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Factors Affecting Validity of Arterial Blood Gases Results among Critically Ill Patients: Nursing Perspectives

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Abstract
Arterial blood gases sampling is one of the most common laboratory tests in intensive care units and might be corrupted by pre-analytical factors that influence the validity of results. Arterial blood gases are valuable only if obtained properly and measured carefully. Corrupted factors in arterial blood gas sampling change significantly the results and adversely affect patient-care decisions when the magnitude of the error is clinically important .Therefore the nurses' role is very important to control these factors. The aim of this study is to assess the different pre- analytical factors affecting ABGs results' validity among critically ill patients at Cairo University Hospitals. The following research questions were formulated Q1: What do critical care nurses know about the different factors that can affect ABG results' validity? , Q2: What are the different practices performed by critical care nurses in relation to ABG results' validity? And Q3: What are the additional pre-analytical factors that might affect the ABG results?. A descriptive exploratory research design was utilized in this study. A sample of convenience of 68 bed side nurses were recruited from three intensive care units affiliated to Cairo University Hospitals which are; Surgical ICU, medical ICU , and Neurological ICU. Three tools were utilized to collect data; ABGs nurses' knowledge questionnaire that consists of two sections, the first section included Socio-demographic data and the second section constituted 17 questions that covered factors affecting ABGs' results, ABG withdrawal technique, and indications, and complications of sampling related questions. The second tool was ABGs observational checklist including arterial sampling practices through two main different methods; direct puncturing from radial or femoral sites and indirect puncturing from arterial line and finally assessment of pre-analytical factors that may affect validity of ABG results. Findings of the study showed that the all the studied subjects (100%) demonstrated unsatisfactory knowledge and practical level in relation to ABG sampling and controlling the different factors that might affect ABG results' validity. Moreover, There were no significant statistical difference between knowledge scores regarding educational level (F=2.73; P=0.07), working area (F=1.07;P=0.34), and gender (F=1.096;P=0.29) among the studied subjects. Results of the current study indicated a real gap between nurses' knowledge and practices as compared to the evidence based guidelines of American Association for Respiratory Care in management of ABG sampling. The current study recommends an enrichment of critical care nurses' knowledge and practices related to this essential procedure in addition to consideration of the different corrupting factors by hospital authorities to keep with the related evidence based guide lines that will be great benefits for patient, hospital, and all health professionals.
Key words: validity of Arterial blood gases' results, pre-analytical factors affecting.

1-Introduction

Nurses are increasingly expected to integrate laboratory and diagnostic procedures and expected results in assessment, planning, implementation, and evaluation of nursing care. Nurses may interface with laboratory and diagnostic testing on several levels, including; maintaining quality control to prevent or eliminate problems that may interfere with the accuracy and reliability of test results, ensuring completion of testing in a timely and accurate manner, collaborating with other health care professionals in interpreting findings and handling the plan of care. as the smallest rate of error may lead to life-threatening medical decisions. (Dunning & Fischbach, 2009).

Arterial blood gases are the most commonly performed laboratory test in intensive care unit and there are no more definitive measurements than arterial-blood-gas values when assessing the need for respiratory therapy. Arterial blood gas studies aid in assessing the ability of the lungs to provide adequate oxygen and remove carbon dioxide, and the ability of the kidneys to reabsorb or excrete bicarbonate ions to maintain normal body PH. Moreover, it evaluates the serum electrolytes sodium and potassium. (Thomas, Rory, & Jefferson, 2006).

Arterial blood gases are valuable only if obtained properly and measured carefully. Because there are corrupted factors in arterial blood gas sampling change significantly the results and adversely affect patient-care decisions when the magnitude of the error is clinically important. Some of studies conducted to determine the impact of pre-analytical factors that influence on the validity of results (Flynn, 2008) and in what extent these factors affecting the result of arterial blood gases and how to overcome, that helps to give true value for each

affected variable, these factors may be related to the preparation of syringe, handling the sample, sending time to the lab. and storage temperature. Other factors related to consider and document the patient pre-sampling condition such as the procedures which done before the time of sample, body temperature, blood transfusion, , oxygen supplementation (American Association for Respiratory Care. 2001).

Moreover, the production of high quality accurate result which are clinically important depend as much on practice before arrival of sample to the laboratory as it does on the analytical processes within the laboratory aspects of the pre testing phase that need to consider the pathology request for the timing of the sample collection, sample technique, right amount of specimen and carefully exclude expected factors that might corrupt the validity of samples results (Higgan, 2007). Therefore, the study will be conducted to Asses the pre-analytical factors that affecting arterial blood gases results' validity among critically ill patients in Cairo university hospital.

2. Material and Methods

2.1 Aim of the study

The aim of this study is to assess the factors affecting arterial blood gases result's validity among critically ill patients at Cairo university hospital, as indicated by nurses' knowledge and practices in addition to the other pre-analytical factors.

2.2 Research questions:

To fulfill the aim of this study the following research questions were formulated:

Q1: What do critical care nurses know about the different factors that can affect ABG results' validity ?

Q2: What are the different practices performed by critical care nurses in relation to ABG results' validity ?

Q3: What are the other pre-analytical factors that might affect the ABG results at Cairo university hospitals?

2.3 Subjects

Sixty eight bed side nurses working in the different critical and intensive care units were recruited for this study regardless of their demographic characteristics. They were classified as the follows: 10 nurses working in the surgical ICU, 38 nurses working in adult critical care unit, and 20 nurses working in Neurological ICU.

