

The Effect of Limiting Fluid Intake on Clinical, Biochemical and Functional Parameters in Compensated Heart Failure Patients at a North Indian Hospital

Prafull Sharma¹, Vivek Guleria², Salil Garg³, Gaurav Batta⁴, Niket Verma⁵, Susheel K. Malani⁶

^{1, 2, 3, 4, 6} Department of Cardiology, Army Hospital Research & Referral, New Delhi, India. ⁵Department of General Medicine, Army College of Medical Sciences, Delhi Cantt, New Delhi, India.

ABSTRACT

BACKGROUND

Restriction of fluid is widely adopted as a strategic non-pharmacological therapy for patients with heart failure (HF). However, insufficient fluid leads to intravascular volume contraction further causing hypoperfusion of vital organs. Renal dysfunction and cardiac ischemia caused by hypoperfusion can further aggravate heart failure. Therefore, the authors decided to study the effect of fluid intake on various functional and cardiac parameters of patients of HF.

METHODS

50 patients with a diagnosis of heart failure with reduced ejection fraction who had been discharged from the hospital since last 6 months and who were on restricted fluid therapy were included in the study. Patients were advised to visit the OPD once every 4 weeks and provide a record of their fluid intake. All patients irrespective of functional class were advised a fluid intake of 30 mL / day / Kg body weight. Functional status, biochemical parameters and clinical parameters were measured regularly until the end of 12 weeks.

RESULTS

There was marked improvement in the functional status of patients and statistically significant number was shifted from NYHA III and IV to NYHA I and II. PFI (Prescribed Fluid Intake) was associated with improvement of exercise tolerance in all NYHA Classes. Creatinine levels declined in all NYHA Classes with very high drop from 2.32 to 1.0 in NYHA Class IV.

CONCLUSIONS

Compensated HF patients should be prescribed physiologically correct dietary fluid intake based on body weight. This improves their functional capacity, biochemical parameters and left ventricular ejection fraction.

KEYWORDS

Heart Failure, Diet, Sodium-Restricted, Diuretics, Exercise Tolerance

Corresponding Author:

Dr. Salil Garg,

Department of Cardiology,

Army Hospital Research & Referral,

New Delhi - 110010, India.

E-mail: gargsal@gmail.com

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BACKGROUND

India faces a major challenge from the epidemic of non-communicable lifestyle diseases. Chaturvedi et al found that prevalence of heart failure (HF) in a rural community as well as tertiary care hospital in North India was 1.2 / 1000.¹ According to the Trivandrum Heart Failure Registry,² India accounts for 25 % of the world HF patients with an estimated 1.3 to 23 million persons. Compared to western countries, Indian patients suffer from HF at a younger age.³

Initially HF was considered a "Cardio-Renal Model" caused by excessive intake of salt leading to water retention and abnormalities of renal blood flow.⁴ This has been the reason that dietary fluid intake became a prime adjunct in management of HF. Later haemodynamic measurements associated HF to reduced cardiac output and excessive peripheral vasoconstriction. Thus the "cardio circulatory" or "haemodynamic" model of HF was considered as a result of abnormalities of the pumping capacity of the heart and excessive peripheral vasoconstriction.⁵

For a healthy person, the physiological fluid requirement is 30 - 35 mL / day / Kg body weight. Physiologically, fluid deficit of 2 % of the body weight or more has been linked to decline in mental functions and reduced capacity to physical exercise. Therefore, restricted fluid intake in CHF (Congestive Heart Failure) patients may deteriorate normal physiological functions, cause dryness of skin and itching and damage kidneys and heart due to hypoperfusion.

In addition, the last two decades have witnessed development of drugs that can improve the cardiac function, reduce preload and afterload on the heart, counteract neuro-hormonal activation and drive out surplus fluid.⁶

Therefore, the authors decided to study the effect of fluid intake on various functional and cardiac parameters of patients of HF.

