ASM 2026
HFSA ANNUAL SCIENTIFIC MEETING
Where Heart Failure Teams Gather
October 9-12, 2026 | Phoenix, Arizona

Inpatient Blood Volume Analysis in Left Ventricular Assist Device and Total Artificial Heart Patients

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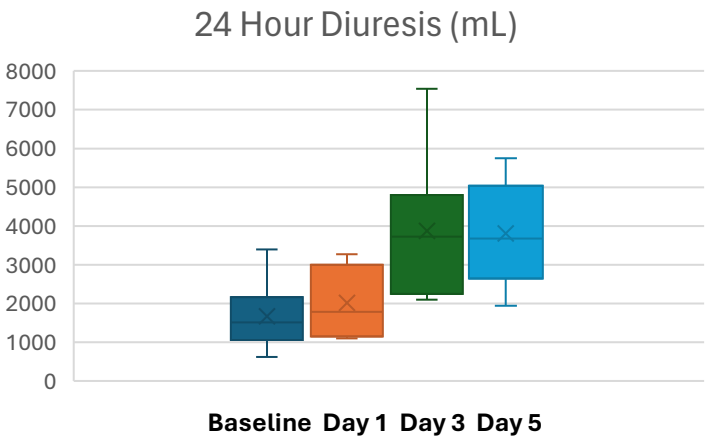
Background:

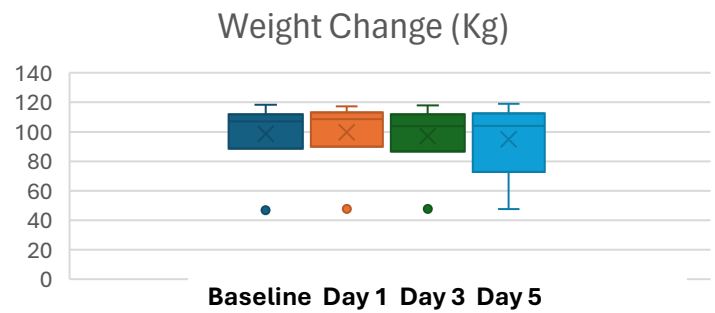
Patients with advanced heart failure undergoing durable mechanical circulatory support (MCS), including left ventricular assist devices (LVAD) and total artificial heart (TAH), often have chronic end-organ dysfunction. After implantation, goals extend beyond postoperative recovery to restoration of functional capacity and circulatory homeostasis. Prior work by Yaranov et al. demonstrated heterogeneous blood volume analysis (BVA) profiles in ambulatory LVAD patients. We describe BVA findings in acutely hospitalized durable MCS patients and its role in identifying and guiding correction of circulatory abnormalities.

Methods:

From January 2023 to March 2026, 13 patients (11 LVAD, 2 TAH) underwent BVA (Daxor, Oak Ridge, TN) testing. This technique uses iodine-131-labeled albumin tracer to quantify total blood volume (TBV), plasma volume (PV), and red blood cell volume (RBC). Results were reported as absolute values (mL) and percent deviation from ideal. A deviation of at least +/-8% in TBV, PV, or RBC was considered clinically significant.

ATR: Albumin transudation rate (ATR) evaluates excess capillary leak.





Results:

Mean age was 60.1 +/- 13.6 years; 69% were male. Hypervolemia was the most common abnormality, seen in 9/13 patients (69%), with extreme TBV excess in 3/9 (33%). Hypovolemia occurred in 2/13 (15%). True anemia was present in 9/13 (69%), while pseudoanemia and polycythemia were seen in 1/13 (8%) and 3/13 (23%), respectively. TAH patients had greater RBC deficits than LVAD patients (-49% ± 2.1 vs -26% ± 11; p=0.04), with otherwise similar profiles. Abnormal albumin transudation slopes were present in 7/13 (54%).

BVA findings were discordant with pretest clinical volume assessment in 5/13 cases (38%). Among hypervolemic patients with preserved renal function, 5/6 (83%) had diuretic escalation, associated with increased 24-hour urine output (1667.5 ± 856.3 mL at baseline vs 3809 ± 1245 mL on day 5; p=0.02), without significant weight change (99 ± 24 kg vs 95 ± 25 kg; p=0.72). In hypervolemic patients on hemodialysis, ultrafiltration volumes were not significantly adjusted (4350 +/- 2039 mL vs 4402 +/- 1734 mL; p=0.83). Among hypovolemic patients, diuretics were stopped in 1/2 (50%). Only 1/9 (11%) of anemic patients received transfusion or iron supplementation. No RBC-directed or anticoagulation changes were made in patients with polycythemia.

CONCLUSIONS

***Patients with durable MCS demonstrate marked heterogeneity in intravascular blood volumes (plasma and RBC volumes.**
***Hypervolemia and true anemia were most common.**
***BVA was frequently discordant with clinical assessment and influenced management.**
***Implementation, however, was inconsistent and effects on outcomes remain uncertain. Documentation precise gaps in intravascular volumes with BVA (plasma and red cell) along with associated abnormalities in capillary leak offer important opportunities to improve immediate and short-term outcomes in patients receiving MCS.**