

Original Article



Impact of Outpatient Diuretic Infusion Therapy on Healthcare Cost and Readmissions

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Conflict of Interest

The authors have no financial conflicts of interest.

Availability of Data and Material

Data can be provided on request.

<https://e-heartfailure.org>

ABSTRACT

Background and Objectives: Heart failure (HF) is a complex syndrome with multiple etiologies resulting in impaired ventricular filling or pumping of blood. HF is as a major public health concern that leads to significant morbidity and mortality resulting in an enormous financial burden on the healthcare system. The study objectives were to assess the 30-day hospital readmission rates and its financial impact on the hospital.

Methods: The study was a retrospective single-center analysis of decoded data of all HF patients admitted to an outpatient diuretic infusion program. Adult patients who were readmitted to the hospital within 30 days despite guideline derive medical therapy were included if they were enrolled in the outpatient diuretic infusion clinic. Adult patients who were included in this study received a furosemide dose of 40 mg intravenously (infusion over 3 hours) at the clinic visit. Patients whose clinical signs/symptoms improved and remained stable in consequent visits were eventually discharged from the clinic. Financial impact was assessed using data obtained from the hospital administration on cost of HF readmissions.

Results: The results show a 30-day hospital readmission rate at 6–9% in the years analyzed (n=56) with a net savings of \$562,815 to \$736,560 per year.

Conclusions: This treatment strategy has no detrimental effects in addition to generating substantial financial savings. It appears to be a useful addition to the existing medical treatment regimens chronic HF patients.

Keywords: Outpatient diuretic therapy; Heart failure, diastolic; Heart failure, systolic; Heart failure; Hospital readmissions

INTRODUCTION

Heart failure (HF) is a complex syndrome with multiple etiologies resulting in impaired ventricular filling or pumping of blood. HF is associated with several symptoms such as dyspnea, fatigue, and peripheral/pulmonary edema.¹⁾ 6.2 million adults currently carry a diagnosis of HF in the United states. An estimated \$30.7 billion was spent in 2012 due to the rising cost of healthcare services and medications and the consequent missed days of work secondary to HF.²⁾³⁾ HF is as a major public health concern that leads to significant morbidity and mortality resulting in an enormous financial burden on the healthcare system mainly

Author Contributions

Conceptualization: Nair N; Data curation:
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Nair N.

due to the chronicity of the disease.¹⁾ Globally, individuals over the age of 65 contribute to the most rapidly expanding population demographic. Such an increase is due to improved survival following myocardial infarctions and more efficient management of chronic conditions such as atherosclerosis, hypertension and diabetes mellitus. HF incidence increases significantly with age as a result of such advancements available in today's medicine.¹⁾

HF results in the inability of the heart muscles to effectively supply blood throughout the body and leads to congestion and fluid accumulation.⁴⁾⁵⁾ The generally accepted form of management involves the use of diuretic therapy, most often loop diuretics such as furosemide due to its effectiveness in treating decompensated HF, to relieve fluid overload.⁵⁾⁶⁾ Deteriorating renal function, diuretic resistance, and electrolyte imbalance all influence the effectiveness of loop diuretics. Loop diuretics are widely accepted as the main form of treatment in patients with decompensated HF at the present time. However, there is no general consensus regarding the preferred mode of loop diuretics administered intravenously.⁷⁾

Although hospitalization due to HF has declined over time since 1995, individuals with underlying chronic conditions, such as diabetes mellitus and hypertension, appear to experience higher rates of morbidity and mortality due to the disease.⁸⁾ As a result, it is of utmost importance to continue developing preventive strategies to help combat the disease and the subsequent financial burden for at-risk populations. The high costs associated with HF stem from poor discharge planning due to lack of communication/coordination of post discharge home care. Such gaps in care coordination becomes one of the leading causes of hospital readmissions. A solution to this problem would be to improve care and reduce costs. This involves shifting from the focus on providing high-intensity, expensive inpatient care to preventing, coordinating, and managing the illness in outpatient or primary care settings.⁸⁾⁹⁾

Several small studies have demonstrated the value of utilizing outpatient diuretic infusion clinics for high-risk patients with decompensated HF without the increased risk of harm.⁹⁾¹¹⁾ Existing studies have shown the benefit of outpatient diuretics.¹⁰⁾¹¹⁾ In a prospective analysis of diuretic infusions in the outpatient setting versus a brief hospitalization, the patients who received diuretics in a clinic had significantly lower 30-day readmission rates and a consequent financial benefit.¹⁰⁾ A prospective study with a standardized protocol of biweekly infusions for 1 month noted a significant decrease in the 30-day hospital readmission rates.¹¹⁾ Other small studies have shown weight loss but no significant change in renal function.¹²⁾ Our study is a single center retrospective analysis which attempts to address medical and financial benefits of outpatient furosemide infusion therapy across a four-year period from 2017–2020. Lowering cost is an important aspect in today's healthcare economics in the United States because greater than 28% 30-day readmissions in the Medicare population will lead to a 3% penalty on all DRGs (Diagnosis related Groups).¹³⁾ Additionally, frequent readmissions increase mortality in the HF population.¹⁴⁾¹⁵⁾