METHODS

This study was carried out at the Army Hospital Research & Referral, New Delhi (AHRR). Patients with a diagnosis of heart failure with reduced ejection fraction, LVEF (Left Ventricular Ejection Fraction) < 40 % on 2-Dimensional echocardiography who had been discharged from the hospital since last 6 months and were on restricted fluid therapy were included in the study. 150 such patients were individually contacted over telephone and requested to voluntarily report in person. Chronic kidney disease patients with creatinine clearance < 30 mL / min, chronic liver disease and patients having grade 3 and grade 4 pedal oedema were excluded. Out of the 150 patients, 50 were followed up every 4 weeks for a total of 12 weeks in Cardiology OPD. On their first visit patients were divided into 4 groups depending upon their functional class as follows and their average voluntary fluid intake (VFI) being taken pre-treatment was noted.

2,300 mL or 37 mL / Kg in NYHA Class I;
2,426 mL or 36 mL / Kg in NYHA Class II;

2,066 mL or 31 mL / Kg in NYHA Class III and
1,466 mL or 23 mL / Kg in NYHA Class IV.

After their acceptance to join this study, all patients irrespective of functional class were advised a fluid intake of 30 mL / day / Kg body weight. Patients were examined and their medical history, symptoms of HF and medications were recorded. Baseline 2D echocardiography was done. Functional assessment was done with modified Bruce TMT protocol. Blood samples were taken at every visit and analysed for sodium, potassium, blood urea nitrogen (BUN), creatinine and haemoglobin and compared against the normal values. (Sodium: 135 - 145 mEq / L, Potassium: 3.5 - 5.5 mEq / L, Creatinine: 0.8 - 1.2 mg / dL, haemoglobin: male > 13 gm / dL and for female > 12 g / dL). Patients were advised to visit the OPD Clinic once every 4 weeks and provide a record of their fluid intake. Weight and waist circumference were measured until the end of 12 week period.

Statistical Analysis

Pre-treatment parameters were obtained from patients when they were on voluntary fluid intake (VFI). The post-treatment parameters were taken after the patients were on prescribed fluid intake (PFI) for at least 12 weeks. The pre and post-treatment parameters were recorded and analysed separately using SPSS software.

RESULTS

50 heart failure patients were enrolled in this study. 60 % had ischemic aetiology while 40 % were non-ischemic. 7 patients (13 %) had CRT device (Cardiac Resynchronization Therapy) and 13 patients (25 %) had AICD's (Automated Intracardiac Defibrillator Device). Out of 50 patients in this study 24 % (12) were females and 76 % (38) were males. All baselines parameters were well balanced in the two groups except serum creatinine and LVEDD. Mean serum creatinine was 1.5 mg / dL in males. LVEF was 33 % in both groups. (Table 1). After 12 weeks of prescribed fluid intake mean serum creatinine decreased to 1.04 mg. There was significant increase (p value < .05) in exercise capacity in female group from 4.2 to 6.3 METS (Metabolic Equivalent of Task) and from 4.9 to 5.5 METS in males.

This study cohort of 50 patients was divided into 5 age groups. 3 patients were less than 40 years; 4 were between 41 - 50 years; 9 were between 51 - 60 years; 17 were between 61 - 70 years and 17 were above 70 years (Table 2). Age group differences for most parameters were non-significant. Lower K + levels were observed for less than 40 years age group. LVEF was minimal in < 40 years age group and maximum of 35 % in > 70 years at baseline. Among all groups exercise tolerance was best among 41 - 50 years (6.42 METS) at base line and least (4.67 METS) in 51 - 60 years age group. Post treatment after 12 weeks there was significant increase in exercise capacity in majority age groups; best improvement was seen in > 70 years age group where exercise capacity increase from 4.8 to 6.3 METS;

followed by 61 - 70 years age group where increase was from 4.67 to 6 METS.

