

Background

Heart failure (HF) is prevalent worldwide, affecting approximately 26 million people¹. In the United States, one in nine deaths is at least partially attributed to HF². More than 1 million patients are hospitalized yearly for HF and over 50% of these patients are readmitted within 6 months of discharge³. HF has a high economic cost, with totals projected to reach \$61.4 billion by 2020⁴, as well as a negative impact on patients' quality of life (QOL). Patients with HF experience impairments including role limitation due to physical problems⁵, decrease in social and physical functioning⁵, lack of energy⁶, difficulty sleeping⁶, shortness of breath⁶, and edema^{7,8}. Rehospitalization has been demonstrated to worsen QOL⁹ and poor QOL has been identified as a risk factor for mortality and hospital readmission¹⁰. Furthermore, higher incidence of HF and HF-related mortality have been noted in African Americans¹¹, especially men¹², and patients from lower socioeconomic status¹², indicating that HF is a health disparity issue.

Identifying successful strategies to reduce the social and economic burden of HF by decreasing HF patient hospitalizations is a valuable endeavor. In addition to pharmacological therapy, behavioral self-management is typically part of a HF treatment plan. A sodium restricted diet (SRD) is consistently recommended as a self-management strategy^{13,14}. While consensus on an optimal level of sodium restriction has not been reached, SRD is consistently recommended as a non-pharmacological treatment of HF¹³. This recommendation is based on a plausible physiological mechanism in which a low cardiac output leads to activation of renin which, through a series of biological responses, increases sodium retention¹⁵. This renin-angiotensin-aldosterone system-activated sodium retention coupled with excess dietary sodium is associated with fluid retention¹⁶. Observational studies have associated SRD with lower symptom burden⁸, all-cause hospitalization¹⁷, mortality¹⁷, and event-free survival¹⁸.

Barriers to adherence to SRD

There are significant barriers to self-care among HF patients. HF self-management is complex and requires high health literacy and cognitive functioning. Studies have found that compliance to SRD is low among HF patients^{4,8,13,19,20}. Sodium restriction is difficult for HF patients to adhere to, even when symptoms of HF are uncomfortable and may be alleviated with SRD. One study found that among patients with symptomatic HF, compliance to SRD was only 33% when assessed by three-day food diaries¹³.

As complex self-management of HF is challenging, many studies have found social and functional barriers to adherence. Common barriers to SRD and self-care in HF include low health literacy¹⁸, presence of multiple comorbidities²¹, clinical depression²¹, social isolation¹⁸, poor financial status¹⁸, poor functional status¹⁸, and decreased cognitive functioning²¹.

Additionally, patients have reported bad taste of food without added salt¹⁸, limited food choices¹⁸, cost of fresh fruit and vegetables¹⁸, receiving inadequate instructions regarding SRD¹⁸, difficulty eating away from home on SRD¹⁸, and social conflict when family members or friends do not follow SRD¹⁸ as barriers to adherence. Combined, all of these barriers create a significant challenge for patients and clinicians in the non-pharmacological treatment of HF.

Education regarding SRD for HF has traditionally been a brief nurse-led education in a physician's office or clinic^{18,22}. Handouts on managing HF are often provided. Studies have reported that in many cases education on SRD has been limited to the suggestion that patients follow a "low salt diet."¹⁸ Not only does this not provide an actual target for the patient, but it also fails to discuss the way that sodium is consumed in the Western diet. While some sodium is consumed as salt added on top of foods, the majority of dietary sodium is found in processed and convenience foods. As many HF patients have difficulties with ambulation and physical activity

from leg edema and shortness of breath, they may gravitate towards these high-sodium processed or convenience foods to meet their energy needs, rather than prepare a home-cooked meal themselves.

Aims

Clearly, current education for HF-related self-management and SRD is not adequate to provide patients with the knowledge, skills, and tools required to manage HF symptoms and avoid costly and uncomfortable HF exacerbation. This literature review aims to assess and integrate interventional studies designed to educate and influence behavior change in HF patients in order to inform future behavioral and educational interventions for self-management of HF.

