Laboratuvar testleri için alınan kan miktarı anemi nedeni olabilir mi?

Does blood drawn for laboratory tests cause anemia?

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Başvuru Tarihi: 17 Temmuz 2018 **Kabul Tarihi:** 31 Aralık 2018

ÖZET

Amaç: Hekimler tarafından talep edilen laboratuvar analizlerinde, farklı tiplerde ve yüksek miktarda kan örneği toplanır. Bu çalışmanın amacı hospitalize hastalarda flebotomi ile kan kaybının miktarını ve hastaların Hb düzeylerine etkisini belirlemektir.

Gereç ve Yöntem: Bir eğitim ve araştırma hastanesinin iç hastalıkları ve genel cerrahi kliniğine başvuran ve aktif kanaması bulunmayan 101 adet yetişkin hasta çalışma kapsamına alındı. Laboratuar analizleri için alınan kan miktarı, kurumun Hastane Bilgi Sistemi kullanılarak hesaplandı. Anemi varlığı, her bir hastanın hemoglobin seviyelerinin başvuru anında ve taburculuk sırasında karşılaştırılmasıyla değerlendirildi.

Bulgular: İç hastalıkları grubunda flebotomi nedeni kan kaybı ortalama 55.18 ± 22.87 (23.5-178) mL iken, genel cerrahi grubunda 29.06 ± 9.12 (12-58) mL idi. Hemoglobin değerlerindeki ortalama değişiklikler iç hastalıkları grubu için -0.31 ± 0.92 g/dL ve genel cerrahi grubu için -0.44 ± 0.51 idi. Yatış sırasındaki ortalama Hb düzeyi, iç hastalıkları grubu için 11.96±1.82 (9.82-14.51) g/dL iken, genel cerrahi grubu için 12.48±0.89 (11.58-13.66) g/dL idi. Taburculuktan hemen önce ölçülen ortalama Hb düzeyi, iç hastalıkları grubu için 11.65±0.95 (9.10-13.22) g/dL iken, genel cerrahi grubu için 12.04±0.96 (11.18-13.21) g/dL olarak saptandı.

Sonuç: Hastaların yarısından fazlası, başlangıçtakinden daha düşük Hb düzeyi ile taburcu edildi. Bununla birlikte, sonuçlarımız göre flebotomize kan hacminin hospitalize hastalarda anemiye neden olmadığını göstermektedir.

Anahtar kelimeler: Flebotomi ile kan kaybı; hastane kaynaklı anemi; iatrojenik anemi

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ABSTRACT

Aim: For laboratory analyses ordered by the physicians, different types and high amounts of blood samples are collected. The aim of this study is to determine the levels of blood loss with phlebotomy, and its effect on the Hb levels of the inward patients.

Materials And Methods: This study enrolled 101 non-bleeding adult patients, admitted to the internal medicine and general surgery clinics of an education and research hospital. The overall blood loss for laboratory analyses were calculated from the computerized Information Systems of the institution. Anemia was evaluated by comparing the hemoglobin levels of each patient at the time of admission and discharge.

Results: The mean blood loss from phlebotomy was 55.18±22.87 (23.5-178) mL in the internal medicine, whereas 29.06±9.12 (12-58) mL in the general surgery group. The mean changes in hemoglobin values were -0.31±0.92 g/dL for the internal medicine and -0.44±0.51 for the general surgery group. Mean hemoglobin (Hb) levels at admission was 11.96±1.82 (9.82-14.51) g/dL for the internal medicine group, and 12.48±0.89 (11.58-13.66) g/dL for the general surgery group. Mean hemoglobin (Hb) levels at the time of discharge was 11.65±0.95 (9.10-13.22) g/dL for the internal medicine group, and 12.04±0.96 (11.18-13.21) g/dL for the general surgery group.

Conclusion: More than half of the patients were discharged with a lower Hb than on admission. However, our results indicate that the phlebotomized blood volume does not cause anemia in inward patients.

