Nurses' Performance Regarding Prevention of Hemolysis in Venous Blood Sampling: Suggested Nursing Guidelines

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Abstract

Background: Blood hemolysis is the most common and most dangerous venous blood sampling error. Nurses are in charge of putting the best performance for venous blood sampling into place to reduce blood sample hemolysis. **The study aim:** Explore Nurses' performance regarding Prevention of hemolysis in Venous Blood Sampling**:** Suggested Nursing Guidelines. **Design and sample:** A cross-sectional descriptive exploratory design was used. A convenient sample of 200 nurses working at medical, neurological surgical, orthopedic, and urology departments. **Setting:** The present study was carried out at medical, neurological surgical, orthopedic, and urology departments affiliated to Suez Canal University hospitals, in Egypt. **Tools of data collection:** Two tools were used: Nurses' knowledge assessment questionnaire, and nurses' practices observational checklist regarding prevention of hemolysis in venous blood sampling. **Results**: Regarding knowledge of the studied nurse's prevention of blood hemolysis there was 99% of studied nurses had unsatisfactory knowledge regarding the prevention of hemolysis. Also, Poor nurses' knowledge about techniques during venous blood collection, exerting strong pressure on the vein, and frequent bending and straightening of the arm during blood collection items got the lowest percentage 8% for both respectively. Regarding practice areas, 92.4% of studied nurses had unsatisfactory practices regarding the prevention of hemolysis. Also, poor practice about not leaving the tourniquet for more than 1 min, avoiding tapping the punctured site during venipuncture, and using veins with large lumens got the highest not done percentages 65.5,65,64 respectively. Also, there was a positive significant correlation between total knowledge score and total practice score with r .887 and P value <.001***Conclusion:** The majority of nurses had an unsatisfactory level of knowledge regarding the prevention of blood hemolysis. The majority of nurses had an unsatisfactory level of practice regarding the prevention of hemolysis. There was a statistically significant positive correlation between nurses' knowledge and practice regarding the prevention of hemolysis. **Recommendations**: Educational nursing guidelines should be conducted for all nursing personnel regarding the Prevention of hemolysis in venous blood sampling as they are the key factor in preventing blood hemolysis.

Keywords: Blood Sampling, Knowledge and Practice, Hemolysis

Introduction

Venous Blood Sampling is the most common process done in health care to make sure the right diagnosis and treatment are given. Unfortunately, mistakes have been found in the pre-analytical part of Venous Blood Sampling collection, which could pose serious risks to the safety and comfort of patients **(Freitas and Alves, 2022).** 60% to 75% of all laboratory mistakes are made when drawing blood from a vein. Often, these mistakes happen when the sample is being taken. Venous Blood Sampling mistakes can lead to several problems, such as delays in treatment, wrong diagnoses, repeated sampling, inefficient treatment, higher costs, and even a life-threatening disease **(Fenta and Ali, 2020; Hjelmgren, 2022).** Blood hemolysis is the most common and most dangerous Venous Blood Sampling error, especially in samples taken from hospital rooms **(Wan Azman et al., 2019).**

The most dangerous mistake in Venous Blood Sampling is when the blood breaks down. About 3% of normal samples are thought to be hemolyzed, and about 60% of samples that can't be analyzed are thought to be hemolyzed **(Natali et al. 2018; Tian et al. 2022).** Hemolysis is the breaking apart of erythrocytes, which allows diagnostically important parts of the cell to leak into the plasma or serum. Hemolysis, in particular, can mess up lab results by releasing intracellular components, diluting

the sample, causing proteolysis, and messing up analytical processes **(Cakirca & Erdal 2017; Lee et al. 2023).**

Hemolysis in blood samples is a regular problem in medicine. Several things, like the way samples are taken and how they are transported, have been looked into as possible causes of sample hemolysis. It has been shown that hemolysis can be caused by intravenous catheters and the vacuum sample method in particular **(Heireman et al. 2017). Wan Azman et al. (2019)** found that inappropriate puncture sites, hard Venous Blood Sampling, long tourniquet use, underfilled tubes, and too much shaking of specimens were all factors. Even though past studies have found that nurses make more mistakes when taking blood samples. This happens not because nurses aren't skilled, but because they don't know how to collect samples for the lab and don't do so **(Proehl et al., 2016; Jagannatha and Chandrakar, 2018).**

Nurses are in charge of putting best practices for venous blood sampling into place to reduce blood sample hemolysis. This is done by following hemolysis-prevention guidelines, such as taking blood samples from larger veins, like those in the antecubital fossa, limiting tourniquet time, and considering direct venipuncture with a steel needle instead of taking blood through an I.V. catheter. Use a needle and a gentle aspiration to help with hard withdrawals or slow blood return into a vacuum tube. Blood tubes should be filled to the right level, especially if they are going to be moved with a gas tube system. **(Phelan et al., 2020)** Also, a continuous record of hemolysis levels and a review of each is required for preanalytical improvement to reduce sampling errors and keep patients safe

Significance:

Hemolysis can have a big impact on the accuracy of lab results, which can lead to wrong results, repeated blood draws, delays in diagnosis and treatment, increased patient discomfort, and higher costs. Between 1.9% and 6.9% of all samples have to be thrown out because they could affect tests **(Cadamuro et al., 2016; Liu et al., 2021).** (**Phelan et al., 2017; Lee et al., 2023)** show that there is evidence that some habits can lower the rate of hemolysis. Nurses play a key part in making sure that the best practices are used to stop blood samples from clotting, which improves patient safety, care, and satisfaction, and saves money. So, nurses' knowledge that supports current practice should be explored.