METHODS

Study design

An observational retrospective single-center analysis of decoded data of all HF patients between the ages of 18 and 89 years of age who received outpatient furosemide infusion therapy was used to identify the impact of outpatient furosemide treatment on 30-day

readmissions. We also sought to understand the financial impact of this therapy on 30-day readmissions. The study was conducted using patient data from January 2017 to December 2020. This study was approved by Institutional Review Board (IRB) at Texas Tech Health Sciences Center, Lubbock, TX. A total of 56 HF patients referred to the Texas Tech University Health Sciences Center, Center for Cardiovascular Health in Lubbock, Texas, USA for outpatient furosemide infusion therapy were included in this study. The following inclusion / exclusion criteria were used to select patients.

Inclusion criteria: Patients who were ≥ 18 years of age who were readmitted to the hospital within 30 days despite guideline derive medical therapy were included in the study.

Exclusion criteria: Patients who could not ambulate independently were excluded from the infusion clinic and the study for logistic reasons within the clinic setting.

Ethical consideration

All data were de-identified and stored securely on encrypted devices accessible only to study investigators in accordance with institutional policies. None of the data analyzed contained individually identifiable information. This study was approved by the Institutional Review Board (IRB) at Texas Tech health Sciences Center, Lubbock, TX 79430.

Study procedure

Adult patients who were included in this study received a furosemide dose of 40 mg intravenously as an infusion over a 3-hour period at the clinic visit. All laboratory values for complete blood count (CBC), complete metabolic panel (CMP) and coagulation parameters were obtained at each visit. The patients were monitored in a full telemetry unit, weights were recorded at the beginning and end of the visit. The patients were observed for 2 hours post infusion before they were discharged home. The frequency of clinic visits for infusion depended on the laboratory values and clinical signs/symptoms of patients at each visit. The visit frequency was hence widely varied from once every week to once every 4–6 weeks depending on the acuity of the patient at the previous visit. Patients whose laboratory values and clinical signs/symptoms improved and remained stable in consequent visits were spaced out and eventually discharged from the clinic. This clinic was used exclusively for chronic disease management in hemodynamically stable patients.

Clinical variables

The clinical characteristics of patients that were extracted for this study included the comorbidities and demographics (age, gender, and race). The vital signs such as blood pressure, heart rate, body weight loss post-infusion and post-treatment and home medications and laboratory parameters such as CBC, CMP, prothrombin time (PT), partial thromboplastin time, and international normalized ratio were monitored at every visit to the clinic.

Financial (economic burden) analysis

The hospital is subjected to CMS penalties for exceeding thresholds for HF readmissions for a 3-year average. From the hospital analysis of data, the chronic HF report is generated which indicated the hospital loss per admitted patient at \$1,064 and the cost avoided per readmission computed from the hospital as \$421. The net annual savings was therefore calculated by adding the annual avoidance cost to the annual savings. The annual savings is the amount generated when patients are not admitted to the hospital and annual avoidance cost is another entity generated by the hospital in addition to the savings generated by

preventing an admission. Therefore, the sum of the annual savings and annual avoidance costs give rise to the net annual savings.

The data obtained from the patients regarding the number of cases per month, the number of readmissions per month, the savings per patient of \$1,064.00 due to prevented readmissions, and the cost avoided per readmission of \$421.00, were entered into a data sheet on Microsoft Excel. The data were then coded to calculate average readmission rates, total monthly and annual savings, average savings per month by year, average savings per month across the four-year period, total monthly and annual avoidance, average avoidance per month by year, average avoidance per month across the four-year period, and the sum of the net savings and avoidance, along with the associated standard deviation and standard error calculations. The avoidance cost data was permuted as per existing hospital data. A p value of <0.05 was considered significant.

