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Correlation between Phlebotomy Blood Loss and Hospital-Acquired Anemia among Acute Coronary Syndrome Patients

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Abstract

Background:*hospital-acquired anemia (HAA) is common, with an incidence that ranges from nearly25% to 74%for the period ofhospitalization. Phlebotomy blood loss is one ofthe etiologies and predictors of HAA in acute coronary syndrome patients.* ***Aim of this Study:*** *identify the correlation between Phlebotomy blood loss and HAA among acute coronary syndrome patients.* ***Material and Method:*** *Descriptive exploratory research design was used to performthe research on one hundred and eighty patients in Cardiac Care Units at Mahallah Cardiac Center. Patients' demographic, health-relevant laboratory investigations data, drug-related data, and estimation of blood loss volume toolswere utilized in the data collection process.* ***Results:*** *Around two-fifth (37.8%) of the studied patients have HAA.There was a statistically significant correlation between HAA and gender & length of hospital stay(X2: 5.229, P: 0.029&X2: 21.832, P:<0.001 respectively). On the otherhand, there was no significant correlation between HAA and phlebotomy blood loss& patient's age (X2: 1.307, P: 0.520& X2: 1.7763, P: 0.620114 respectively).* ***Conclusion:*** *Around two fifths (37.8%) of acute coronary syndrome patients had HAA compared to 62.2% who were non-anemic. There was a statistically significant correlation between HAA and gender & length of hospital stay. In contrast, there was no significant correlation between HAA and phlebotomy blood loss and patient's age among acute coronary syndrome patients atMahallah Cardiac Center.****Recommendations:*** *Future HAA prevention efforts are recommended to be effective if they include multimodal interventions that both decrease unnecessary phlebotomy blood loss through puncturing and bleeding.*

Keywords*, predictors, phlebotomy,hospital-acquired anemia, acute coronary syndrome*

Introduction

Anemia is considered an important cause of morbidity and mortality where even mild anemia is independently relatedto high mortality and increased length of stay (LOS) **(Krishnasivam, et al., 2018)**.Hospital-acquired anemiawas defined as a drop of hemoglobin (Hb) values to less than 13 gm/dl in men and less than 12 gm/dl in women during the hospital stay after they had been admitted with normal Hb values and without any type of bleeding or bleeding complication **(Merono et al., 2012)**.

The prevalence of Hospital Acquired Anemia (HAA) was one-third among the 11,309 hospitalizations from six Texas hospitals (21.6 % with mild HAA; 10.1 % with moderate HAA; and 1.4 % with severe HAA). The majority of patients with severe HAA (85%) were needed major surgery. Patients who developed HAA were older and had more comorbidities than those who did not. For patients hospitalized for acute myocardial infarction(AMI), HAA is associated with increased morbidity and mortality after discharge (**Makam, Nguyen, Clark, & Halm, 2017).**

Acute coronary syndrome (ACS) patients have several factors that are independently associated with anemia as (age, gender, smoking, hyperlipidemia, angina, previous myocardial infarction, previous heart failure, previous stroke, peripheral vascular disease, diabetes mellitus, chronic obstructive pulmonary disease, renal disease, previous coronary intervention, dual antiplatelet treatment with clopidogrel, and aspirin) **(Kaiafa et al.,2015Farhan,Baber&Mehran,2016)**.

Hospital-acquired anemia is common in ACS patients as this condition is life-threatening and requires more monitoring, invasive maneuvers in addition to daily diagnostic phlebotomy tests that are associated with blood loss and anemia. The most significant contributor to HAA is blood sampling for laboratory testing: this is specific towards critically ill patients at the ICU. A single milliliter of phlebotomy blood will reduce hemoglobin by 0.007 g/dl and blood cultures by 0.14 g/dl on average. Clinically relevant blood losses are calculated to be between 0.66 and 1.0 g/dl or 100 mL of phlebotomy blood.This can be done in just 5 days on average every day of the basic laboratory tests. For lab work alone, blood loss in the ICU may be as high as 40 to 70 mL per patient day, with the highest loss occurring within the first 48 hours of admission. If the central venous catheteris inserted, it will further lead tounnecessaryblood tests secondary to ease of phlebotomy **(Salisbury et al., 2011).**

Significance of the Study

Hospital-Acquired Anemia affects approximately 25% to 74 % of patients during their stay in the hospital **(Makam et al., 2017).** Similarly, 76.9% of critically ill patients developed HAA, with an 11 g/dl hemoglobin cutoff for adult males and 10.6 g/dl hemoglobin cutoff for adult females **(El-Soussi, Asfour&Raffat, 2016).** As well, 221 ACS patients were admitted to the coronary care unit (CCU) during the years 2009-2010, with normal hemoglobin levels at admission, nosocomial anemia was registered in 25% of study patients **(Merono et al., 2012)**. Through an empirical observation as a nurse in the cardiac care unit (CCU), it was observed that HAA can occur in ACS patients due to phlebotomy blood loss from recurrent lab tests.

