

## REVIEW

# Whether sodium and fluid restriction reduce exacerbations and readmissions for patients with heart failure: An integrative review

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## ABSTRACT

Heart failure (HF) is a chronic medical condition becoming increasingly prevalent around the world. This condition is linked to poor quality of life (QoL) due to the impact it has on patients functional status and mental health. There have been several advancements in the care and management of patients with HF with little change to self-care interventions resulting. Two self-care interventions which are recommended throughout clinical guidelines are sodium and fluid restriction. These are widely used and encouraged through patient education. Research, however, has questioned their validity and demonstrated a lack of evidence on improved outcomes. In order to determine whether changes to current practice is warranted, an integrative review has been completed. The aim is to assess whether these self-care interventions improve outcomes for patients with HF. From this review identified themes include a lack of robust data, the potential harm of interventions, and various outcomes extending beyond HF exacerbations and readmissions. There appears to be a lack of recent data on the impact of a fluid restriction as an independent variable. However, there are noted improvements in a variety of outcomes from both interventions outside of hospital readmissions which demonstrates they are valuable. Given these findings there is not enough evidence to remove restrictions but there are recommendations which can be made to modify current practice. These recommendations include liberalizing sodium and fluid restrictions and making restrictions more specific to the severity of HF for patients going forward.

**Key Words:** Heart failure, Quality of life, Self-care, Sodium restriction, Fluid restriction, Readmissions

## 1. INTRODUCTION

Heart failure (HF) is a chronic medical condition becoming increasingly prevalent around the world.<sup>[1]</sup> Given its complexity, it is linked to a financial burden on the healthcare system with high readmission and mortality rates.<sup>[2]</sup> More importantly, this condition is linked to poor quality of life (QoL) due to the impact it has on patients functional status and mental health.<sup>[3]</sup> There have been several advancements in the care and management of patients with HF using medications

and device therapy.<sup>[4]</sup> Despite these advancements, there has been little change to self-care interventions.<sup>[4]</sup> Two self-care interventions recommended throughout clinical guidelines are sodium and fluid restriction.<sup>[4]</sup> Though these restrictions are widely used and encouraged through patient education, research has questioned their validity and demonstrated a lack of evidence on improved outcomes.<sup>[5]</sup> To determine whether there should be changes to current practice, an integrative review has been undertaken. The aim is to assess

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whether these self-care interventions improve outcomes for patients with HF.

## 2. SEARCH STRATEGY

To formulate the clinical question and identify appropriate search terms a Patient Intervention Comparison Outcome (PICO) framework was completed as illustrated in Table 1.

The clinical question developed was: Does a sodium and fluid restriction help reduce exacerbations and readmissions for patients with HF?

Having formulated a question and identified PICO, a search was completed using key words adapted from the PICO framework. These terms are illustrated in Table 2.