Key words: phlebotomy blood loss; hospital-acquired anemia; iatrogenic anemia

INTRODUCTION

As the trend using lab tests for clinical decision-making increases, blood samples from inward patients are routinely collected by peripheral venipuncture (1).

For tight glycemic control of patients, blood glucose levels were monitored frequently using point of care (POC) systems which can work with the little amount of blood obtained via fingerstick. However, monitorization of hemostasis status, coagulation, blood chemistry, the functioning of visceral organs, presence of any kind of infection requires a high amount of measurements during the hospital stay (2). For performing these analyses, blood samples need to be collected in different types of test tubes containing different anticoagulants or additives (3).

Thus, the blood amount drawn can lead a decrease in hemoglobin levels causing iatrogenic anemia.

Frequent phlebotomy was introduced one of the major factors for anemia and packed red blood cell transfusions in hospitalized patients (4). According to the World Health Organization (WHO) criteria, anemia was defined as Hb levels less than 13 g/dL for men and 12 g/dL for women (5).

Anemia increases the cardiovascular and respiratory mortality and morbidity risk and deteriorates tissue oxygenation and become a comorbidity (2). In the year 2016, the need for blood products in Turkey was predicted to be up to 3 million units. The highest proportion demanded is comprised of packed red blood cells in order to treat anemia (6).

There is not much investigation about hospital-acquired anemia and consequences of blood loss due to phlebotomy sampling for laboratory tests.

Evidence shows a decrease in the hemoglobin levels up to 0.52 g/dL daily for non-bleeding patients, and frequent sampling for laboratory tests was accused of that consequence (7).

The aim of this article is to define the levels of blood loss with phlebotomy, and its effect on the Hb levels of the inward patients.

MATERIALS AND METHODS

2.1.Patients

This study enrolled patients admitted to internal medicine clinic and general surgery clinic of one of the largest teaching hospitals in Istanbul, Turkey. A total of 71 patients (37 F, 34 M) from internal medicine ward and 30 age-matched patients (17 F, 13 M) from general surgery ward were included. The inclusion criteria were adult patients hospitalized without any condition, that might affect blood cells. The clinical diagnoses of the patients included from internal medicine clinic were Type2 Diabetes Mellitus and Chronic Obstructive Lung Disease. Subjects from the general surgery clinic were admitted for follow-up due to abdominal pain and did not ungergo a surgical procedure until their discharge.

All patients actively bleeding or underwent surgery were excluded.

Patients treated with blood products during the hospital-stay, dialyzed patients, patients taking medication (including corticosteroids), that can have an effect on bone marrow and patients with ≥21 days of hospitalization were also excluded. All the decisions or laboratory test orderings were done independently of this study. Of the 887 samples from 101 patients examined, 189 were ordered from the general surgery ward, whereas 698 were ordered from the internal medicine ward.

2.2.Data collection

The data for age, gender, admission and discharge dates, diagnosis, transfusion and laboratory orders were collected from the computerized Hospital Information System (HIS) and Laboratory Information System (LIS) of the institution. All the patients enrolled in the study were evaluated in a daily base by a single investigator.

2.3.Phlebotomy blood loss

Phlebotomy samples were collected using the Greiner Vacuette system. Sampling volumes per patient were calculated based on the number and type of the tests ordered.

The required standard volumes for each tube types are mentioned on Table 1.

The phlebotomized amount for each patient was calculated by multiplication of the laboratory order types (e.g. clinical chemistry, coagulation, blood gas etc.) with the standard volumes for the tube types. Anemia was evaluated by comparing the hemoglobin levels of each patient at the time of admission and discharge.

2.4.Data analysis

Data were entered into Microsoft Excel for simple analysis. MedCalc, a computerized statistical software was used for statistical analyses. Chi-square and independent samples t-tests were used. The results were evaluated at a 95% confidence interval and a significance level of $p < 0.05$.