Moreover, the critical care nurse most commonly withdraws the blood for laboratory tests. So, this study will be conducted to identify the correlation between phlebotomy blood loss and hospital-acquired anemiain an attempt to decrease the incidence of HAA for ACS patients and minimizing the need for allogeneic blood transfusions that are associated with increased morbidity and mortality due to infectious, immunological, pulmonary and thromboembolic complications. As well, improving the quality of nursing care by learning them how to minimize blood loss due totoo much laboratory blood sampling, as well as the use of blood-saving techniques in intensive care units such as using pediatric tubes for sampling and improving their knowledge about the importance of awareness of the risks for inducing hospital-acquired anemia can assist in reducing the effects of HAA.

Aim of the Study

The study aims to identify the correlation between phlebotomy blood loss and hospital-acquired anemia among ACS patients

Research Questions

To fulfill the aim of this study, the following research question is formulated;

Q1:What is the correlation between phlebotomy blood loss and hospital-acquired anemia among ACS patients?

Subjects and Method

Research Design

The current study used a descriptive exploratory research design. Descriptive exploratory research aims to describe phenomena of interest by focusing on the characteristics, attributes, and/or experiences of a single group or population **(Schmidt & Brown, 2014)**.

Setting

This study was conducted in Cardiac Care Units (CCUs) at Mahallah Cardiac Center. These CCUs were classified into 2 units CCU (A) and CCU (B). CCU (A) consisted of 10 Beds, 10 Cardiac Monitors, one Mechanical Ventilator (MV), and one (DC) cardioversion-defibrillation machine. CCU (B) consisted of 11 Beds, 11 Cardiac Monitors, 2 MV, and one DC shock. The patients flow rate per month in each unit was about 50 patients.

Subjects

All ACSadult patients newlyadmitted to CCUs were included in this study. The number of patients was 180 patients throughout six months. The exclusion criteria included allACS patients with baseline Hemoglobin (Hb) <11 gm /dl for adult males, hemoglobin <10 gm /dl for adult females, patients with bleeding abnormalities, patients with abnormal urea, creatinine values, and abnormal liver enzymes.

Tools

The data was collected using two tools.

Tool (I): Indicators of Nosocomial Anemia

This tool consisted of two parts as follows:

Part 1: Demographic Data & Health Relevant Data

It included the patient's age, gender, admission date, and discharge date, length of stay, current diagnosis, co-morbidities, past medical history, history of anemia, admission hemoglobin level, hematocrit level, total leukocytes count on admission, and presence of invasive lines. It was developed by the researcher after reviewing relevant literature**(Morton, 2009)**.

Part 2:Laboratory Investigations Data

This part was modified by the researcher after the relevant literaturewas

reviewed **(Andrews, 1998; Milbrandt, 2006;Tosiri,Kanitsap&Kanitsap, 2010)**.This part was recorded by the researcher to monitor the laboratory investigated data as patient's serum hemoglobin level (Hb) on admission and before discharge, serum hematocrit level (Hct), red blood cells (RBCs), platelets, and white blood cells (WBCs), PT, APTT, INR, renal function tests as (urea and creatinine), and liver enzymes as (SGOT and SGPT).

Tool (II): Estimation of Sampling Blood Loss Volume

This tool was used to observe and estimate sampling blood lossvolume.It was modified by the researcher after reviewing the relevant literature**(Andrews, 1998)**. It consisted of the name of the following investigations as (chemistry, ABGs, hematology, and coagulation), frequency, amount of blood withdrawn, volume discarded, site of blood sample withdrawal, and the number of trails. These items were designed as a table and calculations of the mean of blood volumes withdrawn per 24 hours from admission until discharge.

Validity and Reliability of the Tools

A panel of five experts from the Critical Care and Emergency Nursing Department, Medical-Surgical Nursing Department, Faculty of Nursing, Mansoura University, and Cairo University evaluated the tools for content-related validity who reviewed the English and Arabic tools for clarity, relevance, understanding, and the applicability for implementation. Internal consistency reliability was assessed in the present study and evaluated whether all items of the tools measured the same variable and internal consistency reliability tested and retested via Cronbach's Alpha to indicate how well the items in tools fit together conceptually. Reliability test was done using Cronbach's Alpha test (r. alpha) based on standardized items where it was (r = 0.63) for the venous sample puncture.

Pilot Study

A pilot study was conducted on 18 patients (10% of the total sample) who were excluded from the study subjects to assess the tools' feasibility, objectivity, and applicability, as well as to estimate the time required to complete the evaluation form. Before data collection, required changes were made based on the findings of the pilot study. Some items have been rephrased to be clear and understood.

