ISSN : 2443-4019 | eISSN : 2502-2083
ADI HUSADA Nursing Journal
Jurnal Keperawatan - Sekolah Tinggi Ilmu Kesehatan Adi Husada Surabaya

Fluid Management in Heart Failure Patients in Reducing Oedema and Fluid Excess: A Systematic Review

Aris Teguh Hidayat[1*], Fermata Sari[2], M Yamin[3], Leny Joice Sianturi[4]
[1,2,3,4]Stikes Hesti Wira Sriwijaya, Palembang, Indonesia

Correspondent Author:
Aris Teguh Hidayat

Email :
arishidayatat@gmail.com

Keywords :
Fluid Management, Fluid Overload, Heart Failure Patient, Reduce Oedema

Abstract

When evaluating and treating individuals with heart failure, volume overload and fluid congestion are issues. One of the main causes of hospital admission, rehospitalization, and mortality in heart failure is fluid congestion. Reducing congestion and preserving euvolemia is crucial because patients with heart failure who are treated with fluid overload have a higher risk of readmission and/or mortality. Fluid management is one intervention that nurses can use to help patients with heart failure avoid oedema and fluid overload. This systematic study aims to reduce oedema and fluid overload in heart failure patients by identifying fluid management strategies. Data collection methods used online databases: PubMed, Google Scholar, Science Direct, Scopus, ClinicalKey, ClinicalKey Nursing, EBSCOhost, Springer Link, and Sage Journal using the keywords Heart Failure Patient, Fluid Management, Reduce Oedema, and Fluid Overload. Data were analyzed using PRISMA. Based on the review of 5 selected articles, it was found that fluid management was carried out to reduce oedema and fluid overload in patients with heart failure. The primary cause of hospitalization for patients with acute decompensated heart failure (ADHF), which mostly manifests as pulmonary and systemic congestion, is excessive water retention brought on by sodium ion imbalance. For patients with ADHF, relieving congestion is a crucial part of treatment.

INTRODUCTION

Heart failure is a complex, progressive clinical syndrome and is the final stage of all types of heart disease, characterized by impaired heart function to fill or eject blood, where the heart cannot respond to the body's metabolic needs (Sohn et al., 2019; Jorge-Samitier et al., 2020; Wu et al., 2019; Stamp et al., 2018). In the world, the prevalence and incidence of heart failure are estimated at 37.7 million people (Sohn et al., 2019). In Indonesia itself, the incidence of heart failure, according to Basic Health Research data in 2013, based on a doctor's diagnosis, was 0.13% or around 229,696 people (Basic Health Research [Riskesdas], 2013). This figure increased in 2018 to 1.5% or around 1,017,290 people (Basic Health Research [Riskesdas], 2018).

According to several studies (Kitsiou et al., 2021; Jorge-Samitier et al., 2020; Hassanzadeh et al., 2021; Jafari et al., 2018; Sohn et al., 2019), 50% of heart failure patients pass away within the first five years after diagnosis, making heart failure the world's largest cause of death and high health care expenditures. Over 9 million deaths occur before the age of 60, and 90% of premature deaths take place in low- and middle-income nations, according to the Indonesian Ministry of Health (2019). Heart failure-related expenses in the United States have risen from $23 billion in 2002 to $31 billion in 2012 and are projected to reach approximately $70 billion by 2030 (Schaumberg et al., 2017).

Clinical symptoms of heart failure occur rapidly or with exacerbation, accompanied by an increase in plasma natriuretic peptide levels, which are often life-threatening and require immediate medical intervention with immediate hospitalization. Acute heart failure is the main reason for hospitalization of patients aged 65 years and older, of which 80-85% present with acute exacerbation of chronic heart failure, namely acute decompensated heart failure (ADHF). ADHF has a poor prognosis, with in-hospital mortality ranging from 4 to 7% and a 60- to 90-day readmission rate of around 30% (Hu et al., 2020).

Rapid or worsening clinical symptoms of heart failure are associated with elevated plasma natriuretic peptide levels. These symptoms are frequently fatal and necessitate prompt medical attention, including hospitalization. Patients 65 years of age and older are primarily hospitalized due to acute heart failure, of which 80–85% have acute decompensated heart failure (ADHF), an abrupt aggravation of chronic heart failure. ADHF has a poor prognosis, with a readmission rate of about 30% after 60 to 90 days and an in-hospital mortality rate of 4 to 7% (Hu et al., 2020).

