

Original Research Article

Awareness of order of blood draw among nurses in tertiary care hospital

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ABSTRACT

Background: Phlebotomy or drawing of blood sample is one of the initial steps in processing of samples for various investigations of the patients in clinical laboratory. The sample for various investigation has to follow certain protocol or order of blood draw into different vacutainers by phlebotomist or the clinical person drawing the blood to avoid errors in test results. Hence awareness of order of blood draw among them is very essential.

Methods: It is a cross sectional and observational study. Based on CLSI H3-A6 (clinical and laboratory standards institute) guidelines, a questionnaire consisting of 13 multiple choice questions was prepared after validation and distributed amongst the nurses, who were on duty during the study. The answers to the questionnaire were analysed using SPSS version 23. Descriptive statistics was done for all the data collected.

Results: Total 120 nurses participated in this study in a tertiary care hospital. Nurses who were able to identify Color of the vacutainer with respective to additives (90%), correct order of draw (52%), volume of blood sample collected in vacutainer (62.9%), sample collected directly into vacutainer with vacuum suction (61.7%) was incomplete. Nurses also had wrong practices, where sample was transferred from one vacutainer to other (3.3%), collected the blood sample from the arm which had IV line (28%).

Conclusions: In this study, it was found that awareness on the level of order of blood draw among nurses was found unsatisfactory. Frequent training and monitoring of work practices should be developed for nurses to reduce the errors in sample collection.

Keywords: Order of blood draw, Phlebotomist, Vacutainer

INTRODUCTION

Phlebotomy has been practiced for centuries and it is one of the most common invasive procedures in health care.^{1,2} However, practice varies considerably between countries, between institutions and individuals within the same institution.² These differences include variations in blood-sampling technique, training, use of safety devices, disposal methods.

Most common pre-analytical (the step from ordering investigation by concerned doctor to the step, the sample is loaded on to the instrument for analysis) error, occurs during blood draw. When multiple samples have to be collected in different vacutainers containing different additives, order of draw has to be maintained to ensure zero contamination/carry over of the additives from one vacutainer to another. This was first published in the

American society of clinical pathologists’ (ASCPs) summary report.^{3,4}

As per the CLSI standard H3-A6 guidelines following is the order of blood draw.⁵ First is blood-culture tubes, followed by sodium-citrate tube (blue-stopper), serum tubes with or without clot activator, with or without gel separator (red, gold, speckled-stopper respectively), heparin tubes with or without gel (green-stopper), EDTA tubes (lavender-stopper) and glycolytic inhibitor (grey-stopper). Failure to follow order of draw leads to wrong results and subsequently affects treatment decisions. Hence sufficient training of the professionals involved in blood sample collection is required. Aim of the study was to know the awareness of the order of blood draw among nurses in a tertiary care hospital.

METHODS

This was a cross-sectional and observational study conducted at St. John’s medical college and hospital, Bengaluru, Karnataka, India. Study carried out from November 2018 to October 2019.

Selection criteria

Nurses on duty from each nursing station in the hospital were included in the study. Staff unwilling to answer / unable to complete the questionnaire and who did not give the consent were excluded from the study

Procedure

Based on CLSI H3-A6 guidelines, a questionnaire consisting of 13 MCQ were prepared, validated and distributed amongst nurses who gave consent for the study. Completed questioners were collected and tabulated using Microsoft excel.

Ethical approval

Institutional ethical clearance was obtained

Statistical analysis

Descriptive statistics was done for all the data collected using SPSS version 23.

RESULTS

120 nurses with five nurses from each station from various ward in a tertiary care hospital participated in this study. The multiple-choice questionnaire was framed with responses as ‘yes’, ‘no’ and ‘maybe’ as shown in Table 1. Several nurses (11%) did not know the order of draw. 11% of nurses were not aware that wrong order of draw affects clinical results. The 3.3% of them were transferring the samples from one vacutainer to another vacutainer. 28% of them were not aware that blood

sample should not to be collected in arm that was connected to IV fluids.

Few questions were asked, where nurses had to tick the correct answer applicable for the question asked as shown in Table 2. Only 27% of the nurses were collecting the blood sample via vacuum suction system and 24.2% of them were collecting the blood sample based on the number of tests requested. Only 63% of them were able to answer the correct order of draw. Most of the nurses were able to identify the heparin, EDTA, sodium citrate and sodium fluoride tube, but they were not able to match gel tube and plain tube colours.