Protection of Human Rights

The dean of Mansoura University's Faculty of Nursing granted official permission to perform the research. The study ethical committee also gave its approval for ethical considerations. After submitting an official letter from the faculty and explaining the purpose and scope of the research, the hospital administrative authority granted permission to conduct the study.

Participation in this study was entirely voluntary: each participant had the right to withdraw from the study at any stage without responsibility and this can't affect the nurses' care to the patients. Informed consent was obtained from the subjects. Anonymity and confidentiality were assured through coding of all data and subjects were assured that these data will not be reused in other researches without their permission.

Procedure

The current study was conducted through two phases: preparation and implementation phases:

- **Preparation Phase**

This phase started from September till December 2016. This phase included a review of relevant literature, as well as the preparation of data collection based on the present, past, local and international literature. Tool (I) part 1 was developed and tool (I) part 2 and tool (II) were modified by the researcher after reviewing relevant literature. Then, the researcher translated the tools into Arabic and checked them for validity and reliability.

- **Implementation Phase**

Data were collected from January to July 2017. After obtaining permission to conduct the proposed study, the researcher explained the nature and purpose of the study for the patients who agreed to participate in the study also the researcher explained the nature and purpose of the study for the staff nurses (9 nurses in CCU (A) and 10 nurses in CCU (B)) who agreed to participate in the study and trained them to observe and record data related to staff performance during night shifts and other shifts where the researcher not found and physicians (5 physicians in each CCU) also agreed to participate in the study.

Written consent was obtained from the patients before data collection. Data was collected through the patients observation, checking the patients' files as admission sheet, physician notes, nursing notes, nursing chart, lab investigations results, and discharge sheet to fill out the study tools. Data collection was performed during the three shifts "morning, evening, and night shift". The researcher started with the tool (I) demographic data and health-relevant data and recorded data upon admission from the patients' files.

180patients were selected from the two CCUs either males or females by the age of 18 years and more according to inclusion criteria mentioned before. Laboratory investigations results were recorded by the researcher from patients file especially hemoglobin and hematocrit level, liver enzymes, and kidney function by using the tool (I) part 2. Estimation of the amount of blood loss was measured and recorded by calculation of volume needed, frequency, volume withdrawn, and the number of trails per 24 hours using the tool (II).

Data Analysis

The data were coded and analyzed using the Statistical Package for Social Sciences on a computer (SPSS version 20) and tabulated frequency and percentages were calculated. Different characteristics were described using frequency, distribution, mean, and standard deviation (SD). Number and percentage were used for describing and summarizing qualitative data.The Chi-Square Test, Fisher Exact Test, and Monte Carlo Test were used for testing the relationship between categorical variables. Paired sample T-Test was used to compare the means of two variables. While the one-way ANOVA test was used to compare the means of three variables. The level of significance was a P-value equal to or less than 0.05.

RESULTS

Table 1: Frequency distribution of patients´ socio-demographic characteristics (n = 180)

Demographic Data	N	%
Gender		
Male	105	58.3
Female	75	41.7
Age (Years)		
31-40	25	8.3
41-50	29	6.7
51-60	42	31.7
More than 60	84	53.3

It is apparent from **Table (1)** that nearly two-thirds of patients (58.3%) were males. Regarding patients´ age, almost half of them, their age were more than 60 years followed by 31.7 % of them their age ranged between 51-60 years.

Table 2:Distribution of the studied patients according to their health-relevant data

Health Relevant Data	N	%
Setting		
CCU (A)	96	53.3
CCU (B)	84	46.7
Length of Stay (Days)		
3-	48	26.7
4-	45	25.0
5-	60	33.3
6-	15	8.3
7 days	12	6.7
Diagnosis		
UA	78	43.3
ACS	60	33.3
Inferior STEMI	18	10.0
Anterior STEMI	18	10.0
Missed Anterior MI	6	3.3

It is apparent from **Table (2)** that the mean length of stay for the patients was 4.4 ± 1.1 days. Concerning patients´ current diagnosis, it revealed that 43.3% &33.3% respectively had Unstable Angina (UA) and Acute Coronary Syndrome (ACS).