No. of Patients Parameters	Female - 12	Male - 38	Overall - 50
Voluntary Fluid Intake (Pre-Treatment)			
Hb	11.83 ± 0.40	12.47 ± 0.32	12.32 ± 0.26
Creatinine	0.82 ^b ± 0.11	1.50 ^a ± 0.18	1.34 ± 0.14
Na +	137.83 ± 1.40	138.47 ± 0.69	138.32 ± 0.62
K +	4.54 ± 0.18	4.44 ± 0.09	4.46 ± 0.08
LVEF	33.33 ± 2.16	33.16 ± 1.38	33.20 ± 1.16
LVESD	45.75 ^b ± 2.09	51.08 ^a ± 1.32	49.80 ± 1.16
LVEDD	57.50 ± 1.94	61.34 ± 1.58	60.42 ± 1.30
TMT	4.20 ± 0.47	4.99 ± 0.24	4.79 ^a ± 0.22
Prescribed Fluid Intake (Post-Treatment)			
Hb	12.56 ± 0.30	12.79 ± 0.23	12.73 ^a ± 0.18
Creatinine	1.42 ^a ± 0.36	1.04 ^b ± 0.05	1.13 ± 0.09
Na +	137.83 ± 1.36	136.50 ± 0.55	136.82 ± 0.53
K +	4.58 ± 0.15	4.32 ± 0.12	4.38 ± 0.10
LVEF	33.33 ± 2.07	34.08 ± 1.80	33.90 ± 1.45
LVESD	49.08 ± 4.47	49.24 ± 1.65	49.20 ± 1.63
LVEDD	58.58 ± 4.66	61.24 ± 1.62	60.60 ± 1.64
TMT	6.33 ± 0.94	5.53 ± 0.23	5.73 ^a ± 0.30

Table 1. Sex Wise Average and Standard Error of Various Parameters in Patients on Voluntary and Prescribed Fluid Intake
Means bearing different superscripts differ significantly (p < 0.05) from each other

No. of Patients Parameter	Age in Years				
	< 40 3	41 - 50 4	51 - 60 9	61 - 70 17	> 70 17
Voluntary Fluid Intake (Pre-Treatment)					
Hb	13.23 ± 0.48 2.17	12.38 ± 1.57 1.01	12.06 ± 0.42 1.47	12.37 ± 0.52 1.13	12.23 ± 0.41 1.40
Creatinine	± 1.52 135.33	± 0.16 139.25	± 0.43 139.22	± 0.09 137.06	± 0.26 139.41
Na +	4.67 3.83 ^b	1.11 4.15 ^{ab}	1.38 4.71 ^a	0.82 4.38 ^{ab}	1.20 4.61 ^a
K +	± 0.23 30.00	± 0.14 33.75	± 0.19 33.89	± 0.13 31.18	± 0.15 35.29
LVEF	± 5.00 48.00	± 6.25 51.50	± 3.38 47.89	± 1.80 49.41	± 1.99 51.12
LVESD	± 4.73 59.00	± 4.37 63.00	± 3.35 59.44	± 1.39 59.29	± 2.33 61.71
LVEDD	± 3.21 4.63 ^{ab}	± 5.21 6.42 ^a	± 2.96 4.14 ^b	± 2.14 4.67 ^{ab}	± 2.57 4.87 ^{ab}
TMT	± 1.89	± 1.25	± 0.46	± 0.28	± 0.31
Prescribed Fluid Intake (Post-Treatment)					
Hb	12.70 ± 0.85 1.07	12.53 ± 0.80 1.05	12.28 ± 0.38 1.21	12.93 ± 0.32 0.97	12.84 ± 0.35 1.29
Creatinine	± 0.09 138.33	± 0.13 137.00	± 0.09 137.00	± 0.06 137.47	± 0.26 135.76
Na +	2.03 3.83 ^b	2.86 4.88 ^a	1.55 4.07 ^{ab}	0.80 4.50 ^{ab}	0.80 4.41 ^{ab}
K +	± 0.15 40.00	± 0.38 31.25	± 0.37 36.67	± 0.16 32.64	± 0.11 33.24
LVEF	± 5.77 32.00 ^b	± 5.91 55.00 ^a	± 12.50 50.89 ^a	± 2.27 49.53 ^a	± 2.42 49.65 ^a
LVESD	± 3.46 42.67 ^b	± 4.04 65.75 ^a	± 3.54 60.67 ^a	± 2.45 60.94 ^a	± 3.11 62.18 ^a
LVEDD	± 2.40 3.90 ^c	± 4.29 7.27 ^a	± 3.61 4.04 ^{bc}	± 2.17 6.00 ^{abc}	± 3.33 6.33 ^{ab}
TMT	± 0.15	± 0.97	± 0.49	± 0.40	± 0.55

Table 2. Age Wise Average and Standard Error of Various Parameters in Patients on Voluntary and Prescribed Fluid Intake
Means bearing different superscripts differ significantly (p < 0.05) from each other

There was a significant decrease in both left ventricular end systolic dimension (LVESD) and left ventricular end diastolic dimension (LVEDD) amongst the patients below 40 years on prescribed fluid intake. Differences for other age groups were not significant for these parameters. Post prescribed fluid intake treatment, left ventricular ejection fraction (LVEF) increased in all group of patients except in > 70 years age group; best improvement was seen in < 40 years age group where ejection fraction (EF) increased from 30 % to 40 %.