Treatment for heart failure may involve triple or quadruple therapy. Diuretic medication, particularly with loop diuretics, has been identified as the primary treatment for heart failure symptoms among the numerous heart failure management approaches. Furosemide, bumetanide, and torasemide are examples of loop diuretics that function by blocking the sodium, potassium, and chloride (Na+, K+, and 2Cl-) co-transporters in the thick ascending loop of Henle. Consequently, loop diuretics alleviate pulmonary congestion, lessen dyspnea, and lessen symptoms of fluid excess. In summary, the two primary purposes of loop diuretics are to reduce pulmonary congestion in patients with acute decompensated heart failure (ADHF) and to maintain normal body volume in patients with chronic heart failure (Eid et al., 2021).

Heart failure patients still have a high short-term risk of death and readmission despite advancements in treatment. Fluid congestion is the primary cause of short-term readmission, with about 25% of patients treated for heart failure being readmitted within 30 days (Zisis et al., 2021). When evaluating and treating patients with heart failure, volume overload and fluid congestion are crucial concerns (Ajello et al., 2020). In heart failure, fluid congestion is a leading cause of hospitalization, readmission, and mortality. Reducing congestion and sustaining euvolemia are crucial because heart failure patients who are hospitalized with fluid overload are more likely to be readmitted and/or die.

The sympathetic nervous system, renin-angiotensin-aldosterone system, arginine-vasopressin system, natriuretic peptides, and endothelin are all activated by decreased cardiac output in heart failure with reduced ejection fraction, which causes the body to retain salt and water. Patients will thus exhibit the primary clinical signs of peripheral edema and dyspnea brought on by fluid excess and/or redistribution to the lungs. Appropriate fluid management for the treatment of edema in heart failure patients is determined by examining these pathophysiological causes.

RESEARCH METHODS

The method used in this literature review uses the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow. The method applied for this study is a journal review, where a study is conducted to analyze the literature that has been selected from various sources, which will later become a new idea. The journals used in this literature study are journals that have discussed various topics about fluid management in heart failure patients in reducing oedema and fluid overload. Academic journal searches were obtained through the online database of the University of Indonesia, including: PubMed, Google Scholar, Science Direct, Scopus, ClinicalKey, ClinicalKey Nursing, EBSCOhost, Springer Link, and Sage Journal. Published from 2017-2022 with the keywords "Heart Failure Patients AND Fluid Management AND Reduce Oedema AND Fluid Overload.

Articles obtained through search results using keywords are 53,066 articles. The selection of articles was carried out by determining limiters such as the last 5 years, full text, title, language, and population, so that 16,319 articles were obtained. Articles were selected according to the predetermined inclusion criteria, with a total of 5 articles. The final results through a feasibility study using the Critical Appraisal Skills Program (CASP) tools obtained 5 articles, consisting of 2 articles using the Systematic Review and Combined Meta-Analysis method, 2 articles using the Randomized Control Trial (RCT) method, and 1 article using the Review Study.

In the journal selection process, there are several inclusion criteria, namely: 1) full-text, 2) in English, 3) clearly explaining the objectives and methods of the study, 4) related to fluid management in heart failure patients in reducing edema and fluid overload, 5) published between 2017-2022, and 6) research abroad. The exclusion criteria are research in the form of journal reviews, such as scoping reviews and systematic/literature reviews. After being adjusted to the inclusion criteria, 23 appropriate journals were obtained. Then, the flow in the article selection process is presented in Figure 1.