Table 3: Comparison of the studied patients´ laboratory readings during their hospital stay through seven days (n = 180)

Laboratory Investigations Data	1st day (Base Line Data)	2nd day	3rd day	4th day	5th day	6th day	7th day	F & P
Hemoglobin	13.4±1.3		12.1±3.2	12.1±3.7	12.5±2.8	12.8±1.05	10.4±0.1	F: 24.712 P: < 0.001*
Hematocrit	40.0±6.8		32.3±15.2	37.0±0.0	35.0±13.3	38.1±3.5	31.2±0.3	F:15.900 P: <0.001*
RBCs	5083.1±741.6		4804.8±476.5	4899.5±812.4	4841.1±903.9	5003.3±485.2894	4053.0±371.30	F: 31.513 P: < 0.001*
Leukocytes	8336.6±3131.2		6438.9±2538.7	7000.0±2276.3	13321.0±21919.7	7466.6±1493.1	9300.0±2190.8	F:132.012 P: < 0.001*
Platelets	209047.4±86674.3		183500.0±45324.4	202909.0±47701.7	190581.2±81979.0	192000.0±40058.7	203000.0±0.0	F:276.674 P: < 0.001*
PT	14.6±4.2	14.5±0.65		15.6±0.38	12.8±0.0	13.0±0.0		F:13.342 P: < 0.001*
APTT	46.0±3.8	36.4±2.3		38.4±0.0	51.8±0.0	35.0±0.0		F:1.963 P: < 0.001*
INR	1.1±0.37	1.1±0.07		1.2±0.0		1.0±0.0		F: 28.100 P: < 0.001*
Na^+	122.6±46.8	134.0±4.3	162.5±3.1					F: 25.723 P: < 0.001*
K^+	4.6±0.4	4.0±0.1	3.2±0.6					F: 279.254 P: < 0.001*
SGOT	55.8±9.7	28.1±13.6	52.0±0.0	42.0±0.0		41.0±0.0		F: 234.4 P: < 0.001*
SGPT	28.3±16.9	40.7±22.5	65.0±0.0	20.0±0.0		35.0±0.0		F: 196.4 P: < 0.001*
Albumin	3.7±1.4	3.3±0.0	3.7±0.0					F: 16.000 P: < 0.001*
Bilirubin	1.1±0.6						0.72±0.0	F: 40.111 P: < 0.001*
Creatinine	1.07±0.9	1.16±0.3	0.70±0.0	.65±0.7				F: 25.185 P: < 0.001*
Urea	37.6±17.6	38.4±8.05	53.1±0.0	60.9±8.2	28.2±0.0			F: 147.9 P: < 0.001*
Glucose	157.1±82.8	105.0±0.0	122.5±2.7					F: 676.6 P: < 0.001*
Cholesterol	178.4±48.9	173.3±11.9		157.0±69.01				F: 102.2 P: < 0.001*
Triglycerides	142.4±56.7	114.3±31.9	178.0±0.0	134.0±0.0				F: 809.7 P: < 0.001*
Direct HDLC	41.0±13.9	40.0±2.2	41.0±0.0					F: 0.283 P: 0.754
CKMB	52.9±68.5	164.0±152.6	89.2±132.6					F: 21.636 P: < 0.001*
Troponin	3.7±1.9	6.3±0.0						F: 400.0 P: < 0.001*
CK	377.9±490.6	594.0±746.1	431.0±465.9	115.0±0.0	38.5±18.0			F: 26.111 P: < 0.001*
T3	2.3±1.2	1.7±0.0						F: 36.00 P: < 0.001*
T4	79.4±46.5	76.6±3.7						F: 3.68 P: 0.545
LDH	820.5±449.7	460.0±0.0						F: 64.464 P: < 0.001*

F: ANOVA test P: P-value of ANOVA test

*Significance at P≤0.05

It is apparent from **Table (3)** that there are statistically significant differences in all mean laboratory readings except HDLC and T4.

Table 4: **Comparison of the studied patients´ CBC parameters by their gender on admission and discharge**

CBC parameters	On Admission (gram/dl)		T & P	On Discharge (gram/dl)		T & P
	Male	Female		Male	Female	
	Mean±SD	Mean±SD		Mean±SD	Mean±SD	
Hemoglobin Level	13.6±1.4	13.3±1.3	T: 2.943 P: 0.088	12.8±1.8	12.8±1.1	T: 0.000 P: 0.992
Total Leukocytes Count	8336.6±3131.2	6446.6±3112.2	T: 5.320 P: 0.022*	9358.8±5965.5	7544.0±3595.94	T: 5.507 P: 0.020*
Platelets	209047.4±86674.3	209146.4±86665.2	T: 2.948 P: 0.087	203000.0±0.0	203012.0±0.0	T: 6.623 P: 0.513

T: Student T-Test

P: P-value of the test of significance *: Significance at P ≤0.05

It is apparent from **Table (4)** that no statistically significant differences were found between males and females on admission and discharge aboutHb and platelets. On the other hand, statistically significant differences were found between them concerning leukocytes count on admission and discharge (T: 5.320; P: 0.022 and T: 5.507; P: 0.020 respectively). So, females showed decreased level of total leukocyte counts on discharge when compared to admission.

