Implementation of a Multimodal Heart Failure Management Protocol in a Skilled Nursing Facility

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Michelle S. Rockwell, PhD, RD[1,2], Emily Cox, MPH, MS, RD[1], Tonja Locklear, PhD[1], Brandy Hodges, LPN[3], Stacey Mulkey, RN, BSN[3], Brandon Evans, RN, BSN[3], John W. Epling, MD, MSEd[1,2], and Anthony R. Stavola, MD[1,3]

Abstract

Hospitals and skilled nursing facilities (SNFs) are incentivized to reduce hospital readmissions among patients with heart failure (HF). We used the RE-AIM framework and mixed quantitative and qualitative data to evaluate the implementation of a multimodal HF management protocol (HFMP) administered in a SNF in 2021. Over 90% of eligible patients were enrolled in the HFMP (REACH). Of the 42 enrolled patients (61.9% female, aged 81.9 ± 8.9 years, 9.5% Medicaid), 2 (4.8%) were readmitted within 30 days of hospital discharge and 4 (9.5%) were readmitted within 30 days of SNF discharge compared with historical (2020) rates of 16.7% and 22.2%, respectively (a potential savings of $132,418–$176,573 in hospital costs) (EFFECTIVENESS). Although stakeholder feedback about ADOPTION and IMPLEMENTATION was largely positive, challenges associated with clinical data collection, documentation, and staff turnover were described. Findings will inform refinement of the HFMP to facilitate further testing and sustainability (MAINTENANCE).

Keywords

30-day readmission, hospital, quality improvement, remote dielectric sensing

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Introduction

Over 65 million people worldwide and more than one-third of skilled nursing facility (SNF) patients have a diagnosis of heart failure (HF), a chronic, progressive condition characterized by the inability to pump sufficient blood to meet the body's needs (Daamen et al., 2015; Jurgens et al., 2015; Savarese et al., 2022). The 30-day all-cause hospital readmission rate for HF in U.S. SNFs is approximately 27% to 43%, higher than any other medical or surgical condition (Weiss & Jiang, 2021). Hospital readmissions are associated with psychological stress, impaired functional status, risk of infection, and mortality (Daamen et al., 2015; Gupta et al., 2019). Financial implications can also be substantial; the cost of all-cause hospital readmission in HF patients exceeds $30 billion annually (U.S.) (Urbich et al., 2020). As such, the Centers for Medicare & Medicaid Services (CMS, 2022a, 2022b) initiated the Hospital Readmissions Reduction Program (HRRP) in 2012 and the Skilled Nursing Facility Value Based Purchasing Program in 2018, assigning a financial penalty to facilities that fail to reach reduced hospital readmission targets.

A variety of interventions have demonstrated efficacy in reducing hospital readmission in HF patients discharged from the hospital to the home setting (Bamforth et al., 2021; Gorthi et al., 2014; Wan et al., 2017). However, few published interventions have focused on patients discharged from the hospital to SNFs despite higher risk of hospital readmission in this population (Daamen et al., 2015; Manemann et al.,

[1]Carilion Clinic, Roanoke, VA, USA
[2]Virginia Tech Carilion School of Medicine, Roanoke, VA, USA
[3]Friendship Health and Rehabilitation Center—South, Roanoke, VA, USA

Corresponding Author:
Anthony R. Stavola, Department of Family & Community Medicine, Carilion Clinic/Virginia Tech Carilion School of Medicine, 1 Riverside Circle, Suite 102, Roanoke, VA 24016, USA.
Email: arstavola@carilionclinic.org

2017). Most available interventions require substantial time and commitment from SNF staff, care after SNF discharge, and additional personnel resources. For example, Weerahandi et al. (2022) and Boxer et al. (2022) describe the efficacy of a complex multimodal protocol administered to HF patients during and 7 days after a SNF stay. Another effective intervention incorporated individual care planning and pharmacological titration via virtual collaboration between SNF staff and a cardiologist (Friedman et al., 2021).