2.4 Operational definition:

Validity of A.B.G's result:

Controlling the pre-analytical corrupting factors in relation to patient assessment and preparation, handling of equipment, sampling technique, transport of samples, and documentation for Ensuring accuracy of ABG's result that augments life threatening decision of management.

2.5..Research Design:

A descriptive prospective exploratory research design was utilized in this study, which describes and observes the occurrence, and frequency of variables as it naturally occurs. (Polit & Beck, 2004).

2.6. Setting:

This study was conducted at the critical and intensive care units affiliated to Cairo university hospitals and consisted of three units, the first unit was the surgical Intensive Care Unit; its capacity is six beds, that unit encompasses one Arterial blood gases analyzer machine. The second unit was medical critical care unit, its capacity is twenty beds, also it encompasses one Arterial blood gases analyzer machine. The last unit was the Neurological Intensive Care Unit; its capacity is twelve beds. That unit hadn't Arterial blood gases analyzer machine, so the collected specimens of ABGs are sent to the central lab, Or to the emergency department lab.

2.7. Tools:

Three tools were formulated to collect data pertinent to the study. These tools were constructed by the researcher, these tools are:

2.7.1 Arterial Blood Gases nurses' knowledge assessment questionnaire: It consists of two sections : section one included 8 questions related to Socio-demographic characteristics of the nurses , and section two constituted 17 multiple choice and fill in spaces questions related to assessment of nurses' knowledge regarding (ABGs) and factors affecting (ABGs) results' validity. The knowledge questionnaire covered the ABGs' Parameters, indications, complications of arterial sampling, Heparinizing the ABG Syringe and Factors affecting ABGs' results. The Scoring System was distributed as follows; each right answer in the multiple choice and the yes and no questions, was given one score. As regards fill in the spaces and open ended questions, each right and complete answer was given two scores, and incomplete answer was given one score. The total scores were 24 grades. Those who obtained less than 80% were considered as having an unsatisfactory knowledge level while equal to or more than 80% were considered as having a satisfactory knowledge level.

2.7.2 Arterial Blood Gases' sampling practices observational checklists: designed to examine nurses' practices in relation to withdrawal of (ABGs) samples by using two different methods: Direct Arterial Blood Sampling method via Radial (40 items) and femoral Arteries (38 items) and arterial blood sampling observational checklist (31 items) by indirect puncture from arterial lines. The Scoring System of ABGs sampling checklists in the current study was distributed as follows; each item checked as: 'done complete' and

'correct' was given two scores, 'done incomplete' was given one score, and 'not done' or 'done incorrect' was given zero. Eventually, those who obtained 80% or more as a total score considered as having a satisfactory practice level, and those who obtained less than 80% are considered as having an unsatisfactory practice level.

2.7.3 Pre analytical factors assessment Sheet : to assess the factors that could affect arterial blood gases results' Validity among Critically ill Patient at Cairo University Hospitals. It included five main areas: a) Items (1- 3), concerned with equipment and supplies, e.g. analyzer machine and ice bag, b) Items (4- 6), concerned with heparinization the ABG syringes, e.g. storage of heparin ampoules and heparinized syringe, c) Items (7- 14) covering the patients' variables before sampling, e.g. Pain, stressful procedures, and change in oxygen supplementation. d) Items (15- 19), covering the factors related to post withdrawal sample management, e.g. Handling the samples, and consumed time before analysis. e) Item (20-22), concerned with documentation of any previous factors affecting ABG results to be considered in addition to recording the current patient temperature and the current medication that might affect ABG results. The Scoring System of that assessment was distributed as follows; Each "yes" response was given 1 score and "no" response was given zero. The totaling score was out of 22 grades.

3. Content validity:

The three developed tools were revised by a panel of critical care and emergency nursing, critical care medicine and clinical pathology expertise for ensuring content validity. Based on the experts' opinions responses, the researchers developed the final validated form of the tools

4.. Pilot study

A pilot study was done on 10 subjects to test clarity, applicability, understanding of language, and time needed for completing the tool. Few items were modified according to participants' responses in the pilot study. The subjects included in the pilot study were excluded from the whole study sample.

5. Reliability assessment:

The developed and validated tool for the knowledge was tested for reliability on a sample of 10 subjects. Test retest results using Alpha Cronbach revealed that all items are significantly differed and has a correlation coefficient above the threshold of significance (r=0.657). On the other hand, the alpha value for the observational checklist and ABG pre analytical assessment checklist in the sample was (r=0.83& 0.65 respectively).which indicating strong reliability of both tools

6. Protection of human rights

Permission to conduct the proposed study was obtained from the authorities of critical care units at Cairo University Hospitals. The researchers introduced themselves to nurses who met the inclusion criteria; the purpose and nature of the study was explained and then an informed consent was taken from participants who accepted participation in the study. The researchers emphasized that participation in the study is entirely voluntary anonymity and confidentiality were assured through coding data

7-Procedure:

7.1. Designing phase:

It was concerned with developing, preparing and testing/retesting of different data collection tools, in addition to managerial arrangement to carry out the study. Nurses who agreed to participate in the study interviewed individually and contacted by the researcher to explain the nature and purpose of the study. Then, A written consent was obtained from them.

A pilot study was carried out on seven nurses working in the selected Critical Care units who meet the inclusion criteria to test the feasibility, objectivity, and applicability of the study tools and estimation of the needed time to fulfill the data collection sheets. Based on the results of the pilot study, no modifications were made in the data collection tools. Accordingly, seven nurses who participated in the pilot study were included in the present study sample.