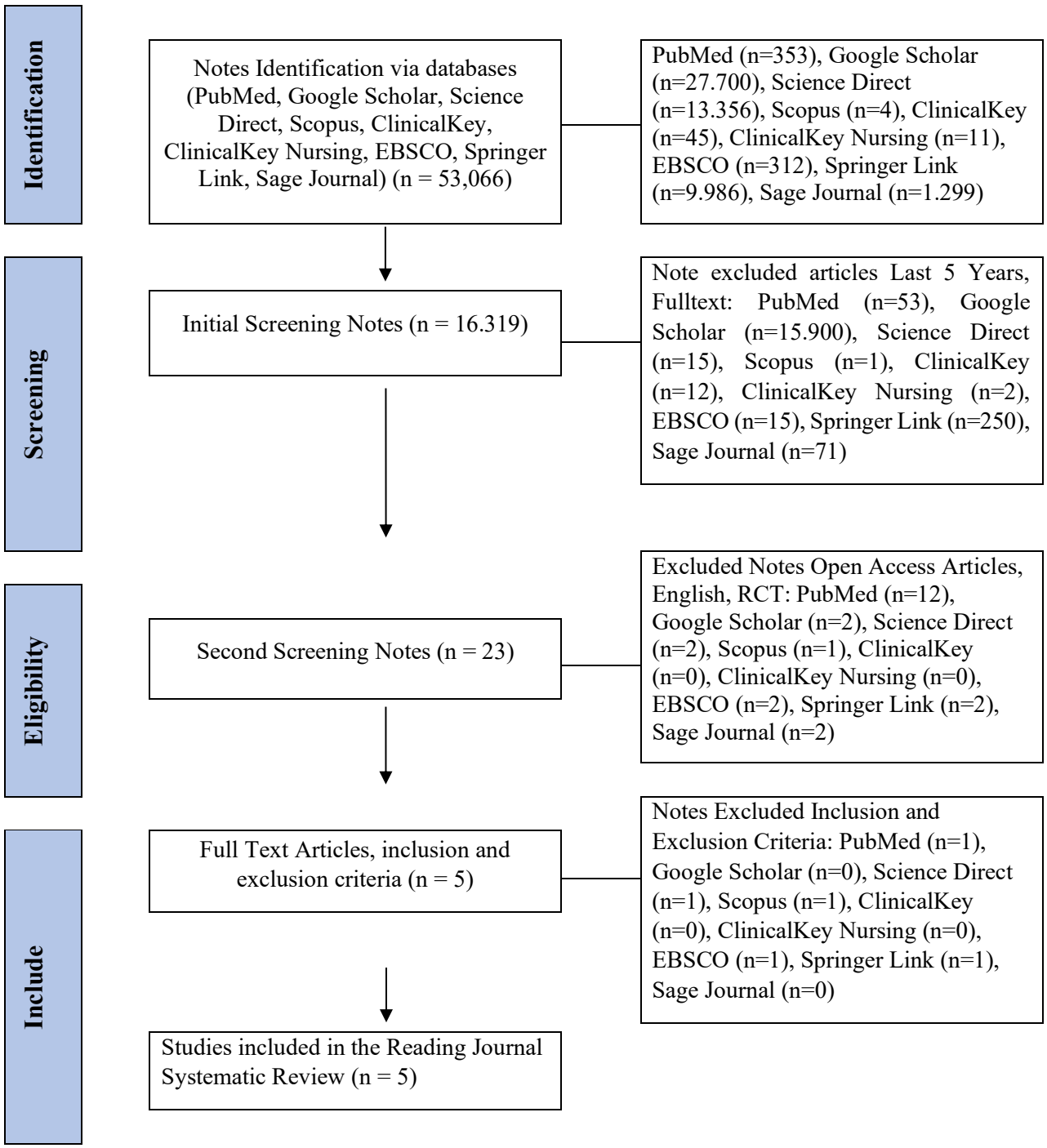

Figure 1. Article Selection Process using PRISMA

RESULT

Based on the suitability of the topic to be discussed, 5 journals were determined to be discussed further. The following are the selected journals that the researcher analyzed in this literature review study.

Table 1. Details of The Results of The Main Selected Journals for Systematic Reviews

No	Author, Year of Publication, Place	Research Title	Purpose	Method	Sample	Procedure	Result
1	Jingyi Hu, Qianli Wan, Yue Zhang, Jun Zhou Miamio Li, Li Jiang, & Fang Yuan (2020), China	Efficacy and safety of early ultrafiltration in patients with acute decompensated heart failure with volume overload: a prospective, randomized, controlled clinical trial	The aims of the study were to investigate the efficacy and safety of early ultrafiltration in acute decompensated heart failure (ADHF) patients.	RCT	Within 24 hours of admission, 100 patients with ADHF were randomly randomized to either the torasemide with tolvaptan (n = 60) or the early ultrafiltration (n = 40) groups. Weight loss and an increase in urine production on days 4 and 8 of treatment were	Patients were randomized to either the torasemide+tolvaptan group or the early ultrafiltration group within 24 hours of arrival. On day four of treatment, the two groups' weight reduction and increased urine production were assessed. Patients in the early ultrafiltration group were treated sequentially with torasemide (mean dose: 20 mg/day) and tolvaptan (mean dose: 10 mg/day) from day 4 to day 7. On day eight,	Weight loss and an increase in urine production on days four and eight of treatment were the main results. On day four, patients who received early ultrafiltration for three days lost more weight (kg) and produced more urine (mL) than the torasemide + tolvaptan group. At one and three months of follow-up, there were no discernible differences between the two patient groups' readmission and death rates. The steady renal characteristics of both groups were comparable.