Table 1: Knowledge of nurses on order or draw and practices.

Questions	Yes (%)	No (%)	May be (%)
In the order of blood draw; blood culture tubes should be collected after the vacutainer with additives?	81 (67.5)	35 (29.2)	4 (3.3)
In the order of draw serum tubes should be collected after the additive tubes?	68 (56.7)	44 (36.7)	8 (6.7)
In order of draw fluoride tube should be collected after ethylene diamine tetra acetic acid tube?	87 (72.5)	26 (21.7)	7 (5.8)
Red capped vacutainer contains clot activator?	85 (70.8)	31 (25.8)	4 (3.3)
Order of draw affects clinical result and treatment decision?	89 (74.2)	15 (12.5)	16 (13.3)
The order of draw is a protocol to be followed to prevent carry over of the additives from one vacutainer to the other?	89 (74.2)	20 (16.7)	11 (9.2)
Have you observed abnormal results due to wrong order of draw?	74 (61.7)	37 (30.8)	9 (7.5)
Have you transferred samples from one vacutainer to another vacutainer?	4 (3.3)	116 (96.7)	-
Intravenous fluid is connected to right arm and blood is collected from left arm for investigation. Does this affect test results?	29 (24.2)	86 (71.7)	5 (4.2)

Table 2: Knowledge of nurses on order of draw and practices.

Questions	Percentage of nurses who selected as answers to respective questions (%)	
How do you collect the blood sample?		
Draw the blood in the syringe and transfer to the vacutainer	74 (69.2)	
Draw the blood directly into the vacutainer, with vacuum suction blood draw IV set	33 (27.5)	
Either of the above	13 (10.8)	
How do you confirm the volume of blood collected in vacutainer is sufficient?		
Up to the mark given by the company	83 (69.2)	
Based on test requested	29 (24.2)	
Either of the above	8 (6.7)	
Arrange in correct order: a. Red/Yellow, b. Heparin, c. Culture bottle, d. EDTA, e. Sodium citrate and f. Sodium fluoride	% of nurses who selected correct coloured cap for each preservative	
Cross match (match the following)		
Heparin	Blue	100-Heparin with green colour
EDTA	Purple/violet	99.1-EDTA with purple colour
Gel tube	Yellow	90.8-Sodium citrate
Plain tube	Green	90-Sodium fluoride
Sodium fluoride	Red	62.5-Plain tube
Sodium citrate	Grey	60.8-Gel tube

DISCUSSION

Order of draw is one of the critical preanalytical step in sample collection. Incorrect order of draw results in contamination of blood sample by additives from previous vacutainer, when multiple vacutainer are involved in sample collection. Wrong results due to preanalytical errors amount to 46-71% of the total reports released from the lab, which further leads to wrong diagnosis and treatment.⁶

Our results showed, only 52.5% of respondents were aware of the correct order of multi-tube blood sampling. This may be due to multiple guidelines available and improper training as shown by other studies.⁶

The 30.8% of the responses did not know how to confirm the volume of blood in respective vacutainer. Incorrect volume of sample in the vacutainer leads to dilution of sample by anticoagulants leading to wrong results. This may be due to lack of awareness or improper training. It may also be due to insufficient blood flow while collecting the sample or less volume of blood drawn by syringe.⁷ It might also be related to the fact that nurses were used to decide the blood volume based on number of test requested and add less volume of blood into the vacutainer for lesser test.^{8,9}

For collection of blood sample from patients, 61.7% of nurses were using vacuum blood collection tubes, 27.5% of were using syringes and 10.8% of were using both the vacuum blood collection tubes and syringes. This may be due to non-availability of vacuum collection system, difficulty in accessing the vein in elderly and paediatric patients, where syringe and needle was used more commonly.¹⁰

Collecting the sample in syringe leads to haemolysis of the sample, when blood is transferred to vacutainer with high pressure, with needle intact or not close to side of the tube without needle, leading to wrong results. As per our records we have come across 12.3% percentage of samples haemolyzed per month leading to rejection of sample and request for repeat sample. The evacuated tubes system grants a higher safety for the operator and its environment, because the blood specimen always circulates in a closed system.¹¹⁻¹² It also ensures the quality of many lab tests, avoiding the mechanical stress of the blood components produced by dispensing, and ensuring to fill the tube with the appropriate quantity of blood for the required additive.