7.2. Implementing phase:

Once official permissions were granted from concerned authority and consent from participants. The investigator visited the critical care units and initiated data collection on a daily bases in morning and afternoon shifts during the specified time. The investigator initiated data collection of socio-demographic data of the nurses and nurses' knowledge utilizing the Interviewing questionnaire schedule (tool 1) as distributed to the nurses during their work shift to be completed in the presence of the researcher to clarify and answer any questions, it took about 15-30 minutes to be completed.

As regard Nurses performance, ABGs sampling checklists were fulfilled by the investigator by direct observation of each nurse three times in different shifts during preparation of equipment, preparation the patient, withdrawing the sample from the different direct and indirect sites of ABG sampling (radial – femoral – and arterial line), transferring the ABGs sample, and finally the documentation of results (tool 2).

Finally, ABGs' pre-analytical factors assessment sheet (tool 3) was utilized to collect data related to compliance of the nurses with guidelines pertinent to controlling the factors that might affect the validity of ABGs results, e.g. storage of heparin ampoules and syringe, patients' condition before sampling e.g. Pain, stressful procedures, oxygen supplementation, and body temperature, post sampling process and documentation until reach of sample to the laboratory for analysis considering handling &chilling of sample and sending time. The data was collected by direct observation three times in different shifts and circumstances. The time of data collection lasted from November 2011 to June 2012.

8- Results:

8.1. Figure 1 shows the distribution of sample according to their demographic data As can be seen from Figure (1), that (85.3%) of the studied subjects were females.

8.2. Figure 2 shows the distribution of sample according to their educational level It is apparent from figure (6), that, (69.1%) of the studied subjects were having nursing diploma degree (22.1%) graduated from technical nursing institute of nursing, and (8.8%) of them were having bachelor science in nursing (BScN.).

8.3. Table 1 shows percentage distribution of the studied subjects as regards to their Age, years of experience, previous training courses, and working Areas .As shown from Table (1), that (59%) of the studied subjects their age ranged between 20-30 years with a mean age of (29.5+ 5.7) years. Regarding years of experience, (30.88%) of the study subjects were having 1-5 years of experience, with mean years of experience of (9.35+ 5.41) years. Moreover, all of the study subjects didn't receive any previous training courses regarding (ABG) interpretation. Finally; in relation to work areas (55.9%) of the study subjects were working in the medical critical care.

8.4. Table 2 shows total and subtotal mean knowledge scores of the studied subjects in relation to arterial blood gases sampling. As can be seen from Table (2), that the total mean knowledge scores of the studied subjects were (10.9$\pm$3.13) out of 24. In relation to Sub-items of questionnaire, heparinizing the ABG Syringe represent the highest mean (1.73 + 0.78) out of 3 and post-sampling corrupting factors showed the lowest mean (2.5 $\pm$ 1.0) out of 8.

8.5. Table 3 shows percentage distribution of the studied subjects' responses regarding arterial blood gases parameters, indications, and complications .It is apparent from Table (4), that (62%) of the studied subjects gave correct responses regarding the question that asked about, normal range of (ABGs') parameters. However, (13.2%) of the studied subjects gave correct responses regarding the question related to, (ABGs) sampling complications.

8.6. Table 4 shows Percentage distribution of the Studied Subjects' responses regarding heparinization of the arterial blood gases' syringes**.** It is apparent from Table (4), that (67.5%) of the studied subjects gave correct responses regarding the question that asked about, types of anti-coagulant used in arterial sampling. Also, (38.2%) of the studied subjects gave correct responses in relation to the question that asked the allowed time for reusing the opened heparin ampoules.

8.7. Table 5 shows percentage distribution of the studied Subjects' responses regarding arterial blood Gases withdrawal technique. It is apparent from Table (5), that (70.6%) of the studied subjects gave correct responses regarding question that asked about, common sites of arterial sampling. On the other hand, (13.2%) of the studied subjects gave correct responses regarding the question related to performing the Allen's test.

8.8. Table 6 shows percentage distribution of the studied subjects' responses regarding Factors affecting arterial blood gases' Results. It is apparent from Table (6), that 51.5% of the studied subjects gave correct responses regarding the question that asked about, rationale for sending the A.B.G samples as soon as possible. Conversely, (4.4%) of the studied subjects gave correct responses regarding the question related to the importance of documentation current patient's temperature.

8.9. Figure (3): illustrates percentage distribution of practice level among the studied Subjects as regards to arterial blood gases' sampling. As shown from figure (3) that 97% of the studied subjects were having an unsatisfactory practical level in relation to (ABGs) sampling.

8.10. Figure (4): illustrates Percentage Distribution of Sub-Total Practice items of the studied subjects. As shown from figure (4) that all studied subjects were having an unsatisfactory Practice level in relation to documentation, While 79.4% of the studied subject got unsatisfactory Practice level in relation to withdrawal technique.

8.11. Table (7): shows total mean practice scores of the studied Subjects in relation to arterial blood gases' sampling via commonly three sites. As can be seen from Table (7) the total mean practice scores in relation to (ABGs) sampling was (47.90 ±7.55) out of (72.6). Regarding the sites of (ABGs) sampling, arterial line (ABGs)

sampling got the highest mean (44.11 ± 8.85) out of (62). While redial (ABGs) sampling got the lowest mean (50.42 ± 7.14) out of (80).

8.12. Table (8): shows frequency distribution of groups of Factors that might affect the arterial Blood gases' results validity among withdrawn ABG samples. As regards equipment and supplies as a group of factors, it is apparent that 70.5% of the observed ABGs samples were analyzed inside the Units, all the observed ABGs samples were withdrawn by permeable syringe material and 85% of late ABG samples were not kept in ice .In relation to Heparinzation of the Syringes factors, it is apparent that 98% of the observed ABGs samples withdrawn by using proper storage heparin ampoules.