Guided by the American Heart Association and American College of Cardiology Foundation's guidelines and recommendations for care of HF patients in SNFs (Jurgens et al., 2015; Resnick, 2020), a novel HF management protocol (HFMP) was designed and implemented in a southwest Virginia SNF in 2021. The HFMP prioritized (a) reducing hospital readmissions, (b) low-burden delivery by regular SNF staff, (c) incorporation of standing intravenous (IV) diuretic orders, and (d) remote dielectric sensing (ReDS) vest readings. Using technology developed by the military, ReDS vest is a 30-second non–invasive assessment that detects potential fluid overload in lungs, which is associated with elevated pulmonary artery pressure (Opsha et al., 2019; Sensible Medical, 2020) . ReDS vest utilization has been associated with reduced rate of hospital readmission among HF patients discharged to their homes (Sattar et al., 2021), but has not been evaluated in SNF settings to our knowledge. In this report, we evaluate the implementation of the HFMP. Our evaluation was guided by the RE-AIM (Reach, Effectiveness, Adoption, Implementation, and Maintenance) framework (Glasgow et al., 1999; Kwan et al., 2019) . RE-AIM is a planning and evaluation framework designed to assess outcomes important to program impact and sustainability (Glasgow et al., 1999).

Methods

We performed a retrospective evaluation of a HFMP implemented in a 120-bed SNF in southwest Virginia from January 1, 2021 through November 30, 2021. As a quality improvement initiative, the Institutional Review Board of Carilion Clinic determined that this project was not considered human subjects research and thus did not require IRB oversight.

Description of Heart Failure Management Protocol (HFMP)

The novel multi-modal HFMP was designed by the SNF medical director in collaboration with SNF clinicians and staff, Accountable Care Organization (ACO) leadership, cardiologists, and home health consultants to offer a low-burden approach to application of evidence-based best practices for the management of HF in the SNF setting (Jurgens et al., 2015; Resnick, 2020). The HFMP, which was comprised of sequential body weight, vital sign, laboratory (blood), and ReDS vest assessments and standing orders for fluid/sodium restriction, oral diuretics, and IV diuretics, was administered by SNF staff to 42 patients in 2021 (Figure 1). Eligibility criteria included recent hospital discharge and a diagnosis of active HF (defined as patients for whom HF is a clinically important issue, but not necessarily the reason for hospitalization). Patients with a history of recent chest surgery or broken ribs, with a diagnosis of stage 5 chronic kidney disease (CKD) or end stage renal disease (ESRD), presently undergoing dialysis, receiving treatment contraindicated for ReDS vest use, and/or on hospice or comfort care were excluded.

Upon admission to the SNF, patients enrolled in the HFMP received a series of baseline assessments, as described in Figure 1. Throughout the entirety of the admission, the patient's body weight was recorded each morning; a 2-pound increase in body weight over 24 hours or a 5-pound increase over 1 week served as the primary triggers for the HFMP. Once the HFMP was triggered, the patient was placed on Day 1 of the HFMP, which involved consultation with the physician for a recommendation about whether or not to activate the HFMP sequence. Upon activation of the HFMP, progression was determined by sequential criteria described in Figure 1. Data related to routine monitoring of enrolled patients and HFMP activation were recorded manually on project data sheets and in the ambulatory and SNF electronic health record (EHR) systems.

Evaluation

Guided by the RE-AIM framework (Glasgow et al., 1999; Kwan et al., 2019), our evaluation of the HFMP took place in January to July 2022 using a mix of quantitative and qualitative data. Evaluation procedures varied across each RE-AIM framework component and are described respectively below.

Reach. We used project data sheets and internal records to compare the number of eligible patients who were enrolled in the HFMP to the number of eligible patients admitted to the SNF during the 10-month implementation period.