Aim of the study:

This study aimed to explore nurses' performance regarding the prevention of hemolysis in venous blood sampling: Suggested Nursing Guidelines

Research questions:

1. Is the nurses' knowledge regarding the Prevention of hemolysis in Venous Blood Sampling adequate?

2. Are the nurses' practices regarding the Prevention of hemolysis in Venous Blood Sampling satisfactory?

3. Is there a relationship between nurses' knowledge and practices regarding the Prevention of hemolysis in Venous Blood Sampling?

Operational definition:

Performance: It meant knowledge and practice **(Mamdouh et al., 2020).**

Subjects and Method:

Design and Sample:

A cross-sectional descriptive exploratory design was used. A convenient sample of all nurses working at medical, neurological surgical, orthopedic, and urology departments affiliated to Suez Canal University hospitals.

Sample size: was determined according to the following equation**:**

$n= (Z\ \alpha/2)^2 * P(1-P)/d^2$ **(Dawson,2004)**

Where

- n= sample size

- Z α/2 = Z is the statistic corresponding to the level of confidence (1.96)
- d = is precision (corresponding to effect size) (0.05)
- P is expected prevalence (33%)
- n=200

Setting:

The present study was carried out in the medical, neurological and surgical, orthopedic, urology departments affiliated to the Suez Canal University Hospital; the medical, neurological departments lie on the 3rd floor and contain 54 beds for each. Orthopedic and surgical departments which lie on the 2nd floor contain 52 beds for each. Urology departments and blood research units which lie in the urology building on the 1st, 2nd, and 3rd floors contain 48 beds for urology and 22 beds for the blood research unit.

Tools of Data Collection:

Data from the current study were collected by utilizing two tools nurses' knowledge assessment questionnaire, nurses' practices observational checklist regarding the prevention of hemolysis in venous blood sampling

TOOL (I): Nurses' Knowledge Assessment Questionnaire:

A knowledge questionnaire was designed by the researcher after reviewing recent related literature to assess nurses' knowledge of the Prevention of hemolysis in Venous Blood Sampling. It was composed of two parts; part 1 was concerned with nurses' profile demographic characteristics; part 2 was concerned with assessing basic knowledge regarding Prevention of hemolysis in Venous Blood Sampling **(Dougherty & Lister, 2021 and Pagana et al., 2017 and Fischbach & Dunning, 2015)**

Part (1):

It was concerned with profile data of the studied nurses (e.g. age and education, and work-related data (department, years of experience, and attending training courses in Prevention of hemolysis in blood Samples).

Part (2):

It was concerned with the basic knowledge regarding the Prevention of hemolysis in Venous Blood Sampling, including vein anatomy and selection, indications of venipuncture, contraindications and complications, blood specimen tube selection, hemolysis, hemolysis prevention, hemolysis-related adverse effects, and nursing role.

Scoring system:

Regarding the score of nurses' knowledge, the respondent was given one point for each correct answer and zero for incorrect answers. A total score below 85% was considered unsatisfactory, while those equal to or above 85% were considered satisfactory.

TOOL (II): An observational checklist**:**

An observational checklist was developed by the researcher to assess the nurse's practice level regarding the prevention of hemolysis in venous blood sampling. It was written in the English language to be collected by the investigator. The checklist regarding venous blood sampling includes the following preparing phase (5) items, procedure (23) items, hemolysis prevention (9) items, post-procedure (3) items were adapted by the researcher based on the following literature **(Dougherty & Lister, 2021 and Pagana et al., 2017**)

Scoring system:

Regarding the score of nurses' practice, the respondent was given one point for each correctly done item and zero for each incorrectly done item. A total score below 85% was considered unsatisfactory, while those equal to or above 85% were considered satisfactory.

Validity and Reliability of the Instrument:

The two tools of data collection were tested for their content validity with a content validity index of 0.83. Comprehensiveness and applicability by the expertise of two medical and three nursing experts to determine whether the included items are comprehensive, understandable, applicable, clear, and suitable to achieve the aim of the study. Also, back translation was done for research tools, and then

it was translated to Arabic language by a linguistic professional using a back-to-back translation approach. The coefficient of reliability of the evaluating tool was measured by Cronbach's alpha which was 0.922 for the knowledge tool, and .887 for the practice tool.

Pilot study:

A pilot study was carried out by the researcher for ten percent of studied nurses. The applicability of study tools was tested. The results of the data obtained from the pilot study helped the researcher to modify the tools: items were corrected or added as needed. Accordingly, modifications were done, the final form was developed.

Fieldwork:

Preparatory Phase:

The present study involves doing a comprehensive evaluation of pertinent literature, both local and international, by utilizing existing books, magazines, and periodicals. This review aims to familiarize oneself with the research problem, as well as to establish the necessary study techniques and content for the current investigation .

The researchers gained permission to gather data and conduct the study at the hospitals affiliated with Suez Canal University in Ismailia. This was achieved by submitting a formal letter from the faculty of nursing at Ismailia, Suez Canal University to the hospital administrative personnel. The researcher convened a meeting and facilitated a discussion with the nurses to apprise them of the objectives and methodology of the study, as well as to foster enhanced collaboration.