As can be seen from Table (8) that 91.7% of the withdrawn ABGs samples for Patients out of peak of hyperactivity, 89.7% ABGs samples withdrawn after 20 minutes after nebulizer, 54.4% of the observed ABGs samples were withdrawn during painful or stressful procedures. Regarding post Withdrawal Arterial Blood Gases' Samples Management as a Group of Factors, 85% of the observed withdrawn ABGs samples didn't reach to the analyzer machine within 10 minutes at room temperature. Finally, in relation to the documentation and recording of factors that may affect the validity of ABG results, all observed ABG samples not documented current patient temperature and current medication regimen.

8.13. Table (9): shows Correlation analysis among the study variables. As can be seen from Table (9) that, there is a significant positive statistical correlations between age, years of experience and practices' scores ($r = 0.491$, $p = 0.00$, $r = 0.598$, $p = 0.00$ respectively). Also, there is a significant statistical correlation between age, Years of Experience and factors affecting ABG result observation checklists' scores ($r = 0.376$, $p = 0.001$, $r = 0.399$, $p = 0.000$ respectively).

9-Discussion

The present study findings are discussed in reference to the aims and research questions of the study. As regards to subjects socio-demographic characteristics, the distribution of nurses by sex and age showed that the majority of nurses were female and two thirds of the studied sample, their age were ranged from 20-30 years old with the mean age 29.5 ± 5.7 . As regards years of experience, two thirds of the study sample had 1-10 years of experience. In relation to work area, more than half of the studied subjects were working in Critical Care Department. Moreover, all the studied subjects didn't receive any previous training courses regarding (ABGs). Finally two thirds of the studied subjects were having diploma degree, that might be due to that 87% -93% of nurses in Egypt were graduate of secondary nursing schools (Gaumer, El Beih,& Fuoad, 2008).

This Socio-demographic findings were consistent with Padmakumar (2010) in an published master thesis entitled, a study to evaluate the effectiveness of structured teaching programme on specimen collection for arterial blood gas analysis in terms of knowledge and skills among staff nurses at selected private hospital at Bangalore, the study revealed that more than three quarters of the studied subjects were females, their age ranged from 20-45 years old, were carrying diploma degree, and all of them working in emergency department. Moreover, all studied subjects didn't receive any previous training courses regarding (ABGs) sampling.

As Regards Nurse's Knowledge level about (ABGs) sampling and factors affecting its validity ,the present study findings showed that all nurses had got an unsatisfactory knowledge level that might be due to lack of nurses' time to improve their knowledge, and lack of updating knowledge especially those who are working in the intensive care units for several years and overloaded by increased number of patients for each nurse .

This study finding is consistent with Ganguly (2007) who conducted a study on "effectiveness of a need based teaching protocol on 'nurses' responsibility in ABG analysis for the nursing personnel working in the critical care units." The author found out that though the nurses take an active part in collecting ABG samples, their knowledge in interpreting ABG reports is inadequate and the study showed that the teaching protocol was found to be effective in promoting the knowledge level of nursing personnel on nurses' responsibility in ABG analysis supported by Frutiger & Brunner (2000)) who conducted a study on computerized blood gas interpretation tool for nurses specialized in intensive care in response to lack of nurses' knowledge, and found that exposure to the ABG consultant has increased the blood gas knowledge of the ICU nurses.

In relation to sub-total knowledge level of the studied subjects, the current study illustrates that the entire studied subject got unsatisfactory knowledge level. One possible factor may explain this finding is that topic is not integrated in the nursing education curricula for nursing students. This finding is in accordance with Baker (2008) who studied the effects of temperature and time delays on the outcome of a blood gas result in South Africa and indicated that the widest nurses' knowledge gap was related to methods of avoiding errors that bias the results of (ABGs) evidenced by Radiometer (2005) philosophy who states that education is the way to control sample quality by controlling the corrupting factors that may affect the results in pre-analytical phase and represent 60 % of all errors in blood gas testing. Moreover Carraro, & Plebani, (2007) emphasized that many of these corrupting factors can be prevented.

The present study findings showed that the majority of the studied subjects were having an unsatisfactory practical level. This finding could be interpreted in the light of fact that the majority of studied subjects depend on random repetition, trial and errors, and imitation during withdrawing (ABGs) samples, in addition to absence of training courses, or workshops regarding (ABG) sampling and controlling the factors that may affect the ABG results. Moreover insufficiency of supplies and equipments such as; separate needles, alcohol swaps, analyzer machines, ice-filled plastic bag could be another factor to explains this phenomenon.

The study finding is in accordance with Rahmani, Aghdam, Azar, & Roshangar, (2008) who conducted a study on comparison of the effect of two clinical teaching models on performance of nurses in intensive care unit in relation to pre-implementing level of taking arterial blood sample and they found a significant statistical difference between pre and post implementing phase due to mal-practices prior to implementing phase and appropriateness of clinical teaching models. Moreover, Doods (2007) emphasized that competency-based education and training program is useful for nurses to maintain knowledge and carry out (ABGs) analysis procedure safely. Finally Ruholl, (2006) & Kavidasan, O'.Phipps (2006) concluded that the nurses can improve and master blood gases sampling with negligible or no complications.

