitted) and not readmitted patients.

The comparison of readmitted and not readmitted patients in 2008 found that significantly more readmitted patients were on aldosterone on index admission (p=0.003), were diabetic (p=0.046) and were discharged with more services, either home with VNA services or to a skilled nursing facility after index hospitalization (p=0.004). These variables did not have a statistically significant difference in 2011.

In 2011 more readmitted patients had dementia (p<0.001), a 7-day UConn follow up visit (p=0.006), and a lower mean creatinine (p=0.049) than not readmitted patients.

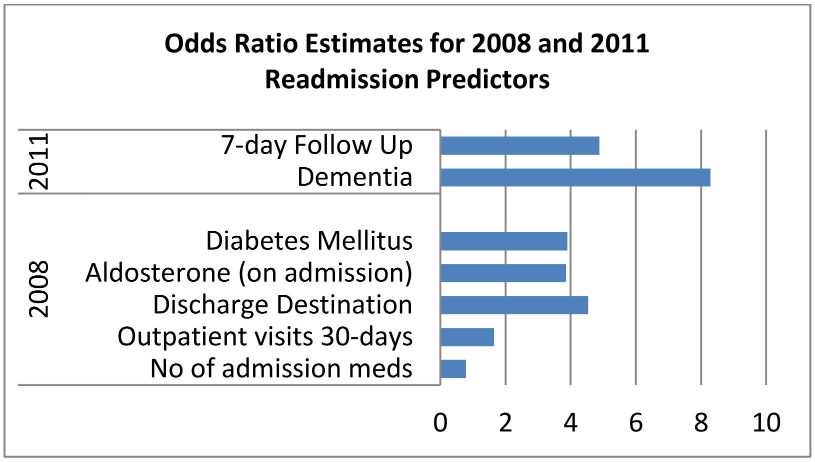
Regression Analysis

Prior to performing logistic regression planned readmissions were removed. The 2008 maximum regression model satisfied convergence criteria after the removal of all variables with greater than

10% missing data, which only required the removal of variables with loop diuretic dosages. The 2011 maximum regression model satisfied convergence criteria after removing variables with 10% missing data and subsequently several variables by order of least significance from the comparison of readmitted vs. not readmitted patients in the above section. The 2011 maximum regression model contained only the following variables: age, gender, dementia (history of), serum sodium, serum sodium less than 130meq/L, creatinine, creatinine greater than 1.5, creatinine greater than 2.0, hematocrit, total outpatient visits 30-days after discharge and 7-day follow up after index admission.

A subsequent variable selection procedure was performed using a logistic regression backward elimination method. The backward elimination alpha was set at 0.01. The variables remaining in the regression model for 2008 include the number of medications on admission, total outpatient visits 30-days after discharge, gender, discharge destination, presence of Aldosterone on admission, presence of an Angiotensin Receptor Blocker (ARB) on admission, presence of Nitrate on discharge, creatinine greater than 1.5, history of Congestive Heart Failure (CHF), history of Chronic Obstructive Pulmonary Disease (COPD), and history of Diabetes Mellitus (DM). The variables remaining in the 2011 regression model after backward elimination were 7-day follow up visit after index admission and history of dementia. In the 2008 model some of the remaining variables were only marginally significant and did not reach full statistical significance. Odds ratios and p-values are provided below in Figure 2 and Table 33.

Figure 2. Odds Ratio Estimates for 2008 and 2011 Readmission Predictors



Note: Odds ratio estimates for 2008 and 2011 representing the likelihood of readmission, determined using backward elimination logistic regression with elimination alpha=0.01. Variables shown represent remaining covariates in final model with p-value<0.05.