Parameter	NYHA Class			
	I	II	III	IV
NYHA Class Average and Standard Error of Various Parameters in Patients on Voluntary Fluid Intake				
No. of Patients	12	23	12	3
Hb	13.46 ± 0.57	11.88 ± 0.36	11.99 ± 0.40	12.53 ± 1.38
Creatinine	1.43 ^{ab} ± 0.35	1.01 ^b ± 0.07	1.62 ^{ab} ± 0.35	2.32 ^a ± 1.24
Na +	139.08 ± 0.76	138.48 ± 0.90	136.83 ± 1.70	140.00 ± 2.31
K +	4.52 ± 0.17	4.51 ± 0.13	4.42 ± 0.16	4.13 ± 0.47
LVEF	35.83 ^a ± 2.12	36.52 ^a ± 1.39	27.08 ^b ± 1.79	21.67 ^b ± 4.41
LVESD	48.58 ^b ± 2.44	48.39 ^b ± 1.79	51.50 ^{ab} ± 1.76	58.67 ^a ± 4.37
LVEDD	61.17 ^{ab} ± 2.49	57.83 ^b ± 2.16	62.25 ^{ab} ± 1.59	70.00 ^a ± 5.29
TMT	5.94 ^a ± 0.49	4.82 ^{ab} ± 0.27	3.65 ^b ± 0.30	3.20 ^{ab} ± 0.20
NYHA Class Average and Standard Error of Various Parameters in Patients on Prescribed Fluid Intake				
No. of Patients	24	21	4	1
Hb	12.80 ± 0.28	12.70 ± 0.29	12.20 ± 0.59	13.90
Creatinine	1.19 ± 0.19	1.12 ± 0.05	0.95 ± 0.06	1.00
Na +	136.92 ± 0.71	136.57 ± 0.89	136.50 ± 2.10	141.00
K +	4.40 ± 0.18	4.32 ± 0.12	4.60 ± 0.23	4.10
LVEF	34.79 ± 2.10	34.76 ± 2.30	27.50 ± 10.05	20.00
LVESD	47.88 ± 2.49	50.29 ± 2.29	48.00 ± 7.07	63.00
LVEDD	59.25 ± 2.48	61.81 ± 2.07	59.50 ± 10.05	72.00
TMT	6.38 ± 0.50	5.01 ± 0.33	5.93 ± 0.81	3.40

Table 3. NYHA Class Average and Standard Error of Various Parameters in Patients on Voluntary and Prescribed Fluid Intake
Means bearing different superscripts differ significantly (p < 0.05) from each other

NYHA Class	Unit	I	II	III	IV
Patients on Voluntary Fluid Intake	Number	12	23	12	3
No. of Patients on Prescribed Fluid Intake	Number	24	21	4	1
Average Voluntary Fluid Intake	ml / Kg BW	37	36	31	23
Average Prescribed Fluid Intake	ml / Kg BW	35	35	35	35
Pre-Treatment Creatinine		1.43	1.01	1.62	2.32
Post-Treatment Creatinine		1.19	1.12	0.95	1
Pre-Treatment LVEF	%	35.83	36.52	27.08	21.67
Post-Treatment LVEF	%	34.79	34.76	27.5	20
Pre-Treatment TMT	METS	5.94	4.82	3.65	4.4
Post-Treatment TMT	METS	6.38	5.01	5.93	5.2

Table 4. Impact of Fluid Intake on Select Parameters before and after Treatment

Among 50 patients in this study patients were grouped according to NYHA Class (Table 3). Serum creatinine was highest in NYHA IV group (2.32 mg / dL). LVEF was maximum in NYHA Class II (36.5 %) and minimum in Class IV group (21 %). Class IV group had maximally dilated left ventricle with LVESD of 58.6 mm and LVEDD of 70 mm. Exercise tolerance was maximum in NYHA Class I group (5.9 METS) and least in NYHA Class III (3.65 METS). Although, LVEF and TMT were higher in NYHA Class I & II in

comparison to NYHA Class III & IV, these differences were statistically non-significant because of large variation.