Implementation phase:

Involved the collecting of data for this project, which spanned six months, commencing on the first of July 2022, and concluding at the end of December 2022. Both study tools have been completed. Tool I was administered by the nurses and took approximately 20-30 minutes to complete. On the other hand, Tool II data collection was conducted by the researcher through direct observation of actual work activities. This observation took place over six months, three days a week, encompassing morning, afternoon, and night shifts.

Ethical Considerations:

After obtaining the permission of the Ethics Committee as well as permits and a letter of introduction from the Faculty of Nursing, Suez Canal University. Written consent was obtained from nurses who were included in the study. The researcher clarified the aim of the study as well as the objectives of the study. The participants had the right to withdraw from the study at any time, confidentiality and anonymity were assured as protection from hazards.

Data analysis:

Data collected through the questionnaire were coded, entered, and analyzed using Statistical Package for the Social Sciences (SPSS version 23). A correlation test was used to test relationships between total nurses' knowledge and total nurses' practice. Linear regression was used to predict the total nurses 'practice score about one unit increase in total nurses' knowledge score. The p-value was set at <0.05 for significant results

The following statistical techniques were used:

- Percentage.
- Mean score degree $\overline{X}$.
- Standard deviation SD.
- Pearson Correlation (r test)
- Linear regression model (coefficient of determination and standard error).
- Proportion probability of error (P-value) and confidence interval.

Table (1) shows that 50% of nurses aged lied between 20 to less than 30 with a mean age of 32.87, 41.5% had technical education, 21.5% worked in at intensive care unit, and 44% had more than 10 years of experience with mean age 11.05.

Figure (1) demonstrated that 90% of nurses didn't attend any training courses about the prevention of Hemolysis in Venous Blood Sampling.

Table (2) revealed that knowledge about cephalic vein, basilic vein, and digital veins got higher percentages of 29%, 27%, and 25% respectively, while the basilic vein got the lowest correct knowledge percentage of 10% with a composite percentage regarding correct knowledge about vein access site anatomy 16%

Figure (2) illustrated that 99% of studied nurses had unsatisfactory knowledge regarding the prevention of hemolysis.

Table (3) showed that correct nurses' knowledge regarding specimen collection, in relation to methods for facilitating, the purpose of venous blood sampling, and the angle of skin penetration got the highest percentage 91.5%,87%,and 86.5% respectively, while correct knowledge regarding poor nursing techniques during venous blood collection can lead to negative results, exerting strong pressure on the vein and frequent bending and straightening of the arm during blood collection can affect the results of the levels of certain electrolyte in the body, applying pressure or a tourniquet for a minimum duration and ensuring relaxed arm muscles are necessary steps for collecting a venous blood sample from an arm, and appropriate action that nurse should take if the vein disappears, appropriate action that nurse should take if the blood flow stops during the collection process changes in the patient's position from standing to lying on their back and effect on the proportion of blood in the body, and the results changed from exerting excessive pressure on the vein during blood collection and not keeping the arm with percentage 8%,8%,9.5%,10%,12%,13%,and 16% respectively.

Figure (3) illustrated that 92.4% of studied nurses had unsatisfactory practices regarding the prevention of hemolysis.

Table (4) revealed that nurses practice hemolysis prevention by removing the needle correctly, documenting the procedure in the patient's records, withdrawing the required amount of blood using a vacuumed blood collection system, and removing the tube from the plastic tube holder got the highest percentage 94%, 91%, 90.5%, 89.5% respectively, while using veins with large lumens, avoid tapping the punctured site with during venipuncture, don't leave tourniquet more than 1 min, leaving the tube long time before ending to the laboratory, vigorous inverting and shaking the collecting tube, avoid use of small veins, slightly advance the needle into the vein with percentage 86.5%, 86%,84%,83.5%,82.5%, 82.5%, and 82.5% respectively.

Table (5) showed that there was a positive significant correlation between total knowledge score and total practice score with r .887 and Pvalue <.001*

Table (6) showed that there was a significant linear regression between the total knowledge score, and total practice score with every increase of one unit in knowledge score practice increased by .656. 89% of the variance in total practice score is explained by total practice score

Table (1): Percentage distribution of the studied nurses according to their demographic characteristics (n=200).

Items	Total Sample (n=200)	
	N	%
Age (Years)		
20: < 30	100	50.0
30: < 40	50	25.0
40: < 50	39	19.5
50: < 60	11	5.5
Mean±SD (Range)	32.87±9.22 (20-56)	
Education		
Bachelor	47	23.5
Technical	83	41.5
Diploma	59	29.5
Postgraduate	11	5.5
Working Area		
Internal Medicine	33	16.5
Surgery	36	18.0
Orthopedic	32	16.0
Neurological	34	17.0
Emergency	22	11.0
Intensive care	43	21.5
Years of experience		
1:<5	67	33.5
5-<10	45	22.5
≥10	88	44.0
Mean±SD (Range)	11.05±9.03 (1-36)	

Figure (1): Distribution of studied nurses according to training courses attendance on prevention of blood specimen hem (n=200)