Table 23. Odds Ratio Estimates for 2008 and 2011 Logistic Regression Backward Elimination Method

2008	Odds Ratio	P-Value
No. of Meds on admission	0.789	0.008
Total Outpatient Visits 30-days	1.646	0.007
Gender	0.404	0.087
Discharge Destination	4.537	<0.001
Aldosterone (on admission)	3.859	0.017
ARB (on admission)	2.898	0.057
Nitrate (on discharge)	4.017	0.062
Creatinine > 1.5	2.559	0.087
CHF	0.338	0.059
COPD	3.067	0.055
DM	3.896	0.010
2011		
Dementia	8.291	<0.001
7-day follow up visit	4.879	0.004

Note: All variables refer to the index admission.

Discussion

This paper describes a study of the UConn Health Center's hospital-wide quality improvement initiative. No similar report documenting the effects of this type of initiative was found on literature review. A number of differences in patient characteristics were found when comparing data before and after the initiative. Although many of these differences were statistically significant, they were not clinically significant but rather may have occurred due to random variation. The most striking difference was an improvement in the outpatient follow up of patients after discharge in 2011. The magnitude of the improvement in follow up makes it likely that this was directly related to the QI initiative.

Full implementation of the initiative was completed by the end of 2010. The 2011 readmission rate represents a 30% reduction in HF readmissions from 2008, the year prior to the start of the initiative. Since the data used in this study are from the years immediately prior to and after implementation, the improvement in readmission rate is likely attributable to the components of this initiative. The initiative included identification of inpatients with HF; patient education through multimedia and specially trained nurses; inpatient consultation by a HF nurse practitioner, pharmacist, social worker, and dietician; follow up phone calls; 7-day follow up appointments; development of partnerships with referral centers in the community (SNFs, VNAs); and multilingual support. It is not possible to tell which among these components were most influential as all were in full effect by 2011. Previous studies have shown that components of this initiative are successful in preventing readmissions but there is limited data demonstrating the expectations of hospital-wide quality improvement on 30-day HF readmissions.

Compared to patients initially admitted in 2008, patients admitted in 2011 were less often hyponatremic and had a higher mean ejection fraction (absolute increase of 4%). These differences were minimal and are unlikely to have been related to the QI initiative. It is more likely that they occurred due to random variation. Furthermore, when serum sodium level and ejection fraction in patients who were readmitted were compared to the same variables in patients not readmitted, a significant difference was not found in either year, indicating that these differences were unlikely to have contributed to the lower readmission rate.

The most evident change which can be attributed to the QI initiative is the increased frequency of follow up. The extent of this increase was greater than any other observed difference between 2008 and 2011 patients. Mean outpatient follow up visits in the 30-day after discharge period increased by 60%. Readmitted patients had a 126% increase in mean 30-day outpatient follow up visits after the initiative which, although not studied, may be influential in preventing a subsequent readmission. Patients were approximately 2.5 times more likely to have a 7-day follow up visit, and the chance of having two or more follow up visits in 30 days increased by nearly 70%. The proportion of patients with no follow-up prior to readmission decreased by over 50%. These results suggest that follow up, and potentially other components of the initiative, were likely the strongest contributors to the lower readmission rate.

Results from the regression analysis indicate that patients readmitted in 2011 were more likely to have had a 7-day follow-up visit than not readmitted patients. Although this may seem as if follow-up in 2011 was a risk predictor, it should be interpreted as having occurred more frequently after initial admission among readmitted patients in 2011. This analysis did not account for the overall increase in follow-up in all 2011 patients and this finding may therefore undermine the importance of follow-up visits. The rate of 7-day follow up among not readmitted patients was 19% (28 patients) in 2008 and 46% (84 patients) in 2011 which likely played an important role in preventing readmission in these patients.

Improvements in the rates of follow up were most likely an important contributor to the lower readmission rate but they are also easy to quantify compared to other parts of this initiative. It should be noted that this initiative involved several other components; although follow up visits are a critical part of the QI initiative, a 30% reduction in hospital readmission rate is more likely to be achievable by the implementation of a multicomponent QI initiative.