Literature Review

A comprehensive literature search of the PubMed database was completed in order to identify publications appropriate for this literature review. Table 1 describes the search terms utilized. We screened studies by duplicates, title, then by abstract. Studies were then read and information about behavioral theories, determinants, methods, and outcomes were extracted. In addition to SRD recommendations, HF self-management includes daily weighing to monitor for fluid retention, self-management of diuretics in response to fluid retention, fluid-restricted diet, and physical activity. Because these behaviors are recommended together and rarely in isolation, this review did not exclude studies that studied a composite “self-care” measure, rather than SRD alone.

Table 1. *Search Terms for Review of Behavioral Interventions to Reduce Dietary Sodium in Heart Failure Patients*

Condition (Heart Failure)	<i>And</i>	Dietary Sodium Restriction	<i>And</i>	Intervention
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<i>Or</i>		<i>Or</i>		<i>Or</i>
Heart Fail* Congestive Heart Failure		Sodium Restrict* Dietary Sodium Salt Restrict* Salt Limit* Sodium Limit* Dietary Salt Low-sodium Low-salt		Interven* Education Behavior Self-manage* Self-care Knowledge Disease manage* Secondary prevention
Filters: Human studies, English language, Peer-Reviewed, 2000-2015				

This search identified 213 studies for possible inclusion. Of these studies, 180 were excluded based on title alone. The remaining 33 abstracts were evaluated for appropriateness of inclusion. Nineteen studies were excluded for a variety of reasons including study design and lacking a true educational or behavioral intervention. A total of 14 studies were identified to fit our inclusion criteria.

Of the 14 articles reviewed herein, we identified characteristics of the interventions: Implementation Settings, Type of Education Provided, and Theory-Based. We also identified inclusion of family members in education as a significant factor in two studies that we will discuss. Most interventions were multi-factorial and had multiple characteristics. Table 2 shows the frequency with which characteristics were found in the interventions.

Table 2: *Frequency of Characteristics in Interventions*

Implementation Settings	
Telehealth	3
In-Home	3
In-Office	5
Type of Education	
Counseling	8
Lecturing	1
Handout	4
Video	3
Theory-Based	
Health Belief Model	2
Theory of Planned Behavior	1
Social Cognitive Theory	1
Self-Determination Theory	2

Implementation Settings

Of the 14 studies included in this review, 11 reported the setting in which the intervention was conducted. Three studies used telehealth to interact with patients, three studies used in-home settings, and four studies used an in-office setting. The counseling techniques and type of education provided differed significantly among these studies.

Telehealth Interventions

Three studies we reviewed used a telehealth intervention. One study included a range of 5-8 ten-minute phone calls from the study educator over the course of four weeks that aimed to reinforce self-care techniques in HF management, including SRD²³. Another study consisted of a single nurse-led intensive educational session, followed by a monthly telephone follow-up for 12 months²⁴. The third study included a home visit by a nurse at baseline, followed by weekly or

biweekly telephone follow-up phone calls by the nurse-manager aimed at reinforcement of education and identifying clinical changes²⁵. Nurse-managers were also available by phone 24 hours per day, 7 days per week if the participant experienced any clinical status changes, such as a change in weight greater than two pounds²⁵.

In-Home Interventions

Three studies we reviewed included an in-home session with the participant, whether for counseling or assessment. One study provided weekly nurse-led low-sodium education to the participant in an in-home setting for six weeks²⁶. Another study had a baseline in-home visit by a nurse that focused on dietary and medication compliance, which was followed by telephone follow-up for 90 days²⁵. The third study included one in-home nurse-led intensive educational and counseling session that was followed by follow-up phone calls²⁴.

