

# Determining the role of intravenous hydration on hospital readmissions for acute congestive heart failure

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## Abstract

The role of intravenous hydration on hospital readmissions due to acute exacerbation of congestive heart failure (CHF) has not been studied sufficiently to the best of our knowledge. We sought to determine the possible role of intravenous hydration on hospital readmissions for acute CHF and fluid overload and explain how an intravenous fluid (IVF) restriction strategy may help reduce hospital readmission rates. We retrospectively studied the electronic medical records of 98-patient cohort who had hospital readmission due to acute decompensated congestive heart failure (ADHF) during the period of January 1, 2016 to July 9, 2016. These patients were admitted with reasons other than ADHF during the index admission. The patients were divided into two groups; those with ADHF readmissions within 15 days of index admission (group A) and those after 15 days (group B). Various factors affecting CHF readmissions as outlined in the results were compared between these two groups. Cohort of 98 patients (53 females, 54.1%; 76.4±11.6 years) re-admitted during the study period of 1/1/2016 to 7/9/2016 were analyzed. 71 patients had only received IVF during index admission. These were subdivided into group A (12 females, 54.5 %; mean age 75.9±12.9 years) and group B (25 females, 51.02%; mean age 76.08±11.90 years) based on readmission ≤15 days or >15 days from the index admission. There was no statistically significant difference (P=0.97) in amount of IVF prescribed between two subgroups but the duration of prescribed IVF significantly affected readmission in group A compared to group B (P=0.03). While the drop in albumin and rise in creatinine were not significant, the mean hemoglobin (Hb) drop in group A compared to group B was significant at P=0.008. Type of IVF and nature of CHF (heart failure with reduced

ejection fraction, HFREF/heart failure with preserved ejection fraction, HFpEF) were not found to significantly affect early readmissions associated with IVF hydration.

In patients with history of CHF, duration of IVF prescribed during the index admission seems to play important role in early CHF readmission (defined as <15 days in our study).

## Introduction

Congestive heart failure (CHF) is a complex clinical syndrome that results from structural or functional impairment of ventricular filling or ejection of blood which in turn leads to cardinal symptoms of dyspnea, fatigue and signs of heart failure, namely edema and rales.<sup>1</sup> With estimated worldwide prevalence of around 26 million patients, CHF is a major public health issue.<sup>2</sup> 550,000 individuals are newly diagnosed with CHF every year in the United States. Approximately 5 million patients with a diagnosis of CHF live in the US.<sup>3</sup> Those ≥65 years old account for more than 80% of deaths and prevalent cases related to CHF in the USA and Europe.<sup>4</sup> With improvement in life expectancy, higher survival rate after myocardial infarction and advent of medications like angiotensin converting enzyme inhibitors, angiotensin II receptor blockers, beta blockers, aldosterone antagonist and electrical devices such as implantable cardioverter defibrillator, the odds of patients surviving with a diagnosis of CHF have increased significantly. Consequently, the increasing number of patients with heart failure has led to more cases of hospital readmissions. Recent data suggest that 30-day readmission rates have surged up to 25% in the United States.<sup>5</sup> Notably, mortality in CHF is closely associated with ADHF requiring hospital admission, particularly frequent admissions and early (60 days or less) readmissions.<sup>6</sup> Many predictors associated with readmission of patients with CHF have been recognized. Most commonly identified causes have been established as excessive salt intake, other non-cardiac causes such as upper respiratory tract infection or pneumonia, non-compliance with medications, uncontrolled hypertension, and coronary ischemia.<sup>7</sup> To the best of our knowledge the role of intravenous hydration on hospital readmissions due to acute exacerbation of CHF has not been studied. We aim to establish any possible role of IVF administration during an index admission and early re-admission due to ADHF. Any readmission within 15 days of index admission has been defined as early re-admission in our study.