A discount analysis of the net present value (NPV), internal rate of return (IRR), and the profitability index was then performed using a discount rate of 5%, a period of 4 years during which the Center for Cardiovascular Health has administered furosemide infusion therapy for HF patients, an initial cash outflow based on investment values provided from fiscal year (FY) 2020, including medical supplies/equipment cost, infusion pharmacy costs, facilities (communications), and annual nurse salary, and cash inflows based on the total annual savings accrued per year from prevented readmissions from 2017 to 2020. The NPV, or the time series of the sum of the incoming and outgoing cash flows, was used to determine the financial viability of the project.¹⁶⁾ The IRR was used to estimate the profitability of potential investments and is the discount rate at which the NPV of all cash flows is equal to zero.¹⁶⁾ The profitability index was used to measure the attractiveness of the project.¹⁶⁾

Additionally, a single-factor ANOVA test was performed to determine whether there was sufficient evidence to conclude that the means of savings from prevented readmissions were equal across years to further explain the financial viability of the clinic. A data analysis tool pack called the “Real Statistics Resource Pack” for Excel was used to conduct the Kruskal-Wallis test (a non-parametric test) This has been done in addition to a one-way ANOVA.

RESULTS

Characteristics of study patients

Characteristics of the study cohort are shown in **Table 1**. The study population comprised of 25 patients with HF with reduced ejection fraction (HFrEF) and 31 patients with HF with preserved ejection fraction (HFpEF). The HFrEF patients had an ejection fraction (EF) of <35% and those with HFpEF had an EF of >50%. **Table 1** describes the baseline characteristics of the two groups of patients. Both HFrEF and HFpEF patients have comparable rates of morbidity and mortality with some studies reporting slightly lower mortality rates in HFpEF patients.¹⁷⁾¹⁸⁾

The HFpEF patients had a significantly higher body mass index, systolic blood pressure, left ventricular hypertrophy. A higher number of HFpEF patients has obstructive sleep apnea on continuous positive airway pressure (CPAP). With reference to laboratory values the HFpEF patients had a higher hematocrit (Hct) and Sodium (Na) levels. The HFrEF patients had higher pulmonary pressures. A higher number of HFrEF patients had no CPAP though

Table 1. Baseline characteristics of study population

Variables	HF _r EF [†] (n=25)	HF _p EF [‡] (n=31)	p value
Age (years)	59 (50–69)	65 (54–72)	0.145
Female gender	20%	39%	0.13
Ethnicity			
Caucasian	32%	29%	0.78
Hispanic	56%	61%	0.78
Black	12%	10%	0.8
Weight (kg)	105 (84–125)	128 (107–148)	0.021*
BMI (kg/m ²)	34 (27–43)	41 (34–50)	0.007*
Obesity			
Underweight	0.00%	0.00%	
Normal	12.00%	0.00%	
Overweight	28.00%	3.20%	0.017*
Obesity class I	12.00%	22.60%	0.03*
Obesity class II	16.00%	22.60%	0.032*
Obesity class III	32.00%	51.60%	0.02*
NYHA			
I	0%	0%	
II	20%	3.20%	0.018*
III	56.00%	71.00%	0.023*
IV	24%	25.80%	0.7
SBP (mmHg)	118 (109–135)	135 (119–158)	0.004*
DBP (mmHg)	73 (65–79)	72.5 (61–78)	0.207
Afib/PAF	32%	22.60%	0.429
CKD stage 3,4	52%	56%	0.65
T2DM	56%	67.70%	0.357
HTN	84%	96.80%	0.096
Dyslipidemia	92%	100%	0.2
Stroke/TIA	12%	9.70%	0.78
PHT due to LHD			
Mild	16.00%	16.10%	0.34
Moderate	44.00%	35.50%	0.4
Severe	0.00%	3.20%	0.47
COPD	16.00%	19.40%	0.745
CAD	56%	45%	0.42
OSA			
OSA, no CPAP	84%	22.60%	0.015*
OSA, on CPAP	16%	54.80%	0.01*
Unknown	0%	22.60%	0.015*
Home medications			
Furosemide	72%	80.60%	0.446
Torsemide	24.00%	16.10%	0.461
Bumetanide	4.00%	3.20%	0.877
Metolazone	0.00%	6.00%	0.196
Chlorothiazide	28%	16.10%	0.282
HCTZ	0.00%	6.50%	0.196
ACEI/ARB	68%	61%	0.802
Sacubitril/Valsartan	52.00%	3.20%	0.0001*
Aldosterone antagonist	20.00%	3.20%	0.044*
Beta-blockers	88%	83.90%	0.661
Digoxin	4.00%	0.00%	0.269
Nitrate	16.00%	25.80%	0.374
Hydralazine	12.00%	19.40%	0.456
NDCCB	4.00%	3.20%	0.877
DCCB	4.00%	25.80%	0.027*
Sildenafil	28%	6.50%	0.029*
Home milrinone	4.00%	0.00%	0.261
ICD	20%	0.00%	0.009*
CRT	19.20%	0%	0.009*
Wearable defibrillator	24%	0%	0.019*
LVIDD (cm)	6.1 (5.5–6.6)	5.2 (4.7–5.4)	0.001*

