

Research Article

Diuretic Efficiency in Acute Decompensated Heart Failure Patients is Associated with Greater Rates of Discharge Home After an Observation Unit Stay

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Abstract

Background: Acute Decompensated Heart Failure (ADHF) is a common Emergency Department Observation Unit (OU) disease. Diuretic efficiency is net fluid output produced per fixed dose of loop diuretic and patients with lower diuretic efficiency have worse outcomes. We evaluated if diuretic efficiency rates were associated with discharge home after ADHF treatment in an OU.

Methods: We performed a retrospective study of 607 ADHF OU patients. Diuretic efficiency was defined as the net UOP per equivalent dose of 40 mg furosemide. Patients were stratified in quartiles by levels of diuretic efficiency and rates of discharge were compared with the Cochrane Armitage test.

Results: In the final cohort of 607 patients, 309 (51%) were male and 325 (54%) were discharged after OU treatment. The median total diuretic dose was 80 mg furosemide (IQR 40-116 mg) and the median diuretic efficiency was 1.4L (IQR 0.85-2.3L). Quartiles arranged by decreasing diuretic efficiency demonstrated decreasing rates of discharge home Q1 63% (50-75%), Q2 58% (51-65%), Q3 53% (45-61%), Q4 44% (37-52%) which was statistically significant (P=0.023)

Conclusion: In patients presenting to the OU with ADHF, increased diuretic efficiency is associated with higher incidence of discharge home versus admission to the hospital but was not associated with 30-day readmissions.

Keywords: Heart failure; Loop diuretic; Observational medicine

Introduction

Acute Decompensated Heart Failure (ADHF) is a common medical condition for patients with shortness of breath, fatigue, or peripheral edema presenting to the Emergency Department (ED). ADHF has been estimated to effect 5.8 million people in the United States and has a prevalence of over 17% in people whom are 85 or older [1]. As our population ages we should expect the number of patients treated for ADHF in the ED to increase.

Patients admitted with ADHF suffer from high rates of re-hospitalization and mortality with 33% of patients having this outcome within 3 months [2]. In the United States most patients presenting to an ED with acute ADHF will be admitted to the hospital with less than 20% being discharged home [3]. Options for admission include admission to the hospital as a full admission or admission to an observation unit. Admission to the observation unit has the advantage of being billed as an outpatient visit and is not considered a re-admission by the Center for Medicare and Medicaid Services (CMS). This has a distinct advantage as medical centers with high re-admission rates for ADHF may be subject to

monetary penalties resulting in decreased revenues.

Treatment of acute ADHF in the ED consists of vasodilators and diuretics [4,5]. In patients with mild disease, treatment can be started in the ED and if the patient improves can be extended as an outpatient. In patients with more moderate disease, treatment is often started in the ED and continued as an inpatient or in an observation unit. For the majority of ADHF patients, the main treatment is decongestion through the use of diuretics. Other treatment includes afterload reduction of blood pressure often through the use of medications including nitroglycerin and angiotensin converting enzyme inhibitors. While afterload medications often work quickly, diuretics may take several hours to have an effect.

The degree with which the kidney can produce urine for a fixed dose of loop diuretic has been termed diuretic efficiency. A patient who produces 1000 mL of urine after a 40 mg dose of furosemide would be more efficient than a patient who produces 500 mL of urine after the same 40 mg dose. This term diuretic efficiency for the purposes of treating ADHF, has been defined as milliliters of net fluid output per 40 mg of furosemide equivalents [6]. Patients with low diuretic efficiency have been shown to have worse rates of survival and poor in-hospital and post-hospital outcomes [6,7].

It would be useful if diuretic efficiency could be used in the clinical arena. For patients with moderate ADHF, if you knew they had higher diuretic efficiency one might discharge them or admit them to an observation unit rather than an in-patient hospital bed. Conversely those with low diuretic efficiency who would be very unlikely to be discharged home after an observation unit stay might more appropriately be admitted to the hospital.

We sought to further evaluate the question, for patients with moderate ADHF, does increased diuretic efficiency predict successful discharge after an observation unit stay? If diuretic efficiency can predict outcomes in this manner it would be a useful tool to assign risk for patients with this acute disease.

Methods

We performed a retrospective cohort study on all patients diagnosed with ADHF and admitted to our observation unit. After approval and receiving a waiver of informed consent from our Institutional Review Board, patients were identified using International Classification of Diseases version 9 codes whom were admitted to our observation unit.

Data were abstracted by trained investigators using a structured abstraction tool. For this study, we reviewed five years of observation unit admissions for ADHF. Data collected included demographic data, initial vital signs, initial electrolytes and blood

urea nitrogen and creatinine, total amounts of intravenous loop diuretic and total Urine Output (UOP) measured in milliliters. We used the standard definition of diuretic efficiency meaning UOP for every 40 mg of IV furosemide. For patients on bumetanide we use the conversion of 1 mg of bumetanide was equal to 40 mg of furosemide. Total doses of intravenous loop diuretics and total measurements of UOP were used to determine the amount of diuretic efficiency.

Patients were excluded if they were transferred to another hospital system, left against medical advice, had a primary diagnosis of something other than ADHF, or were not given intravenous loop diuretics. Patients who were had end stage renal disease and received dialysis were also excluded. Patients were not excluded for chronic kidney disease.