In-Office

Five studies included in-office counseling or education. One intervention provided diet and nutrition counseling, a food exchange list, a food preparation list, and a 4-step approach to managing a low-salt diet²⁷. The authors did not provide information regarding the 4-step approach used. A second intervention provided two 1-hour counseling and education sessions with a registered dietitian²⁸. One intervention provided an in-office 40-minute lecture and group-teaching session²⁹. Lastly, two studies by the same research group provided family-patient dyads with counseling by a nurse and registered dietitian^{22,30}.

Type of Education/Information Provided

All of the studies reviewed provided some form of education or counseling to participants regarding HF self-management, including SRD. Some studies provided information via multiple means, providing a DVD, a handout, and an in-person educational session.

Counseling

Eight of the 14 studies provided counseling to study participants. In one study, a nurse provided instructions on the relationship between high dietary sodium intake and symptoms of fluid volume excess, identifying high- and low-sodium foods, strategies for reducing dietary sodium intake, and tips for choosing low-sodium food items²⁶. Two studies by the same research group provided in-depth education and counseling to participant-family member dyads by a nurse and registered dietitian that lasted approximately 60-90 minutes^{22,30}. One study provided patients with two one-hour sessions with a registered dietitian who counseled patients about strategies to follow a 2g/day sodium-restricted diet²⁸.

Lecturing

One intervention provided in-office education without counseling²⁹. This intervention provided a single 40-minute education session that included lecturing and group teaching.

Handout

Four of the 14 studies provided patients with an educational handout about self-management of HF. One study provided a booklet for both patients and family that contained information that described HF, listed recommendations to maintain a heart-healthy lifestyle, and signs and symptoms of changes in condition status in HF that would warrant medical attention²⁷. A second study provided each participant with a low-sodium shopper's guide handout for patients who had been prescribed a 2g/day sodium restriction²⁸. The low-sodium shopper's guide included tips for label reading, eating in restaurants, and seasoning food without the use of salt²⁸.

One intervention utilized direct mail to provide patients with a simple fact sheet about HF³¹. Lastly, one study reported that it provided written education, but did not elaborate on the content of this education²⁴.

Video

Three of the 14 studies provided patients with an educational DVD or CD-ROM with information about home self-care of HF. One study provided a CD-ROM aimed at interactive HF education, but it did not elaborate on the details of the CD-ROM or the education²⁴. A second study provided an “educational film” on CD, which was also not elaborated upon by study authors²⁹. Last, a study provided a *Living with Heart Failure* DVD and associated booklet³¹.

Theory-Based

Six of the 14 studies included in this review based their intervention on a behavioral theory. However, none of these studies elaborated in full on the way that the theory was operationalized into an intervention.

Self-Determination Theory

Two studies authored by the same research team utilized Self-Determination Theory to inform the educational and behavioral aspects of the intervention^{22,30}. Briefly, Self-Determination Theory posits that people have “innate psychological needs for autonomy, competence, and relatedness, which, when satisfied, enhance their autonomous motivation and well-being. The enhancement of growth and well-being requires strategies to satisfy those basic needs and supportive social conditions³².” Both of these studies aimed to apply Self-Determination theory by enrolling participants with a family member, most often a significant

other, and providing education and counseling on effective open communication that provides the patient with autonomy and support^{22,30}.

Health Belief Model

Two studies used the Health Belief Model (HBM) as the theory behind their intervention. One study identified the perceived barriers and benefits to self-care held by HF patients, and provided targeted messaging in response to the barriers and benefits that patients reported most frequently. Another study did not use HBM to inform the intervention, but rather used constructs of HBM, namely perceived benefits, barriers, susceptibility, and threat as outcome measures²⁹.

Theory of Planned Behavior

One study stated that it utilized the Theory of Planned Behavior (TPB) in informing the educational intervention, but did not discuss the intervention in detail, nor how TPB was operationalized²⁶.

Social Cognitive Theory

One study reported that it utilized the Social Cognitive Theory to inform an educational intervention²³. Briefly, the SCT assumes that behavior is a result of personal, environmental, and behavioral factors that interact and influence each other,³². The goal of this intervention was to increase adoption of self-care behaviors. The study did not report how SCT was used to inform the intervention.