Table 5: Frequency distribution of the studied patients according to the diagnostic blood loss in obtaining lab chemistry tests such as SGOT, SGPT, Urea, Creatinine, Na, k+, CK, CKMP, and Cholesterol

Estimated Blood Loss in (ml)	1st day		2nd day		3rd day		4th day		5th day		6th day		7th day		F & P
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	
Frequency															
Once	180	100.0	45	25.0	24	13.3	12	6.7	12	6.7	3	1.7	3	1.7	----------
Volume Withdrawn															
Mean ± SD	4.9±0.19		4.7±0.40		4.9±0.16		5.1±0.56		4.5±0.52		4.0±0.0		5.0±0.0		F:146.569 P:<0.001*
Volume Discarded															
Mean ± SD	0.74±0.25		0.80±0.25		1.0±0.0		1.5±0.0		1.0±0.0		---------		1.0±0.0		F:512.11 P:0.518
No. of Trails															
Mean ± SD	1.0±0.2		1.2±0.4		1.5±0.5		1.7±0.8		1.2±0.7		1.0±0.0		2.0±0.0		F:517.10 P:0.522
Site of Withdrawal															
Hand	165	91.6	21	11.7	18	10.0	6	3.3	6	3.3	0	0.0	3	1.7	-------
Antecubital	12	6.7	21	11.7	3	1.7	6	3.3	6	3.3	3	1.7	0	0.0	--------
CVC	3	1.7	3	1.7	3	1.7	0	0.0	0	0.0	0	0.0	0	0.0	--------

F: ANOVA test P: P-value of ANOVA test *Significance at P≤0.05

It is clear from **Table (5)** that all of the studied patients on the first day of admission underwent withdrawal of

blood once with the mean 4.9 ± 0.19 and the most site for withdrawing venous blood samples was the hand (91.6%). As well, there is a statistically significant difference regarding the means of blood volume withdrawn for chemistry tests in the days of admission where F: 146.569; P: <0.001.

Table6:Frequency distribution of the estimated blood loss during withdrawing sample for hematology testssuch as CBC

Estimated Volume Loss in (ml)	1st day		2nd day		3rd day		4th day		5th day		6th day		7th day	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Frequency														
Once	180	100.0	0	0.0	45	25.0	51	28.3	66	36.6	9	5.0	6	3.3
Volume Withdrawn														
Mean ± SD	4.4±0.6				4.6±0.4		4.3±1.6		4.0±1.6		3.0±2.5		5.0±0.0	
Volume Discarded														
Mean ± SD	1.0±0.0				0.9±0.2		1.0±0.2		1.0±0.0		1.0±0.0		1.0±0.0	
No. of Trails														
Mean ± SD	1.1±0.4		1.0±0.0		1.6±0.4		1.6±0.4		1.5±0.4		2.0±0.0		1.5±0.5	
Site of Withdrawal														
Hand	168	93.3	0	0.0	24	13.3	39	21.7	30	16.7	3	1.7	6	3.3
Antecubital	9	5.0	0	0.0	21	11.7	12	6.7	33	18.3	6	3.3	0	0.0
CVC	3	1.7	0	0.0	0	0.0	0	0.0	3	1.7	0	0.0	0	0.0

Table (6) shows that all of the studied patients were exposed to the diagnostic hematology test for one time on the first day of admission. The volume of blood withdrawn for each time was within the satisfactory standard ranged between 4 to 5 ml with the higher mean on the seventh day 5.0±0.0. The most common site for withdrawing the sample was the hand.

Table 7: Frequency distribution of the estimated blood loss during withdrawing sample for coagulation tests such as PT, APTT & INR

Estimated Volume Loss in (ml)	1st day		2nd day		3rd day		4th day	
	No	%	No	%	No	%	No	%
Frequency								
Once	102	56.7	15	8.3	0	0.0	9	5.0
Volume Withdrawn								
Mean ± SD	2.9±0.5		3.4±0.8				3.0±0.0	
Volume Discarded								
Mean ± SD	0.4±0.5		0.7±0.7				0.3±0.0	
No. of Trails								
Mean ± SD	1.5±0.5		1.2±0.4				1.3±0.5	
Site of Withdrawal								
Hand	45	25.0	12	6.7	0	0.0	9	5.0
Antecubital	57	31.7	3	1.7	0	0.0	0	0.0

Table (7) portrays that More than half (56.7%) of patients were exposed to the coagulation tests once on the first day of admission. The volume of blood withdrawn for each time was ranged between 2.9 ml to 3 ml; the volume discarded was less than 1ml for each time. The hand was used for withdrawal of blood sample for one quarter (25.0%) of the patients on the first day of admission compared to around one-third (31.7%) withdrawn from the Antecubital site.