After 12 weeks of Prescribed Fluid Intake NYHA Class differences were non-significant for all the parameters. This may be attributed to the significant improvement observed in NYHA Class through PFI. For example, there were 3 patients in NYHA Stage IV when on VFI but on PFI only 1 remained in Stage IV. The corresponding reduction of patients in NYHA III and NYHA II were 12 to 4 and 23 to 21. This improvement has led to increase in number of patients in NYHA I heart failure condition from 12 pre-treatment to 24 post-treatment. This may be attributed to the PFI.

DISCUSSION

Fluid overload in patients with heart dysfunction is detrimental and can precipitate acute decompensation. Therefore, restriction of fluid is widely adopted as a strategic non-pharmacological therapy for patients with HF. However, insufficient fluid volume as a result of fluid restriction can cause hypoperfusion of vital organs. Renal dysfunction and cardiac ischemia caused by hypoperfusion can further aggravate heart failure.

In this study, we investigated the effect of a weight based fluid intake on various parameters of HF patients. Pre-treatment parameters were those recorded while the patients were on their wilful and uncompelled fluid intake. The post-treatment parameters were taken after the patients were prescribed fluid intake (PFI) of 30 mL / Kg / day continued for the study period of at least 12 weeks. This is one of the first studies to apply a uniform weight based fluid intake for comparison of results. The results of this study raise an interrogation point on the conventional approach of restricting the fluid intake universally for all patients of HF. The observed impact of fluid intake on important HF indicators is presented in Table 4.

Effect of PFI on NYHA Class

Within the 12 week's period, the number of patients that shifted from NYHA III and IV to NYHA I and II were large enough to justify our prescription. In contrast to our study Philipson et al.⁷ restricted the intake of fluid to 1.5 L / day and that of sodium to 135 mg / dL / day. In their study, the number of patients in NYHA III came down from 35 to 28. Of these, one patient was upgraded to Class I and 6 upgraded to Class II.

Effect of PFI on Serum Creatinine Level

Creatinine levels declined in all NYHA Classes with very high drop from 2.32 to 1.0 in NYHA Class IV. There was no significant variation in creatinine in other studies.^{8,9,10} In a trial conducted by Albert et al.⁹ creatinine had increased almost by 50 percent in the group that was given water at 2 litre / day with low dose of diuretics and salt restricted diet as compared to the group given 1 l / day and high dose of diuretics.

Effect of PFI on LVEF

In our study, the PFI improved the LVEF of all NYHA Classes even though the increase in LVEF was non-significant.

Effect of PFI on Exercise Tolerance

PFI was associated with improvement of exercise tolerance in all NYHA Classes. In fact, the improvement was very noteworthy and significant in NYHA Class III. Our results are contrary to intervention comparison on 6-minute walk test between a fluid intake of 1.5 l / day and 30 mL / Kg per day intake.¹¹

Effect of PFI on Biochemical Parameters

We noted that with PFI, there were no significant difference in biochemical parameters such as sodium and potassium. Our results confirmed the findings of obtained in other studies.^{7,12} As in our study fluid restriction did not improve outcomes in a number of other studies,^{8,10} Only in those subsets of patients who have hyponatremia and fluid overload; fluid restriction has been found to be useful.^{9,12,13} It has been shown that beneficial effect of fluid restriction is short lived, as contraction of intravascular volume leads to increase in anti-diuretic hormone which increases the absorption of water from distal renal tubules and nullifies the effect of fluid restriction.^{13,14}

CONCLUSIONS

Compensated HF patients should be prescribed physiologically correct dietary fluid intake based on body weight of the patient. Such a prescription on fluid intake improves their functional capacity, biochemical parameters and LVEF. It is therefore submitted that dietary fluid restriction should not routinely be recommended to all HF patients. Their condition with regard decompensated HF and / or hyponatremia must be assessed and fluid restriction based on body weight should be recommended.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.

Financial or other competing interests: None.

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