Only 32.5% of the respondents knew that Blood culture tubes to be collected first followed by additive tubes. This may be due to lack of awareness about collection method. Culture tubes to be collected first, as they are sterile and require blood for investigation without contamination with environment and additives, for correct test results.^{13,18} Study by Hall et al showed that 27.8% were interpreted as contaminants of the samples due to wrong collection and the report were abnormal.¹⁴

The 43.3% of the respondents answered that blood sample to be collected in additive tubes followed by serum tube. 27.5% were collecting the blood sample in EDTA followed by fluoride tubes. This would have led to wrong results with high potassium values and request for repeat sample for analysis. In our tertiary care hospital we have requested repeat sample for high potassium values without haemolysis in 20.8% percentage of patients, which is due to wrong order of draw.

Nurses (29.2%) were unaware that red cap container contains clot activator. Currently, vacutainer comes with added clot activator for faster clot formation and serum separation (Red capped vacutainer).⁷ Further

modification to this, the vacutainer comes with separator gel to separate the serum without clot activator, to prevent haemolysis of the sample.¹⁵ Faster clot formation helps to prevent haemolysis during transportation and also it reduces the time required for clot formation and further it can proceed for centrifuge.

More than 90% of the nurses are able to match the vacutainer with respective cap colour, whereas 40% of them are not able to recognize the colour difference between gel tube and plain tube.

The 25.8% of nurses were unaware why the order of blood draw has to be followed. Also 3.3% of the respondents were decanting the blood sample from one additive vacutainer to another, without the knowledge that it will affect results and treatment decision.

The 28.3% nurses were not aware that, if IV fluid is connected to right arm and the blood is collected from the right arm for investigation, it may affect results of the test in hospitalized patients. Blood from an existing peripheral venous access site should not be drawn because this may give false results because of dilution. Haemolysis, contamination and presence of intravenous fluid and medication can alter the results.¹⁶ Nursing staff and physicians may access central venous lines for specimens following protocols. However, specimens from central lines carry a risk of contamination or erroneous laboratory test results. It is acceptable, but not ideal to draw blood specimens when first introducing an in-dwelling venous device, before connecting the cannula to the intravenous fluids.¹⁶

Adiga et al reported that the nursing staff required training in sample collection especially “the order of draw”. They also felt that it is very essential to bring an awareness regarding causes of hemolysis during sample collection and factors contributing to pre analytical errors necessitates an intervention, in the form of training program.¹⁷

Cai et al conducted a study in China from four economic region, where 13 specialized hospital were included in the study and they found that only a small proportion of the nurses (15.5%) were aware of the correct order of multi-tube blood sampling. There was requirement to strengthen education with a focus on phlebotomy.¹⁹

Twelve European countries participated in the study by Simundic et al. They concluded that, phlebotomy staff have less awareness on patient safety and sample collection which causes hemolysis of the blood sample. They also showed that nursing staff require attention towards blood draw protocol.^{20,21}

Yüksel et al also concluded that healthcare workers' awareness should be evaluated in terms of preanalytical variables and issues that need improvement should be determined. Then, continuous programs for educating

healthcare workers, such as nurses, health officers, and laboratory technicians, should be planned. Certification programs will contribute to this process.⁹

Simundic et al conclude the following for European countries, that there is a need to assess the quality of current practices, compliance to the CLSI H3-A6 guidelines and to identify most critical steps which occur during phlebotomy, in different healthcare settings. Existing CLSI H3-A6 phlebotomy guidelines should be adapted and used locally by all. National European federation of clinical chemistry and laboratory medicine societies need to be engaged in basic training program development and continuous education of healthcare phlebotomy staff.²¹

Limitation of the studies are less sample sizes. Phlebotomy staff are not included in this study. Detailed work experience of nurses was not collected. Because of frequent exchange of posting of nurses from one ward to another ward, it is difficult to point out the nurses, who are involved in wrong order of draw, to have focused training.

CONCLUSION

In this study the awareness on the order of blood draw among nurses was found unsatisfactory. There was incorrect order of draw, wrong sample volume collection, wrong practices being followed. Frequent training and monitoring of work practices on order of blood draw should be developed for nurses to reduce the errors in sample collection.

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