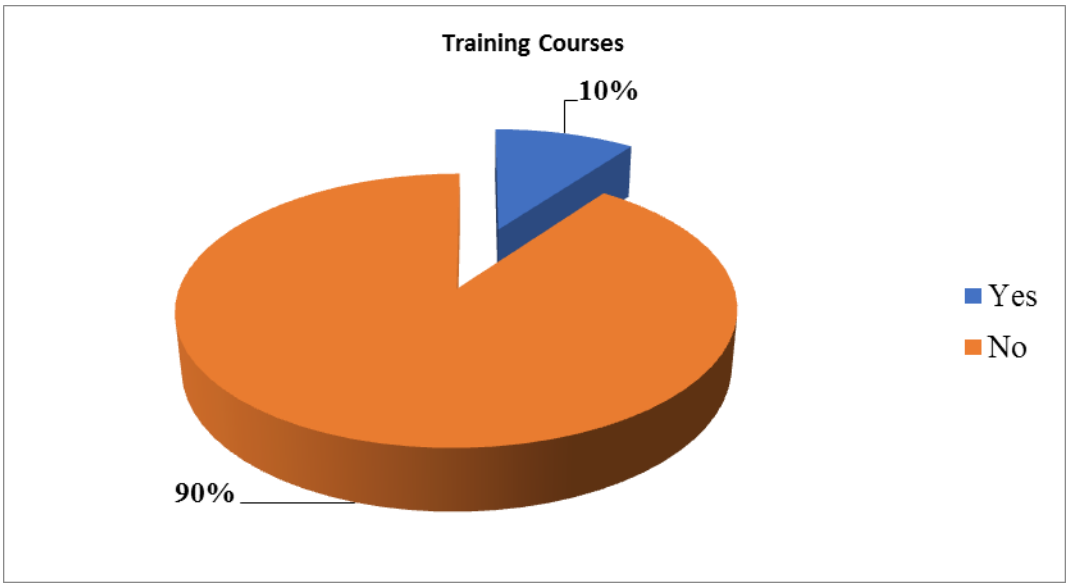

Table (2): **Percentage distribution of correct nurses' knowledge regarding vein access site anatomy (n=200).**

Knowledge item	Correct Answer N (%)
Cephalic vein	58(29)
Radial nerve	40(20)
Accessory cephalic vein	22(11)
Radial artery	30(15)
Median nerve	52(26)
Basilic vein	54(27)
Brachial artery	68(34)
Basilic vein	26(13)
Ulnar nerve	12(6)
Anterior interosseous nerve	20(10)
Ulnar artery	22(11)
Median antebrachial vein	22(11)
Cephalic vein	22(11)
Basilic vein	20(10)
Dorsal venous arch	22(11)
Metacarpal veins	58(14)
Digital veins	40(25)
Composite percentage	32(16)

Table (3): **Percentage distribution of correct nurses' knowledge regarding prevention of hemolysis during venous blood sampling (n=200).**

Items		Correct Answer
		N (%)
1.	The purpose of venous blood sampling	174(87)
2.	Methods for facilitating the collection of a venous blood sample	183(91.5)
3.	The angle of skin penetration during the sample collection	173(86.5)
4.	Pressure should be applied to the site after ending venous blood sampling	54(28)
5.	The time that pressure should be released from the vein after completing blood specimen collection	41(20.5)
6.	Necessary measures that nurse should take during venous blood specimen if pain occurs	36(18)
7.	Appropriate action that the nurse should take if the vein disappears during the collection process	19(9.5)
8.	Appropriate action that a nurse should take if the blood flow stops during the collection process	24(12)
9.	Complications of the venous blood sampling process	37(18.5)
10.	Factors that can affect the results of the venous blood sample	50(25)
11.	Applying pressure or a tourniquet for a minimum duration and ensuring relaxed arm muscles are necessary steps for collecting a venous blood sample from an arm.	20(10)
12.	The results changed from exerting excessive pressure on the vein during blood collection and not keeping the arm.	32(16)
13.	Poor nursing techniques during venous blood collection can lead to negative results.	16(8)
14.	Exerting strong pressure on the vein and frequent bending and straightening of the arm during blood collection can affect the results of the levels of certain electrolytes in the body.	16(8)
15.	Changes in the patient's position from standing to lying on their back effect the proportion of blood in the body.	26(13)
16.	Delay in transferring a sample to the laboratory can lead to damage to the sample integrity, resulting in false negative results.	47(23.5)
17.	Both red blood cell count and hematocrit levels increase in the presence of blood hemolysis during the blood draw procedure.	28(24)
18.	Superficial veins of the upper limb are the most commonly used veins for blood sampling.	33(16.5)
19.	The tourniquet should be placed 3-4 cm above the venipuncture site during blood draw.	43(21.5)
20.	The tourniquet should not be left on for more than a minute during the blood draw procedure.	43(21.5)
21.	Liver function tests may increase in the presence of blood hemolysis during the blood draw procedure.	40(20)
22.	The sample should be sent to the laboratory within 6 hours of collection.	52(26)
23.	Bilirubin levels decrease in the presence of red blood cell hemolysis due to the blood draw procedure.	44(22)
24.	Potassium levels may decrease in the presence of blood hemolysis during the blood draw procedure.	48(24)
25.	Magnesium levels may increase in the presence of blood hemolysis during the blood draw procedure.	39(19.5)
26.	Ammonia levels may decrease in the presence of blood hemolysis during the blood draw procedure.	54(27)
27.	Phosphate levels may increase in the presence of blood hemolysis during the blood draw procedure.	57(28.5)
28.	Tubes with light blue color are used for blood chemistry analysis.	59(29.5)
29.	Tubes with purple color are used for coagulation tests.	84(42)
30.	The substance inside the light blue tube is called sodium citrate.	55(27.5)
31.	To avoid hemolysis during the blood collection process, the amount of blood that enters the sample tube should be controlled by negative pressure.	76(38)
32.	Changing the patient's position from lying down on their back to standing during the blood draw procedure may increase the potassium level in the sample.	33(16.5)
Total mean score (Mean±SD)		26.18±4.98

