Peripheral Blood Hematocrit Is a Poor Surrogate for Red Blood Cell Volume in Patients with Volume Excess or Depletion

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BACKGROUND

Anemia (Hg <11) is associated with poor prognosis in acutely and chronically ill patients – particularly in those with volume excess or depletion. Conversely Hg above 13 portends greater morbidity and mortality. [3,4]

While peripheral hematocrit (pHct) may provide a good estimate of red blood cell volume (RBCV) in euvolemic patients, discordance between pHct and RBCV has been reported in critical care, hematology and congestive heart failure (CHF) settings.

Analysis often produces large variations in pHct; 4 hours of ultrafiltration may increase pHct by >30%.

We considered whether volume status may be important in assessments of RBCV in clinical situations in which achievement of adequate perfusion and tissue oxygenation dictate management.

To examine whether pHct is a suitable proxy for RBCV, we performed a retrospective analysis on a large population of patients with a wide variety of medical conditions.

DEFINITIONS

TBV = PV ± RBCV (where PV= plasma volume)

pHct (% packed red cell volume)= [RBCV/(RBCV + PV)]x100

Normalized Hct (nHct)= pHct (TBV/Ideal TBV)

Blood Volume Analysis (BVA): FDA approved, radioactive method of determining PV, RBCV and TBV. Observed results are compared with ideal volumes which are predicted based on patient gender, height and weight.

RESULTS

Peripheral blood Hct (pHct) provides a good estimate of RBCV in states of fluid excess (dilutional anemia) and overestimates RBCV when PV is low (hemoconcentration).

Evaluation of anemia is inextricably linked to volume status.

Peripheral blood Hct (pHct) provides a good estimate of RBCV in normovolemic patients, but not in hypo- or hypervolemic patients.

TBV  = PV +  RBCV  (where PV= plasma volume)

RESULTS

To examine whether the peripheral blood Hct is a suitable proxy for RBCV in patients with a variety of volume states.

METHODS

Fig. 2. Normalized Hct – Available Only from Blood Volume Analysis – Correlates Better with True RBCV than Does Peripheral Hct

Fig. 3. Bland-Altman Analysis Examines Difference Between Peripheral and Normalized Hct Methods as a Function of Volume Status

Fig. 4. Peripheral Hct Both Underestimates (Fig. 4A) and Overestimates (Fig. 4B) True Anemia

Fig. 5. Normalized Hct is a Better Proxy than pHct for Reductions in RBCV

Fig. 6A: Relationship between pHct and RBCV (n=940)

Fig. 6B: Relationship between nHct and RBCV (n=940)

CONCLUSIONS

Peripheral blood Hct (pHct) provides a good estimate of RBCV in normovolemic patients, but not in hypo- or hypervolemic patients.

The normalized Hct (nHct) provided by blood volume analysis offers dramatically improved correlation with true RBCV in hyper- and hypovolemic patients because it corrects for abnormal volume status.

Blood volume analysis may greatly improve anemia and volume management in a wide variety of patient types.

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