(continued to the next page)

Table 1. (continued) Baseline characteristics of study population

Variables	HFrEF [†] (n=25)	HFpEF [‡] (n=31)	p value
LVSD (cm)	1.0 (0.9–1.1)	1.0 (0.9–1.1)	0.491
LVH			
Mild	12%	12.90%	0.702
Moderate	4%	9.70%	0.029*
RV dysfunction	44%	9.70%	0.003*
LAE			
Mild	56%	38%	0.021*
Moderate	20%	16.10%	0.11
Severe	12%	0%	0.001*
Hb (g/dL)	14.3 (11.4–16.0)	12.8 (10.3–13.8)	0.081
Hct %	42.3 (35.5–47.6)	38.8 (32–42)	0.039*
Na (mEq/L)	139 (136.5–141.5)	141 (139–142.3)	0.024*
K (mEq/L)	4.3 (4.1–4.6)	4.3 (4.0–4.5)	0.798
BUN (mg/dL)	22 (15.0–34.0)	26.5 (16.8–40.0)	0.364
Cr (mg/L)	1.2 (1.1–1.9)	1.4 (1.0–1.7)	0.856
GFR	59.9 (37.3–71.7)	52.7 (34.8–77.0)	0.717
Albumin (g/dL)	4.2 (4.1–4.4)	4.0 (3.8–4.2)	0.055
BNP (pg/mL)	3,022 (1,097–7,448)	991 (207–2,399)	0.001*

BMI = body mass index; NYHA = New York Heart Association; SBP = systolic blood pressure; DBP = diastolic blood pressure; CKD = chronic kidney disease; T2DM = type 2 diabetes; HTN = hypertension; TIA = transient ischemic attack; PHT = pulmonary hypertension; LHD = left heart disease; COPD = chronic obstructive pulmonary disease; CAD = coronary artery disease; OSA = obstructive sleep apnea; CPAP = continuous positive airway pressure; HCTZ = hydrochlorothiazide; ACEI = angiotensin-converting-enzyme inhibitor; ARB = angiotensin II receptor blocker; NDCCB = non-dihydropyridine calcium channel blocker; DCCB = dihydropyridine calcium channel blocker; ICD = intracardiac defibrillator; CRT = cardiac resynchronization therapy; LVIDD = left ventricular internal end diastolic dimension; LVSD = left ventricular systolic dysfunction; LVH = left ventricular hypertrophy; RV = right ventricular; LAE = left atrial enlargement; Hb = hemoglobin; Hct = hematocrit; BUN = blood urea nitrogen; GFR = glomerular filtration rate; BNP = brain natriuretic peptide.

*p<0.05; [†]Heart failure with reduced ejection fraction; [‡]Heart failure with preserved ejection fraction.

they carried a diagnosis of OSA. The medication regimen showed that a higher number of patients were on Sacubitril/Valsartan, and aldosterone antagonists as expected with a low the HFrEF.¹⁹ The number of HFrEF patients on sildenafil was higher consistent with higher pulmonary pressures in this group. Consistent with guidelines all patients with an intracardiac defibrillator, wearable defibrillator, cardiac resynchronization therapy were in the HFrEF group.¹⁹ Higher left ventricular internal end diastolic dimension, left ventricular end systolic dimension and severe left atrial enlargement were more common in the HFrEF group as expected with dilated hearts and low EF. BNP was higher in the HFrEF patients as compared with those with HFpEF which is consistent with existent data.²⁰ All other characteristics shown in **Table 1** did not differ in the two groups.

On longitudinal analysis (3–12 months of outpatient diuretic therapy) the renal function remained stable between and within the groups. Creatinine was 1.8±0.2 p=0.2, 2.0±0.3 p=0.9 respectively. The liver function tests (aspartate aminotransferase [9±2 p=0.2, 13±3 p=0.3 respectively], alanine aminotransferase [15±4 p=0.3, 17±3 p=0.2 respectively], total bilirubin 0.9±0.2 p=0.7, 1.2±0.3 p=0.2 respectively), were stable throughout the course of longitudinal follow up of 3–12 months.