Inclusion of Family Members

HF patients have reported that a significant barrier to adherence to SRD is social conflict with family members and friends who are not also adhering to SRD¹⁸. Additionally, it seems appropriate to involve a family member in the education of heart failure treatment, as the family

member is often fully or partially responsible for meal planning and preparation, and may also take part in helping with or reminding patients to adhere to medication schedules and other daily self-care behaviors, such as fluid restriction, physical activity, and daily weighing.

Two studies authored by the same research group included a family member, most often a significant other, in the educational intervention^{22,30}. The most recently published study worked with participant and family member dyads in communication skills, allowing the member of the dyad with heart failure to feel supported by the family member²². Main discussion topics in the intervention setting covered perceptions of living with heart failure or having a loved one with heart failure, communication techniques to promote patient autonomy (part of the Self-Determination Theory), and role playing of heart failure-related self-care scenarios. This study was successful, finding that at four months there were significant differences between the intervention and control groups with regard to heart failure knowledge, autonomy support, and perceived family criticism scores. The other study authored by the same team was a pilot study that included two sessions with family aimed at enhancing family support and communication³⁰. This study found a decrease in dietary sodium in both the control and intervention group, but a greater number of participants in the intervention group were able to reduce sodium intake by 15%³⁰.

Synthesis and Discussion of Results

Each of the behavioral interventions reviewed here utilized multiple approaches to affect behavior change in heart failure patients. Results were mixed and inconclusive. In-person education alone was not sufficient to induce behavior change^{24,26}, regardless of number of education sessions. Only one study provided educational materials to patients without providing additional in-person resources, and found no significant difference in sodium intake

between the intervention and control groups³¹. Other studies provided educational materials of various media (DVD, CD-ROM, video, paper handouts) in combination with counseling, and found significant decrease in sodium intake²⁸ and patient-reported quality of life²⁷

Both dietitian-led and nurse-led counseling and educational interventions were included in this review^{25,27,28}, and consistently found statistically significant increases in self-care behavior, decrease in hospital readmissions²⁵ and decrease in sodium intake²⁸. Family-focused interventions showed promise and found significant increases in HF self-care knowledge but no change in behaviors. Both of these interventions were completed by the same research group, and more studies are needed support these findings^{22,30}.

Theory-based interventions showed mixed results. Two studies utilized the Health Belief Model and had no significant findings^{29,33}. One study utilized the Social Cognitive Theory and found a significant increase in patient self-care²³. Two studies utilized Self-Determination Theory and found significant increases in knowledge, but no significant change in behaviors^{22,30}. One study employed the Theory of Planned Behavior and found no change in dietary sodium intake²⁶.

Limitations

There are significant limitations to our review. First, HF self-management is complex and multi-faceted, with SRD as only one component. Only one of the 14 studies reviewed looked at SRD in isolation. The remaining 13 studies aimed to increase HF self-management and adherence to recommendations as a whole. It is possible that providing education and counseling for all aspects of HF self-management behavior change at one time is too complex for patients to grasp all together, and thus interventions were unsuccessful. It is also possible that each intervention highlighted different aspects of HF self-management more or less than other

interventions, and thus we are unable to make a true comparison. None of the papers that looked at self-management as a whole elaborated on the amount of time focused on SRD, and thus we can't fully extrapolate from these studies to inform a similar intervention.

None of the articles reviewed discussed how they operationalized the theories on which the intervention was based. While theoretical frameworks are often used to inform behavioral and educational interventions, and can be quite successful, the success is contingent upon correctly applying the framework to the intervention. As there was no discussion of how the framework was used to inform the intervention, we do not know if the framework itself was responsible for significant or insignificant findings.