Figure (2): Satisfactory levels of knowledge of the studied nurses regarding the prevention of hemolysis (n=200)

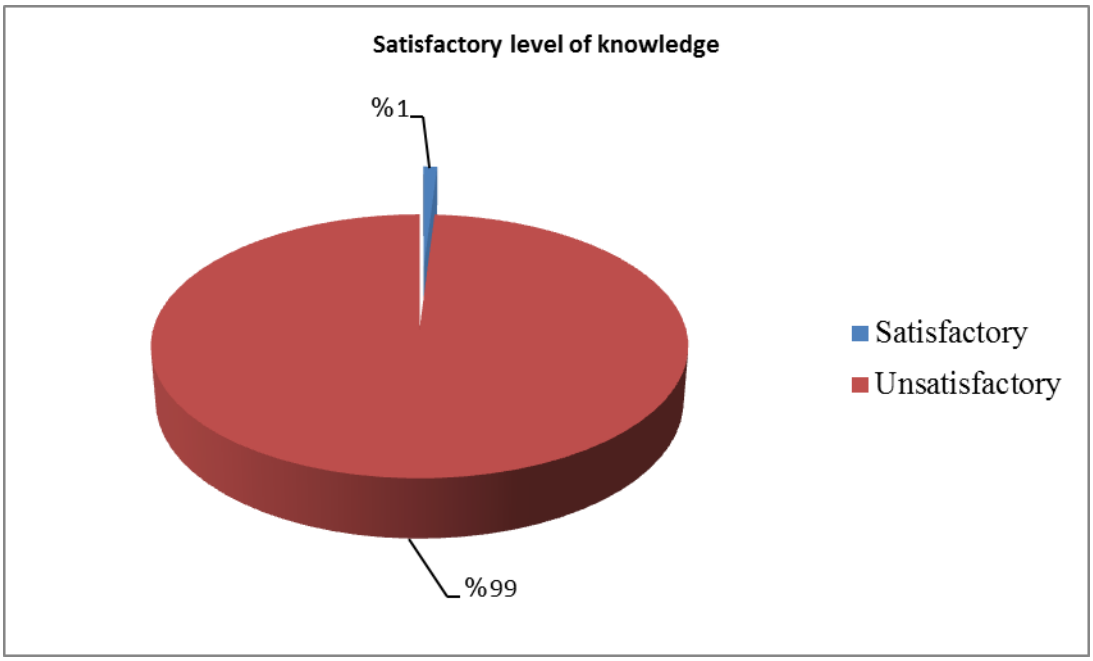

Table (4): **Percentage distribution of studied nurses' practices regarding prevention of hemolysis in blood sampling (n=200).**

Items		Done	Not Done
		N (%)	N (%)
A. Preparing phase			
1)	Introduce yourself to the patient, explain and discuss the procedure with them, and identify the patient.	82(41)	118(59)
2)	Check whether the patient has any allergies	40(20)	160(80)
3)	Assemble the equipment necessary for venipuncture.	39(19.5)	161(80.5)
4)	Wash hands using bactericidal soap and water or alcohol-based hand rub, and dry.	59(29.5)	141(70.5)
5)	Check all packaging before opening and preparing the equipment on the chosen clean receptacle.	109(54.5)	91(45.5)
B. Procedure			
6)	Take all the equipment to the patient, exhibiting a confident manner.	130(65)	70(35)
7)	Support the chosen limb on a pillow	73(36.5)	127(63.5)
8)	Apply a tourniquet to the arm on the chosen side, making sure it does not obstruct arterial flow (do not leave it for more than 1 minute)	61(30.5)	139(69.5)
9)	Select the vein by careful palpation to determine size, depth, and condition	182(91)	18(9)
10)	Release the tourniquet.	150(75)	50(25)
11)	Select the device, based on vein size, site and volume of blood to be taken.	46(23)	154(77)
12)	Wash hands with bactericidal soap and water or alcohol-based hand rub and allow to dry.	52(26)	148(74)
13)	Reapply the tourniquet (not leave it more than 1 min)	58(29)	142(71)
14)	Clean the patient's skin carefully for 30 seconds using an appropriate preparation.	37(18.5)	163(81.5)
15)	Remove the cover from the needle and inspect the device carefully.	84(42)	116(58)
16)	Anchor the vein by applying manual traction on the skin a few centimeters below the proposed insertion site	89(44.5)	111(55.5)
17)	Insert the needle smoothly at an angle of approximately 30°.	64(32)	136(68)
18)	Reduce the angle of descent of the needle as soon as a flashback of blood is seen or when a puncture of the vein wall is felt.	55(27.5)	145(72.5)
19)	Slightly advance the needle into the vein, if possible.	35(17.5)	165(82.5)
20)	Do not exert any pressure on the needle.	37(18.5)	163(81.5)
21)	Withdraw the required amount of blood using a vacuumed blood collection system	181(90.5)	19(9.5)
22)	Remove the tube from the plastic tube holder.	179(89.5)	21(10.5)
23)	Place a low-linting swab over the puncture point.	85(42.5)	115(57.5)
24)	Remove the needle, but do not apply pressure until the needle has been fully removed.	188(94)	12(6)
25)	Discard the needle immediately in a sharps bin.	68(34)	132(66)
26)	Apply digital pressure directly over the puncture site.	64(32)	136(68)
27)	Gently invert as guided by the manufacturer's instructions.	76(38)	124(62)
28)	Label the bottles with the relevant details at the patient's side.	112(56)	88(44)
C. for hemolysis prevention			
29)	Don't leave the tourniquet more than 1 min	32(16)	168(84)
30)	Avoid tapping the punctured site during venipuncture	28(14)	172(86)
31)	Avoid bending the arm or fisting during blood sampling	38(19.5)	162(81)
32)	Drawing the sample above IV fluid infusion	38(19)	162(81)
33)	Vigorous inverting and shaking of the collecting tube	35(17.5)	165(82.5)
34)	Leave the tube a long time before ending in the laboratory	33(16.5)	167(83.5)
35)	Use a large needle gauge of more than 23	36(18)	164(82)
36)	Avoid the use of small veins wherever possible.	35(17.5)	165(82.5)
37)	Use veins with large lumens.	27(13.5)	173(86.5)
D. Post-procedure			
38)	Remove gloves and discard waste and sharps according to local policy.	63(31.5)	137(68.5)
39)	Follow hospital procedures for the collection and transportation of specimens to the laboratory.	183(91.5)	17(8.5)
40)	Document the procedure in the patient's records.	182(91)	18(9)
Total mean score		15.83±7.18	