In the same regard, the study finding revealed that the worst sub-total practice was related to the documentation. This finding may have relevance to lack of nurses time to document, work load by increased number of patients for each nurse, overwhelming by a lot of duties, and unclear policy for nurses' documentation in the patients' records.

This finding is congruent with Safy Aldine study (2012) that aimed to evaluate the effect of a comprehensive nursing documentation training program for staff nurses on their documentation skills at critical care departments in Cairo university hospitals and revealed that two thirds of the studied subjects performed documentation skills inadequately. As well, (Larrabee, 2001) conducted study about evaluation of documentation before and after implementation of a nursing information system in an acute care hospital, and also revealed improper nursing documentation that had negative effect on achievement of patient outcomes. Accordingly, the author developed and applied nursing information system (NIS) to improve quality of care. After implementation of (NIS). , the author reported a significant improvement.

In relation to frequency of use (ABG) withdrawal sites, the current study showed that half of the (ABGs) samples were withdrawn via femoral site that might be due to; the femoral artery is easy to feel, permits obtaining large amount of blood when needed for many blood tests, fixation of femoral puncture site is easier than radial site, and re-puncturing can be allowed in case of failure of withdrawal of arterial sample. Moreover, the nurse may tend to select femoral artery for sampling when ABG sampling is difficult to perform in patients who are uncooperative or in whom pulses cannot be easily identified While the lowest frequency of used sites of (ABGs) samples was via arterial line that because the number of patients connected with arterial line was few in the selected settings. In addition, withdrawal of ABG sample from arterial line got the highest total mean practice score that might be due to, the steps of withdrawing sample is easier and shorter than direct puncturing from redial or femoral sites .on the contrary, performing radial artery sampling got the lowest mean practice score that might be due to difficulty of radial puncturing, increasing rate of failure of trials and re-puncturing (usually by the same syringe), requiring to perform Allen's test and increased number of steps.

This finding is inconsistent with Danckers & Rowe (2011), who illustrated that the first chosen site of arterial puncture is the radial artery because the superficial anatomic presentation of this vessel makes it easily accessible. However, this should be done only after it has been demonstrated that there is sufficient collateral blood supply to the hand. In cases where distal perfusion is compromised and distal pulses are diminished, femoral artery puncture can be performed instead. On the same line, McCann & Holmes (2007) demonstrated that the radial artery best meets criteria of most suitable artery for the reason that it is easy to palpate, surrounded by insensitive fatty and muscular tissue, , less painful, and has good collateral supply.

In relation to the equipment and supplies used in arterial sampling, the current study finding illustrated that all ABG samples were withdrawn by heparinized plastic syringe because impermeable glass syringe and tubes weren't available due to its high costs as compared to the plastic syringe. Other factor may have relevance to this phenomenon is the lack of knowledge among studied subjects in relation to the importance using impermeable syringe to maintain the validity of the ABGs' result as indicated by knowledge assessment questionnaire. In relation to the availability of the ABG analyzer machine inside the unit, the current study showed that one third of the withdrawn ABG samples analyzed outside the ICU and did'nt reach to the analyzer machine in 10 minutes at room temperature and the average sending time was (38.4+ 8.5) minutes because ABG analyzer machines were not available inside the Units in addition to the unavailability of ice boxes.

These findings are incongruent with, Thompson, et al, (2012) who demonstrated the guidelines for intensive care unit design, and recommended that each (ICU) must include ABG analyzer machine and other supplies to manage the ABG quickly. Moreover, Andersen (2003), mentioned that always analyze a sample as soon as possible after collection. This is particularly important when determining PO2, glucose, and lactate values

because the sample consumes oxygen and glucose, and lactate forms rapidly during storage and added that Oxygen consumption by the sample is affected storage temperature , , white blood cell count and reticulocyte count

Finally the current study finding revealed that there is no significant correlation what so ever between ages, years of experience and knowledge. On the other hand, there is a significant positive statistical correlations between ages, years of experience in relation to practices' scores of the studied subjects and factors affecting ABG result assessment scores. This finding may be interpreted in the light of increasing the age is allied with increasing the years of experience that may have enhanced the technical competences of the studied subjects.

10-Conclusion and recommendations:

The current study concluded that, there is a gap between nurses' knowledge and practices as compared to the current evidence based guidelines in management of ABG sampling. In addition, the study subjects didn't control the pre-analytical factors that might be affecting the validity of ABGs results .Accordingly, the present study recommended that educational and training programme be available to all health professionals involved in arterial blood gases analysis, whether this be the intensive care units, emergency and trauma units with special attention to handling and storage of samples. Also, the current study recommended that blood gases analyzers are being placed in the clinical work to ensure immediate availability of test data and attain accurate results. Finally, the study supports and recommends competency certification for nurses who are responsible for withdrawing, analyzing and interpreting arterial blood gases results.

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Figure 1: Percentage distribution of studied Subjects as regards to their gender (n=68).