Table 8: Frequency distribution of the total blood loss estimation (n = 180)

Total Blood Loss Estimation	N	%
Phlebotomy Losses (ml)	**n=180**	**100%**
10 to less than 20	126	70.0
20 to less than 30	42	23.3
30 ml and more	12	6.7
Minimum-Maximum	10-35 ml	
Mean ± SD	18.6±5.6 ml	

It is apparent from **Table (8)** that 70% of patients, their blood loss ranged between 10 - < 20 ml due to withdrawal of blood sample from veins.

Table 9: Frequency distribution of the studied patients according to the incidence of hospital-acquired anemia

Hospital-Acquired Anemia	N	%
Anemic	68	37.8
Non-Anemic	112	62.2

It is apparent from **Table (9) and Figure (1)** that more than one-third (37.8%) of the patients developed HAA.

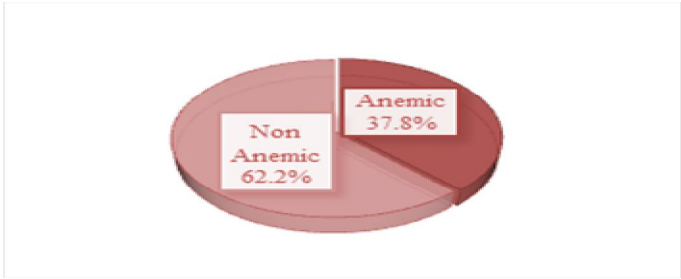

Figure 1:Incidence of hospital-acquired anemia among the studied patients

Table 10:Associationbetween different variables and HAA among the studied patients

Variables	Hospital-Acquired Anemia				Total		X2 & P
	Anemic n =68		Non-Anemic n =112				
	No	%	No	%	No	%	
Age (Years)							
31-40	11	16.2	14	12.5	25	13.9	X^2: 1.7763 P: 0.620114
41-50	8	11.8	21	18.8	29	16.1	
51-60	16	23.5	26	23.2	42	23.3	
60	33	48.5	51	45.5	84	46.7	
Gender							
Male	47	69.1	58	51.8	105	58.3	X^2: 5.229 p: 0.029*
Female	21	30.9	54	48.2	75	41.7	
Length of Stay (Days)							
3	17	25.0	31	27.7	48	26.7	X^2: 21.832 P:<0.001*
4	15	22.1	30	26.8	45	25.0	
5	18	26.5	42	37.5	60	33.3	
6	6	8.8	9	8.0	15	8.3	
7	12	17.6	0	0.0	12	6.7	
Estimated Blood Losses							
Phlebotomy Losses (ml)							
10 to less than 20	47	69.1	79	70.5	126	70.0	X^2: 1.307 P: 0.520
20 to less than 30	18	26.5	24	21.4	42	23.3	
30 cc and more	3	4.4	9	8.0	12	6.7	

X^2: Chi-Square Test P: P-value of test of significance *: Significance at P≤0.05

It is apparent from **Table (10)** that almost half (48.5%) of the anemic patients were more than 60 years old and two-thirds of the anemic patients (69.1%) were males.Regarding hospital stay,half of the anemic patients spent 3 and 5 days in the hospital while non-anemic patients spent 3 and 4 days.As well as there was no significant correlation among patients´ incidence of HAA and Phlebotomy blood loss and in this regard two-thirds of the anemic patients lost blood from phlebotomy.

DISCUSSION

The current study aims to identify the correlation between phlebotomy blood loss and hospital-acquired anemia among ACS patients. The cut-off point for defining HAA used in this study is hemoglobin value less than 13/dl in men and less than 12/dl in women it was similar to what is defined by WHO as well as the vast majority of recently published researches. The current study provided an updated snapshot of Hospital Acquired Anemia and its predictors.

The current study covered the following sections as follows; firstly, socio-demographic characteristics and its correlation with occurrence of HAA; Second, the incidence of HAA and hemoglobin level readings; Third, the correlation between phlebotomy blood loss and HAA among ACS patients; finally, preventing occurrence of HAA and additional findings pertinent to the study.

Section I: socio-demographic characteristics and its correlation with occurrence of HAA;

This study was conducted in CCUs at Mahallah Cardiac Center. All newly admitted adult patients with ACS consisted of 180 patients who were included in the study. About two-thirds of the studied patients were male. Slightly less than one-third of the studied patients aged 51-60 years and more than half of the patients in the study were over the age of 60. These findings are consistent with **Caetano et al., (2018)** in his study entitled Outcomes in Ischemic Cardiomyopathy with acute kidney injury and **Mushtaq et al., (2017)** entitled the frequency of anemia and blood transfusion in critically ill patients and found that the mean age of their studied patients was 58-61 years old. As well, **Choi et al., (2013)** who studied the clinical impact of hospital-acquired anemia in association with acute kidney injury and chronic kidney disease in patients with acute myocardial infarction added that61.3 ± 12.4 yearswas the mean age in the total study population and that three-quarters of the patients were men.