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## Materials and Methods

We conducted this retrospective cohort study among the patients admitted to a community-based teaching hospital. It was a part of a quality improvement project and was exempt from the local institutional review board (IRB) approval. We analyzed the electronic medical records of patients re-admitted to our hospital with a diagnosis of ADHF between the period of 1/1/2016 and 7/9/2017. ADHF was defined as the sudden or gradual onset of the signs or symptoms of heart failure requiring unplanned office visits, emergency room visits, or hospitalization.<sup>8</sup> All of the patients had a pre-existing diagnosis of stable CHF during their index admission. For the purpose of comparative data analysis, study cohort was divided into two groups; those with acute CHF readmissions within 15 days of index admission (group A) and those after 15 days (group B). Head-to-head comparison was done between amount, nature and duration of IVF prescribed during the index admission; incidence of readmission based on type of heart failure defined as systolic, diastolic and combined. Major contributing factors in exacerbation of CHF such as deterioration in renal function defined by acute rise in serum creatinine >0.3 mg/dL, acute drop in hemoglobin below the standard baseline for sex and drop in albumin level were also accounted for. Compliance to home medication, new onset myocardial infarction as a cause of CHF exacerbation and major non-cardiac cause comprising of different types of infec-

tions were ruled out as a cause of ADHF on readmission.

### Statistical analysis

Descriptive statistics were calculated for continuous variables, and frequencies and percentages were displayed for categorical data. Continuous data was expressed as mean  $\pm$  one standard deviation. Standard t-test was used for comparison of outcomes among the patients divided under group A and group B. A P-value of  $<0.05$  was considered statistically significant.

## Results

### Clinical characteristics

A total of 98 patients (53 females, 54.1%;  $76.4 \pm 11.6$  years) were re-admitted with ADHF as a primary diagnosis during our study period, which extended between 1/1/2016 to 7/9/2016. Out of these, 71 patients had received IVF during their index admission. Thus, 27 patients did not meet the criteria for study and were excluded from data analysis. There were 22 patients in group A (those who were re-admitted with ADHF  $\leq 15$  days of index admission) while 49 patients were in group B (those who were re-admitted with ADHF  $> 15$  days after index admission). Total cohort consisted of 37 females (52.1%); with mean age of all patients being 76.37 years,  $\pm 11.6$ . There were 12 females (54.5%) with mean age of

patients 75.96,  $\pm 12.94$  years in group A while there were 25 females (51.02%) with mean age of  $76.08 \pm 11.90$  years in group B.

### Causes and duration of index hospital admission

Major cause of index hospital admission was sepsis (56 patients, 57.14%), followed by acute coronary syndrome (9 patients, 9.18%) and Anemia due to gastrointestinal bleeding (9 patients, 9.18%). Among sepsis, 6 cases of cellulitis, 2 cases of *Clostridium difficile* colitis, one case of osteomyelitis was noted while the remaining 47 cases were due to community or healthcare associated pneumonia. Details of different causes of index admission are presented in Table 1, whilst the amount of intravenous hydration prescribed on index admission is resumed in Table 2.

### Nature of congestive heart failure

Most common type of heart failure was HFpEF (ejection fraction  $\geq 50\%$  and borderline HFpEF with ejection fraction 41-49%) in nature (35 cases received IVF; mean IV fluids prescribed  $2.94 \pm 2.21$  L) followed by HFrEF (ejection fraction  $\leq 40\%$ ) in nature (25 cases; mean IVF  $2.87 \pm 2.59$  L). There were 11 cases of HFrEF with features of diastolic dysfunction based on Doppler assessment that were classified under combined nature of CHF. This group received IV fluid with a mean of  $2.0 \pm 1.32$  L. On further statistical analysis, no statistically

significant difference was found between the IV fluid prescribed and readmission due to CHF exacerbation based on nature of heart failure (Tables 3 and 4). The duration of IVF received during index admission and early re-admission is presented in Table 5.

### Analysis of associated contributing factors

Other contributing factors such as dropping hemoglobin below the standard range for the sex, drop in serum albumin level and a rising creatinine by at least 0.3 mg/dL on readmission were analyzed. Mean hemoglobin in group A on readmission was  $9.68 \pm 1.50$  gm% compared to mean hemoglobin of  $10.64 \pm 1.69$  gm% in group B. This was statistically significant at a two-tailed P-value of 0.0087, 95% confidence interval of 0.248 to 1.671. In our study, this implied that a greater drop in hemoglobin acted as a contributing factor to early readmission with acute exacerbation of CHF apart from a longer duration of IV fluids prescribed. Besides, mean total albumin in group A was  $3.45 \pm 0.51$ , in group B was  $3.48 \pm 0.45$ , statistically insignificant at P-value=0.7710. None of the patients in our study were found to have a rising creatinine of at least 0.3 mg/dL on readmission.