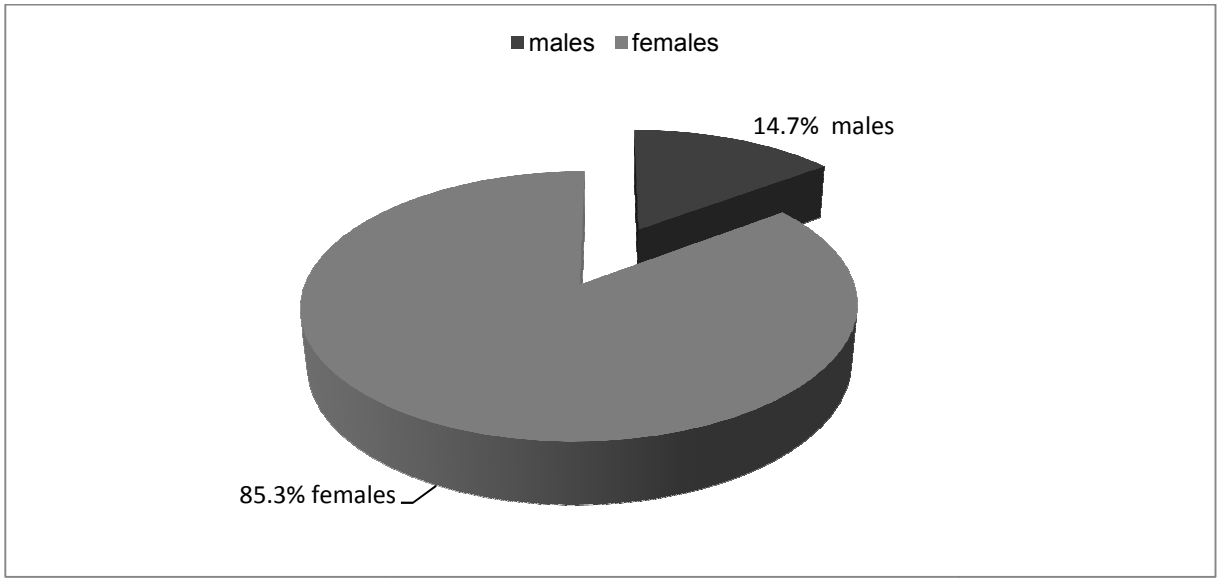

Figure2: percentage distribution of educational levels of studied subjects (n=68).

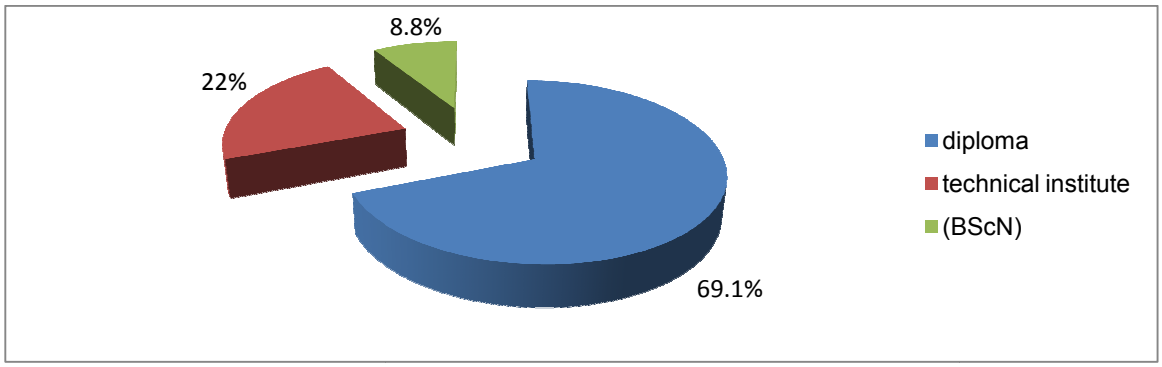

Table 1: Percentage Distribution of the Studied Subjects as Regards to Their Age, Years of Experience, Previous Training Courses, and Working Areas (n=68).

sample / Variables	Study sample n=68	
	No	%
Age:		
20-25	21	31.1
26-30	19	27.9
31-35	15	22
>35	13	19
Mean± SD 29.5± 5.7		
Years of experience:		
1-5	21	30.88
6-10	19	29.94
11-15	18	26.47
>15	10	14.7
Mean± SD 9.35± 5.41		
Receiving previous training courses :		
- Yes	0	0
- No	68	100
working areas:		
-Medical ICU	38	55.9
-Neurological ICU	20	29.4
-Surgical ICU.	10	14.7

Table 2: Total and Subtotal Mean Knowledge Scores of the Studied Subjects in Relation to Arterial Blood Gases Sampling (N=68):

Items	Total score	Mean ± SD
Total Knowledge score.	24	10.9 ± 3.13
Subtotal knowledge items		
-ABG parameters, indication, and complications.	6	3.11 ± 1.19
-Heparinizing the ABG Syringe.	3	1.73 ± 0.78
-ABG withdrawal technique.	7	3.55 ± 1.5
-Factors affecting ABGs' result.	8	2.5 ± 1.0

Table 3: Percentage Distribution of the Studied Subjects' Responses Regarding Arterial Blood Gases Parameters, Indications, and Complications (n=68).

Variable	Study Group n=68	
	No	%
1- All of the following data can be obtained from A.B.G's result, except.		
A. Acid base status.	11	16.2
B. Oxygenation (Dissolved (pO2)-Saturation of hemoglobin).	4	6
C. The ability of the body to eliminate CO2.	3	4.3
D. Potassium, calcium, and magnesium blood level.	18	26.5
E. Hemoglobin level. (correct answer)	32	47
2- The normal range of HCO3 is:		
A. 7.35 – 7.45 mEq/L.	12	17.6
B. 22 – 26 mEq/L. (correct answer)	42	62
C. 7.1 - 7.5.mEq/L.	7	10.2
D. 18-30. meq/l	7	10.2
3- indications of A.B.G. sampling are ----------,----------,----------, ----------		
- Correct answer.	12	17.4
- Incorrect answer.	4	5.9
- Incomplete answer.	51	75
- No response.	1	1.5
4- Complications of arterial blood sampling are. ----------,----------,---------,-----.		
- Correct answer.	9	13.2
- Incorrect answer.	5	7.4
- Incomplete answer.	54	79.4
- No response.	0	0

Table 4: Percentage Distribution of the Studied Subjects' Responses Regarding Heparinization of the Arterial Blood Gases' Syringes (n=68).

