

Non-Pharmacological Therapies for Treatment of Heart Failure -An Update

G. Muthu Laakshmi
Saveetha Dental College, Chennai

Abstract:

Aim:

Aim is to analyse non-pharmacological therapies which are available for treating patients with fluid overload in the case of heart failure.

Objective:

Objective of the review is to analyse new non pharmacological therapies which does not have impact on blood pressure, heart rate or balance of electrolytes.

Background:

Commonly used therapies for treating fluid overload are diuretics, inotropic drug therapies, vasoactive drug therapies, but the response of these therapies gets diminished or lost before a therapeutic goal has been achieved. In order to overcome these defects new medical therapies like fluid removal by ultrafiltration, continuous renal replacement therapy and aquapheresis via the aquadex flex flow can be used as alternatives.

Reason:

Since heart failure is becoming more common among Indian population, usage of alternatives is very essential in overcoming difficulties in decreasing the fluid overload.

INTRODUCTION:

Heart failure occurs when the heart fails to maintain sufficient circulation to provide adequate tissue oxygenation in the presence of normal filling pressures. It is classified into high output, low output, right, left, biventricular, forward, backward, systolic and diastolic failure. There are pharmacological and non-pharmacological therapies for the treatment of heart failure. In this review recent advances in non-pharmacological therapies for treatment of heart failure will be discussed.

Etiology of Heart Failure:

Pulmonary embolism, thyrotoxicosis, left ventricular aneurysm, beri beri, anaemia, infective endocarditis, associated liver cirrhosis.

Investigations for Heart Failure:

Chest x-Ray, electrocardiograph, echocardiography.

Management of Heart Failure:

Correction of underlying cause. I.e. congenital heart disease, rheumatic heart disease, control of fluid and sodium retention, enhancement of myocardial contractility, reduction of pulmonary and systemic venous congestion, minimisation of cardiac workload.

PHARMACOLOGICAL MEASURES FOR THE TREATMENT OF HEART FAILURE:

Diuretics:

Diuretics play an important role in managing cardiac failure. Commonly used diuretics are furosemide, bumetanide, ethacrynic acid, chlorothiazides, metolazone, indapamide, spironolactone, amiloride.

Disadvantages of Diuretic Therapy:

Potential to activate the neurohormonal vasoconstrictor system. Can create electrolyte abnormalities. Has been associated with increased risk of morbidity and mortality. Can lead to the development of pre-renal azotemia. May result in diuretic resistance. (1)

Vasodilator therapy:

Vasodilators are used to minimise the workload to the heart. Arterial dilators reduce the after load and venodilators reduce the preload to the heart. Oral and parenteral vasodilators are used, the oral vasodilators include ACE inhibitors like captopril, lisinopril, ramipril, spirapril, Nitrates like isosorbide mono nitrate, isosorbide dinitrate, nitroglycerin, Hydralazine, Adrenergic blockers, calcium channel blockers.

Parenteral vasodilators include nitroglycerine, sodium nitroprusside, enalaprilat, recombinant BNP-Nesiritide. (2)

Digitalis:

Digoxin is the most effective drug in the management of heart failure especially in the presence of supra ventricular tachycardia, dilated left ventricle, impaired systolic function.

Mechanical circulatory support:

This may be considered when medical measures fail either in transient myocardial dysfunction or when alternative procedures like coronary artery bypass graft surgery or cardiac transplantation are planned. This includes intra aortic balloon pump, ventricular assist devices, enhanced external counter pulsation, desynchronisation therapy/biventricular pacing. (3)

NON-PHARMACOLOGICAL MEASURES FOR THE TREATMENT OF HEART FAILURE:

Compliance:

Give careful advice about disease, treatment, and self help strategies

Diet:

Ensure adequate general nutrition and, in obese patients, weight reduction .

Salt:

Advise patients to avoid high salt content foods and not to add salt (particularly in severe cases of congestive heart failure).

Fluid:

Urge overloaded patients and those with severe congestive heart failure to restrict their fluid intake

Alcohol:

Advise moderate alcohol consumption (abstinence in alcohol related cardiomyopathy)

Smoking:

Avoid smoking (adverse effects on coronary disease, adverse haemodynamic effects)

Exercise:

Regular exercise should be encouraged

Vaccination:

Patients should consider influenza and pneumococcal vaccinations

Physical rest:

In acute phase, absolute bed rest is advised. early ambulatory is advocated to avoid deep vein thrombosis. prophylactic low dose heparin 5,000 units SC/IV BD can be given. degree of activity can be decided depending on the cardiac status.

Mental rest:

Diazepam 2-5mg twice or thrice daily is given for several days.

Oxygen:

It improves oxygen delivery and relieves dyspnoea.

Diet:

Sodium Restriction:

In severe cases sodium is restricted to 500 mg/day and subsequently it can be increased to 2-3g/day with usage of diuretics.