Financial (economic burden) analysis

This observational study focused on the retrospective analysis of 30-day congestive HF readmissions for patients who received outpatient Furosemide infusion therapy between the years 2017 and 2020 and the savings associated with the number of prevented readmissions within 30 days of receiving the treatment. Across the four-year study period, the average 30-day congestive heart failure (CHF) readmission rates following outpatient furosemide therapy

Outpatient Diuretic Therapy for Heart Failure

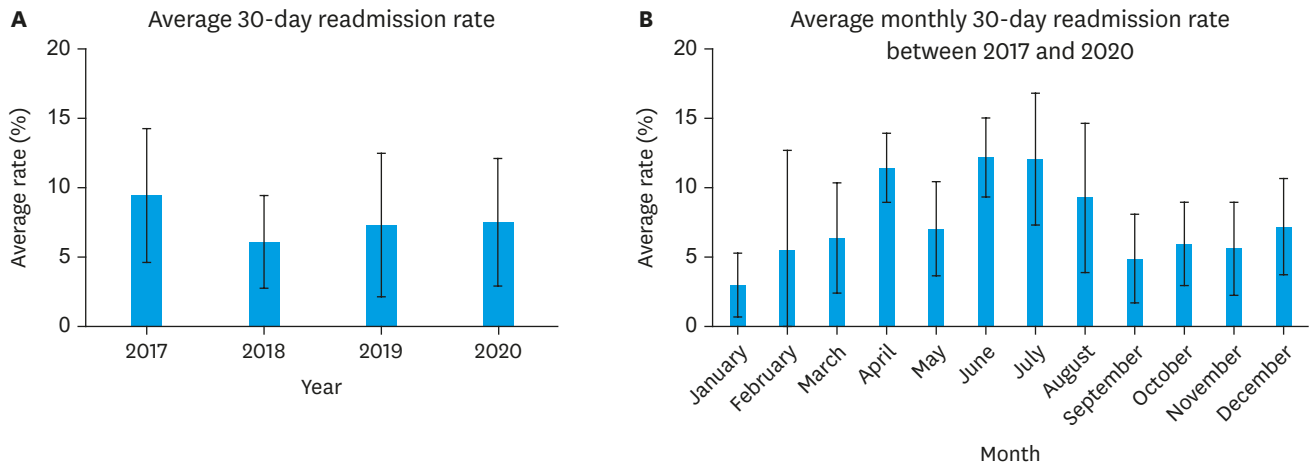


Figure 1. (A) Graph shows the average 30-day readmission rate for the years 2017 to 2020. (B) Graph shows the average 30-day readmissions per month for the years 2017 to 2020. Error bars denote the variations per month for each year.

were 9% in 2017, 6% in 2018, 7% in 2019, and 8% in 2020 (**Figure 1A**). Readmission rates by month across the 2017–2020 study period ranged from 3% to 12% (**Figure 1B**).

During this study period from 2017–2020, the total annual savings ranged from \$400,000 to \$530,000 by utilizing a value for savings per patient of \$1,064.00 (**Table 2, Figure 2A-D**).

