Does Hematocrit Reflect Red Cell Volume when Adjusted for Plasma Volume

Kurt Edwards, MD; Mihae Yu, MD; Fedro Lurie, MD; Danny Takanishi, MD; Andrew Tan, MD; Hao Chih Ho MD, Susan Apte, MD, Wega Kos MD

From University of Hawaii, Department of Surgery and Critical Care and the Queen’s Medical Center

Introduction

Hematocrit (Hct), a term coined in 1903, is defined as the proportion of volume of a blood sample that is red blood cells(1). Dorlands medical dictionary. It is this inferred red blood cell volume from the Hct which clinicians utilize. We propose that in critically ill patients the hematocrit may not agree with red cell volume as determined by radionucleotide studies.

Methods

We performed a retrospective review comparing red cell volume to Hct values in critically ill surgical patients. These studies were performed within a university affiliated, single institution, surgical intensive care unit.

A "normalized" hematocrit or adjusted hematocrit is defined as the ratio of the patient’s measured red cell volume (as determined by a radionucleotide study) to the predicted normal whole blood volume. Unlike the Hct, this measurement provides an accurate indication of the degree of red cell deviation without being distorted by variations in plasma volume.

Bland and Altman analysis compared bias and precision (error) between Hct and "normalized" hematocrit.

Results

370 patients contributed 689 blood volume measurements. Demographics are presented below:

- Age: 67 years
- Sex: 36% female, 64% male
- Weight: 78 kg
- Height: 167 cm
- Severe sepsis/ septic shock: 36%
- Trauma: 118 (31.2%)
- Congestive heart failure: 10%

Bland and Altman analysis showed a bias of -3.16 with limits of agreement of 14.17 to -20.15 between Hct and "normalized" hematocrit. A linear regression analysis demonstrated an R2 of 0.295.

In 28(5%) of the instances, there was greater than 40% deficit in red cell volume despite a Hct of 30% or greater. In 12 (1.7%) instances, there was a red cell volume deficit of less than 10% with a Hct of <30%

Discussion

It is the current practice to utilize Hct to guide red cell transfusion. Since Hct is the ratio of red cell volume to plasma volume, Hct may be misleading and not reflect red cell volume. This study shows poor agreement between Hct and “normalized” hematocrit, the latter being a better indicator of the degree of red cell deviation without being distorted by variations in plasma volume.

5% of the measurements had a severe red cell deficit (>40%) which was masked by a laboratory Hct of ≥30%. These patients may have poor oxygen delivery to the tissues from anemia as described by Valeri et al as the “missing blood syndrome”.

Conclusions

There is very little agreement between the hematocrit and the “normalized” hematocrit. Measurement of Blood volume may provide a more specific guide to red cell transfusion although future studies are needed to confirm the clinical benefit of utilizing a “normalized” hematocrit.