Figure (3): Total studied nurses' satisfactory practice scores related to the prevention of hemolysis (n=200)

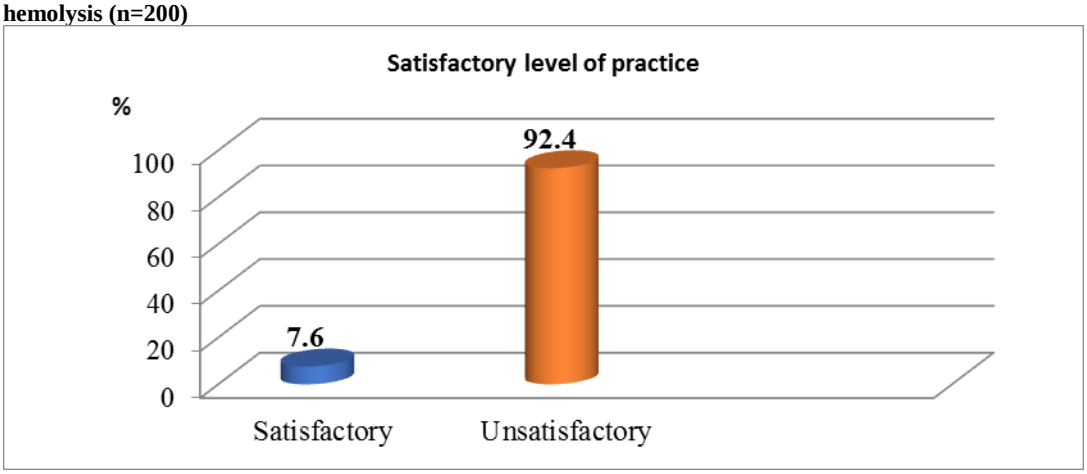

Table (5): Correlation between total studied nurses' knowledge and practice

Items	Total practice score	
	Pearson Correlation (r)	Sig. (2-tailed)
Total knowledge score	.887	<.001*

*** Significant at p < 0.05**

Table (6): Regression analysis between total studied nurses' knowledge and practice (n=200).

Dependent factor	Independent factor	Unstandardized coefficients		Beta	t	P value	95% CI
		B	Std.Err				
Total practice score	Constant	123.82	6.362		19.46	**<.001***	7.27-8.74
	Total knowledge score	.656	.024	.887	.656	**<.001***	.608 - .704

t is an independent t test & the P value is significant (two-tailed significance) ≤.05
R, 887; R^2 .787, F 731, 63, and P value <.001*

Discussion

Blood sampling is the most common procedure performed in health care practice for accurate diagnosis and proper treatment. Unfortunately, blood sampling errors have been discovered in the pre-analytical phase of blood sampling collection, which could represent major threats to patient safety and comfort. Blood sampling errors account for the majority of all laboratory errors. These errors frequently occur during the collection of the specimen. Pre-analytical errors can have a variety of consequences: Treatment delays, incorrect diagnoses, repetitive sampling, ineffective treatment, increasing costs, perhaps resulting in a life-threatening disease. Among the most serious blood sampling errors, blood hemolysis is the most common as noted by Lippi, **Cadamuro & Simundic (2019).**

Nurses play a critical role in healthcare settings, providing essential care and support to patients. One area where their knowledge and practice are vital is in preventing blood sample hemolysis, a common issue that can compromise the accuracy of laboratory test results. The ability of nurses to understand the factors contributing to hemolysis and implement appropriate preventive measures is crucial for ensuring reliable diagnostic outcomes. By staying up-to-date with best practices, enhancing their understanding of phlebotomy techniques, and effectively communicating with patients, nurses can contribute to minimizing hemolysis rates, improving patient care, and optimizing

clinical decision-making as stated by **Phelan, Hustey, Good & Reineks (2020).**

In terms of the study's nurses' personal profile, it can be seen that the majority of them were between the ages of twenty and thirty, less than half had technical training; less than one-third worked in intensive care units; and less than half had more than ten years of experience. Additionally, the majority of nurses didn't participate in training sessions on preventing hemolysis during venous blood sampling. These results were by the study done by **Atef Hussien Ibraheem, Rabie Abd El-sadik, & Abd El-ghany Mohamed, (2023)** that revealed that more than one-quarter of the studied nurse's age ranged between twenty to twenty five years. Moreover, a study done by **Iswari, Murad & Parwati, (2015)** clarified that the majority worked for eleven-nineteen years.