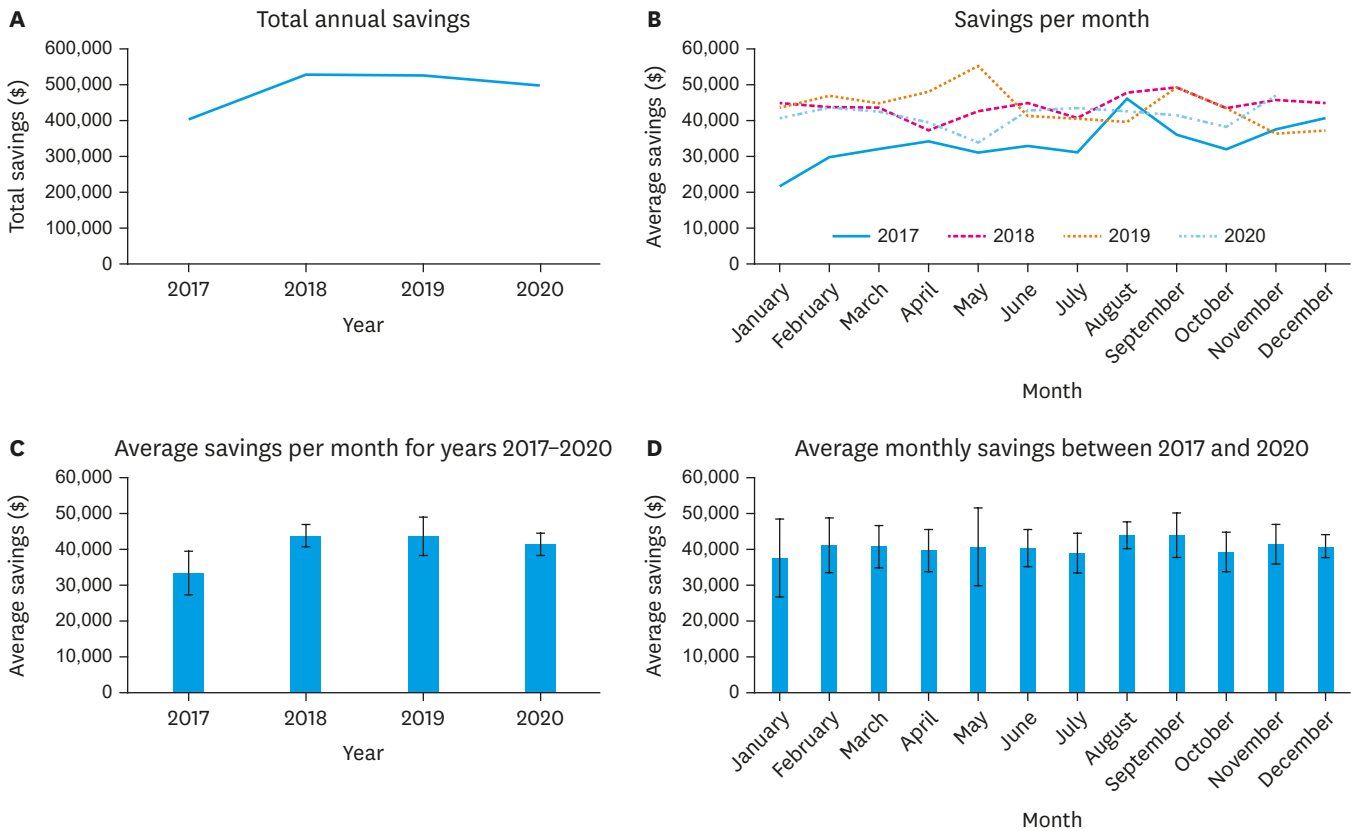


Figure 2. (A) Graph shows total annual savings plotted against the years analyzed 2017 to 2020. (B) Graph shows the average savings per month plotted per month over the years 2017 to 2020. (C) Graph shows average savings per month for the years 2017 to 2020. (D) Graph shows average savings per month for the years 2017 to 2020. Error bars in (C and D) show variations per month for each year.

Outpatient Diuretic Therapy for Heart Failure

Table 2. Total savings generated from the outpatient diuretic clinic

Year	Total annual savings	Average monthly savings	Average cost avoidance/month	Total cost avoidance/year	Net savings*/month	Net savings/year
2017	\$403,256	\$33,604	\$13,296	\$159,559	\$46,901	\$562,815
2018	\$527,744	\$43,978	\$17,401	\$208,816	\$61,380	\$736,560
2019	\$525,616	\$43,801	\$17,331	\$207,974	\$61,132	\$733,590
2020	\$497,952	\$41,496	\$16,419	\$197,028	\$67,915	\$694,980

*Net savings were calculated by adding avoidance cost and monthly savings.

The total annual avoidance ranged from \$150,000 to \$210,000 by utilizing a value for cost avoided per readmission of \$421.00 (Table 2, Figure 3A-D). The net savings were calculated by combining the total annual savings and the total annual avoidance values (Table 2).

The discount analysis utilized a discount rate of 5%, a study time period of 4 years, a cash outflow of \$116,155 based on investment values provided from FY 2020, and a cash inflow based on the total annual savings accrued per year from prevented readmissions of \$403,256 in 2017, \$527,744 in 2018, \$525,616 in 2019, and \$497,952 in 2020 (Table 3). These values were used to calculate the NPV of \$1,610,290, an IRR of 369%, and a profitability index of 14.9 (Table 3).

A single-factor ANOVA test was performed using the total savings per month across the four-year study period to determine if there was sufficient evidence to conclude that the means of savings from prevented readmissions are not equal across the study years. At least

