Red Cell Volume Phenotypes in Hospitalized Heart Failure Patients

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Abstract

Background: Total Blood Volume (TBV) overload frequently causes shortness of breath and fatigue in heart failure (HF)-related hospital admissions. Red cell volume (RBCV) variations in the same population, unrecognized and largely untreated without quantitative blood volume analysis, suggest an independent causal role in symptom production, short, and long-term outcomes. RBCV phenotypes, their prevalence, distribution, and impact on length of stay (LOS) were studied in a previously published series of hospitalized heart failure patients.
Methods: In a series of 245 consecutive HF admissions to a community hospital (Sept 2007–Apr 2014, age 78±10 yrs., HFrEF 46%, Stage 4 CKD 30%), Total blood volume (TBV) and Red Cell Volume (RBCV) were measured at admission by blood volume analysis (BVA), an I-131 labeled albumin indicator-dilution technique (Daxor BVA-100). True anemia was diagnosed with a RBCV deficit >10% of ideal RBCV and polycythemia was diagnosed with a RBCV excess of >10% of ideal RBCV. True anemia was corrected with IV iron, epoetin, and/or packed red blood cells when appropriate.

Results: Only 37% of these patients were hypervolemic (TBV >10% excess), but 62% had true anemia (> 10% deficit from ideal RBCV); true anemia was equally distributed across ejection fraction (EF) ranges, 50.3% of patients with reduced EF (<40%), and 49.7% of patients with preserved EF (≥40%) demonstrated true anemia. The most prevalent RBCV Phenotypes were Anemia with Normovolemia (50%), Anemia with Hypervolemia (TBV > 10% excess from ideal TBV) (12%), and Polycythemia (> 10% excess from ideal RBCV) with Hypervolemia (10%). Peripheral hematocrit measured at the time of blood volume analysis was unable to distinguish between RBCV phenotypes. True Anemia was present in 44/60 patients whose hospital length of stay (LOS) exceeded 10 days compared to 16/60 patients without anemia and a > 10 day LOS (p < 0.033).
Conclusion: True anemia was a surprisingly consistent feature in 62% of the HHF patients. Only 27% of patients in the series presented with a normal RBCV. Peripheral hematocrit could not be used to identify RBCV phenotypes. True anemia was present in nearly three times as many patients with LOS > 10 days, indicating it is a marker of disease severity that must be recognized and treated early in the hospital course. Treatment should be guided by the specific RBCV phenotype and the laboratory evaluation of the anemia. Further controlled evaluation of the impact of RBCV phenotype on short- and long-term outcomes in HHF patients following volume-guided treatment is necessary.

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Figure 1.

Common Blood Volume Analysis Phenotypes in Patients Admitted with "Decompensated" Heart Failure

Total Blood Volume	RBC volume	N	% (of 245 pts)	
Normal or low	Low	122	50	
Normal or low	Normal	29	12	
Normal or low	Polycythemic	3	1	62%
Hypervolemic	Low	29	12	
Hypervolemic	Normal	37	15	
Hypervolemic	Polycythemic	25	10	

Figure 2.

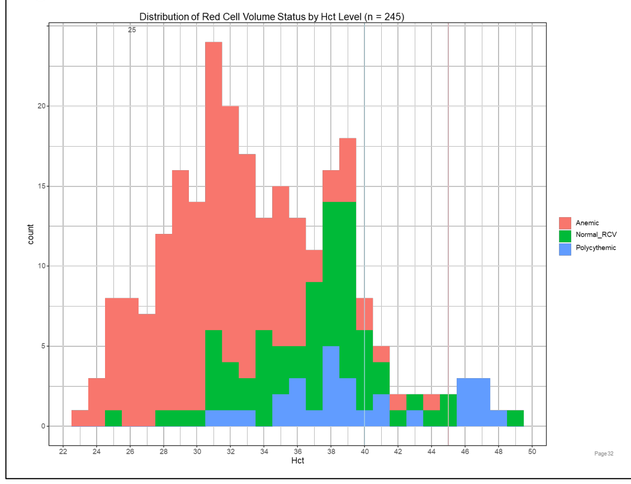
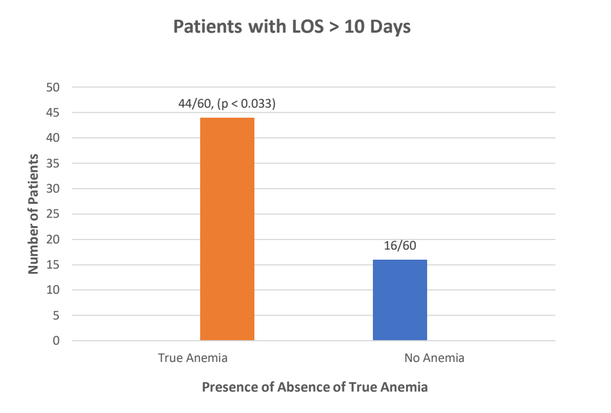


Figure 3.



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Discussion

Achievement of the guideline-based treatment goal, euvolemia of both Total Blood Volume and Red Cell Volume, is nearly impossible without direct measurement of blood volume in the heart failure patient. Accurate assessment and treatment of true anemia in heart failure patients is impossible using only the concentration dependent measures of hemoglobin and hematocrit. Therefore, proper assessment combined with more detailed evaluation of the optimal protocols of decongestion and red blood cell volume correction represent fertile areas of future study with prospective randomized clinical trials.

References

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