This could be explained in the light of the fact that recruiting youthful nurses offers numerous benefits to departments. First, they are typically better able to tolerate the nature of the work, as they are typically more resilient and adaptable to the demands of the healthcare environment. Second, their relative lack of experience can be viewed as an opportunity for them to acquire valuable skills and knowledge through a mentorship program and hands-on learning, and elaborate the current condition of nursing qualification. On the other hand, the results the study conducted by **Atalla & Henedy, (2018)** found that more than half of the studied sample aged above thirty years old.

On the same line, the majority of nurses didn't participate in training sessions on preventing hemolysis during venous blood sampling. It is now generally accepted that one of the most effective ways to reduce the amount of pre-analytical errors is to train nursing staff on the protocols for blood sample handling and processing, and this can be due to a lack of in-service training programs.

Concerning the nurses' knowledge regarding the prevention of blood hemolysis**,** the great majority of studied nurses had unsatisfactory total knowledge regarding the prevention of hemolysis. Also, nurses had a low percentage of correct answers regarding specific areas of knowledge, such as the fact that poor nursing techniques during venous blood collection can lead to negative results, that exerting strong pressure on the vein and frequently bending and straightening the arm during blood collection can affect the results of the levels of certain electrolytes in the body, that applying pressure or a tourniquet for a minimum period and ensuring relaxed arm muscles are necessary steps for collecting blood, and that applying pressure or a tourniquet.

These findings were on the same line with **Dorotić et al.,(2015)** who pointed out that nurses have insufficient knowledge regarding the factors that produce hemolysis and how these factors influence laboratory test findings. In the same context, **Lee et al., (2023)** revealed that tourniquet time, needle gauge, IV catheter collection, stick position, syringe transfer, aggressive mixing, vacuum tube underfilling, and more affect hemolysis during blood collection. These considerations demonstrate the complexity of blood collection and the need for nurses to be well-versed in hemolysis prevention. Lack of knowledge can have serious consequences. Nurses who are uninformed of tourniquet time may prolong it, increasing hemolysis risk. Poor needle gauge selection or IV catheter collection might also increase hemolysis during blood collection. The stick's position, such as in a hematoma or infiltration, might also cause hemolysis. Hemolysis might happen from improper syringe transfer or blood sample mixing. Vacuum tube underfilling is crucial. Nurses unfamiliar with fill volumes may draw inadequate blood, causing tube turbulence and hemolysis.

These findings were contradicted by **Dilshika et al., (2020)** who noted that the overall knowledge of nurses was satisfactory regarding blood sample collection, aspects such as knowledge of the correct volume of blood needed for specific investigations, choosing a suitable site for blood drawing, and practices such as the provision of duly filled investigation forms need to be improved. Additionally, **Zehra et al., (2016)** reported that more than two-thirds of the participants had adequate knowledge regarding blood sampling. **Moreover & Kaur (2019)** stated that the majority had above-

average knowledge, while none had fallen in below-average knowledge regarding blood sample collection.

This discrepancy between your study and the findings of **Dilshika et al. (2020); Zehra et al., (2016)** could be explained because several factors can explain the nurses' knowledge of blood sample collection. Variations in sample size, participant characteristics, and data collection methodologies, among others, may have influenced the results and conclusions of each study. In addition, the context and timing of the studies may have caused variations in clinical practices and educational methods. Differences in the measurement instruments and criteria used to evaluate the knowledge of nurses may also contribute to the contradictory results as supported by **Burchill et al., (2021)** who revealed that there is a lack of restricted application of evidence-based best practices. There is no access to data, and very few participants stated that steps to reduce the incidence of hemolysis in their department had been implemented.

Moreover, the knowledge disparity between nurses and best practices for preventing blood sample hemolysis, as indicated by the findings, highlights the importance of proactive measures. To prevent blood samples from becoming hemolyzed, it is crucial to resolve this knowledge gap among nurses. Without proper knowledge of prevention techniques, diagnostic accuracy may be compromised, leading to delays in patient care and increased costs. By emphasizing education and training, healthcare organizations can equip nurses with the knowledge necessary to prevent hemolysis effectively. This can lead to enhanced patient outcomes, decreased delays in diagnosis and treatment, and optimized resource utilization, resulting in improved care quality and cost savings. The preanalytical phase is a subject that many nurses are interested in learning more about so that they can improve their clinical practice.

Regarding the nurses 'practice regarding the prevention of blood hemolysis, the study results showed that the majority of studied nurses had unsatisfactory practices regarding the prevention of hemolysis. Also, nurses practice hemolysis prevention by removing the needle correctly, documenting the procedure in the patient's records, withdrawing the required amount of blood using a vacuumed blood collection system, and removing the tube from the plastic tube holder got the highest percentage, while using veins with large lumens, avoid tapping the punctured site with during venipuncture, don't leave tourniquet more than 1 min, leaving the tube long time before ending to the laboratory, vigorous inverting and shaking the collecting tube, avoid use of small veins, slightly advance the needle into the vein got the lowest percentage.