Water Restriction:

1-1.5 L/day is permitted. Fluid intake Fluid restriction (1.5-2 litres daily) should be considered in patients with severe symptoms, those requiring high dose diuretics, and those with a tendency towards excessive fluid intake. High fluid intake negates the positive effects of diuretics and induces hyponatraemia.(4)

Dialysis and ultrafiltration:

Ultrafiltration is a medical therapy that mechanically removes excess water and salt from the body. Hydrostatic pressure is applied to blood across a semi-permeable membrane (filter) to separate isotonic plasma water from the blood. Ultrafiltration provides greater control over fluid removal rate and total volume . Ultrafiltration removes isotonic fluid. Removes significant amount of sodium per unit of fluid withdrawn (3g/L). Not associated with significant electrolyte depletion. Neurohormonal down-regulation, sustained weight loss and diuretic efficacy may be observed. Ultrafiltration shown to effectively and safely decreased readmissions and length of stay. This procedure is indicated in severe cardiac failure with renal dysfunction.

Ultrafiltration is an alternative method to sodium and fluid removal. Ultrafiltration allows for the production of plasma water from whole blood across a semipermeable membrane in response to a transmembrane gradient. (5) In doing so, the resultant fluid or ultrafiltrate is isotonic to plasma. Fluid obtained with the use of loop diuretics is virtually always hypotonic to plasma. Consequently, ultrafiltration removes more sodium than diuretic therapy. There are no electrolyte disturbances with ultrafiltration. More extracellular fluid volume can be achieved through ultrafiltration as compared to diuretic induced fluid loss.

Ultrafiltration does not decrease GFR. Studies have also shown a progressive decrease in neurohormone levels (norepinephrine, plasma renin activity, and aldosterone) with prolonged ultrafiltration as opposed to intravenous loop diuretics. The Plasma Refill Mechanism may be an explanation for the success of ultrafiltration in removing fluid without having the problems of long term loop diuretic usage. When fluid is removed from one vascular compartment (blood vessel), there is a transient reduction in blood volume.(6) Plasma Refill lessens this reduction in blood volume by allowing fluid to come across the vascular membrane from the over-hydrated interstitium.

This is governed by oncotic and hydrostatic forces between the vascular and interstitial compartments.(7) Fluid overload can be caused by numerous reasons, mainly by heart, liver and kidney diseases. Congestive heart failure (CHF) is the most common reason for severe hypervolemia. The reduction, or even total removal, of extra body fluid is crucial to the successful therapy of the acute decompensated heart failure (ADHF) in patients with advanced heart failure. This is usually achieved with the use of saluretics, usually furosemide, indapamide, or torasemide, given orally in outpatient settings. If the in-patient treatment for ADHF is needed, furosemide as intravenous bolus or infusion is the therapeutic gold standard.(8)

ADHF is defined as rapid appearance or worsening of clinical symptoms resulting from systolic or diastolic heart dysfunction, cardiac rhythm disturbance, or

inadequate pre- or afterload. It can present in patients with or without previous heart dysfunction, and both conditions lead to the impaired blood volume distribution (to the venous compartment – pulmonary or systemic). Typically, the body fluid volume is increased in patients with chronic heart failure, and normal in patients with no underlying heart disease. The use of diuretics, which is obligatory in ADHF and CHF, in patients presenting ADHF and no fluid retention needs very careful, individualized evaluation, to avoid further decrease in effective blood volume. The most common factors that precipitate hospitalization for decompensated heart failure . Noncompliance with medical regimen, sodium and/or fluid restriction, Acute myocardial ischemia, Uncorrected high blood pressure, Atrial fibrillation and other arrhythmias, Recent addition of negative inotropic drugs (e.g., verapamil, nifedipine, diltiazem, beta blockers), Pulmonary embolus, Nonsteroidal anti-inflammatory drugs, Excessive alcohol or illicit drug use. Endocrine abnormalities (e.g., diabetes mellitus, hyperthyroidism, hypothyroidism). Concurrent infections (e.g., pneumonia, viral illnesses). The venous blood volume expansion, pulmonary and systemic (both, splanchnic and peripheral), typical of CHF, results from decreased cardiac output, vascular resistance or pathological flow between the cardiac cavities. Even if the effective blood volume (i.e. inside the big arterial vessels) in chronic heart failure has been well preserved, the venous compartment is enlarged, second to sodium and water retention resulting from renal hypoperfusion.(9) The chronic renal hypoperfusion second to heart dysfunction (cardiorenal syndrome type II) triggers many adaptive mechanisms – activation of renin-angiotensin-aldosterone axis, vasopressin release, increased blood natriuretic hormone levels and many others. Fluid retention leads to the increased pre- or afterload, increased cardiac filling pressures, myocardial distention and remodeling, which close the vicious circle of progressive heart injury , and further deteriorate renal filtration (GFR). It is well known the hemoconcentration resulting from intensive diuretic treatment correlates positively with reduction of GFR in CHF and the decreased post hospital survival . The higher the dose of diuretics is needed for reducing hypervolemia the worse is the prognosis . The reduction in GFR and the CHF are the well known independent risk factors for death in general population.(10) The coexistence of the two is even more fatal , which clearly suggest, aggressive diuretic therapy resulting in worsening renal function should be avoided. Renal failure worsens prognosis in both, the systolic and the diastolic CHF, and the impact of renal failure is more visible in patients with preserved ejection fraction , and even more in those with coexisting anemia. The episode of ADHF further worsens post-hospital CHF patients' survival, irrespective of renal failure . In-hospital mortality is increased and the length of stay prolonged in ADHF patients with renal failure . (11) Worsening of renal