No	Author, Year of Publication, Place	Research Title	Purpose	Method	Sample	Procedure	Result
					the main results.	measurements were taken of the two groups' increased urine output, weight loss, dyspnea score, inferior vena cava (IVC), inferior vena cava collapse index (IVC-CI), jugular venous pulse (JVP), JVP score, BNP, and NYHA (New York Heart Association) functional class.	
2	Ying Yang, Chao Shen, Jiangting Lu, Fen Xu, Jinshan Tong, Jiangfen Jiang, & Guosheng Fu (2019), China	Early continuous ultrafiltration in Chinese patients with congestive heart failure (EUCCHF): study protocol for an open-label registry-based	The early continuous ultrafiltration in Chinese patients with congestive heart failure (EUC-CHF) trial was designed to evaluate the efficacy and	Study Protocol	Two therapy groups of fourty individuals with heart failure will be formed (n = 20 for each group).	Patients will be sequentially enrolled 1:1 to receive either UF or regular medical therapy (control group). In accordance with local clinical practice and with nursing monitoring capabilities available during UF, patients from the early UF	The findings demonstrated how weight loss and dyspnea severity levels changed following treatment.

No	Author, Year of Publication, Place	Research Title	Purpose	Method	Sample	Procedure	Result
		prospective clinical trial	safety of early UF in patients with acute decompensated HF to reduce volume overload and improve clinical outcome. In addition, the study will determine risk factors help to screen out patients appropriate for early UF treatment.			group will get treatment with one or more UF sessions within 24 hours of admission until their symptoms improve. Hematocrit will be tracked throughout the UF procedure to lower the possibility of acute hypovolemia-related kidney damage brought on by severe dehydration. The patient's cardiologist will have the last say over any further medical treatments. During the UF procedure, IV LDs that were initiated prior to enrollment will be stopped. In accordance with the diuretic protocol, the doctor may adjust the LDs dosage during the follow-up period based	

No	Author, Year of Publication, Place	Research Title	Purpose	Method	Sample	Procedure	Result
						on the patient's circumstances.	
3	Peter Samuel Eid, Doaa Alaa Ibrahim, Ahmad Helmy Zayan, Manal Mahmoud Abd Elrahman, Mostafa Ahmed Abdo Shehata, Hend Kandil, Mahmoud Ahmed Abouibrahim, et al (2021), China	Comparative effects of furosemide and other diuretics in the treatment of heart failure: a systematic review and combined meta-analysis of randomized controlled trials	To summarize the relative efficacy and safety of all available diuretics used in the treatment of patients with heart failure.	A Systematic Review and Combined Meta-analysis of Randomized Controlled Trials	34 RCTs with 2709 individuals qualified for meta-analysis out of the 54 studies (10,740 patients) that made up this systematic review.	With the exception of two studies that recruited patients with acute heart failure and were excluded from our analysis due to insufficient data, all of the trials recruited patients with chronic heart failure. With the exception of two trials that used intramuscular dosage forms and six studies that used intravenous dosage forms, the majority of studies evaluated the effectiveness of loop diuretics in oral dosage forms. The studies' follow-up periods varied from three to seven hundred and twenty-eight days.	In comparison to furosemide, the spironolactone-treated group had significantly higher serum potassium levels, and the bumetanide-treated group had significantly higher serum sodium levels [MD (95% CI) = 0.30 (0.05, 0.55) and MD (95% CI) = 0.30 (0.5, 0.05)]. Additionally, diapamide caused more gastrointestinal side effects [RR (95% CI) = 2.65). Additionally, compared to furosemide alone and furosemide + high dose spironolactone (40 mg + 100 mg), the combination of

