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 acutely 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.

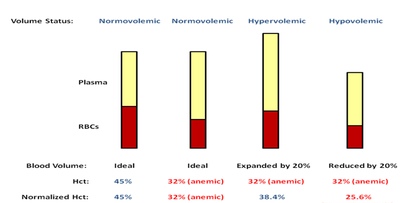
➢ Dialysis often produces large variations in pHct; 4 hours of ultrafiltration may increase pHct by > 5 % points (i.e.,19-24%).

➢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?"**

➢To begin to answer this question, and to examine whether pHct is a suitable proxy for RBCV, we performed the following retrospective analysis on a large population of hospitalized patients, who had simultaneous measurements of pHct and isotope blood volume analysis (BVA), in clinical settings where volume status was in question.

DEFINITIONS

Figure 1. Is pHct a good surrogate for RBCV?



➢ 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.

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 pHct 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. Simultaneously, radio-isotope labeled BVA was performed using the hospital's BVA-100 (Daxor Corporation, New York, NY). 1 mL of ^{131}I-labeled albumin (<25 uCi) was injected IV over 1 min. 5mL blood samples, collected at 12, 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, stratified 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).

SUBJECTS

Table 1. n=627	Patient Characteristics
Gender	321 F, 306 M
Age (years)	69.6 (19-95)
BMI kg/m^2	30 (18-75)

Table 2. Volume status of all patients (n=627)	Number (%)
Euvolemic (TBV=Ideal TBV +/- 8%)	226 (36.0%)
Hypovolemic (TBV>8% below Ideal TBV)	155 (24.7%)
Hypervolemic (TBV>8% above Ideal TBV)	246 (39.2%)

RESULTS

Table 3. Sample Patient Data

Patient n=5	Age (yrs)/ sex	% Dev from ITBV (Normal ±8%)	% Dev from IRBCV (Normal ±10%)	% Dev from IPV (Normal ±8%)	pHct% (goal 30-33)	nHct %	BVA Volume
1	52/M	+18	+16	+4.9	33	40.7	Hypervolemic
2	65/F	-5.8	-31.1	+7.8	32.8	32.6	Normovolemic
3	36/M	+7.4	-29.7	+28.5	33	31	Normovolemic
4	73/M	-13.3	-33.8	+7.3	31	28.6	Hypovolemic
5	81/F	-35.7	-46.5	-28.1	32	19	Hypovolemic

RESULTS

Figure 2. Correlation between pHct (A) and nHct (B) with RBCV in hospitalized patients (n=627).

Fig 2A.

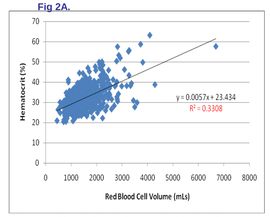


Fig 2B.

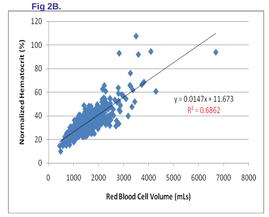


Figure 3. Bland-Altman analysis of pHct and nHct in hospitalized patients, by volume status.

Fig 3A. Euvolemic patients (n=226)

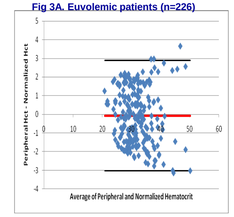


Figure 4. Correlation between pHct & deviation from ideal RBCV, by anemia status. (anemia defined as pHct<33%)

Fig 4A. Non-anemic patients (n=233)

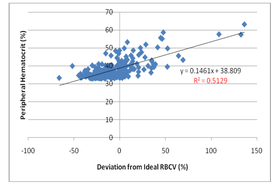


Fig 4B. Anemic patients (n=394)

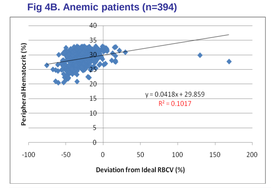


Figure 5. Correlation between nHct & deviation from ideal RBCV, by anemia status. (anemia defined as pHct <33%)

Fig 5A. Non-anemic patients (n=233)

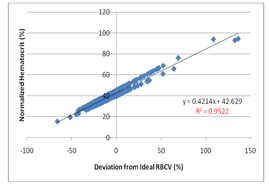


Fig 5B. Anemic patients (n=394)

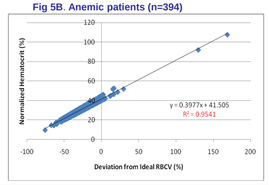
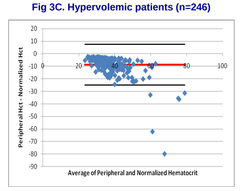


Fig 3B. Hypovolemic patients (n=155)

Fig 3C. Hypervolemic patients (n=246)



CONCLUSIONS

➢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 (hemoconcentration).

➢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.

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Poster Session: Vascular Physiology/Renal Hemodynamics 11-6-08 (10:00 AM-12:00 PM) Poster Board Number: TH-PO250. Contact: luanapillon2002@yahoo.com