Regarding the relationship between the incidence of HAA and patient's age, the current study showed that there was no significant correlation between HAA and patient's age, whereas, two-thirds of anemic patients (69.1%) were males with a statistically significant correlation between HAA and gender. In contrast, an age-group analysis by **Kurniali et al., (2014)** study about a retrospective study investigating the incidence and predisposing factors of HAAand **Choi et al., (2013)** showed that elderly patients had a higher incidence of HAA compared to the younger counterparts and female gender.

Regarding the length of stay (LOS), the current study showed that one-third of the studied patients stayed 5 days in CCU compared to the minorities who stayed 6 and 7 days in CCU. As well, about one quarter stayed 3 days to 4

days in the hospital with a mean of 4.4 ± 1.1 days. This finding went in line with **El-Soussi, Asfour&Raffat (2016)**who discovered that more than half of the patients had an ICU stay of 5 to 10 days.

Concerning the relationship between occurrence of HAA and LOS, the current finding revealed half of the anemic patients spent 3 and 5 days with a highly statistically significant correlation between them. This finding agreed with **Kurniali et al., (2014)**who said LOS is a key HAA development predictor. Furthermore, **Choi et al., (2013)** reported that the mean hospital length of stay was stated to be longer in HAA patients than in non-HAA patients. Similarly, **Jenkins &Shander (2015)** in their study about anemia prevention and management program implementation guide and **Koch et al., (2013)** who studied hospital-acquired anemia: prevalence, outcomes, and healthcare implicationsadded that as LOS increases, more initially non-anemic patients develop HAA, while anemia in those who had it at admission continues to worsen.

From the researcher perspective point of view, the association between LOS and HAA may be attributed to the increased chance of exposure to hospital-related stress, invasive maneuvers and procedures as well as the extra exposure to the inflammatory process that in turn leads to the development of HAA, so critical care nurse must act to decrease this process and factors associated with hospitalization days as much as possible.

Section II: Incidence of HAA and hemoglobin level readings;

Concerning the incidence of HAA among the studied patients, this study showed that two-fifths (37.8%) of the studied patients in the current study have HAA, the same findings supported by **Caetano et al., (2018)Tiwari&Rance (2014)Merono et al., (2012)** study who studied in-hospital acquired anemia in ACS. predictors, in-hospital prognosis, and one-year mortality**,** but **Kurniali et al., (2014)** who conducted a retrospective study investigating the incidence and predisposing factors of HAA found that nearly half of the studied patients develop HAA. Moreover, a national study was conducted at Alexandria university hospital ICUs in Egypt about factors contributing to nosocomial anemia in critically ill patients showed that more than 75% of the selected patients had HAA (**El-Soussi, Asfour&Raffat, 2016).**

Concerning the level of hemoglobin estimation in the current study, the baseline means reading was 13.4 ± 1.3g/dl, while the seventh-day reading was 10.4 ± 0.1g/dl. It was noticed that the level of hemoglobin decline from the baseline observation to the seventh-day of admission. Nearly the same findings reported by **Mushtaq et al., (2017)** study showed that the mean hemoglobin level at admission was 12.10 ± 2.20 g/dl, while the mean hemoglobin level at the start of anemia was 10.02 ± 2.08 g/dl.

Section III: The correlation between phlebotomy blood loss and HAA among ACS patients;

Concerning the estimated phlebotomy blood loss that ranged from 10 ml to less than 20 ml, the amount of blood loss from the phlebotomy was ranged from 10 ml to 35 ml with a mean of 18.6 ± 5.6 ml. These findings were supported by **Juffermans& Walsh (2015)**who stated that blood loss is a major cause of anemia in intensive care patients, and that diagnostic blood sampling is one of the possible causes of blood loss, estimating that 30-40 ml of

blood is removed in blood samples every 24 hours, with more blood sampled in sicker patients and those on renal replacement therapy. Moreover, **Rawal et al., (2016)** who studiedanemia in intensive care: utilizing a review of current concepts reported that the average amount of blood drawn in the process of performing laboratory tests for a patient admitted to an ICU was about 40-70 ml per day.

As well, phlebotomy blood tests led to extra loss when studied by other researchers, since **Tiwari&Rance(2014)** who studied hospital-acquired anemia secondary to phlebotomy in elderly patients found that an average blood loss due to phlebotomy was 132 ml in the anemia group compared with 80.2 ml in the non-anemic group. Moreover, **Hohmuth et al., (2014)** who studied patient-centered blood management, stated that Blood loss associated with laboratory tests was observed in the vast majority of hospitalized patients, typically no more than 5-10 ml at a time, accounting for just 0.1-0.2 percent of total blood volume.