Third, many of these studies only focused on influencing one specific level of influence to human behavior. Nutrition education theory posits that nutrition education is more likely to be successful when it includes multiple levels of influence, focuses on behaviors and actions, addresses the influences on determinants of behavior change, uses theory and evidence, and uses appropriate behavior change strategies and education principles³². Similarly, the Social Ecological Model posits that behavior has multiple spheres of influences, rather than just personal motivation. Some studies reviewed intervened at both the individual and interpersonal levels by including family members in counseling sessions^{22,30}, but many simply provided education and brief counseling. While knowledge is certainly important when influencing behavior change, it is certainly not sufficient for true and lasting change. Nonetheless, this review provides some guidance to help inform future interventions.

While outside the scope of this review, it is imperative to mention the food environment when discussing patient adherence to SRD. The US food system is high in processed convenience foods that are high in sodium. Individuals trying to adhere to SRD need to work

exceptionally hard to avoid foods high in sodium. This would require cooking most meals in the home and avoiding many frozen or canned foods. A study by Hendriksen and colleagues³⁴ modeled the possible health benefits of sodium-reduction strategies in processed foods in the Netherlands and found that 1.7% of heart failure cases might be preventable if salt intake met the recommended 6g/day restriction in the Netherlands. In the United States, most medical groups have recommended a 1.5-3g/day sodium restriction, so it is possible that if our food environment were better able to provide this level of sodium in foods, even more cases of heart failure could be prevented or controlled. Public health officials and medical practitioners may wish to explore possible partnerships with government and the private sector to reduce unnecessary sodium in packaged and processed foods.

Informing Future Research

Self-management of heart failure is complex and challenging for patients, caregivers, and medical providers. Heart failure exacerbations and subsequent hospital readmissions can be costly⁴, and negatively impact patient quality of life. Thus, it is imperative to develop and research interventions aimed at helping patients manage their condition at home. The studies analyzed in this review all aimed to help individuals decrease sodium intake, both independently and concurrently with other HF self-management behaviors. Of the 14 studies reviewed, 3 had null findings, 4 found significant improvement in overall self-care, and 3 found a significant decrease in dietary sodium.

As discussed previously, behavioral and educational nutrition theory posits that interventions that aim to affect behavior change at multiple levels of influence have a better chance of being successful. Few, if any, of these studies aimed to intervene at multiple levels of influence. All of the interventions reviewed intervened at the individual level of the

socioecological model, and two intervened at the interpersonal level^{22,30} by including family members in education. However, none were able to successfully intervene at the community or societal level. Future interventions are more likely to be successful if they are able to intervene at these upper levels, perhaps by changing the food environment or linking community resources to primary care and hospital facilities.

Interventions Currently Being Studied

There are two interventions currently being trialed at large medical centers in the United States that are worth noting, even though they are in the early stages.

University of North Carolina Health Care FLEX Diet

Dietitians at the University of North Carolina at Chapel Hill Hospitals are piloting a new intervention for the inpatient HF population. These patients are traditionally placed on a sodium-restricted diet of 3g sodium per day. The dietary software that regulates patients' meals in the hospital restricts the patients to one gram of sodium per meal. Patients often feel limited by this restriction, as many of the preferred foods at lunch and dinner contain more than one gram of sodium. Alternatively, in the new FLEX diet being trialed, patients are educated about the sodium restriction and the physiological mechanisms driving it. They are provided a list of food items the hospital offers and the amount of sodium in each food. The patients are able to call the diet office to order their own meals, and they are educated on meal planning to remain under 3g of sodium per day. If they choose to have a meal high in sodium for lunch, the diet office personnel informs the patient that they will need to have a lower-sodium meal for dinner. Patients are also provided feedback about their success in limiting their sodium so they are able to learn and continue self-restricting.

While statistical outcomes are not currently available for this intervention, anecdotal evidence has been positive. Patients have appreciated the flexibility the diet allows them, and have reported having a better grasp on sodium sources while in the hospital. Those who remain hospitalized for extended periods of time, for example in the case of patients awaiting heart transplant, have become accustomed to the diet and are able to plan their meals successfully. While food sources will change once patients are discharged from the hospital, this education is likely to stay with them as they move forward.