Variable	Study Group n=68	
	No	%
1- **Sodium and Lithium heparin are the only types of anti-coagulant used in arterial sampling**.		
• Yes. **(correct answer)**	46	67.5
• No.	19	28
• No response.	3	4.5
2-The maximum allowed time for reusing the opened heparin ampoules is 48hrs.		
• Yes.	38	56
• No. **(correct answer)**	26	38.2
• No response.	4	5.8
3-During hepranizion of syringe for ABG sampling, all remaining heparin should be expelled		
• Yes. **(correct answer)**	42	61.7
• No.	25	36.7
• No response.	1	1.6

Table (5): Percentage Distribution of the Studied Subjects' Responses Regarding Arterial Blood Gases withdrawal technique (n=68)

Variable	Study Group n=68	
	No	%
1- The allowed number of arterial puncturing trials from the same site is:		
A. One trial.	27	40
B. Three trials.	5	7.5
C. Two trials (correct answer)	30	43.5
D. Four trials.	6	9
2- **Three common sites of A.B.G sampling are** ----------, ----------. ----------.	48	70.6
-Correct answer.	3	4.4
-Incorrect answer.	17	25
-Incomplete answer.	0	0
-No response.		
3 - **When withdrawing arterial sample from the ---------- artery, Allen's test must be done to assess the patency of the ----------and ---------- arteries.**		
- Correct answer.	9	13.2
- Incorrect answer.	33	48.5
- Incomplete answer.	21	30.9
- No response.	5	7.4
4 – When puncturing the radial artery, the angle of needle insertion must be------°. While in femoral puncturing the angle must be------ °.		
-Correct answer.	42	61.7
-Incorrect answer.	7	10.3
-Incomplete answer.	14	20.6
-No response.	5	7.3

Table (6): Percentage Distribution of the Studied Subjects' Responses Regarding Factors Affecting Arterial Blood Gases' Results. (n=68).

Variable	Study Group No	%
1- The time allowed for the A.B.G. sample to be injected in the analytical machine (within room temperature) is:		
A. 5 min.	10	14.7
B. 10 min. (correct answer)	33	48.5
C. 20min.	19	28
D. 60 min.	6	9
2-ABG sampling should be done 15- 20 minutes after completion of ……..procedure(s):		
A. Nebulizer.	6	9
B. Suctioning.	11	16.2
C. Change oxygen supplementation volume or rate.	11	16.2
D .Change position.	12	17.6
E-All of the above. . (correct answer)	28	41
3-The only rationale of sending the A.B.G samples as soon as possible to the lab is to avoid clotting	33	48.5
• Yes.	35	51.5
• No. (correct answer)	0	0
• No response.		

4- Is it important to send the ABG sample to the lab immediately for the patient who has leuckocytosis >100000 mm^3, even if chilled.		
• Yes. (correct answer)	33	49
• No.	24	35.2
• No response.	11	15.8
5- A.B.G. sampling errors that may affect the result are --------, --------, -------, ------		
- Correct answer.	8	11.8
- Incorrect answer.	14	20.6
- Incomplete answer.	45	66.2
- No response.	1	1.4
6-It is important to document current patient's temperature in A.B.G. sampling, explain why?	3	4.4
- Correct answer.	10	14.7
- Incorrect answer.	8	11.8
-Incomplete answer.	47	69.1
- No response		

Figure (3): Percentage Distribution of Practice Level among the Studied Subjects as Regards to Arterial Blood Gases' Sampling (n=68).

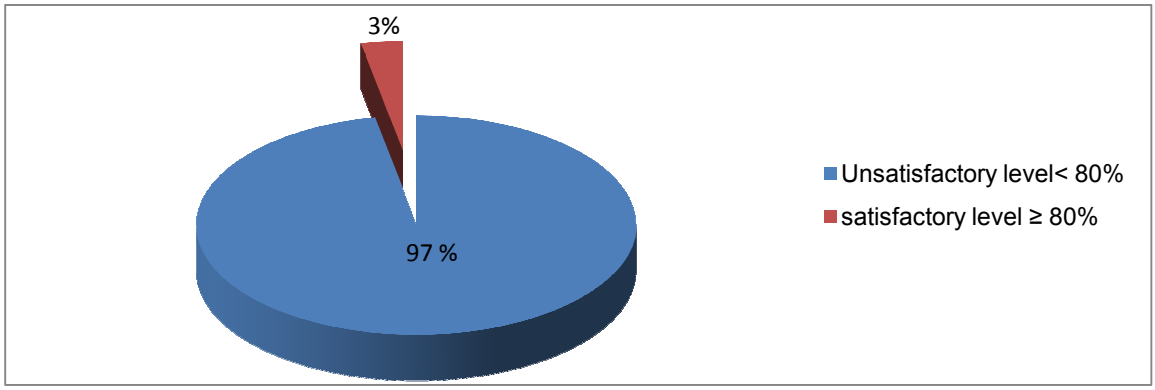

Figure (4): Percentage Distribution of Sub-Total Practice Level of the Studied Subjects (n=68).