## Discussion

There is a lifetime risk of 1 in 5 of

**Table 1. Different causes of index admission. All patients re-admitted during the study duration with acute CHF have been included in the table.**

Cause of index admission	Both groups (N=98)	Group A (N=30)	Group B (N=68)	P-value
Sepsis*	56 (57.14 %)	15 (50%)	41 (60.29%)	0.0018
Acute coronary syndrome	9 (9.18%)	2 (6.66 %)	7 (10.29%)	0.17
Anemia due to GI bleeding	9 (9.18 %)	5 (16.66 %)	4 (5.88%)	0.75
Atrial fibrillation with rapid ventricular rate	6 (6.12 %)	1 (3.34 %)	5 (7.35%)	0.21
Syncope	6 (6.12%)	2 (6.66%)	4 (5.88%)	0.48
Surgery°	6 (6.12%)	3 (10%)	3 (4.41%)	0.99
Hypoglycemia/DKA	2 (2.04 %)	0	2 (2.94%)	-
Permanent pacemaker placement	1 (1.03%)	0	1 (1.48%)	-
Stroke	2 (2.04%)	1 (3.34 %)	1 (1.48%)	0.99
Hyponatremia	1 (1.03%)	1 (3.34 %)	0	-

\*Sepsis: 6 cellulitis, 2 *Clostridium difficile* colitis, 1 osteomyelitis, community acquired/healthcare associated pneumonia = 47; °Surgery: 1 case each of umbilical hernia repair, hip replacement, vesiculo-intestinal fistula repair. Cholecystectomy, aortic valve replacement and common femoral artery repair. For hypoglycemia/DKA, permanent pacemaker and hyponatremia, P-value cannot be calculated. Total number of hospital days during index admission was  $6.5 \pm 4.2$  days. Group A included  $7.27 \pm 5.72$  days of hospital admission compared to  $6.22 \pm 3.32$  days in group B. This was statistically insignificant at a P-value of 0.8675.

**Table 2. Amount of IVF prescribed during index admission.**

Group A ( $\leq 15$ days readmission)	Group B ( $> 15$ days readmission)	P-value
Total patients =22	Total patients =49	
Average IVF prescribed = $2.87 \pm 2.8$ L	Average IVF prescribed = $2.89 \pm 1.9$ L	P-value=0.97, 95% CI = -1.16 to 1.12
Range of IVF prescribed =1-12 L	Range of IVF prescribed =1-8 L	

There was an average of  $2.87 \pm 2.8$  L of IVF prescribed to group A on index admission compared to  $2.89 \pm 1.9$  L to group B. The P-value was not statistically significant at 95% confidence interval.

developing CHF among the U.S population.<sup>9</sup> The financial burden it has incurred is more elaborate by the fact that around 20% Medicare beneficiaries are readmitted within 30 days of discharge due to ADHF and the total estimated cost of these readmissions is more than \$15 billion per year. The patient protection Affordable Care Act of 2010 has created financial incentives to reduce the admissions using the publicly reported measures, as hospitals with high readmission rates can lose up to 3% of the Medicare reimbursement by 2015.<sup>10</sup> In this context, every attempt must be made to identify all the possible factors associated with CHF exacerbation so that an effective comprehensive plan can be devised to prevent frequent hospital readmissions. Not only the cost of care but also the quality of life will improve with avoidance of frequent episodes of CHF exacerbations.