Effectiveness. Measures of effectiveness included the rate of hospital readmissions and direct readmission costs, both acquired from insurance claims data and the Health Information Exchange (HIE) (ConnectVirginia, 2021; Health IT, 2020). We calculated 30-day all-cause hospital readmission rates (30 days from hospital discharge and 30 days from SNF discharge, see Supplemental Appendix A). Table 1 describes two cohorts established for comparison of readmission rate and hospital costs associated with the HFMP to the same outcomes in previous years and peer SNFs.

To provide more insight into the effectiveness of the HFMP at the patient level, we explored

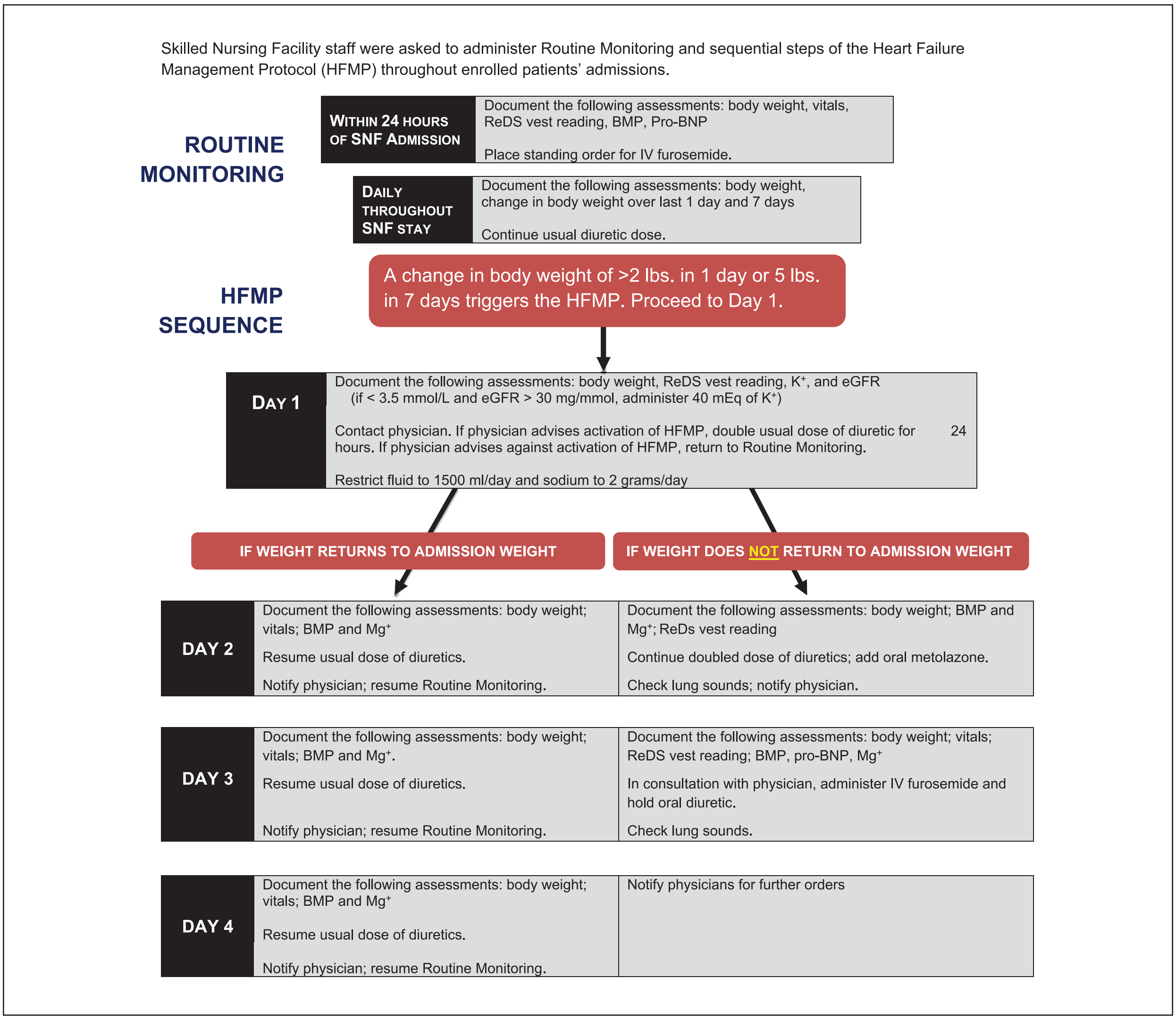

Figure 1. Heart failure management protocol.
Note. HFMP = heart failure management protocol; BMP = basic metabolic panel; trigger = body weight change that initiates HFMP; SNF = skilled nursing facility; Pro-BNP = pro b-type natriuretic peptide; activate = HFMP proceeds to day 2; ReDs vest = remote dielectric sensing; Mg+ = magnesium; IV = intravenous; eGFR = estimated glomerular filtration rate; K+ = potassium.

demographic and clinical factors as common clinical indicators of heart failure status and treatment effects associated with triggering of the HFMP and hospital readmission (i.e., predictors variables—age, body mass index, baseline BUN/creatinine/GFR, presence of kidney disease, and type of diuretic; outcome variables—triggering HFMP and readmitting to hospital). We used stepwise multivariable logistic regression to evaluate the association between the described predictor and outcome variables. For variables with >25% missing data, we used *t*-tests to assess differences between patients who activated the HFMP vs. those who did not. Statistical analysis was conducted using SAS Enterprise Guide (Cary, North Carolina) and significance was set at the .05 level.

Adoption. The degree to which the HFMP was adopted by SNF physicians and staff members was assessed via research assistant field notes and information obtained during interviews with key stakeholders (physicians, staff, and administrators). A convenience sample of eight stakeholders participated in semi-structured interviews in-person or via telephone (approximate duration = 20 minutes). The interview guide was developed by the research team and piloted internally. Questions included the following: *What factors contributed to the success of the HFMP?; What factors were barriers to success of the HFMP? What considerations should be made for future implementation of this protocol in the same or other SNFs?