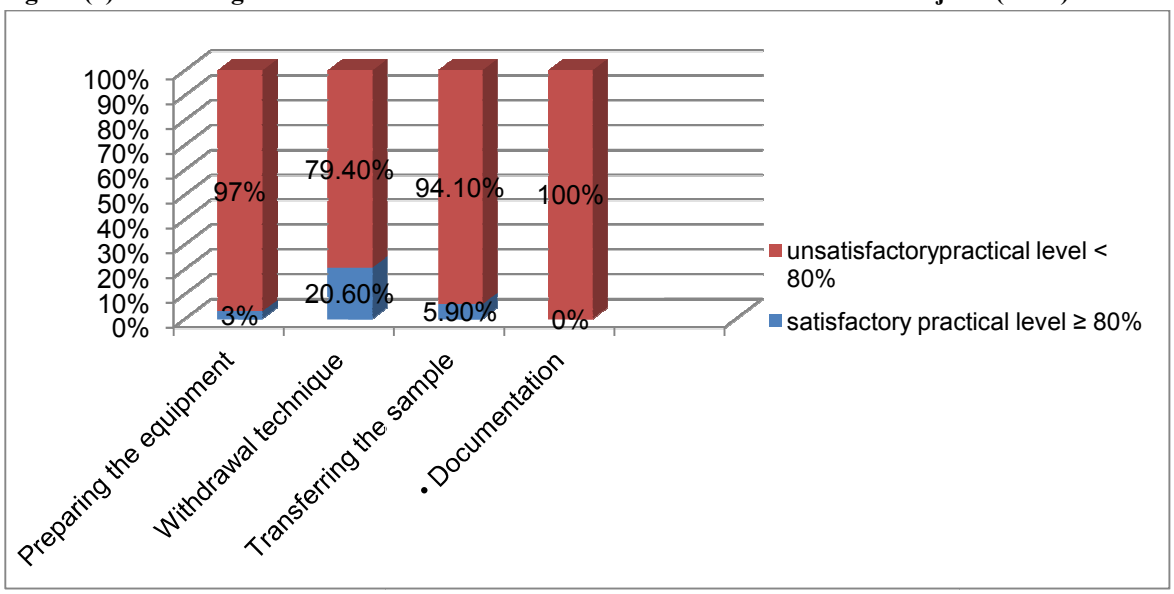

Table (7): Total Mean Practice Scores of the Studied Subjects in Relation to Arterial Blood Gases' Sampling Via Commonly uses Three Sites (n=68):

Sites of (ABGs) Sampling.	total score	Total mean of the three observational scores (n=68)
		Mean ± SD
Radial	80	49.17 ± 6.67
Femoral	76	50.42 ± 7.14
Arterial line	62	44.11 ± 8.85
Average mean	72.6	47.90 ± 7.55

Table (8): frequency distribution of factors that might affect the arterial Blood gases' results (n=204 arterial sample).

Factors	Response		
	Yes	**No**	**Not applied**
	n (%).	n (%)	n (%).
A- Equipment and supplies:			
1- ABG Analyzer machine inside the unit.	144(70.5)	60 (29.5)	--
2- Using impermeable syringe material; glass or impermeable tubes.	0.0	204(100)	--
3-Using ice bag to keep late ABG samples.	0.0	173(85)	34(15)
B- Heparinization the ABG syringes:			
4- Storage of the heparin ampoules in refrigerator (0- 4°).	201(98.5)	3(1.5)	--
5- Storage the heparinized syringe in refrigerator (0- 4°).	154(57.5)	21(10)	--
6-Discard the opened heparin ampoules after 24hrs.	186(91.1)	18(8.9)	--
C-Patient Variables:			--
7- Patient Was free from severe pain?	178(87.2)	26(12.8)	--
8- Patient Was out of peak of hyperactivity?.	187(91.7)	17(8.3)	--
9- Withdraw ABG sample 15 minutes after endo tracheal suctioning.	172(84.3)	32(15.7)	--
10- Withdraw ABG sample 15 minutes after any painful	93(45.6)	111(54.4)	--
11- Withdraw ABG sample 20 minutes after nebulizer.	183(89.7)	21(10.3)	--
12- Withdraw sample 15 minutes after modification in oxygen therapy	64(31.3)	19(9.5)	121(59.2)
13- withdraw ABG sample 15 minutes after modification in parameters of mechanically ventilated patient	151(74)	21(10.3)	32(15.7)
14- Withdraw ABG sample 15 minutes after blood transfusion.	6(3.4)	21(10.3)	177(86.3)
D- after withdrawal sample management:			
15- Expel all air bubble from the ABG sample:	137(67.1)	67(32.9)	--
16-Send the sample within 10 min. to the analyzer machine	31(15)	173(85)	--
17-chill the sample in ice bag if the time consumed is 10 to 60 min.	0.0	204(100)	--
18-Handle sample smoothly not moving vigorously to avoid hemolysis.	194(95)	10(5)	--
19- Send the arterial Specimens immediately with extremely elevated white blood cell counts of more than100000 mm3 even if chilled..	27(13.4)	19(9.6)	158(77)
E- Documentation:			--
20-Record Current patient temperature.	0.0	204(100)	--
21- Record &report any regular and specific current medications regimen	0.0	199 (97.5)	5 (2.5)
22-Document and report any previous mentioned factor that may affect validity of ABGs' results to consider it.	0.0	204(100)	--

Table (9) Correlation analysis among the study variables

Variables	Knowledge		practice		factors affecting ABG	
	R	p-value	R	p-value	R	p-value
Age	-0.143-	0.122	0.491	0.000**	0.376	0.001**
Years of experience	-0.199-	0.052	0.598	0.000**	0.399	0.000**

**. Correlation is significant at the 0.01 level (1-tailed).

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