RESULTS

A total of 101 patients were reviewed from the internal medicine clinic with a mean length-of-stay of 4.9 days and from the general surgery clinic with 2.6 days. A total of 71 patients (37 F, 34 M) from internal medicine ward and 30 age-matched patients (17 F, 13 M) from general surgery ward were included. Of the patients from the internal medicine clinic, 52% were women and 48% were men. The mean age was 65·7 ± 11.59 years for the internal medicine group and 55.2 ± 11.40 years for the general surgery group. The distribution of the patients from the general surgery clinic was as 57% women and 43% men. Patient demographics and the key findings of the study are summarized in Table 2. The mean blood loss from phlebotomy was 55.18±22.87 (23.5-178) mL in the internal medicine group, whereas 29.06± 9.12 (12-58) mL in the general surgery group ($p<0.05$).

Mean hemoglobin (Hb) levels at admission was 11.96±1.82 (9.82-14.51) g/dL for the internal medicine group, and 12.48±0.89

(11.58-13.66) g/dL for the general surgery group.

Mean hemoglobin (Hb) levels at the time of discharge was 11.65±0.95 (9.10-13.22) g/dL for the internal medicine group, and 12.04±0.96 (11.18-13.21) g/dL for the general surgery group.

When the Hb levels at the time of admission and discharge were compared within the groups, the difference was found to be statistically significant ($p<0.05$ for the internal medicine; $p<0.001$ for the general surgery group).

The mean change in Hb values between the admission and discharge were -0.31±0.92 g/dL for the internal medicine group and -0.44±0.51 for the general surgery group ($p>0.05$).

More than half (59.1% for the internal medicine group; 60% for the general surgery group) of the patients were discharged with a lower Hb than on admission (Table 2).

The orders for blood tests and samples were predominantly for routine hematology and clinical chemistry, for both of the groups (Figure 1). Total collected blood volumes were 3861.4 mL for the internal medicine group and 843.2 mL for the general surgery group (Table 3).

Table 1. Standard blood collection volumes of tubes used for laboratory testing.

Tube Type	Cap color	Specimen	Test Types	Draw Volume
Blood Culture	Green or Orange	Whole blood	Blood culture	10 mL
Sodium Citrate (1:9)	Blue	Plasma	Coagulation testing	2 mL
Sodium Citrate (1:4)	Black	Whole blood	Sedimentation rate	1.8 mL
Clot Activator	Red	Serum	Clinical chemistry, immunology	10 mL
K_2EDTA	Lavender	Whole blood	Complete blood count, HbA1c, proBNP, genetic testing	2 mL
Lithium-Heparin	Green	Whole blood	Blood gas	2 mL

Table 2. Summary of data.

Parameter	Internal medicine clinic			General surgery clinic			
Number of patiens	71			30			
Female, %	52			57			
Number of the patients discharged with lower Hb values	42/71 (59.1%)			18/30 (60%)			
	Range	**Mean**	**SD (±)**	**Range**	**Mean**	**SD (±)**	**P value**
Mean age (years)	45-78	65.7	11.59	36-69	55.2	11.4	NA
Length-of-stay (days)	2-10	4.9	1.52	1-3	2.6	0.61	NA
Blood loss volume (mL)	23.5-178	55.18	22.87	12-58	29.06	9.12	**0.048***
Hb at admission (g/dL)	9.82-14.51	11.96	1.82	11.58-13.66	12.48	0.89	0.12
Hb at discharge (g/dL)	9.10-13.22	11.65	0.95	11.18-13.21	12.04	0.96	0.18
ΔHb (g/dL)	-3 - 0.6	-0.31	0.92	-0.9-0.2	-0.44	0.51	0.52
ΔHct (%)	-7.05-1.41	-0.81	2.22	-2.49-0.27	-1.21	1.42	0.48
* Data shows statistical significance ($p<0.05$).							

Table 3. Number of tubes and blood sample volumes collected.