GOURMET-HF Pilot Study

Researchers at Columbia University Medical Center have received a grant for a pilot study aimed at helping patients to adhere to SRD after discharge from the hospital. In this three-center, randomized, single-blind pilot study, the intervention group of approximately 30 subjects with heart failure will receive prepared, home-delivered DASH/SRD-compliant meals for four weeks. The control group containing a similar number of research subjects will receive usual dietary advice for four weeks. The study is aiming to increase patient-reported quality of life scores.

While there is no behavioral theory driving this intervention, study authors have theorized that a hedonic shift happens when patients restrict sodium from their diet for extended periods of time. This hedonic shift refers to a change in an individual's affinity for salt when adhering to SRD. At first, an individual who decreases intake of salt will experience a higher affinity for salt taste, but with continued sodium restriction, the patient's taste for salt will decrease³⁵, and they will experience an increased acceptance of low-sodium foods³⁵. The GOURMET-HF study plans to provide DASH/SRD-compliant meals to these HF patients throughout the period when the hedonic shift occurs, assuming that when the intervention is

complete and patients are no longer receiving the meals, that they will have an increased taste for lower-sodium meals.

There are some possible limitations to this study. Heart failure patients are often older with limited mobility. As such, cooking healthy meals can be difficult. Providing DASH/SRD-compliant meals to these patients will certainly help them to consume less sodium throughout the intervention period. However, the question remains if the patients will be able to procure lower-sodium foods after the intervention ends. Much of the sodium in the Western diet is found in processed and convenience foods, rather than in home-cooked foods. While patients may experience an increased taste for low-salt foods, they may not have the luxury to procure these foods after the intervention has ended.

As has been previously discussed in this review, interventions aimed at multiple levels of influence have a greater chance of success. Adding an educational and behavioral component to this intervention may increase the likelihood of success. Additionally, including case managers or social workers in this intervention to provide financial or meal assistance may also increase likelihood of success.

If this pilot study is found to be successful, one barrier to implementing this intervention on a greater scale will be cost. It is expensive to provide three meals per day to individuals in their home. However, recurrent hospital admission for heart failure exacerbation is also quite costly. It is possible that hospital centers will be willing to provide an at-home meal-delivery service in order to decrease readmissions and save money. It will be interesting to see the results of this pilot study to inform additional interventions and research.

Conclusion

Patient self-management of HF is time-consuming, multi-faceted, and confusing. It requires significant knowledge of medications, fluids, and foods. Developing educational and behavioral interventions to help HF patients adhere to SRD and perform other HF self-management tasks are imperative to lowering the prevalence of hospital readmission for HF exacerbation, which can be costly and unpleasant. The interventions reviewed here all aimed to assist patients in adhering to SRD, either in isolation or combined with other self-care practices. Most studies showed modest success, with some statistically significant findings. However, no studies met all study aims.

It is possible that these studies were unsuccessful because they intervened only at the individual level of influence, and did not take into account the many elements that influence eating behavior. Factors such as time, money, education, and physical mobility influence the day-to-day intake of an individual, but the food environment and social and cultural influences can't be ignored. Studies that are able to successfully influence HF patients' knowledge, attitudes, and beliefs about sodium in food while also influencing the environment in which the patient consumes their food, whether it be at home, at a restaurant, or in assisted living, will likely find the most success. Using theory to inform interventions may be helpful, but only if the theory is properly operationalized into the intervention.

As more individuals in the US and worldwide population continue to age, the prevalence of HF will continue to grow. It is imperative that successful, cost-effective, and interdisciplinary interventions are developed to help patients manage their disease outside of the hospital. The studies reviewed here were all good steps to developing a successful intervention. It is likely that combining facets of each intervention will lead to greater success. Additional research is needed in order to identify the most effective interventions. While these interventions are being

researched and developed, it would benefit providers to work together to provide interdisciplinary care aimed at helping patients to acquire and consume lower-sodium foods.

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