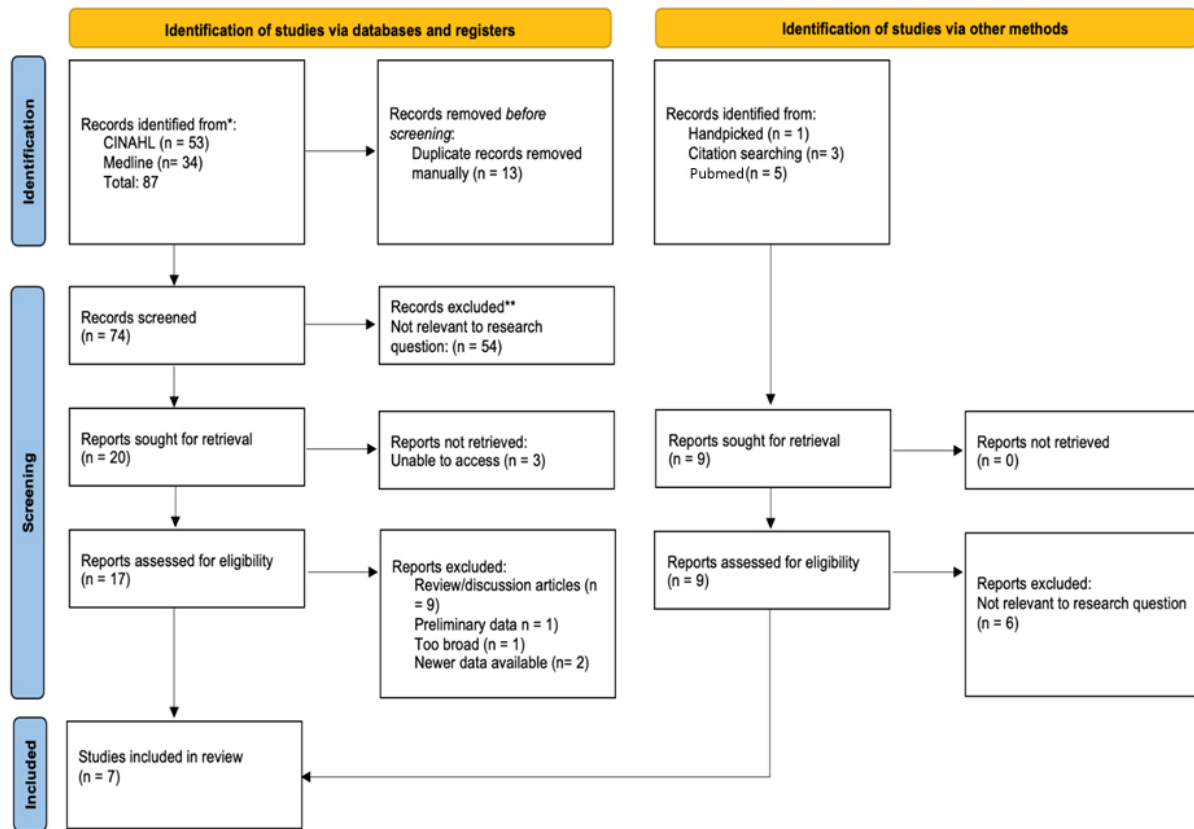
**Table 1.** PICO framework

P (patient/population)	I (Intervention)	C (Comparison)	O (Outcome)
Patients with heart failure	Sodium and fluid restriction	No intervention	Reduce heart failure exacerbations and readmissions

Databases which were utilized included CINAHL, Ovid MEDLINE, Scopus, and PubMed (see Table 3 for complete search strategy). An extensive search of the literature led to identification and selection of seven articles relevant to the clinical question developed. To clearly outline study selection, a template for the PRISMA diagram, adapted from Page et al.<sup>[6]</sup> was utilized (see Figure 1). This clearly outlines the inclusion, exclusions criteria used for this search.

**Table 2.** Key words used for search

Key term	Synonyms
Heart failure	CHF OR Reduced ejection fraction
Sodium restriction	Sodium reduc OR restrict
Fluid restriction	Fluid reduc OR restrict
Reduce exacerbations	Outcomes