* The research assistant kept detailed notes during interviews. Two members of the research team evaluated de-identified interview notes by hand, identifying emerging themes and emblematic quotations. Themes and quotations were discussed and agreed upon between the researchers. All themes are described in Results under Adoption and Maintenance sections.

Implementation. To evaluate fidelity to the HFMP, we assessed adherence to the sequential steps described in

Table 1. Comparison Cohorts.

Comparison cohort	Years	Facility	Patient eligibility criteria	Readmission rate
A	2020, 2019, and 2018	Same SNF in which HFMP was implemented	Active HF diagnosis No diagnosis of stage 5 CKD or ESRD	Supplemental Appendix Figure A
B	2021, 2020, 2019, and 2018	SNF Collaborative (21 regional SNFs)	Active HF diagnosis No diagnosis of stage 5 CKD or ESRD	Supplemental Appendix Figure A

Figure 1 using manual review of medical charts and administrative records.

Maintenance. Projected facilitators and barriers to HFMP maintenance were described during key stakeholder interviews using the procedures outlined under *Adoption.*

Results

Results of the HFMP evaluation are presented under the sub-heading of the respective RE-AIM component.

Reach

Of 56 patients eligible for the HFMP during the study period, 50 (89.2%) were enrolled. Of the 50 enrolled, 42 were included in the final analysis (3 were excluded due to no record of a HF diagnosis and 2 were excluded upon transfer to hospice care within 1 week of admission; data sheets were not available for 3 enrolled patients). Characteristics of the study cohort are shown in Tables 2 and 3.

Effectiveness

Compared with the expected readmission rate (11.3%–16.7% in the same SNF in previous years), only 4.8% of patients in the HFMP were readmitted to the hospital within 30 days of discharge (Table 4). This reflects a projected savings of at least $90,000. Similarly, compared with the expected readmission rate (18.9%–22.4% in the same SNF in previous years), only 9.5% of patients in the HFMP were readmitted to the hospital within 30 days of discharge from the SNF, a projected cost savings of over $100,000 (Table 4).