These results were consistent with **Atalla& Hendy, (2018)** who studied who reported that the maximum of the studied nurses had average practice scores in the pretest before the program. This could be explained in the light of the fact that nurses were less knowledgeable about blood sample quality control, most likely because they were more concerned with the blood sample technique than with the quality of the blood sample, and several of the participants also had no idea how to identify test tubes or how to execute a blood collection process in the proper sequence and order. This might also be due to nurses' insufficient blood sample training. Contradictory, **Atef Hussien Ibraheem, Rabie Abd El-sadik, & Abd El- ghany Mohamed, (2023)** pointed out that the majority of studied nurses had satisfactory practice related to venous blood samples withdrawal.

As regards, studying the relationship between nurses' total knowledge and their total practices regarding the prevention of hemolysis in blood sampling, the study results revealed that there was a positive significant correlation between total knowledge score, and total practice score the regression analysis demonstrated that the majority of the variance in the total practice score could be explained by the total knowledge score. This suggests that a substantial proportion of the variation in practice scores can be accounted for by the level of knowledge possessed. For that reason, researchers, theorists, and practitioners have explored the relationship among knowledge and practice, to explain why an expected relationship occurs or does not occur to understand the current state of nurses'

knowledge regarding preventing hemolysis, blood sample hemolysis, and practices that assist to maintain current conditions; the status quo.

These results came by **Atia, (2019) & Zaki, (2022)** who found that there was a significant relation and positive correlation between total knowledge and practice of studied nurses regarding blood sampling withdrawal. The findings indicate a strong and statistically significant relationship between the knowledge and practice scores, with an increase in knowledge corresponding to an increase in practice. Additionally, the knowledge score was found to explain a significant amount of the variability in the practice score, highlighting the importance of knowledge in predicting and understanding practice outcomes.

Lastly, the results of this study indicated that additional research is required to determine the impact of the time spent by staff on repeating hemolyzed samples on delays in patient care and to implement best practices for reducing hemolysis. Understanding nurses' performance may be the first step in devising a program to increase the interest of nurses in changing their practice. Monitoring the integrity of diagnostic blood samples will become increasingly crucial as time passes. In addition, the adoption of a set of standardized and universally accepted policies for managing unsuitable samples and associated quality indicators will become increasingly important for improving the overall quality of in-laboratory diagnostics and this point of point of view is supported by **Lippi, (2019).**

The findings of this study are promising. It is crucial to have a comprehensive understanding of the extent of the knowledge gap before proposing any guidelines. Proposed educational nursing guidelines for enhancing nurses' knowledge to prevent hemolysis during venous blood samples. Based on the findings of the study, there should be educational guidelines about the anatomy of venous access sites, and nursing knowledge techniques during venous blood collection to prevent venous blood hemolysis. Specifically, the application of excessive pressure on the vein and repetitive bending and straightening of the arm during blood collection can have an impact on the measured levels of certain electrolytes in the body. To ensure the successful collection of a venous blood sample from the arm, it is recommended that pressure or a tourniquet be applied for a minimal duration and that the arm muscles remain relaxed. Moreover, the appropriate course of action for a nurse in the event of vein disappearance or cessation of blood flow during the collection process, as well as the influence of changes in patient position from standing to supine on blood volume distribution.

Moreover, in light of the findings from the study, it is imperative to establish educational nursing guidelines aimed at enhancing nurses' practice in preventing hemolysis during venous blood sampling. This suggestion includes the implementation of educational nursing guidelines regarding the utilization of large-lumen veins, the avoidance of tapping the punctured site during venipuncture, the limitation of tourniquet application to no more than one minute, the prompt transfer of collected tubes to the laboratory, the vigorous inversion and shaking of collecting tubes, the discouragement of using small veins, and the careful advancement of the needle into the vein.

Conclusion

The majority of nurses had an unsatisfactory level of knowledge regarding the prevention of blood hemolysis. Also, the majority of nurses had an unsatisfactory level of practice regarding the prevention of hemolysis. The findings indicate a strong and statistically significant relationship between the knowledge and practice scores, with an increase in knowledge corresponding to an increase in practice. Additionally, the knowledge score was found to explain a significant amount of the variability in the practice score, highlighting the importance of knowledge in predicting and understanding practice outcomes

Recommendations

1. Educational nursing guidelines should be conducted for all nursing personnel

regarding the Prevention of hemolysis in venous blood sampling as they are the key factor in preventing blood hemolysis.

2. Periodically assess knowledge and practice (performance) to prevent hemolysis in venous blood sampling to assess what is needed and appraisals.

3. Manual procedures regarding suggested guidelines for the Prevention of hemolysis in venous blood sampling should be available in each ward as a reference and should be up to date periodically to suit new trends in the Prevention of hemolysis in Venous Blood Sampling.

4. Booklets and posters about nursing guidelines are recommended to give the nurses the reinforcement of their knowledge about the Prevention of hemolysis in Venous Blood Sampling.

5. Further research is directed toward the Prevention of hemolysis in caring for patients.

6. Further research aimed to investigate factors that cause hemolysis in Venous Blood Sampling.

Implications

1. Add nursing role in Prevention of hemolysis in venous blood sampling in nursing curriculum.
2. There should be a standardized protocol for blood sampling that guides nurses in their practice.
3. Monitoring blood hemolysis during the pre-analytical and analytical phase to explore other factors affecting hemolysis occurrence.

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