**Figure 1.** PRISMA<sup>[6]</sup>

**Table 3.** Search strategy: databases

<b>Date: 4 April, 2022. Database: CINAHL 2016-01-01 to 2022-12-31</b>		
<b>Search</b>	<b>Limiters/Expanders</b>	<b>Results</b>
S8	S3 AND S7 Limiters - Published Date: 20160101-20221231; English Language; Peer Reviewed Expanders - Apply equivalent subjects Search modes- Find all my search terms	53
S7	S4 OR S5 OR S6 Expanders - Apply equivalent subjects Search modes - Find all my search terms	2,300
S6	TI sodium N4 (restrict OR reduc) Expanders - Apply equivalent subjects Search modes - Find all my search terms	495
S5	TI fluid N4 (restrict OR reduc) Expanders - Apply equivalent subjects Search modes - Find all my search terms	346
S4	MH "Diet, Sodium-Restricted" Expanders - Apply equivalent subjects Search modes - Find all my search terms	1,666
S3	S1 OR S2 Expanders - Apply equivalent subjects Search modes - Find all my search terms	23,056
S2	TI "heart failure" OR "chf" Limiters - Published Date: 20160101-20221231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	20,068
S1	MH "Heart Failure" Limiters - Published Date: 20160101-20221231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	16,352
<b>Date: 4 April, 2022. Database: Ovid MEDLINE 2016 to current</b>		
<b>Search Terms</b>		<b>Results</b>
1	Heart Failure/	132,848
2	Heart failure.m_titl.	70,392
3	1 or 2	137,279
4	Diet, Sodium-Restricted/	2,855
5	(Fluid restrict or fluid reduc).m_titl.	200
6	4 or 5	3,049
7	3 and 6	184
8	limit 7 to (English language and yr="2016 -Current")	34
<b>Date: 10 April 2022 via Scopus</b>		
<b>Search Terms</b>		<b>Results</b>
TITLE-ABS-KEY (impact AND of AND dietary AND sodium AND restriction AND on AND heart AND failure AND outcomes)		20
(TITLE-ABS-KEY (impact AND of AND dietary AND sodium AND restriction AND on AND heart AND failure AND outcomes) AND AUTHOR-NAME (doukky)		1
Impact of dietary sodium restriction on heart failure outcomes Doukky R., Avery E., Mangla A., Collado F.M., Ibrahim Z., Poulin M.-F., Richardson D., Powell L.H. (2016) JACC: Heart Failure, 4(1), pp. 24-35.		Cited by 71
Refined to: LIMIT-TO (PUBYEAR, 2022)		3
<b>Date: 11 April, 2022 via PubMed 2008-2022</b>		
<b>Search Terms</b>		<b>Results</b>
Sodium restriction and heart failure		511
Sodium restriction and heart failure and reduced ejection fraction		28
Sodium restriction and heart failure and randomized control trial		5

### 3. RESULTS

Evidence was obtained from studies assessing outcomes related to fluid restriction, a sodium restriction and a combination of the two interventions for patients with HF. A summary of the included articles has been compiled in the Supplementary. Of these chosen articles, three were randomized control trials (RCT's),<sup>[4,5,7]</sup> and three were systematic reviews and meta-analyses.<sup>[1,8,9]</sup> One of the studies looked at data collected from a previous RCT known as the Heart Failure Adherence and Retention Trial (HART).<sup>[10]</sup> Each article was then critically appraised to ensure articles selected were relevant to the clinical question and provided valid evidence.<sup>[11]</sup> For the RCT's, a critical appraisal checklist from the Critical Appraisal Skills Programme (CASP)<sup>[12]</sup> for RCTs was utilized. For the metanalysis, and systematic reviews the CASP critical appraisal checklist specific for these studies was completed.<sup>[13]</sup> A summary of these articles appears in the Supplementary.

From these articles several themes were identified. These themes included a lack of robust data, the potential harm of interventions, and various outcomes extending beyond HF exacerbations and readmissions.<sup>[7]</sup> Though the aim of this review was to assess exacerbations and readmissions, outcomes related to thirst perception, nutritional intake, QoL, New York Heart Association (NYHA) functional class, and N-terminal pro-B-type natriuretic peptide (NT-pro BNP) are important to explore to guide further practice recommendations. Furthermore, comparing outcomes of a sodium and fluid restriction for patients with heart failure with preserved ejection fraction (HFpEF) and heart failure with reduced ejection fraction (HFrEF) are valuable to assess whether recommendations should vary depending on HF diagnosis.

#### 3.1 Lack of data

An overall theme throughout the literature is that there is a lack of quality evidence and RCTs assessing the impact of both a sodium and fluid restriction on patients with HF.<sup>[11]</sup> Additionally, there are a lack of studies assessing these interventions independent of one another and that restrictions which have been assessed, are often too restrictive and not in line with current guidelines.