No	Author, Year of Publication, Place	Research Title	Purpose	Method	Sample	Procedure	Result
						Heart rate, blood pressure, urine parameters, mortality, adverse events, hospitalizations, and body weight were among the outcomes evaluated in the research.	furosemide and optimal dose spironolactone (20 mg + 40 mg) demonstrated a substantial improvement in ejection fraction (EF). Additionally, we did not find any significant differences between diuretics in terms of body weight, blood pressure, urea, elevated pulmonary venous congestion, neurological symptoms, electrolyte imbalances and dehydration, hospital readmission, or death rates. We were unable to draw meaningful conclusions about the effects of several medications on blood uric acid, BUN, and creatinine levels because baseline data were unavailable.

No	Author, Year of Publication, Place	Research Title	Purpose	Method	Sample	Procedure	Result
4	Georgios Zisis, Amera Halabi, Quan Huynh, Christoper Neil, Melinda Carrington, & Thomas H Marwick (2021), Australia	Use of novel non-invasive techniques and biomarkers to guide outpatient management of fluid overload and reduce hospital readmission: systematic review and meta-analysis	To determine the effectiveness of AFMP (Advance Fluid Management Program) in improving patient outcomes.	Systematic Review and Meta-analysis	Nine studies with a total of 5362 patients (2759 in the control group and 2603 in the intervention group).	Patients discharged with standard diuretic therapy or a plan made up the control group, whereas patients assigned to the treatment group either followed a guided fluid management protocol in the hospital or were discharged with an advanced fluid management program follow-up. Optimal decongestant and fluid management, together with education and adherence to fluid limitations, were the main goals of intervention follow-up programs.	Our findings encourage and urge maintaining euvolemia upon discharge. Rehospitalization is less likely for heart failure patients with AFMP in the hospital and/or after discharge.
5	Richard B. Thompson, Kelvin Chow, Joseph J. Pagano, Viktor Sekowski, Evangelos D. Michelakis, Wayne	Quantification of lung water in heart failure using cardiovascular	To develop a simple cardiovascular magnetic resonance	Review Article	After excluding four patients with incomplete hemodynamic	A widely accessible single-shot fast spin-echo collection was used to estimate lung water density	CMR LWD and invasively recorded left-sided filling pressures were associated in the validation cohort (R =

No	Author, Year of Publication, Place	Research Title	Purpose	Method	Sample	Procedure	Result
	Tymchak, Mark J. Haykowsky, et al (2019), Canada	magnetic resonance imaging	(CMR) approach for lung water quantification, to correlate CMR-derived lung water with intracardiac pressure, and determine its prognostic significance.		data and one with cardiovascular magnetic resonance (CMR) image abnormalities, nineteen heart failure patients (16 males, age 51 ± 13 years) were recruited into the validation cohort.	(LWD,%) in two study cohorts. Validation Cohort: In 19 heart failure patients receiving cardiac catheterization, LWD was compared with either pulmonary capillary wedge pressure or left ventricular end-diastolic pressure. Prospective Cohort: 256 participants—121 with heart failure, 82 at risk for heart failure, and 53 healthy controls—had their LWD assessed. Clinical results were assessed for a maximum of one year.	0.8, $p < 0.05$). The mean LWD in the prospective cohort was 16.6 ± 2.1% for controls, 17.9 ± 3.0% for patients at risk, and 19.3 ± 5.4% for patients with heart failure ($p < 0.001$). LWD > 20.8% (mean + 2 standard deviations of healthy controls) was an independent predictor of mortality, hospitalization, or ER visit within a year in patients with or at risk of HF, with a hazard ratio of 2.4 (1.1-5.1, $p = 0.03$).

DISCUSSION

The primary cause of hospitalization for patients with acute decompensated heart failure (ADHF), which mostly manifests as pulmonary and systemic congestion, is excessive water retention brought on by sodium ion imbalance. One of the main treatments for ADHF is congestion relief. According to a study by Hu et al. (2020), individuals with hypervolemic ADHF who had early ultrafiltration lost more weight and produced more urine than those who received torasemide with tolvaptan.