There was an insufficient number of readmissions to explore the predictive value of various patient factors. However, some results associated with likelihood of activating the HFMP are shown in Supplemental Appendix B.

Adoption

Implementation of the HFMP was reviewed positively by all stakeholders, both in terms of their experience with delivery and their perceived benefit to patients.

Stakeholder feedback:

Table 2. Demographic Characteristics of the Heart Failure Management Protocol (HFMP) Cohort at Admission to the SNF ($n = 42$).

Demographic characteristic	Result
Age, *M* (*SD*) (years)	81.9 (8.9)
Sex, *n* (%)	
Female	26 (61.9)
Male	16 (38.1)
Race, *n* (%)	
Asian	1 (2.4)
Black	2 (4.8)
White	39 (92.9)
Ethnicity, *n* (%)	
Non-hispanic	42 (100)
Insurer, *n* (%)	
Medicare fee-for-service	28 (66.7)
Medicare advantage	10 (23.8)
Dual eligible (medicaid + medicare)	4 (9.5)

> *"It is a clear protocol that was easy for everyone to follow."*

> *"Staff engagement and enthusiasm for this were high and contributed to successful implementation." "Leadership. . . supported this effort and devoted considerable time to implementation and monitoring."*

> *"Having the protocol in place and using the ReDs vest was a source of security for the patients and staff."*

Barriers encountered during the implementation period include staff turnover, staffing shortages, and other COVID-19-related stresses. These issues led to enhanced training needs and some inconsistencies and incompleteness in documentation of study data. There was also a 60-day period when the ReDs vest was not available due to an expired license. Variation in physicians' likelihood of approving HFMP activation was described by two stakeholders. Recommendations for refinement of the HFMP for future implementations were provided:

> *"Since there are multiple factors that can influence weight, such as diet and activity level, it may be important to more closely monitor these other factors in the future."*

Table 3. Clinical Characteristics of the Heart Failure Management Protocol (HFMP) Cohort at Admission to the SNF ($n = 42$).

Clinical characteristic	Result
BMI (kg/m^2), *M* (*SD*)	28.7 (10.3)
Heart failure diagnosis, *n* (%)	
HfpEF	18 (42.9)
HfrEF	15 (35.7)
Other	9 (21.4)
Time since initial heart failure diagnosis, *n* (%)	
<1 year	12 (28.6)
1 through <5 years	11 (26.2)
5 through <10 years	6 (14.2)
>10 years	6 (14.2)
Unknown	7 (16.7)
Comorbidities, *n* (%)	
Atrial fibrillation	23 (54.8)
COPD or asthma	14 (33.3)
Diabetes	23 (54.8)
Heart disease	29 (69.0)
Kidney disease	16 (38.1)
Sleep apnea	2 (4.8)
Thyroid conditions	7 (16.7)
Medications (total number at admission), *M* (*SD*)	18.1 (7.5)
Medications, *n* (%)	
Diuretics	23 (55): 16 loop, 3 thiazide, 3 aldosterone, 4 metolazone
RAS inhibitors	10 (23.8): 3 sacubitril/valsartan
Beta blockers	21 (50)
Vasodilators	4 (9.5)
Inotropes	3 (7.1)
Calcium channel blockers	7 (16.7)
Basic metabolic panel, *M* (*SD*)	
Sodium (135–145 mmol/L)	138.6 (3.9)
Potassium (3.5–5.3 mmol/L)	4.3 (0.5)
Chloride (95–107 mmol/L)	99.8 (5)
CO_2 (21–31 mmol/L)	26.4 (4.1)
BUN (6–20 mg/dL)	28 (14.7)*
Creatinine (0.5–1.4 mg/dL)	1.2 (0.4)
Glucose (70–99 mg/dL)	121.2 (36.1)*
Total protein (6.0–8.3 g/dL)	6 (0.7)
Albumin (3.2–5.5 g/dL)	3.4 (0.4)
Calcium (8.5–10.7 mg/dL)	8.6 (0.5)
Total bilirubin (<1.3 mg/dL)	0.6 (0.4)
Alkaline phosphatase (42–121 IU/L)	165.3 (140.2)*
Aspartate aminotransferase (10–42 IU/L)	31.7 (18.6)*
Alanine transaminase (10–660 IU/L)	26.9 (24.1)
eGFR (>60 ml/minutes/1.73 m^2)	54.3 (21)*
Magnesium (1.7–2.8 mg/dL)	2.2 (0.2)
Pro B type natriuretic peptide (<450 pg/ml)	6,806.7 (7,907.2)*
ReDS vest reading (%), *M* (*SD*) ($n = 29$)	37 (4.1)[&]