Related to fluid restriction, there were very few articles that evaluated the outcomes of this intervention alone. This finding was also highlighted in a systematic review.<sup>[8]</sup> Within one analysis, only two of the six articles reviewed were solely on the impact of fluid restriction with the quality of evidence noted to be poor.<sup>[8]</sup> Findings were similar for sodium restriction. Though studies on a sodium restriction were much easier to locate, systematic reviews highlighted the limited quality evidence available on the impact of sodium restric-

tion on patients with HF in both an inpatient and outpatient basis.<sup>[9]</sup> Fortunately, a RCT was published which evaluated the impact of a sodium restriction on HF outcomes.<sup>[4]</sup> This study adds much needed data on the impact of a sodium restriction on patients with HF.<sup>[4]</sup>

As noted, in many of the RCTs completed, the restrictions were very aggressive and not in line with best practice guidelines leaving the value of the findings to be questioned. Current recommendations for patients with HF are that they limit sodium intake to 2,000-3,000 mg per day and keep fluid intake below 2,000 ml per day.<sup>[14]</sup> In the most recent RCT, the sodium restriction in the intervention group was 1,500 mg per day which is much less than guidelines.<sup>[4]</sup> Despite this, clinical outcomes were similar to other trials with a more liberal sodium restriction making the findings valuable.<sup>[4]</sup>

Restrictions were also aggressive in studies which assessed outcomes of a fluid restriction. In one RCT, the amount of fluid allotted ranged between 800 ml to 1,500 ml per day.<sup>[8]</sup> This leaves a gap in the evidence on outcomes based on current guidelines. Recommendations to undertake further studies has been emphasized extensively in the literature and would need to be a priority going forward to recommend change.<sup>[9]</sup>

#### 3.2 Is a sodium restriction harmful?

Another theme which emerged from the literature is whether sodium restriction is harmful for patients.<sup>[11]</sup> In large RCT's it is noted that sodium restriction has potential to produce negative outcomes, such as hospitalizations, especially when patients are on high levels of diuretics and fluid restriction.<sup>[11]</sup> Furthermore, it is highlighted that restricting sodium can lead to hyponatremia which in itself can lead to hospitalization and poor outcomes for patients.<sup>[11]</sup>

Despite harms being discussed in the literature, in the most recent RCT there was no evidence to support this statement.<sup>[4]</sup> Within this trial there was no increase in hospitalizations, death or visits to the emergency department (ED) for patients on a sodium restricted diet.<sup>[4]</sup> This is supported in other RCTs completed which illustrate there were no reported negative outcomes for patients on a sodium restriction.<sup>[7]</sup> Related to hyponatremia, however, there is not a significant variation between patients on a sodium restriction and those who were not.<sup>[7]</sup> This brings to question the validity of a sodium restriction causing hyponatremia and ultimately leading to poor outcomes.<sup>[7]</sup>

These negative outcomes for patients on a sodium restriction could be related to not being on an angiotensin converting enzyme (ACE) inhibitor or angiotensin receptor blockers (ARB) at the same time as a sodium restriction rather than

the restriction itself.<sup>[7]</sup> This means that negative outcomes are correlated to not following guideline directed medical therapy as opposed to not adhering to self-care interventions.<sup>[7]</sup>

### 3.3 Readmission rates

It is clear that patients with HF have high readmission rates with twenty five percent of patients being readmitted within thirty days of discharge.<sup>[2]</sup> Though there are significant advances in medical therapy shown to improve readmission rates for patients with HF, there is a lack of evidence indicating the benefit of nonpharmacological interventions such as sodium and fluid restrictions.<sup>[9]</sup> This lack of evidence was highlighted throughout the literature.

The most recent RCT completed on outcomes related to a sodium restriction, found no significant variation in readmission rates or visits to the ED between the intervention group and the control group.<sup>[4]</sup> In contrast, a systematic review found evidence that patients who consumed greater than 3,000 mg of sodium per day were sixty percent less likely to be hospitalized.<sup>[1]</sup> Furthermore, it was noted that patients who had severe HF with NYHA class III-IV symptoms who consumed 2,000-3,000 mg of sodium per day were less likely to be hospitalized than those who consumed greater than 3,000 mg per day.<sup>[1]</sup> These findings bring to question whether current guidelines are too restrictive for those who do not have severe HF, and if sodium recommendations should be more liberal for those with NYHA class I-II symptoms.