In order to reduce extra volume, ultrafiltration involves passing water and small to medium-weight solutes across a semipermeable membrane. Torasemide and tolvaptan were administered sequentially to patients in the early ultrafiltration group; this treatment had a greater impact on volume load reduction than intense diuretic therapy. Urine production increased more in patients receiving early ultrafiltration and sequential therapy with diuretics than in patients receiving ultrafiltration alone. Ultrafiltration reduces congestion symptoms, enhances heart pressure and exercise capacity, and restores diuretic response in individuals with diuretic resistance after draining a significant amount of isotonic fluid (Hu et al., 2020).

This is consistent with a study by Yang et al. (2019), which found that ultrafiltration (UF) improves hemodynamics, restores diuretic responsiveness, and eliminates peripheral edema in patients with severe fluid overload and Loop Diuretic (LD) resistance. Fluid evacuation from LDs therapy may be accomplished more quickly and physiologically with UF treatment. Compared to LDs, ultrafiltration is linked to longer clinical stabilization, reduced rehospitalization rates, greater decongestant effects, and improved hemodynamic variables (Yang et al., 2019).

By activating the sympathetic nervous system (SNS) and the renin-angiotensin-aldosterone system (RAAS), loop diuretics can exacerbate the prognosis of heart failure. Distal nephron epithelial cells experience hypertrophy and hyperplasia as a result of enhanced solute transport to the distal segment by diuretics, and the natriuretic response following diuretic dosage gradually diminishes. Diuretic resistance and adaptability are also influenced by post-diuretic sodium retention. Loop diuretics are nevertheless necessary despite these possible issues, particularly for ADHF patients, as the average length of hospital stay is inversely correlated with the intensity of congestive symptoms (Eid et al., 2021).

According to research by Eid et al. (2021), torasemide performed better than furosemide in treating heart failure patients in a number of ways, including lowering BNP, CVF, and edema. In contrast to furosemide, spironolactone preserved elevated serum potassium levels, and bumetanide raised salt levels. GFR, water extraction, sodium excretion, body weight, blood pressure, urea, increased pulmonary venous congestion, neurological symptoms, mortality, and other renal parameters like urea and creatinine did not significantly differ between the various diuretics (Eid et al., 2021).

Zisis et al. (2021) published another study on fluid management, characterizing AFMP (Advance Fluid Management Program) as an intervention that offers diuretic medication in hospitalized patients or after discharge, guided and regulated by intravascular volume monitoring. According to the findings, patients with heart failure who used AFMP while in the hospital and/or after being discharged were less likely to be readmitted (Zisis et al., 2021).

In addition to the use of AFMP, Thompson et al. (2019) described Cardiovascular Magnetic Resonance (CMR) as an appealing tool for evaluating pulmonary edema because the intensity of the image signal is directly proportional to the density of water. Although they have not been tested in a clinical environment, CMR techniques for lung water quantification have been verified against gravimetric data and utilized to investigate regional lung water distribution.

CONCLUSION

Early ultrafiltration can be utilized to manage fluid in individuals with heart failure; torasemide is more effective than furosemide in lowering edema; and pulmonary edema can be evaluated using AFMP (Advance Fluid Management Program) and Cardiovascular Magnetic Resonance (CMR). When starting volume overload therapy for ADHF patients, early ultrafiltration is better than diuretics. Patients are more sensitive to diuretics after ultrafiltration (Hu et al., 2020). The effectiveness and safety of choosing appropriate individuals who can benefit from early UF with specific risk variables to direct early UF treatment were assessed in this study. Our research may help lower volume overload and enhance clinical outcomes for the heart failure population by offering clinical evidence for early UF in Chinese patients with acute decompensated heart failure. Additionally, with low UF rates in the present domestic clinical practice, it might help doctors avoid delaying the implementation of UF (Yang et al., 2019). Both implanted and extracorporeal ultrafiltration have a wide range of potential clinical uses. With biologically tailored fluid removal rates and a supposedly lower risk of infection when compared to external devices, new technologies like implantable hemofilters hold great promise. To maximize the use of ultrafiltration, advancements in material engineering, device design, and patient selection are required (Gologorsky & Roy, 2020). Increased lung water from Cardiovascular Magnetic Resonance (CMR) is linked to higher intracardiac filling pressures in heart failure patients and is predictive of 1-year outcomes. Standard CMR scans can include Lung Water Density (LWD) (Thompson et al., 2019).

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