Data were analyzed using STATA v13 (State College, TX). Patients were stratified into quartiles based on diuretic efficiency and rates of discharge were compared among the groups using the Cochrane Armitage test. Interquartile Ranges (IQR) and 95% Confidence Intervals (CI) were used when appropriate.

Results

We evaluated 607 patients who met the inclusion criteria of which 309 (51%) were male and 325 (54%) were discharged after treatment in the observation unit. Baseline demographic data can be seen in Table 1. The median total equivalent diuretic dose of furosemide was 80 mg (IQR 40 mg-116 mg) and the median volume of UOP was 2.8L (IQR 1.8L-3.9L). Rates of discharge home after observational unit stay decreased as diuretic efficiency decreased based on quartiles; Q1 63% (50-75%), Q2 58% (51-65%), Q3 53% (45-61%), Q4 44% (37-52%) which was a significant trend, $P = 0.023$ Table 1.

	Number (%)
Diabetes	332 (55)
Hypertension	525 (86)
Coronary artery disease	245 (40)
Coronary artery bypass	101 (17)
Prior myocardial infarction	131 (22)
Atrial fibrillation	130 (21)
Renal disease	121 (20)
Prior stroke	95 (16)
Peripheral vascular disease	30 (5)

Table 1: Demographic data.

Of the original cohort, 34 (6%) had a repeat observational unit stay and 147 (24%) had a repeat hospitalization within 30 days of their original ED visit. The percentages of 30-day readmission based on quartile were similar with quartile 1 through 4 having readmission rates of 23%, 25%, 21%, and 27%, $P = 0.85$ respectfully. Baseline laboratory values can be seen in Table 2.

	Total Population	Quartile 1	Quartile 2	Quartile 3	Quartile 4
Sodium	139 mmol/L (137-141)	139 (137-141)	139 (137-140)	139 (137-141)	139 (137-141)
Potassium	4 mmol/L (3.6-4.3)	3.9 (3.7-4.2)	3.9 (3.6-4.3)	4 (3.6-4.4)	4 (3.6-4.3)
BUN*	21 mg/dl (13-26)	16 (13-24)	16 (12-22)	17 (12-25)	21 (16-29)
Creatinine	1.3 mg/dl (0.9-1.5)	1.1 (0.9-1.4)	1.1 (0.9-1.4)	1.2 (0.9-1.5)	1.3 (1.1-1.6)
*BUN=Blood Urea Nitrogen					

Table 2: Laboratory Values.

Discussion

This study is the first to show that diuretic efficiency is related to successful discharge home after an observation unit stay for ADHF. There was 19% difference in the rate of successful discharge home between the 1st and 4th quartiles. This is not surprising given known association of lower diuretic efficiency and poor outcome [6-8].

The next step is to evaluate how one might use this information in clinical practice. If a patient has a good response to a dose of loop diuretic this may reassure the physician that the patient will do well in an observation unit setting or even after discharge from the ED. Futures studies are required to determine if higher efficiency can guide clinic practice in terms of disposition of patients with ADHF.

It was surprising that rates of efficiency did not translate to rates of discharge home. Other studies have shown that diuretic efficiency maintained good outcomes. For example, in a study by Maaten, et al. increased diuretic efficiency was associated with improved mortality at 30 days but not at 180 days although this has been disputed by other studies [9,10]. There are possible explanations for this that include factors which can affect all heart failure patients including changing response to loop diuretics, dietary adherence, medication adherence, and progression of other problems including coronary artery disease. Keirnan, et al. have shown that patients with poor diuretic efficiency are more likely to have poor outcomes but this may be partially mitigated by the use of higher doses of diuretics [11].

Limitations include accuracy of urine output collected and medications administered. As we have electronic medical records, we feel these limitations are small. Readmission rates were for any cause readmission even if the readmission was not related to heart failure. We did not review all admission decisions, so some admissions could have been placed for non-heart failure related conditions. The decision to count all readmissions was made because CMS counts all cause readmission and does not exclude based on readmissions for diseases other than heart failure.

Patients with higher diuretic efficiency are more likely to be discharged home after an observation unit stay for ADHF compared

to those with lower diuretic efficiency. This trend did not continue for 30 day readmissions. Further study is needed to determine if this effect exists in the ED and if so, how this knowledge should be used clinically.

This is the first research to show that patients with better diuretic efficiency are more likely to be discharged home after observational unit care for ADHF. This may impact clinical practice by actively following how efficient a patient responds to loop diuretics and with that knowledge treat in a more appropriate setting. For example, patients with mild to moderate disease who are very efficient might be discharged home after ED treatment and those who have very poor efficiency might be better cared for in a cardiac care unit. Future work is needed to see if initial diuretic efficiency in the ED can be used to predict ADHF outcomes.

Conclusion

A decrease in diuretic efficiency is associated with a significant decrease in discharge rates for patients treated for ADHF in an OU setting. Rates of diuretic efficiency are not associated with 30 day readmission rates. Future study should evaluate if using known rates of diuretic efficiency could lead to less readmission for patients with ADHF.

Disclosures

Dr. Schrock has no disclosures to report concerning this research. Dr. Wang has no disclosures to report.

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