Regarding fluid restriction, a systematic review assessing outcomes for patients on a fluid restriction demonstrated no significant difference in readmission rates between patients on a restriction and those who were allotted a liberal amount of fluid.<sup>[8]</sup> Despite the overall conclusion finding no significant difference, one study in the review did demonstrate that those who were on a fluid restriction as well as high dose diuretics did have decreased hospitalizations.<sup>[8]</sup> This leaves uncertainty as to whether the benefit of fluid restriction can be completely ruled out, or whether further studies are required.<sup>[8]</sup>

Despite articles identifying a lack of statistically significant variation in readmissions for both a sodium and fluid restriction, it is clear there is a need for more research in this to assess the value of these interventions going forward.<sup>[1]</sup> There also seemed to be conflicting results throughout the literature and variations in allotted sodium and fluid in the trials.<sup>[1]</sup> This makes it difficult to draw concrete conclusions and completely eliminate sodium and fluid restrictions going forward.

### 3.4 Further clinical outcomes

#### 3.4.1 Thirst and nutritional intake

One of the outcomes explored in the literature was a patient's perception of thirst and nutritional intake while on both a sodium and fluid restriction.<sup>[5]</sup> In one study, a patient's thirst perception was noted to be higher in the restricted group which can impact a patient's QoL.<sup>[5]</sup> Additionally, it was determined that those who were in the restricted group had decreased nutritional intake which can negatively impact clinical outcomes.<sup>[5]</sup> Though these negative outcomes were highlighted, patients could only have 800 ml of fluid per day which is very aggressive<sup>[5]</sup> and is much more restricted than in standard clinical practice.<sup>[14]</sup> Given the severity of the restriction there is a gap in knowledge because if the fluid restriction had been more liberal and in line with current guidelines, thirst and nutritional intake would have been improved.

#### 3.4.2 Quality of life

QoL was frequently assessed throughout the studies. There are several tools which are recommended by clinical guidelines to assess QoL.<sup>[14]</sup> These tools include the Kansas City Cardiomyopathy Questionnaire (KCCQ), and the Minnesota Living with Heart Failure Questionnaire (MLHFQ).<sup>[14]</sup> In the most recent RCT on the impact of a sodium restriction, QoL was assessed using the KCCQ.<sup>[4]</sup> Findings demonstrated an improvement for patients in the sodium restricted group receiving less than 1,500 mg of sodium per day.<sup>[4]</sup> Similar findings occurred in an RCT which used the MLHFQ with a more liberal sodium restriction of 2,500 mg.<sup>[7]</sup> An additional finding is that improvements in QoL were not seen until six weeks from the start of a sodium restriction.<sup>[7]</sup> This demonstrates the effect of a sodium restriction takes time. Despite many studies showing improvement, one study found no improvement in QoL in the restricted group.<sup>[10]</sup> The tool utilized to assess this outcome, however, was not guideline recommended questioning the validity of the results.<sup>[10]</sup>

Related to a fluid restriction, results varied amongst trials on whether there was an improvement in QoL or not.<sup>[8]</sup> One study noted there was improvement, but it is unclear which tool was used to assess this outcome and whether the tool was guideline recommended.<sup>[8]</sup> As noted however, there was an increased thirst perception and decreased nutritional intake when on a fluid restriction which could lead to the conclusion that there was a negative impact on QoL.<sup>[5]</sup>

#### 3.4.3 New York Heart Association (NYHA) functional class

NYHA functional class is the most commonly used system classify patients with HF.<sup>[15]</sup> There are four classifications which are based on patients' limitations during physical ac-

tivity.<sup>[15]</sup> A patient with NYHA class I symptoms has no limitations to physical activity, and a patient with class IV symptoms is unable to participate in activity without symptoms.<sup>[15]</sup> In the literature, there was an improvement in NYHA functional class in the sodium restricted group by one class.<sup>[4]</sup> This improvement can have a positive impact on patients QoL demonstrating further benefits to a sodium restriction.<sup>[3]</sup>

Unfortunately, in the selected articles NYHA class was not measured on patients adhering to a fluid restricted diet alone. It was noted, however, in one meta-analysis that an improvement in HF symptoms occurred with patients who were on a fluid restricted diet independent of a sodium restriction, but NYHA class was not specified.<sup>[1]</sup>

