Accuracy of Anemia Evaluation is Improved in Acutely and Chronically Ill Patients By Accounting for Volume Status

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BACKGROUND

- Anemia is associated with poor prognosis in acute and chronically ill patients – particularly in those hospitalized, with volume excess or depletion.
- 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.
- Dialysis often produces large variations in pHct; 4 hours of ultrafiltration may increase pHct by > 5 % points (i.e., 18-24%).
- We considered the current anemia recommendations by KDOQI and KDIGO (goal pHct: 30-33%) and asked, “Should volume status be considered when assessing RBCV in clinical conditions where achievement of effective perfusion and tissue oxygenation dictate management?”

HYPOTHESIS

We hypothesize that pHct is a good surrogate measure for RBCV in all states of hydration.

METHODS

- **Design**: Retrospective study of a cohort of hospitalized patients from two large, urban, tertiary care teaching hospitals.
- **Inclusion criteria**: 627 consecutive hospitalized patients referred to nuclear medicine for tagged isotope blood volume analysis (BVA), for question of volume status (i.e. uncertain TBV, PV or RBCV). Patients included all ages (18-100 years) any race/ethnicity, gender and body mass index (BMI). Laboratory RBCV was done simultaneously with BVA.
- **Exclusion criteria**: Age < 18 years, pregnancy, nursing, or iodine-allergic.
- **Study protocol**: Baseline 5mL sample of peripheral blood was drawn and sent to hospital central lab for pHct was done simultaneously with BVA.
- **Tagged albumin**: 25 uCi was injected IV over 1 min. 5mL blood sample was collected at 18, 24, 30, and 36 min post injection, were assayed for radioactivity in duplicate and the results plotted (minimum three sample points, standard deviation SD <2.9%). Plasma volume (PV) was measured by extrapolating to time zero. BVA presents RBCV, PV, TBV and nHct as absolute values and as deviation (mL and %) from ideals, based on a large, healthy, heterogeneous population, straited by gender, height and weight.
- **Statistics**: Regression Analysis. pHct and nHct were analyzed with Bland-Altman. p value of < 0.05 and 95% Confidence Intervals were considered statistically significant. Distribution of RBCV deficit and excess was categorized by deviation from norms. (SPSS, Chicago, IL).

RESULTS

- By comparing RBCV to pHct we found that in hospitalized patients pHct is a poor surrogate for RBCV.
- pHct may underestimate RBCV in states of fluid excess (dilutional anemia) and may overestimate RBCV when PV is low (hemococoncentration).
- In states of fluid excess and depletion, pHct may be misleading if volume status is not factored into the evaluation.
- Normalized hematocrit (nHct) may provide a more reliable assessment of anemia in patients whose volume status is uncertain.

DEFINITIONS

- **TBV** = PV + RBCV (where PV=plasma volume).
- **pHct** = (packed cell volume) = [RBCV/(RBCV + PV)]x100
- **Normalized Hct (nHct)** = pHct (TBV/ideal TBV)
- **Blood Volume Analysis (BVA)**: is a validated, FDA approved, tagged isotope method, whereby PV, RBCV and TBV are ascertained by a standard method and compared with established ideal values based on patient gender, height, and weight.

SUBJECTS

- **Table 1**: n=627
- **Gender**: Female 321 (51), Male 306 (49)
- **Age (years)**: 69.6 (19.6)
- **BMI kg/m2**: 28.4 (5.5)
- **Height cm**: 168 (16.7)
- **Weight kg**: 95 (34)

- **Table 2**: n=627
- **Volume status of all patients (n=627)**
- **Euvolemic (TBV=Ideal TBV +/- 8%)**: 442 (70%)
- **Hypervolemic (TBV>8% above Ideal TBV)**: 105 (24.7%)
- **Hypovolemic (TBV<8% below Ideal TBV)**: 44 (10.8%)

- **Table 3**: Sample Patient Data

BIBLIOGRAPHY

3. Bland Altman.  p value of < 0.05 and 95% Confidence Intervals were considered statistically significant. Distribution of RBCV deficit and excess was categorized by deviation from norms. (SPSS, Chicago, IL).

Figure 1. Is pHct a good surrogate for RBCV?

Figure 2A. Non-anemic patients (n=394)
Figure 2B. Anemic patients (n=233)

Figure 3. Bland Altman analysis of pHct and nHct in hospitalized patients (n=627)

Figure 4. Correlation between nHct & deviation from ideal (A) and pHct deviation from ideal (B) in hospitalized patients (n=627)

Figure 5. Correlation between pHct & deviation from ideal TBV (normal vs. hypervolemic vs. hypovolemic) in hospitalized patients (n=627)

Figure 6. Anemic patients (n=233)
Figure 7. Non-anemic patients (n=394)