In the same line, **Salisbury et al., (2011)** added that the average approximate phlebotomy volume was 173.8 ml, which is approximately half a unit of whole blood. One milliliter of blood contains 0.5 milligrams of iron; hence, phlebotomy of 50 milliliters of blood results in a loss of 25 milligrams of iron evidenced in the study of **Thakkar et al., (2015)** who studied the impact of an educational intervention on the frequency of daily blood test orders for hospitalized patients. Whereas, **Bom&Cannegieter (2015)** who studied hospital-acquired anemia: the contribution of diagnostic blood loss concluded that diagnostic blood sampling was not a major cause of hospital-acquired anemia. As well, **Ullman et al., (2016)** who studied blood sampling practice across three adults, pediatric, and neonatal intensive care settings added that blood samples from critically ill patients are regularly obtained by arterial and central venous access devices, peripheral venipuncture, or a heal/finger prick. The need to first remove a clearing or "discard" volume from the device to ensure the resulting sample is whole blood and not partially drug or infusion fluid increases blood loss when blood is drawn from intravascular lines.

The current study concluded that there was no significant correlation between HAA and phlebotomy loss. From the researcher point of view, it may be attributed to that the study settings follow certain laboratory investigation policy (phlebotomy policy) where all patients had been requested full labs on the first day of admission and complete blood count (CBC) only on discharge and all labs were repeated as needed where there was no daily routine full labs request as well as there was small number only three patients with the arterial line for withdrawing ABGs while other patients were withdrawing venous blood gases as needed with the other venous lab investigations that may limit blood loss, the development, and severity of HAA. This phlebotomy policy may reduce phlebotomy blood loss.

Section IV: preventing occurrence of HAA and additional findings pertinent to the study;

Numerous recent studies have shown anemia to be associated with worse outcomes and considerable morbidity in patients with coronary artery disease **(Athar, Puri& Gerber, 2012 Choi et al., 2013Thakkar et al., 2015Rawal et al., 2016 Caetano et al.,**

2018). HAA is linked to morbidity and mortality in nearly half of all acute myocardial infarction hospitalizations. They explored the prevalence, correlates, and implications of acute hospital-acquired anemia in patients with acute myocardial infarction in their research to gain a better understanding of how HAA can be avoided and whether prevention can enhance patient outcomes **(Salisbury et al., 2010)**.

Furthermore, reducing the repentance of blood testing to include only ordering the right blood test during initial clinical evaluation may lead to decreasing the blood testing errors **(Zhi et al., 2013)**. As well, shifting the order of lab blood tests from a routine morning default to as need will decrease un-necessary phlebotomy blood loss **(Jenkins &Shander, 2015).** In the same line, this decrease in blood tests may very well have translated into less phlebotomy-related discomfort, reduced workload for phlebotomists, and lower costs **(Thakkar et al., 2015)**. Understanding the risk factors for HAA is an important step toward learning how to prevent and manage in-hospital anemia. Patients may benefit from increased use of stored serum samples for appropriate tests, minimizing wasted blood when drawing from central venous catheters, smaller-volume blood tubes, and elimination of routinely scheduled phlebotomy **(Salisbury &Kosiborod, 2012).**

Salisbury (2010) study on the association of diagnostic blood loss from phlebotomy and hospital-acquired anemia during admission with acute myocardial infarction suggested that HAA can be prevented by limiting the number of blood draws and the amount of blood removed for diagnostic testing. Usually, small-volume phlebotomy tubes require less than 2 ml of blood, and in some cases, as little as 0.5 ml. The use of small-volume or pediatric tubes for ICU patients, either alone or in conjunction with other blood-saving steps, will minimize blood loss by this route by 33 to 80 percent. Point-of-care blood analysis leads to test results with minimal delay and often includes samples of less than 0.5 ml **(Hayden et al., 2012)**.

Intensive care nurses are the first line of care for patients who are at risk of or have been diagnosed with HAA. It is their responsibility to be mindful of the dangers of causing HAA and to be a strong advocate for patients. They also have a responsibility to inform staff and members of the care team about hospital-acquired anemia when necessary. Posters, unit-based programs, and other forms of educational outreach may all help to reduce the burden of HAAas mentioned in the study of **Martin & Scantling (2015)** abouthospital-acquired anemia: a contemporary review of etiologies and prevention strategies**.**

CONCLUSION

The current findings showed thataround two fifths (37.8%) of ACS patients had HAA compared to 62.2% who were non-anemic. There was a statistically significant correlation between HAA and gender & length of hospital stay. On the other hand, there was no significant correlation between HAA and phlebotomy blood loss &patient's age.

RECOMMENDATIONS

Future HAA prevention efforts are recommended to be effective if they include multimodal interventions that both decrease unnecessary phlebotomy blood loss through puncturing and bleeding.

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