Note. HFpEF = heart failure with preserved ejection fraction; HfrEF = heart failure with reserved ejection fraction; BMI = body mass index; CO2 = carbon dioxide; BUN = blood urea nitrogen; eGFR = estimated glomerular filtration rate; ReDs Vest = remote dielectric sensing.
*Outside of normal limits.
[&]ReDSvest ranges: <21 = below normal, 21 to 24 = low normal, 25 to 35 = optimal, 36 to 41 possible hypervolemic status, >41 hypervolemic. status, and >50 extreme overload (Sensible Medical, 2020).

Table 4. 30-day Readmission Rate and Readmission Costs for Heart Failure Management Protocol (HFMP) Cohort and Comparison Cohorts.

	Year	Cohort size, *n*	Readmissions within 30 days of hospital discharge, *n* (%)	Total cost of readmissions	Average cost per patient	Readmissions within 30 days of SNF discharge, *n* (%)	Total cost of readmissions	Average cost per patient
HFMP cohort	2021	42	2 (4.8)	$50,583	$1,204	4 (9.5)	$88,583	$2,109
Comparison cohort A$	2020	54	9 (16.7)	$183,001	$3,389	12 (22.2)	$265,156	$4,910
	2019	53	6 (11.3)	$143,365	$2,705	10 (18.9)	$199,775	$3,769
	2018	67	10 (14.9)	$200,906	$2,999	15 (22.4)	$246,149	$3,674
Comparison cohort B$$	2021	215	24 (11.2)	$512,159	$2,382	34 (15.8)	$806,688	$3,752
	2020	419	53 (12.6)	$1,113,000	$2,656	67 (16.0)	$1,845,420	$4,404
	2019	489	79 (16.2)	$1,422,000	$2,908	98 (20.0)	$1,865,442	$3,814
	2018	541	102 (18.9)	$1,999,850	$3,697	106 (19.6)	$2,222,185	$4,108

$Same SNF, 2018 to 2020.
$$Regional SNF's, 2018 to 2021.

"One opportunity to improve would be more clearly defining enrollment criteria."

Some suggested further exploration into the unique contribution of the ReDs vest to HFMP outcomes and considering the ideal cadence and frequency to repeat measurements. Potential generalizability of the HFMP to other sites may be limited by accessibility to ReDs vest technology.

Implementation

Upon SNF admission, all or almost all patients received baseline assessments: body weight and vital signs (n=42, 100%), basic metabolic panel (BMP) (n=39, 93%), and pro-B-type natriuretic peptide (pro-BNP) (n=38, 90%). The one exception was ReDS vest readings, which were only recorded for 29 (69%) patients. Use of ReDS vest is not recommended in individuals with BMI $>30\,kg/m^2$, which was the case for five patients. Other reasons for missing ReDS vest readings included unclear readings (n=2), scoliosis (n=1), shortness of breath (n=1), pain at pacemaker site (n=1), and unknown reasons (n=3).