Several patients admitted to the UConn Health Center with HF were seen by outpatient providers at the institution and some data indicate that the QI initiative may have had spillover effects on outpatient care. Patients in 2011 with systolic HF were more likely to be on a beta-blocker at their initial hospitalization and less likely to be on aldosterone. Beta blockers have proven benefit in all patients with systolic HF whereas aldosterone is indicated in only some HF patients based on their functional limitation and ejection fraction. Fewer patients with diastolic HF admitted in 2011 were on an angiotensin receptor blocker (ARB) compared to 2008. Although this medication has proven benefit in systolic HF, it does not have a clear indication in diastolic HF. The fact that these medication differences were specific to HF type makes it less likely that they were due to random variation alone. It is possible that these medication changes represent improved adherence to guidelines in 2011 compared to 2008, which may have contributed to the lower readmission rate. This explanation relies on a closely linked inpatient and outpatient population for generalizability to other hospitals; under health care reform this is likely to become much more common.

With improved outpatient care of patients in 2011 it is possible that the risk of readmission in certain patients decreased due to management of their overall health including comorbidities. In the comparison of readmitted and not readmitted patients, diabetes was more prevalent among readmitted patients in 2008, whereas this difference was not seen after the QI initiative in 2011. This finding was supported by the regression analysis, which showed that the odds of readmission were significantly greater among patients with diabetes in 2008, but not in 2011. The QI initiative through patient education, closer follow up and higher quality care could have led to better management of diabetes and in doing so modified the risk of diabetes on readmission.

However, there are at least two major limitations of this conclusion. First, an analysis of the laboratory data such as hemoglobin A_1C which would support the idea that diabetes control improved was not performed. Second, with such few readmissions in 2011 it is possible that the regression analysis did not have enough power to detect a significant increase in the odds of readmission due to diabetes. Previous studies have identified diabetes as a significant risk predictor for readmission and the current CMS risk standardization model includes diabetes in risk stratification; it does not include factors that are associated with quality of care. It is important that the model continue to consider diabetes risk as these patients may still be more likely to be readmitted over non-diabetics. It is encouraging that the specific risk attributable to diabetes may potentially be responsive at least in part to QI initiatives.

A finding which highlights a potential shortfall of the initiative was that readmitted patients after the initiative were more likely to have dementia (2008: 12.5%; 2011: 34.8%, p-value 0.035). The percentage of not readmitted patients with dementia was roughly the same (11%) in both years as was the percentage of all patients with dementia (2008: 11.7%; 2011: 10.1%). As there was a significant decrease in the number of readmissions after the QI initiative, the data indicate that readmissions were more often prevented in patients without dementia. The finding in the regression analysis of an increased odds of readmission for patients with dementia is most likely the result of more patients without dementia being shifted into the not readmitted group. Therefore, this finding should not be interpreted as a greater risk of readmission for dementia patients after the initiative but rather that the UCHC initiative was less efficacious for patients with dementia. Quality Improvement initiatives may require additional features to be more helpful to this patient group.

There were other variables which were associated with readmission in 2008 but not in 2011. In 2008 an increased likelihood of readmission was observed in patients on aldosterone, discharged with more services (SNF), and those who had an increased frequency of outpatient follow up in the 30 days following discharge from their initial hospitalization; a decreased likelihood of readmission was found in patients on fewer medications at their initial admission. There are probably various reasonable explanations as to why these variables were associated with readmission in 2008. For example, aldosterone may indicate a greater severity of HF; outpatient follow up may have occurred after readmission, as the total number of outpatient visits within 30-days after discharge were associated with readmission, whereas 7-day follow-ups were not; and discharge with more services may indicate a sicker patient with greater readmission risk. Therefore, it is most likely that these variables were not associated with readmission in 2011 due to the limited ability of the regression analysis to detect an association, as there were fewer readmissions. It is also possible that random variation may account for the differences here as well. It is least likely that the association of these variables and readmissions changed due to an effect of the QI initiative as their relationship with the initiative is not easily explainable.