Parameter	Internal medicine clinic		General surgery clinic	
	Number of tubes collected	Total volume collected (mL)	Number of tubes collected	Total volume collected (mL)
Clinical chemistry	217	2170	42	420
Serology	76	760	15	150
Coagulation	100	200	31	62
Hematology	164	328	69	138
Microbiology	20	200	2	20
Sedimentation	103	185.4	29	52.2
Blood gases	18	18	1	1
TOTAL	**698**	**3861.4**	**189**	**843.2**

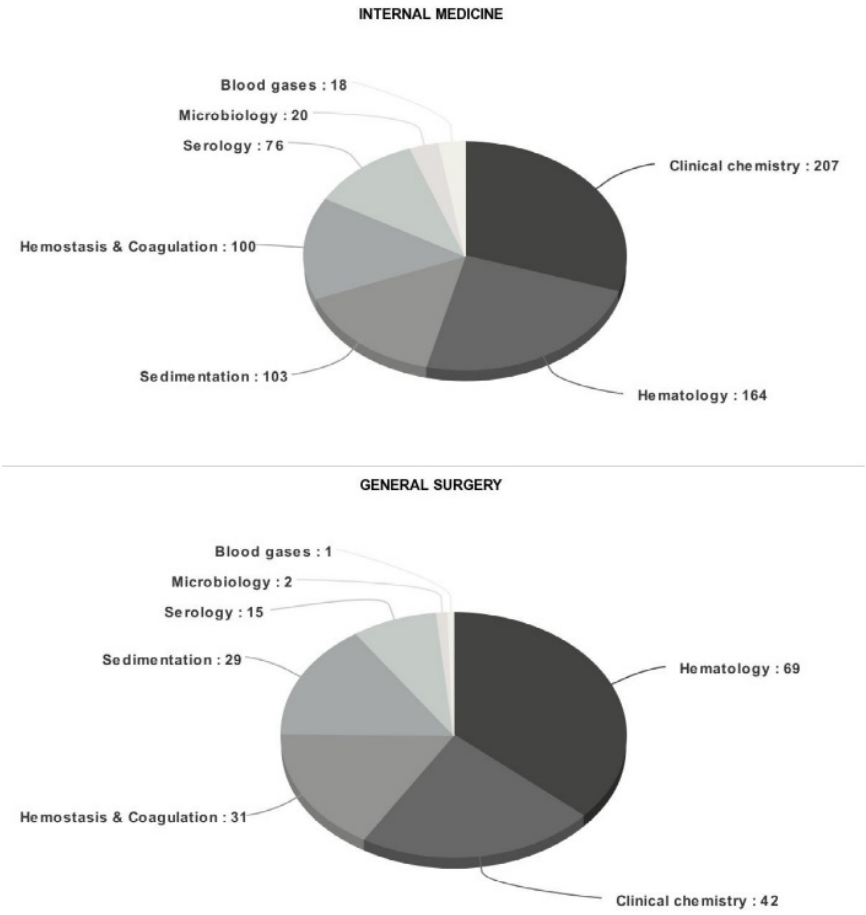

Figure 1. Distribution of the ordered test groups in the clinics.

DISCUSSION

The aim of this study was to determine the amount of blood loss and change in Hemoglobin values due to phlebotomy in patients on two different medical wards during a single admission.

The causes of anemia during the hospital stay are various and blood loss due to phlebotomy is included (1, 3, 8). It has been shown that the disease severity and transfusion requirement increase with the degree of anemia (4, 9). Additionally, the risk of anemia development within the hospital-stay period

increases together with the collected volume of blood with phlebotomy (10).

The study groups chosen had no disease or intervention that can cause a decrease in the Hemoglobin levels during the hospital stay period. Various studies claim that the volume of blood collected for the laboratory tests is much more than the required amount for the analyses (3, 11-13).

In our study group, among the 101 patients involved, the blood loss amount due to phlebotomy was more than 100 mL in four patients. The mean blood loss from phlebotomy as 55.18 mL for the internal medicine group, and 29.06 mL for the general surgery group was lower when compared to the findings of different studies for the similar patient groups (1, 8). However, our results indicate that the phlebotomized blood volume is not related with Hb and Hct levels of the inward patients, since the decreases in Hb and Hct levels of general surgery patients are higher when compared to the internal medicine group despite the lower levels of blood loss with phlebotomy.

Since red blood cells transfusion is the most common treatment for blood-related conditions, the need for blood products in Turkey was predicted to be up to 3 million units per year with an increasing demand (6). The transfusion rate for intensive care unit patients was found to be up to 30-40% (11).

