Do blood tests cause anemia in hospitalized patients?
The effect of diagnostic phlebotomy on hemoglobin and hematocrit levels

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PURPOSE

This research studied whether considerable volumes of blood drawn contribute to changes in hemoglobin and hematocrit. The study focused on general internal medicine (GIM) patients, ensured adequate sample sizing—controlled for the impact of other sources of blood loss on hemoglobin values—and used conventional measures of anemia.

MATERIALS AND METHODS

A retrospective cohort study was conducted at a GIM inpatient service at a tertiary care hospital, Toronto General Hospital, between January 1 and June 30, 2001. A total of 989 hospital visits were reviewed, and 404 hospitalizations were included in the analysis.

Patients were excluded from the study who:

› Had acute medical conditions that may have caused or contributed to anemia

› Were on therapy that could affect hemoglobin/hematocrit levels

› Were on dialysis

› Had fewer than 2 hemoglobin/hematocrit values during admission

› Received a red blood cell transfusion

› Were hospitalized for more than 21 days

RESULTS

The mean hemoglobin values on admission and discharge were 125.6 g/L and 117.6 g/L, respectively. This reflects a mean change of 7.9 g/L. The corresponding mean change in hematocrit was 2.1%.

On univariate analysis, changes in hemoglobin and hematocrit were predicted by the volume of phlebotomy, length of hospital stay, admission hemoglobin/hematocrit value, age, Charlson comorbidity index (CCI), and admission intravascular volume status (see Table 1).

TABLE 1: Predictors of Change in Hemoglobin During Hospitalization

Variable	Unvariable Analyses		Final Multivariate Analysis	
	Parameter Estimate (SE)	P Value	Parameter Estimate (SE)	P Value
Volume of blood draw, mL	0.073 (0.012)	<.0001	0.070 (0.011)	<.0001
Age, y	-0.069 (0.038)	.0704	-0.8211 (0.036)	.0247
Gender, male vs. female	0.770 (1.266)	.5432	*	*
Length of hospitalization, days	0.468 (0.150)	.0019	§	§
Hemoglobin level on admission, g/L†	0.184 (0.033)	<.0001	0.168 (0.032)	<.0001
CCI score (0, 1, or ≥ 2)	-0.987 (0.719)	.1705	§	§
Intravascular volume depletion at admission‡	2.472 (1.255)	.0496	2.615 (1.203)	.0303
Chronic diseases that may cause anemia	0.833 (1.275)	.5142	*	*

* Not included in multivariate model as it was not a univariate significant predictor (P ‹ .2)

† To convert g/L to g/dL, divide by 10.

‡ BUN (mg/dL) to creatinine (mg/dL) ratio › 25 and a calculated osmolality › 295 3Osmol

§ Not included in final multivariate model as variable was not a significant predictor after controlling for other factors

CCI, Charlson comorbidity index; BUN, Blood Urea and Nitrogen

The mean volume of phlebotomy during hospital stay was 74.6 mL. The volume of phlebotomy remained a strong predictor of decrease in hemoglobin and hematocrit after adjusting for other predictors using multivariate analysis. On average, every 100 mL of phlebotomy was associated with a decline in hemoglobin and hematocrit of 7.0 g/L and 1.9%, respectively.

Although small changes in hemoglobin may not be of clinical consequence, a clinically significant change has been found to be between 6.6 and 10 g/L.[1,2] In this study, the mean drop in hemoglobin during admission was 7.9 g/L, and larger volumes of phlebotomy resulted in larger decreases. Expected changes in hemoglobin and hematocrit corresponding to volumes of phlebotomy due to hypothetical clinical settings are displayed in Table 2.

TABLE 2: Volumes of Blood Draw and Predicted Drops in Hemoglobin and Hematocrit Based on Clinical Scenarios

Volume of Blood Draw, mL	Expected Change in Hemoglobin, g/L (95% CI)*	Expected Change in Hematocrit, % (95% CI)	Scenarios Resulting in the Volume of Blood Draw
10	0.7 (0.5 to 0.9)	0.19 (0.13 to 0.25)	Routine labs (CBC, electrolytes, renal and coagulation profiles)
50	3.5 (2.4 to 4.6)	0.95 (0.65 to 1.25)	Routine labs for 5 days
100	8.0 (4.8 to 10.2)	1.90 (1.30 to 2.50)	Routine labs for 5 days, acute anemia work-up, 3 sets of cardiac enzymes
200	14.00 (9.6 to 18.4)	3.80 (2.60 to 5.00)	Routine labs for 10 days, 3 sets of cardiac enzymes, 3 sets of liver profile, transaminitis work-up

*Divide by 10 to convert g/L to g/dL.
CBC, Complete Blood Count

Interestingly, among the 404 hospitalizations, 56 had investigations for anemia and fecal occult blood. Eleven of these patients were not anemic on admission and were not admitted for conditions that cause anemia. These findings were likely, at least partially, to be attributed to changes in hemoglobin values caused by phlebotomy.

CONCLUSION

Phlebotomy is highly associated with decreases in hemoglobin and hematocrit levels for patients admitted to a general internal medicine services and can contribute to anemia. This anemia may have significant consequences, especially for patients with cardiorespiratory diseases. Being able to anticipate the expected changes in hemoglobin and hematocrit due to diagnostic phlebotomy will help guide when to investigate anemia in hospitalized patients.

This study highlights the need to perform blood testing judiciously, and techniques that have been shown to decrease volumes of phlebotomy in the critical care setting could easily be adapted to general medicine units.

References

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