#### 3.4.4 *N-terminal Pro-B-type natriuretic peptide*

NT-pro BNP is released when there are changes in the pressure inside the heart.<sup>[16]</sup> This blood test is used to determine whether a patient has HF, and whether it is worsening or improving.<sup>[16]</sup> RCTs which studied the impact of a sodium restriction over a shorter period (less than twelve weeks) did not demonstrate improvements in this value.<sup>[7]</sup> When patients were on a sodium restriction for longer (greater than 20 weeks), however, improvements in this value were noted.<sup>[7]</sup> This leads to the hypothesis that sodium restriction can be beneficial to improve HF in the long term.<sup>[7]</sup> Related to fluid restriction, there was one study which demonstrated an improvement in NT-pro BNP when fluids were limited.<sup>[8]</sup> This highlights the benefit to this intervention on HF outcomes as well.<sup>[8]</sup>

#### 3.4.5 *Heart Failure with Preserved Ejection Fraction (HFpEF) and Heart Failure with Reduced Ejection Fraction (HFrEF)*

Both patients with HFpEF and HFrEF are treated on an inpatient and outpatient basis. The pharmacological management of patients diagnosed with HFpEF and HFrEF differs as there is little evidence demonstrating an improvement in outcomes for patients with HFpEF.<sup>[17]</sup> Despite being managed with a different medical regime, lifestyle interventions such as sodium and fluid restriction are consistent between both populations.<sup>[14]</sup> Given the medical treatment of patients in each population varies, it is worth assessing if lifestyle interventions also require variation.

One study assessed the impact of a sodium restriction on patients with HFrEF.<sup>[7]</sup> During this trial, there was a lack of adherence to the sodium restriction by the intervention group which led to no improvement in overall outcomes.<sup>[7]</sup> Despite the overall intervention group lacking statistically significant changes, patients who did adhere to a sodium restriction of less than 2,500 mg per day demonstrated improvements in

NT-pro BNP and QoL.<sup>[7]</sup> Unfortunately, there were no studies identified which assessed the impact of a fluid restriction on patients with HFrEF independently.

Related to patients with HFpEF, no trials were located which assessed the impact of a sodium restriction and fluid restriction independently. There was one study, however, which assessed the impact of a sodium restriction and fluid restriction combined on patients with HFpEF, noted to be the only one of its kind.<sup>[5]</sup> Outcomes measured included NT-pro BNP, weight loss, symptoms, readmission and mortality.<sup>[5]</sup> The trial found no improvements for patients on a sodium and fluid restriction on any of the measured outcomes.<sup>[5]</sup> It is important to highlight, however, as previously mentioned that NT-pro BNP is hypothesized to show improvements in trials greater than 20 weeks.<sup>[7]</sup> In this study patients were only assessed for a maximum of seven days in hospital and at thirty day follow up.<sup>[5]</sup> This brings to question if the intervention was for a longer period whether NT-Pro BNP would have improved. It is also important to highlight for HFpEF patients, medical management of this condition is based on symptoms and contributing factors such as hypertension.<sup>[1]</sup> A low sodium diet can be beneficial in controlling hypertension and therefore could be of benefit to patients who have HFpEF.<sup>[1]</sup>

Interestingly, there appears to be more benefits demonstrated in a sodium restriction in patients with HFrEF.<sup>[7]</sup> There is a need for more research to make this observation more concrete. Further studies with longer interventions for HFpEF patients as well as assessments of a fluid restriction independently for both populations would be of benefit going forward.

## 4. DISCUSSION

There is a vast amount of evidence pertaining to the benefits of various pharmacological therapies for patients with HF.<sup>[18]</sup> Despite this, there is a lack of evidence regarding the benefits of lifestyle interventions including sodium and fluid restriction.<sup>[1]</sup> Given the lack of robust evidence it is clear that these interventions are based on opinion and a hypothesized benefit from experts.<sup>[1]</sup> Throughout the highlighted RCTs, meta-analysis and systematic reviews there was an overall consensus that further studies are needed in order to discredit these lifestyle interventions.<sup>[9]</sup> More specifically, there appears to be a lack of recent data on the impact of a fluid restriction as an independent variable.<sup>[8]</sup> However, there are noted improvements in a variety of outcomes from both interventions outside of hospital readmissions which demonstrates they are valuable.<sup>[7]</sup> Given these findings, there is not enough evidence to remove restrictions but there are recommendations which can be made to modify current prac-

tice. These recommendations include liberalizing sodium and fluid restrictions and making restrictions more specific to the severity of HF for patients going forward.