As the demand for laboratory tests increase in order to help clinical decision-making, the number of laboratory test orders increase worldwide. This requires novel strategies in order to reduce avoidable phlebotomy-caused blood loss, especially in patient populations with a higher risk of anemia and with other comorbidities.

Education of the healthcare professionals on the deliberate ordering of laboratory tests and good phlebotomy practices in order to reduce rejected amounts of blood tests due to hemolysis might reduce phlebotomy-caused blood loss. The amount of blood withdrawn for laboratory tests reduced by half with the use of pediatric sample tubes and staff education (14, 15). This strategy can be applied to patients with anemia, long duration of hospitalization and patients with higher risk for anemia. However, since most of the automated analyzer systems are not compatible with the pediatric tubes, and the transfer of blood samples from pediatric tubes to the analyzer-compatible sample cups is time and labor-consuming, practical application of this approach can be unfavorable.

Since most of the tests require little amounts as microliters for analyses, prevalent use of point of care testing (POCT) can also reduce blood volumes for sampling. However, the accuracy of POCT is still controversial (16, 17). The decrease in phlebotomy blood volumes is anticipated with the use of POCT devices for electrolyte analysis, measurement of Hb and Hct values and routine coagulation tests, and the introduction of POCT systems and devices to hospital laboratory systems.

Repeated blood sampling also increases costs by causing anemia-related blood product transfusion and use of multiple phlebotomy devices and sample tubes and even increases patient anxiety (18).

It has been shown that, as the frequency of laboratory studies decrease, costs were decreased (11).

Our study has several limitations. The study is performed in a single-center and therefore shows the practices of one institution. Additionally, the calculated blood loss volume does not include the additional losses due to the use of central lines, finger-prick blood samples for the determination of glucose levels.

In spite of being on a non-bleeding state, the reason for decreases in the Hb and Hct amounts can be a result of hemodilution, since all the patients were hospitalized and spending most of their day within their beds. Although the phlebotomy-related blood loss volume is much less in the patients from the general surgery ward, the similar rate of

decrease in the Hb levels of patients between two different clinics can be due to hemodilution. However, it is not possible to calculate the amount of hemodilution using the infused volume of i.v. fluids.

This is the first study from Turkey and its region on phlebotomy practices and blood volume withdrawn for the laboratory analyses. Our study comprises only non-bleeding patients from two different clinic types (one internal medicine, one general surgery), who did not take any medications or treatments (including inhaled steroids) that can have an effect on bone marrow during the hospital stay.

During the study period, we realized that when the clinicians need additional tests for a patient, that requires another sampling. But, if clinician gives consent for testing from the last sample kept in the laboratory, and laboratory information systems can keep tracking of samples, the analyses could be made from the previous sample without the requirement of the new blood withdrawal.

However, this can only be applied to parameters such as serological markers, autoimmune markers, cancer markers or analysis of some types of vitamins, since other analytes such as renal and liver function tests and electrolyte levels can change dramatically within the day.

Keeping the track of diagnostic blood loss in hospital medical records using hospital and laboratory information systems with a simple algorithm that can use the sample type data required for the tests ordered and sample tube volumes can also minimize diagnostic blood loss.

Since the laboratories are specialized and grouped into sub-divisions, one sample type or one tube of the same sample type is not adequate for analysis and quick results. For instance, although the required sample type is the serum for both of the clinical chemistry and serology tests, for the hospital set-ups where the serology and clinical chemistry laboratories localized separately, two tubes of blood is taken from the same patient at the same time.

Development of strategies for testing of different test groups from the same blood specimen has the potential for reducing the daily volumes of diagnostic blood loss and benefits both adult and pediatric patients.

In conclusion, future studies, investigating the blood sampling and test ordering patterns of different centers for various patient populations, and novel strategies to decrease the collected blood volume for laboratory analyses are needed for better understanding and gaining consciousness of professionals, working on both laboratory medicine and clinical set-ups on this matter.

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