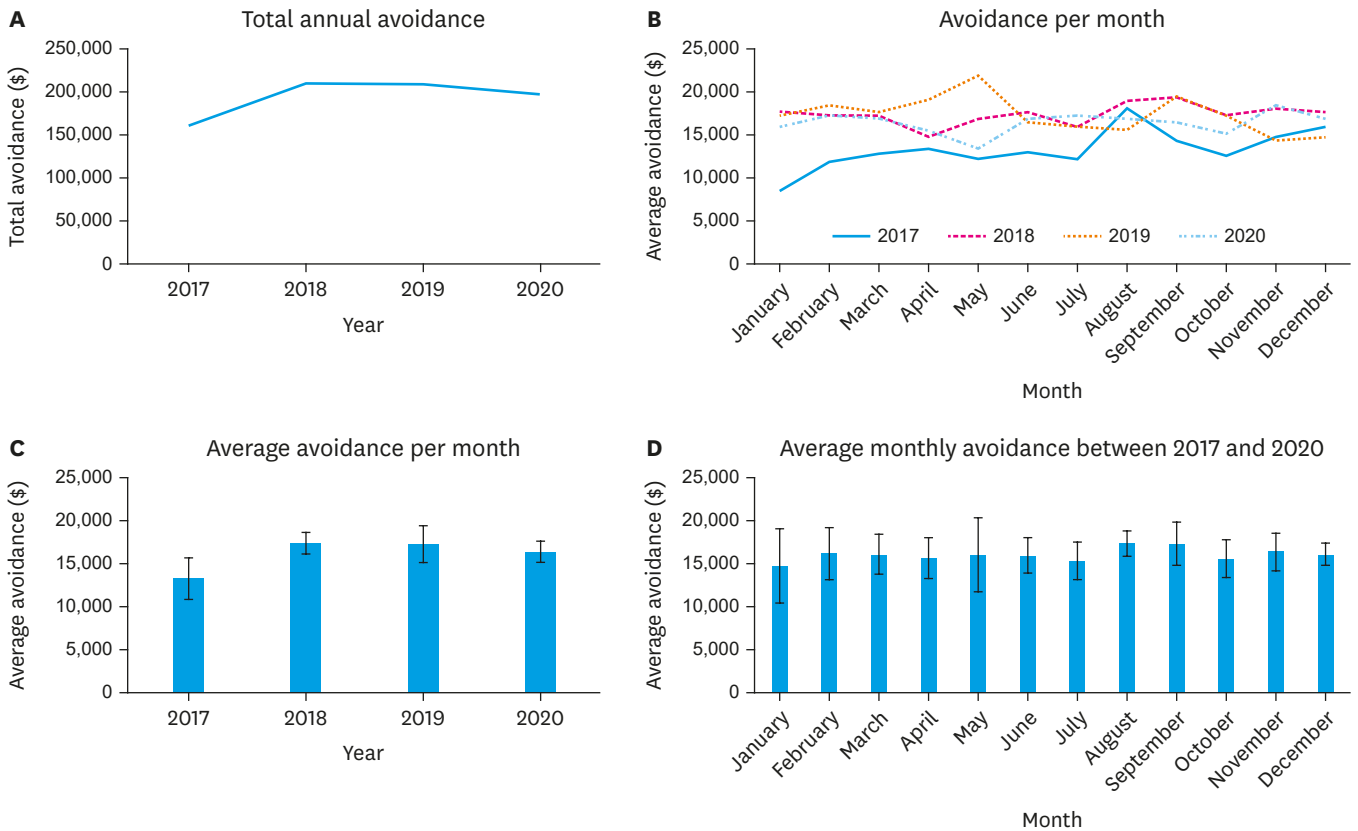


Figure 3. (A) Graph shows total avoidance of cost per year for the years 2017 to 2020. (B) Graph shows avoidance of cost per month for the years 2017 to 2020. (C) Graph shows avoidance of cost per month for the years 2017-2020. (D) Graph shows average monthly avoidance of cost per month for the years 2017 to 2020. Error bars in (C and D) show variations per month for each year.

Table 3. Discount analysis

Variables	Values
Discount rate	5%
Investment	Cash outflow
Medical supplies/Equipment	\$32,665
Infusion (pharmacy)	\$25,223
Facilities (communications)	\$6,267
Nurse annual salary	\$52,000
Cash outflow	\$64,155
Year (t)	Total annual savings (undiscounted cash flow)
- (0)	\$(6,267)
2017 (1)	\$403,256
2018 (2)	\$527,744
2019 (3)	\$525,616
2020 (4)	\$497,952
Net present value	\$1,610,290.90
Internal rate of return	6,465%
Profitability index	14.86

Table 4. Kruskal-Wallis test

Variables	Values
Kruskal-Wallis H-stat	19.6
Df	3
p value	0.0001887

one of the population means is different from the others as there is a significant difference in the means of savings from prevented readmissions between the years 2017 and 2018, 2017 and 2019, and 2017 and 2020 (**Figure 4**). We have also performed a Kruskal-Wallis test, (a non-parametric test) (**Table 4**) in addition to the one-way ANOVA test which was used to account for the violations of the assumptions of normality in a single-factor ANOVA test using the Real Statistics Resource Pack in Microsoft Excel. Because the Kruskal-Wallis Test (**Table 4**) showed a significant difference between the medians of savings from prevented readmissions between the years 2017 and 2020, this demonstrates that at least one of the group populations is dominant over the others. As a result, a pairwise comparison using a single-factor ANOVA test was utilized to pinpoint the exact differences between groups as seen in **Figure 4**.

From the financial standpoint an NPV of \$1,610,290.9 was calculated across the time period. This large positive value indicates the positive financial viability of the project. The IRR estimates the profitability of potential investments and is essentially the discount rate at which the NPV of all cash flows is equal to zero. An IRR of 369% was calculated. If the IRR on a project exceeds the cost of capital, net cash flows would be higher. The profitability index is a measure of the project's success. A high profitability index (greater than 1) of 14.86 indicates that this project is successful.

