



# Hemoconcentration-guided Diuresis in Heart Failure

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## ABSTRACT

One quarter of patients hospitalized for heart failure are readmitted within 30 days, perhaps related to ineffective decongestion. Limited data exist guiding the extent and duration of diuresis in patients hospitalized for heart failure. The objective of this review was to determine the prognostic value of hemoconcentration, or the relative increase in the cellular elements in blood, in patients hospitalized for heart failure and to clarify its role in guiding inpatient diuretic practices. Six post hoc retrospective studies from 2010 to 2013 were available for review. Hemoconcentration was consistently associated with markers of aggressive fluid removal, including higher diuretic dosing and reduced body weight, but increased risk of in-hospital worsening renal function. Despite this, hemoconcentration was associated with improved short-term mortality and rehospitalization. Hemoconcentration is a practical, readily available, noninvasive, economically feasible strategy to help guide diuresis and monitor congestion relief in patients hospitalized for worsening heart failure. Clinicians should strongly consider using changes in hemoglobin and hematocrit as an adjunct to other available measures of decongestion and clinical acumen in inpatient heart failure care.

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**KEYWORDS:** Diuresis; Heart Failure; Readmission

Heart failure accounts for more than 1 million primary and 2 million additional secondary hospitalizations in the United States annually.<sup>1</sup> Congestion is the main reason for the majority of these hospitalizations and is the primary target for inpatient management. Intravenous diuretics are used in more than 90% of patients hospitalized for worsening heart failure<sup>2,3</sup> and remain the mainstay of

medical therapy. Despite their widespread use, limited research and clinical practice guidelines exist to help guide the use of volume removal strategies. Hemoconcentration, or the relative increase in the cellular elements in blood, has emerged as a putative metric to help guide inpatient decongestion. This article discusses the available data, practical applications, and possible future prospects of

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hemoconcentration in contemporary management of hospitalized patients with heart failure.

## CONCENTRATING ON THE PROBLEM: OPTIMIZING VOLUME AND QUALITY

Despite adequate relief of clinical symptoms during hospitalization and incremental reductions in hospital length of stay,<sup>4</sup> postdischarge mortality and rehospitalization remain exceedingly high. Approximately 20% to 25% of all hospitalized patients with heart failure are readmitted within 30 days, with more than 60% of them returning to the hospital within the first 15 days.<sup>5</sup> Of these 30-day readmissions, 35% are related directly to heart failure and may reflect inadequate decongestion during hospitalization.<sup>5</sup> More weight loss during hospitalization for heart failure has been associated with early dyspnea relief and reduced short-term mortality.<sup>6</sup> However, registry-based studies have revealed that many patients are discharged with persistent signs or symptoms suggesting incomplete relief from congestion.<sup>7</sup> Indeed, only approximately 50% of patients with heart failure lose more than 2 kg of fluid weight during hospitalization, according to contemporary experiences.<sup>2,3</sup> As readmission continues to gain significant traction as a measure of quality and reimbursement/penalty, index of disease severity, and end point for clinical trials,<sup>8</sup> evidence-based inpatient volume management seems important in optimizing early readmission risk.

## PITFALLS OF TRADITIONAL APPROACHES

Although the type<sup>9</sup> and intensity<sup>10</sup> of volume removal have become a focus of recent trials, data are scarce regarding the optimal duration and therapeutic targets of inpatient volume reduction therapy. A number of parameters are currently being used empirically in the tailoring of inpatient diuresis, including resting or exertional symptoms, urine output, natriuretic peptide levels,<sup>11</sup> orthostasis,<sup>12</sup> renal function,<sup>13</sup> body weight,<sup>14</sup> and intravascular volume.<sup>15</sup> We currently lack randomized controlled trials comparing these various metric-guided approaches to diuresis. However, considering the persistent suboptimal short-term postdischarge outcomes for patients hospitalized for heart failure, the strategies guiding inpatient decongestion are clearly falling short. The latest iteration of the American College of Cardiology/American Heart Association heart failure guidelines advocate for close monitoring of fluid intake and output, vital signs, body weight, electrolytes, and renal function

in helping to titrate inpatient diuretics.<sup>16</sup> However, the guidelines fail to provide a specific strategy for guiding inpatient decongestive therapy or an evidence-based end point for diuresis that facilitates appropriate decision-making regarding the patient's ultimate disposition.

### CLINICAL SIGNIFICANCE

- Limited data exist guiding the extent and duration of diuresis in patients hospitalized for heart failure.
- Hemoconcentration, or the relative increase in cellular elements in blood, is associated with increased risk for in-hospital worsening renal function, but is consistently associated with improved postdischarge mortality and rehospitalization.
- Clinicians should strongly consider using changes in hemoglobin and hematocrit as an adjunct to other available measures of decongestion in inpatient heart failure care.

## Clinical Judgment

Considering the limited sensitivity and specificity of symptoms and physical examination,<sup>17</sup> coupled with large variations in assessment among providers, more objective metrics to help guide diuresis beyond the clinical examination and intuition are required. Degree of congestion at the time of discharge, as assessed by clinicians and patients, is strongly correlated with postdischarge mortality and readmission.<sup>18</sup> However, it is notable that even patients with minimal signs or symptoms of heart failure at the time of discharge experience high postdischarge clinical events.<sup>18</sup> On the basis of post hoc data from the Efficacy of Vasopressin Antagonism in Heart Failure Outcome

Study With Tolvaptan (EVEREST) trial, patients with no evidence of orthopnea, pedal edema, or jugular venous distension at discharge experienced a heart failure rehospitalization rate of 26.2% and an all-cause mortality rate of 19.1% during follow-up at 9.9 months.<sup>18</sup>

## Body Weights

Simple serial body weights, although perhaps effective in guiding outpatient management, may not be sensitive to accurately guide inpatient therapy because of only modest daily fluctuations in weight, variations in day-to-day food and fluid intake, and poor reliability of hospital scales.<sup>19</sup> Weight loss per unit of diuretic dose, a proxy of diuretic responsiveness, has shown promise in selecting patients with favorable postdischarge outcomes<sup>20,21</sup>; however, this metric requires further prospective testing.

## Natriuretic Peptides and Hemodynamic Monitoring

Invasive hemodynamic monitoring using pulmonary artery catheterization led to a marked improvement in signs and symptoms of heart failure, but did not affect overall mortality and rehospitalization in the Evaluation Study of Congestive Heart Failure and Pulmonary Artery Catheterization Effectiveness (ESCAPE) trial.<sup>22</sup> Robust data support natriuretic peptide levels as one of the most powerful objective predictors of outcome for outpatients and

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