Although it may have been the case, the results do not clearly show that patients readmitted in 2011 were sicker than those readmitted in 2008; however, patients readmitted despite the QI initiative may have been more difficult to manage. The average number of follow up visits until readmission in 2008 was 0.45, compared to 1.13 in 2011. Despite a significant increase in follow up visits patients were still readmitted. This may indicate that patients readmitted after the QI initiatives may require additional services; however, until readmission occurs it is unclear which patients may require these services. Most patients readmitted in 2011 were discharged home with VNA services after the initial hospitalization. In addition to the increased follow-up these patients may presumably require more outpatient nursing care such as through a SNF. Readmitted patients in 2011 were more likely to be discharged from rehospitalization on more medications than readmitted patients in 2008. This may support the idea that readmitted patients in 2011 were sicker and had indications for additional medications but it is also possible that there was simply better guideline adherence in these patients at the time of readmission.

There are several limitations to be considered in these analyses. First, this was a retrospective review. Therefore, the nature of the association between certain identified factors and readmission cannot be clearly defined. Some variables may indeed be risk factors but this cannot be determined by this type of study alone. Because this study involved chart abstraction of previously documented data in the medical record, missing data could not be obtained. This could have affected significance values of some of the variables and contributed to type II error. Additionally, missing data resulted in the removal of several variables prior to satisfying convergence criteria for the maximum regression model. It cannot be determined whether these variables would have been influential on the final regression model had they remained as potential covariates. In addition to there being fewer variables associated with readmission in 2011, there were also fewer readmissions and this may have diminished the ability to detect associated factors (such as diabetes in the 2011 regression model). The sample size of the HF population in 2008 and 2011 is also a limitation as a larger group may have identified additional findings. However, all hospitalizations and readmissions from both years were examined. Patients readmitted to outside institutions were included among not readmitted patients in the analyses; although an accurate readmission rate including readmissions to outside institutions was provided by the Connecticut Hospital Association, data identifying which patients were readmitted to outside institutions could not be provided. However, of 86 readmissions in both years only 16 were to an outside institution.

In summary, this study shows that the 30-day all cause readmission rate after an initial hospitalization for HF decreased 30% from 2008 to 2011 after the implementation of a hospital-wide QI initiative. Some trivial changes of little clinical significance were observed in the inpatient HF population. The most notable change was a significant increase in outpatient follow up since the start of the initiative which likely contributed the most to the lower readmission rate, as increases in follow up were more apparent than any other difference between 2008 and 2011.

Differences in the state of health of readmitted patients compared to not readmitted patients were more easily identifiable in 2008 than in 2011. While the QI initiative might have been successful at preventing readmission in patients, despite the severity of their illness or comorbidities, with such few readmissions it is possible that a difference in 2011 was simply not detectable. It was, however, evident that patients in 2011 may have been more difficult to manage as those readmitted did have adequate follow-up.

The study also shows that although this QI initiative may have had a strong impact, there is still room for improvement. Particular attention is suggested for patients who are receiving appropriate follow-up care after discharge but nonetheless are readmitted despite the initiative, and for patients with dementia.

Conclusion

Hospital readmissions, notably for HF, are a major burden on patients, families, health care providers, and contribute to concern about the sustainability of the Medicare program. This study shows that significant reductions in readmission rates can be achieved through a well-planned QI initiative. As hospitals continue to respond to pressure to improve their quality of care, this analysis suggests that a thorough and well-developed intervention can achieve notable decreases in readmission after a hospitalization for heart failure. It also contributes an understanding of the expected changes in HF patient characteristics, potential readmission risk predictors, and improvements in follow up after a QI initiative is implemented. While readmission rates have remained steady over the past decades, this study shows potential for a significant reduction as hospitals nationwide are stimulated to implement similar initiatives.

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