The HFMP was activated a total of 25 times for 17 patients. Although the majority of activations (84%) were triggered by body weight changes as outlined by the HFMP (Figure 1), there were four activations for alternate reasons (abnormal chest X-ray, shortness of breath, and twice for unknown reasons). Throughout the study period, there were 185 instances in which body weight changes met criteria for triggering the HFMP. Activation occurred 25 (18.5%) of these times, with the remaining 160 times attributed to physician's advisement that activation was not warranted or appropriate at that time. Compared with HFMP indication, labs were assessed 28/30 times (93%), diuretic dosage was doubled 17/19 times (89%), IV diuretics were administered 9/11 times (82%), and ReDS vest readings were assessed 19/29 times (65.5%). Documentation of reasons for missing values was not available.

Maintenance

Stakeholders provided feedback about maintenance of the HFMP throughout the implementation period and following the implementation period. Motivation to help patients was consistently described as the motivation to maintain the program for a full year, while staffing shortages secondary to the pandemic were the most frequently recognized barrier. Some aspects of the HFMP were continued after the implementation period ended (e.g., greater attentiveness to daily weight changes, continued use of standing IV furosemide orders, collection of ReDs vest readings when staff were available, etc.). Stakeholders expressed a desire to formally implement the HFMP again in the future and to expand to other SNFs, perhaps for a randomized controlled trial. Resource needs for future implementation include staff training, project coordination, clinical assessments (e.g., daily weights), access to and administration of ReDs vest readings, and ongoing documentation of HFMP data.

Discussion

Heart Failure is the leading cause of hospitalization and hospital readmission among older adults in the U.S., accounting for nearly one-quarter of Medicare spending (Kilgore et al., 2017). The economic burden associated with HF continues to risk globally (Savarese et al., 2022). Our evaluation of a 10-month implementation of a novel multimodal SNF HF management protocol showed a 30-day all-cause readmission rate of <10%. This preliminary evidence suggests that implementation of the HFMP has the potential to reduce costs and consequences associated with hospital readmission for SNF patients with HF. Due to the limited controls in place during the present investigation, further research is needed to confirm the HFMP's effectiveness.

Multiple barriers to the consistent application of evidence-based recommendations for HF patients in the SNF setting exist (Morrow et al., 2022). A limited number of previous interventions have decreased HF-related hospital readmission through a coordinated approach to care delivery, particularly outside of the U.S. (Boxer et al., 2013; Daamen et al., 2015; Friedman et al., 2021; Manemann et al., 2017). The primary difference between these and the HFMP is the burden of delivery to SNF staff and involvement of specialists outside of the SNF. Considering the ongoing COVID-19 pandemic, multiple demands for SNF staff members' time, and SNF staff turnover, low-burden, in-house delivery was prioritized in the development of the HFMP. Our findings align with those of Jacobs (2011) , which associated daily weight monitoring, fluid/dietary restriction, diuretic adjustment, and follow-up with a primary care provider with a reduction in hospital readmissions. Although some opportunities to refine and improve implementation of the HFMP were identified by our evaluation, the demonstrated support for and applicability of the protocol in the SNF setting are encouraging.

Primary limitations of this evaluation include gaps and inconsistencies in the documentation of study data, the inability to incorporate patient feedback, and the lack of data on long-term maintenance. Strengths include the analysis of multiple data sources, the incorporation of readmission costs, and close collaboration with the implementation team. In conclusion, our findings suggest that the HFMP is a feasible, low-burden approach that may be effective in reducing HF-related hospital readmissions among SNF patients. Reducing readmissions can improve the quality of life and health outcomes for patients with HF, reduce health system burden, lower costs, and align with CMS Hospital Readmissions Reduction Program. Sustainability and generalizability of the HFMP should be explored in future research.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Human Subjects Approval

The Institutional Review Board (IRB) of Carilion Clinic determined that this project does not meet the definition of human subjects research as outlined in 45 CFR 46.102(d) and therefore did not require IRB oversight or approval.

ORCID iDs

Michelle S. Rockwell https://orcid.org/0000-0001-7910-6083
John W. Epling, Jr. https://orcid.org/0000-0001-9445-8669

Supplemental Material

Supplemental material for this article is available online.

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