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Patients Are Not Normovolemic Following Cardiac Surgery Despite Concerted Efforts To Manage Fluid And Volume Status

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Purpose

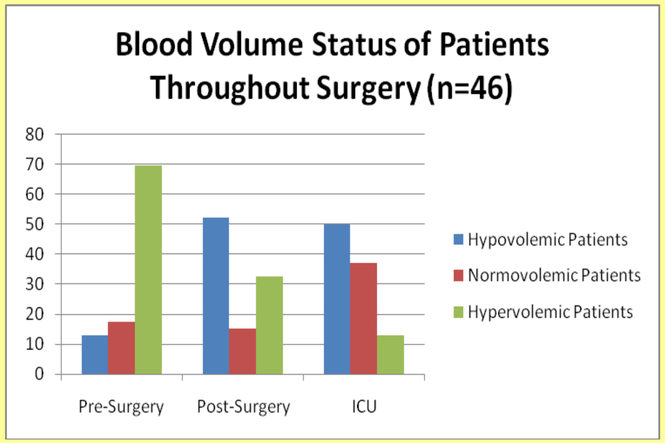
Following cardiac surgery, fluid replacement therapy is employed to restore patients to a normovolemic state. Standard surrogate measures of volume status are used as guides in volume assessment and restoration. Here, direct blood volume measurement was utilized to determine patients' true volume status.

Methods

Three blood volume measurements were performed on each of 46 patients: (1) before surgery; (2) immediately following surgery; and (3) 2 hours after transfer to the ICU. Total Blood Volume (TBV), Red Blood Cell Volume (RBCV) and Plasma Volume (PV) were measured using the indicator dilution technique via a commercially available, FDA approved semi-automated system (BVA-100 Blood Volume Analyzer, Daxor Corporation).

Results

Blood volume analysis revealed that the majority of patients (32/46; 69.6%) entered surgery in a hypervolemic state. Following surgery (24/46; 52.2%) of patients had become hypovolemic – despite the fact that commonly used invasive technology indicated that they were normovolemic. With progression into the ICU and fluid management, the number of hypovolemic patients began to decrease (23/46; 50%).



Blood Volume Status	Pre-Surgery	Post-Surgery	ICU
Hypovolemic (>8% Deficit Relative to Ideal)	6/46 = 13.0%	24/46 = 52.2%	23/46 = 50.0%
Normovolemic (≤8% Deviation Relative to Ideal)	8/46 = 17.4%	7/46 = 15.2%	17/46 = 37.0%
Hypervolemic (>8% Excess Relative to Ideal)	32/46 = 69.6%	15/46 = 32.6%	6/46 = 13.0%

Conclusions

Blood volume analysis provided direct measurement of the volume status of patients before and after cardiac surgery for the first time. Although all patients were believed to be normovolemic following surgery, direct blood volume measurement revealed that the majority of patients were in fact volume expanded prior to surgery and substantially volume contracted after surgery. We postulate that the use of vasoconstrictors, hypothermia, presence of peripheral edema, and avoidance of volume overload in post-operative patients are potentially responsible for the large degree of hypovolemia observed in post-operative patients.