Starting with a sodium restriction, the current recommended sodium intake for a patient with HF is 2,000 mg per day.<sup>[19]</sup> This recommendation, however, is on the more restrictive side of recent HF guidelines.<sup>[14]</sup> Evidence has demonstrated that patients who were on a restriction of greater than 3,000 mg were less likely to be hospitalized and yet those with severe HF with NYHA class III-IV symptoms had improved outcomes with a sodium restriction of 2,000-3,000 mg per day.<sup>[1]</sup> There were also improvements in QoL, NYHA class, and NT-pro BNP for patients with a sodium restriction showing improvement in patient outcomes for this population.<sup>[4]</sup> This brings forward the recommendation to change current practice to a more individualized restriction as per physician. This allows the treatment team to decide a sodium allotment on the basis on HF severity going forward. It should still, however, be recommended that all patients consume less than 5,000 mg of sodium per day regardless of condition as per World Health Organization (WHO) guidelines.<sup>[20]</sup>

Similar recommendations would also apply for a fluid restriction. Currently, patients are educated to restrict fluid to 1,500-2,000 ml per day.<sup>[19]</sup> There is a consistent lack of data, however, on the benefits of a fluid restriction throughout the literature and only one study showed benefits on readmission rates.<sup>[8]</sup> Furthermore, evidence illustrated this intervention had potential to negatively impact QoL with patients reporting decreased nutritional intake and an elevated thirst perception.<sup>[5]</sup> Given the significant lack of evidence related to a fluid restriction it is recommended that this intervention should only be applied at the discretion of the patient's physician. It would also be recommended that further studies be completed related to fluid restriction within the organization to help guide practice going forward.

To answer the clinical question on whether a sodium and fluid restriction help reduce exacerbations and readmissions for patients with HF, the general consensus is inconclusive. In some trials, readmission and hospitalization rates improved with varying sodium allotments depending on severity of HF,<sup>[1]</sup> whereas in other trials there was no improvement.<sup>[4]</sup> Studies assessing fluid restrictions had similar outcomes with one trial noting decreased hospitalizations and others demonstrating the opposite results.<sup>[7]</sup>

Given current recommendations for both sodium and fluid restrictions have a noted lack of clear evidence, it is reasonable to shift self-care recommendations to a more liberal sodium and fluid restriction. Furthermore, there is a gap in robust research on the impact of a sodium and fluid restriction on

patients with HF providing the organization an opportunity to engage in further research opportunities. This includes the impact of these self-care interventions on both HFpEF and HFrEF patients. Ideally, by completing further research the impact of self-care interventions can be further evaluated on whether they truly improve care for this challenging population.

## 5. CONCLUSION

There have been several advancements in the care and management of patients with HF with little change to self-care interventions resulting. Two self-care interventions which are recommended throughout clinical guidelines are sodium and fluid restriction which are widely used and encouraged through patient education. Research, however, has questioned their validity and demonstrated a lack of evidence on improved outcomes. In order to determine whether there should be changes to current practice, an integrative review has been completed of seven articles. This review revealed a number of themes, namely a lack of robust data, the potential harm of interventions, and various outcomes extending beyond HF exacerbations and readmissions. There appears to be a lack of recent data on the impact of a fluid restriction as an independent variable. However, there are noted improvements in a variety of outcomes from both interventions outside of hospital readmissions which demonstrates they are valuable. Given these findings there is not enough evidence to remove restrictions but there are recommendations which can be made to modify current practice. These recommendations include liberalizing sodium and fluid restrictions and making restrictions more specific to the severity of HF for patients going forward. There is also a need for more research into this area.

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## AUTHORS CONTRIBUTIONS

LM responsible for initial review. LJ responsible for revising and editing.

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**DATA SHARING STATEMENT**

No additional data are available.

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