The significant difference in the means of savings from prevented readmissions between the years 2017–2018, 2017–2019, and 2017–2020 from the single-factor ANOVA and the Kruskal-Wallis tests indicates that the outpatient diuretic infusion clinic has become more efficient since its inception in 2017. The nonsignificant difference between the years 2018–2019, 2018–2020, and 2019–2020 indicate that the clinic has maintained steady inflows and savings since then.

ANOVA: Single factor

SUMMARY

Groups	Count (months)	Sum	Average (SD)
2017	12	\$403,256	33,604 (6,043)
2018	12	\$527,744	43,978 (3,088)
2019	12	\$525,616	43,801 (5,422)
2020	12	\$497,952	41,496 (3,208)

ANOVA

Source of variation	SS	df	MS	F	p value	F crit
Between groups	856124015	3	285,374,672	13.310964	2.57E-06	2.8164658
Within groups	943318992	44	21,439,068			
Total	1.799E+09	47				

Tukey Kramer	QSTAT	3.44
	Critical range	4,598.0191

Pairwise comparison

		Absolute difference in means
2017	2018	10,374*
	2019	10,196*
	2020	7,891*
2018	2019	177
	2020	2,482
2019	2020	2,305

Figure 4. Single factor ANOVA test with pairwise comparisons.

SD = standard deviation.

*p<0.05 using critical range.

DISCUSSION

This is a single center observational retrospective study which addresses the role of outpatient diuretic therapy in reducing 30-day hospital readmissions for chronic disease management. The important medical aspects are that both HFrEF and HFpEF patients appear to benefit from this treatment with no significant worsening of kidney function or liver function. This approach can potentially lead to a reduction in healthcare costs, amongst other benefits, such as possible improvement in quality of life and reduction in mortality as they remain outside the hospital. The definitive effects of the outpatient diuretic therapy on quality of life and reduction in mortality were not investigated in this study and will need future investigation. This study shows a much lower 30-day readmission rate in this cohort as compared to the average 30-day hospital readmissions which is around 25% at a national level. Allowing more healthcare institutions to adopt outpatient diuretic infusion clinics for high-risk CHF patients may pave the way for a new model in healthcare which could help reduce the number of hospital admissions due to this disease. This is especially important in patients with both chronic kidney disease and chronic CHF with symptom burden, hospitalization, and mortality increase.²¹⁾ Outpatient diuretic clinics will help chronic disease management in improving clinical and financial benefits. This concept needs further investigation in a randomized clinical trial.²²⁾

The NPV, IRR, and PI values calculated for this clinic are very high, and consistent with the overall high profitability of the outpatient diuretic infusion clinic. Some factors that may have contributed to this high profitability include the already existing infrastructure of the clinic prior to setting up this outpatient therapy, reduced hospital readmissions, an established patient base, and the effectiveness of the treatment.

In this small study there appears to be no difference in the readmission rates of patients with HFrEF versus HFpEF who are treated in the outpatient diuretic clinic. This suggests that the cost savings is essentially the same between the two groups because the financial impact is computed from the readmission rates. This finding needs to be investigated and validated in larger studies.

It is interesting that on computation of our savings we get an average of approximately \$681,986 as annual net savings and when calculated per patient annually it appears to be \$12,718. This is in close agreement with the published value of \$12,113 per patient annually.¹⁰⁾ This suggests that outpatient diuretic therapy produces a standard financial benefit which needs to be validated in larger studies.

The clinical outcome addressed here is 30-day readmission rate which is 6–9% for the years analyzed (2017–2020). This is considerably lower than the average 30 day readmission rates noted in the United States which is 25%. There was no difference in readmission rates between the two groups examined (HFrEF and HFpEF).

The main causes of increased medical costs during inpatient admissions are due to hospital charges for in patient stay, tests ordered by the different teams because HF management is a multidisciplinary approach and increase length of stay. All of these costs can be avoided if efficient management occurs in the outpatient setting. Due to organizational confidentiality issues more granular details of inpatient costs were not available for analysis. Therefore, the available data were used to calculate financial benefits for the outpatient management presented in this paper.

This is the first report that approaches the role of an outpatient diuretic treatment from a medical and financial perspective in terms of its impact on healthcare costs with important medical significance. However, the study has its limitations in that it is a retrospective study and a single center experience.

In summary the financial analysis of this pilot study shows its feasibility and needs to be further investigated in larger populations. From the medical standpoint it is a safe treatment which does not have a detrimental effect on the kidney and liver function as well as metabolites which are reviewed at every visit. This approach should be tested in larger populations to establish its role in chronic disease management of HF.

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