



Intravenous Fluids in Acute Decompensated Heart Failure

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ABSTRACT

OBJECTIVES This study sought to determine the use of intravenous fluids in the early care of patients with acute decompensated heart failure (HF) who are treated with loop diuretics.

BACKGROUND Intravenous fluids are routinely provided to many hospitalized patients.

METHODS We conducted a retrospective cohort study of patients admitted with HF to 346 hospitals from 2009 to 2010. We assessed the use of intravenous fluids during the first 2 days of hospitalization. We determined the frequency of adverse in-hospital outcomes. We assessed variation in the use of intravenous fluids across hospitals and patient groups.

RESULTS Among 131,430 hospitalizations for HF, 13,806 (11%) were in patients treated with intravenous fluids during the first 2 days. The median volume of administered fluid was 1,000 ml (interquartile range: 1,000 to 2,000 ml), and the most commonly used fluids were normal saline (80%) and half-normal saline (12%). Demographic characteristics and comorbidities were similar in hospitalizations in which patients did and did not receive fluids. Patients who were treated with intravenous fluids had higher rates of subsequent critical care admission (5.7% vs. 3.8%; $p < 0.0001$), intubation (1.4% vs. 1.0%; $p = 0.0012$), renal replacement therapy (0.6% vs. 0.3%; $p < 0.0001$), and hospital death (3.3% vs. 1.8%; $p < 0.0001$) compared with those who received only diuretics. The proportion of hospitalizations that used fluid treatment varied widely across hospitals (range: 0% to 71%; median: 12.5%).

CONCLUSIONS Many patients who are hospitalized with HF and receive diuretics also receive intravenous fluids during their early inpatient care, and the proportion varies among hospitals. Such practice is associated with worse outcomes and warrants further investigation. (J Am Coll Cardiol HF 2015;3:127-33) © 2015 by the American College of Cardiology Foundation.

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**ABBREVIATIONS
AND ACRONYMS****HF** = heart failure**ICD-9-CM** = International
Classification of Diseases-Ninth
Revision-Clinical Modification

Many signs and symptoms of heart failure (HF) are the result of volume overload (1). Diuretic therapy, which reduces excess volume, is the most common treatment applied to improve symptoms and cardiovascular function (2,3).

For patients treated with diuretics, the administration of intravenous fluids is counterintuitive. Although some studies have investigated the benefits of co-administration of small volumes of hypertonic saline (4,5), the guidelines generally suggest fluid restriction for patients with HF and do not generally recommend intravenous fluid therapy (6-8). However, intravenous fluids are routinely administered to hospitalized patients (9,10), and little is known about the frequency with which this occurs in patients with HF who are treated with diuretics. If this practice were common, it could indicate conflicting treatment patterns.

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We investigated the frequency and pattern of early treatment with intravenous fluids among inpatients with HF who received loop diuretic therapy in a national sample of hospitals. We focused on early treatment to avoid treatments that are in response to changes in the clinical condition of the hospitalized patient, such as use of fluids in response to intensive diuretic therapy. We also examined the association between the early administration of intravenous fluids and in-hospital events, including subsequent critical care admission, subsequent endotracheal intubation, subsequent renal replacement therapy, and in-hospital death. Further, we examined the variability in hospital rates of intravenous fluid administration in patients who concomitantly received loop diuretics.

METHODS

DATA SOURCE AND STUDY SAMPLE. We conducted a retrospective cohort study using a database created by Premier, Inc. (Charlotte, North Carolina) that roughly represents 20% of annual acute care hospitalizations in the United States. In addition to information available in the standard hospital discharge file, the database contains a date-stamped log of all

billed items at the patient level, including diagnostic tests, medications, and therapeutic services (11).

We included hospitalizations from 2009 and 2010 for patients age 18 years or older with a principal discharge diagnosis of HF, as defined by International Classification of Diseases-Ninth Revision-Clinical Modification (ICD-9-CM) codes 402.01, 402.11, 402.91, 404.01, 404.11, 404.91, or 428.xx, who were treated with loop diuretic therapy in the first 2 days of hospitalization. Hospitalizations were excluded if the patients were hospitalized for <2 days, had a pediatric attending physician, or were transferred in. We focused on patients who were stable and excluded those who may have received intravenous fluids for another reason such as invasive cardiovascular procedures in the first 2 days; those with a secondary discharge diagnosis of sepsis, bleeding, or anaphylaxis; and those who received vasopressor or inotropic therapies. We excluded patients who had ICD-9-CM codes for stage 5 chronic kidney disease or end-stage renal disease because the use of diuretics and fluids is largely driven by kidney function status in such patients (Online Appendix 1). We also excluded hospitalizations during which patients had a critical care admission in the first 2 days, underwent endotracheal intubation in the first 2 days, or received renal replacement therapy in the first 2 days because we were interested in studying in-hospital outcomes of new critical care admission, new intubation, and new dialysis after the first 2 days.

**INTRAVENOUS FLUID USE, LOOP DIURETIC USE,
AND CLASSIFICATION OF TREATMENT INTENSITY.**

We defined intravenous fluid use as any use ≥ 500 ml of normal saline, half-normal saline solution, Ringer's/lactated Ringer's, or a combination of these solutions during the first 2 days of hospitalization, using 34 different administrative codes for intravenous fluids. We selected the volume cutoff to ensure that we captured fluid use that was administered for fluid management rather than for administration of other medications such as antibiotics or intravenous antiarrhythmics (12). We did not include codes related to administration of dextrose 5% solution because dextrose 5% would minimally enhance the intravascular volume.

We defined loop diuretic use as any use of furosemide, bumetanide, torsemide, or a combination

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