insufficiency leads to less secretion of diuretics into the tubular fluid, so it requires an increase in the total dose of diuretic for an effective amount reaches its site of action . However, the diuretic-induced activation of the renin-angiotensin-aldosterone system, results in an increased sodium and water reabsorption through a variety of mechanisms. Hypertrophy of distal tubule epithelial cells results in greater sodium absorption distal to the loop of Henle, the site of action of loop diuretics . In patients with decompensated heart failure, venous pressure is also elevated, leading to decreased absorption of oral agents and decreased renal blood flow and consequently, renal sodium excretion . In case the diuretic resistance ensues, due to renal injury or any other cause, the retained fluid can be rapidly removed from the body by inducing massive diarrhea, the use of vasopressin receptor antagonists (vaptans), which is still not well established, or by a well known mechanical, extracorporeal support which enables to control the volume and rate of water removal. The first action on blood taken by the kidney is to separate plasma water in the renal glomerulus. Exactly the same process is mimicked by dialysers and hemofilters in a process driven by exerting the hydraulic pressure difference between blood and the contralateral side of the semipermeable filtration membrane.(12) This convective technique became available to dialysis patients in mid-seventies of the past century. And from the very first moment it was clear the procedure could be useful in treating decompensated heart failure. This convective process has to be individually tailored regarding the volume and rate of fluid removal. If it takes several hours (usually more than 6), and the rate of ultrafiltration is of maximum 0.16 ml/min/kg lean body mass (usually 500 ml/h in adults), the procedure is called slow continuous ultrafiltration (SCUF). The higher ultrafiltration volumes and higher ultrafiltration rates cause hemoconcentration and call for intravenous infusion of crystalloids to prevent it. In such case the process is called hemofiltration (HF). The infusion of a substitution fluid is the only factor to differentiate SCUF and HF.(11) The last one can last longer than 24 hours, which is known as continuous hemofiltration. It is usually performed on venous blood (continuous veno-veno hemofiltration, CVVH). Quick removal of relatively small amount of plasma water is called isolated ultrafiltration (IUF), to differentiate it from the ultrafiltration (UF) occurring during hemodialysis. There are three types of engines enabling filtration – hemodialysis monitor to perform isolated ultrafiltration, continuous renal replacement therapy monitors to perform SCUF or CVVHF, and specialized ultrafiltration monitors to perform solely the SCUF. All three techniques operate on venous blood, which means blood is taken from the splanchnic overloaded compartment and returned to it after the volume has been reduced by ultrafiltration.(12)

Aquapheresis:

Aquapheresis means taking away (apheresis, gr.) water (aqua, lat.) from the body, with an objective to restore euvolemia in fluid overloaded patients. Aquapheresis via the Aquadex FlexFlow™ is alternative to conventional ultrafiltration for patients with refractory intravascular and extravascular volume overload. Unlike CRRT, the Aquadex FlexFlow™ is highly automated, portable, and uses both central and peripheral venous access. It is a small self-contained unit resembling a programmable intravenous pump. Several studies have shown no clinically significant effect on electrolyte balance, blood pressure, or heart rate with aquapheresis. The Aquadex FlexFlow™ uses low blood flow, drawing 10-40 mL/ min. Only 33 mL of blood is in the entire circuit outside the vascular space at anytime as opposed to 300 mL with CRRT. The Aquadex FlexFlow™ can precisely remove anywhere from 10-500 mL of fluid an hour depending on patient needs and fluid status. It is important to remember that the rate of fluid removed per hour (ultrafiltration rate) from the intravascular space must not exceed the rate of fluid entering the intravascular space from the extravascular space (plasma refill rate). Setting the appropriate rate minimizes the risk of hypovolemia and hypotension. Periodic monitoring of systolic blood pressure and monitoring hematocrit with the Hematocrit Monitoring feature of the Aquadex FlexFlow™ aid in avoiding overaggressive fluid removal. Patients qualifying for aquapheresis include those who are more than five pounds over dry weight and diuretic resistant. Aquapheresis should be done before any significant administration of intravenous loop diuretics or vasoactive drugs. Fluid removal rate can be initiated at 250 mL/hr (six liters in 24 hours) with blood flow rate of 30-40 mL/ min. With these settings, approximately 3200 mg of salt will be removed with each liter of isotonic fluid. Anticoagulation with intravenous heparin to two times normal value aids in keeping the ultrafiltration filter from clotting. (13)

CONCLUSION:

Though several pharmacological and non-pharmacological measures available in treating heart failure, aquapheresis-A recent advancement in non pharmacological measures for the treatment of heart failure is more efficient in treating difficult heart failure patients with increased intra vascular and extra vascular fluid overload.

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