Current strategies to prevent acute exacerbation of CHF can basically be divided into primary prevention and secondary prevention. Addressing the lifestyle changes with healthy weight and avoidance of obesity, engaging in exercise, Dietary approach to stop hypertension (DASH) diet basically constitute the primary prevention aspect of CHF. Secondary prevention encompasses aspect of aggressive control and treatment of risk factors associated with development of ADHF. Early detection and prevention of coronary artery disease with aspirin, beta-blockers, statin and angiotensin-converting enzyme inhibitors (ACEI) are vital to prevent acute CHF. Optimizing treatment of hypertension, encouraging smoking cessation and optimal lipid control provide substantial benefit especially in patients with coronary artery disease. In asymptomatic patients with reduced left ventricular ejection fraction, ACEI have been proven to prevent further decline in ejection fraction and ventricular remodeling in long-term.<sup>11</sup> The use of beta-blockers inhibit sympathetic activity, reduce the risk of disease progression and improved symptoms associated with CHF. Metoprolol succinate, Carvedilol and Bisoprolol have been shown by several large clinical trials as suitable agents to improve left ventricular function, symptoms of CHF along with reduction in hospital readmission and overall mortality.<sup>12</sup> Patients with diabetes mellitus need aggressive metabolic control and control of lipids with optimal level of blood pressure achievement. ACE inhibitor, regardless of the level of LV dysfunction is considered ideal for such purpose.<sup>13</sup> Discouraging alcohol consumption, restriction in excessive salt intake, limited fluid intake with daily measurement of weight at home have been

beneficial effect in maintaining the patients with known left ventricular dysfunction in remission.<sup>14</sup>

Among all these factors associated with primary and secondary prevention of CHF exacerbation, no study has been done to establish intravenous hydration as a possible cause of readmission with ADHF. In this context, aim of our study can be considered unique. Our study does not establish statistically significant relationship between amount of IVF prescribed and frequency of early readmission due to acute CHF or the type of the CHF. However, we cannot rule out that the smaller size (N=71) of study population could have played a role in rendering this value statistically insignificant. This study does show that duration of IV fluids prescribed during the index admission likely acts as a contributing factor to early readmissions with CHF exacerbation. The early re-admission is also more evident in patients with significant drop in baseline hemoglobin compared to the group with late re-admissions.

### Limitations

We conducted our single-center retrospective cohort study in a community hospital setting rather than a multicenter clinical trial setting, which would have allowed a larger study cohort. Incorporation of a control group would have made the compar-

ative data on impact of IVF on early readmission due to acute CHF more elaborate. Despite these limitations, we opine that our results form a basis for a larger, adequately powered, randomized control trial/s to establish relationship of intravenous hydration on hospital readmissions due to acute CHF.

### Conclusions

In view of lack of sufficient contemporary data, we aimed to ascertain the role of intravenous hydration on re-admission with ADHF through a retrospective chart analysis on patient cohort obtained at a community teaching hospital. Our study results indicate that the duration of prescribed IVF during the index admission in patients with established stable CHF does contribute towards early re-admission ( $\leq 15$  days) especially in patients with lower baseline hemoglobin. Caution should be taken while hydrating a patient with history of CHF based on sepsis guideline. Though our study cannot be extrapolated to a larger population without emergence of further bigger studies, it points towards the need for systematic, well-structured studies to establish definite relation between intravenous hydration and early readmission with acute CHF.

**Table 3. Different types of CHF and IVF prescribed.**

Type of heart failure	Number of cases receiving IV fluids	Mean IV fluids received (L) +/- SD
HFrEF	25	2.87+/-2.59
HFpEF	35	2.94+/-2.21
Combined	11	2.0+/-1.32

**Table 4. Statistical significance between each different type of CHF and IVF fluid received.**

Comparison of IV fluid received	P-value	95% confidence interval	Interpretation
HFrEF vs HFpEF	0.9108	-1.1 to 1.3	Statistically not significant
HFrEF vs combined	0.3013	-0.8 to 2.5	Statistically not significant
HFpEF vs combined	0.1898	-0.48 to 2.36	Statistically not significant

**Table 5. Significant statistical relationship between duration of IVF and early re-admission.**

Group	Duration of IVF (days)	Statistical relationship
A	2.9 ± 3.28	P-value=0.03
B	1.78 ± 1.18	95% confidence interval=0.071 to 2.16

There was a statistically significant relationship between duration of IVF received during index admission and early re-admission in patients under group A compared to those under group B. The two-tailed P-value was 0.0367, with difference in mean of 1.12 L.

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