Effect of Self –Learning Package on Nurses' Knowledge and Practice Regarding Arterial Blood Gases Analysis for Critically Ill Patients

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Abstract

Background: Arterial blood gases analysis is major part of the diagnosis and management of the oxygenation status, acid base balance, and ventilation in critically ill patients**. Aim**: The study aimed to evaluate the effect of self-learning package on nurses' knowledge and practices regarding arterial blood gases analysis for critically ill patients. **Subject and methods**: Quasi experimental research design conducted at three intensive care units affiliated to Zagazig University Hospital; Surgical, Anesthetic, Cardio and Chest intensive care units, using pretest/posttest and follow-up test approach. Subject: A convenient sample of all available nurses with total number 60 was recruited from the selected units. **Tools of data collection:** Two tools were used for collecting data: Interviewing questionnaire to assess nurses' knowledge and observational checklist to assess nurses' practice regarding arterial blood gases analysis for critically ill patients**. Results:** There was a statistically significant positive correlation between total knowledge and total practice scores of the studied nurses. Preprogram (93.3%) of the studied nurses had unsatisfactory level of knowledge while in post program (91.7%), and in follow-up (86.7%) had satisfactory level, Regarding practice , pre-program (86.7%)of the studied nurses had unsatisfactory level , post- program (93.3) had satisfactory, and while follow up (86.7%) had satisfactory level. **Conclusion**: The study finding concluded that, implementation of self- learning package had highly statistical significance positive effect on improving nurses' knowledge and practice scores regarding arterial blood gases analysis. **The main study recommendation**: The importance of conduction the self- learning package in a wider field including all hospitals to raise the efficiency of nursing care provided, and a further study to be carried out in different settings on a larger sample for a wider utilization of the developed package, in order to achieve generalization of the results.

Keywords: Arterial Blood Gases, Critically ill Patients, Self Learning Package, Nurses' knowledge and practice.

Introduction

Arterial blood gases (ABG) analysis is defined as a test that measures the acid – base balance of blood and the levels of oxygen (O2) and carbon dioxide (CO2) in the blood. The test is used to examine the function of the lungs of the patient, and how they can exchange gases. This test is commonly performed in the setting of intensive care unit (ICU) and may be performed to any patient at any floor depending on their diagnosis (**Gaines, 2020**).Arterial blood gases (ABG) analysis is a major part of the diagnosis and management of the oxygenation status, acid – base balance and ventilation in critically ill patients. Blood sampling can be taken from radial, brachial, femoral artery or from the arterial line for studying ABG (**Soltani, et al, 2019**).

Arterial blood gases should be tested in all critically ill patients whose O2 saturation drops below 94 percent, patients with increased breathlessness, patients with O2 therapy at risk of CO2 retention, quantification of oxyhemoglobin, which combined with arterial oxygen tension (PaO2), and also provides useful information on the O2 carrying capacity (**O'Driscoll et al., 2017**).

It is important to consider the basic facts to be easy to interpret the results of ABG. These facts are that the shift in PaCO2 is compensated for the shift in HCO3 and vice versa. This fact is critical to understanding the distinction between primary acid – base disorders with adequate compensation versus mixed acid- base disorder. Without an understanding of the fundmental physiology of acid base balance in the body, the right

interpretation of an ABG study is not possible (**Mcdaniel, 2019**).

Nurses play an important role in early detection of high risk patients with acid base imbalance in critical care units. In extreme circumstances in which therapeutic compensation is required, the nurse should be knowledgeable about potential risks of this therapy and able to carefully monitor administration rates and therapeutic responses (**Adhikari &Thapa, 2019**). Because nurses are often the first members of the health care team to see ABG results and an understanding of their significance and the ability to decide when medical staff needs to be informed is important (**Dash, et al, 2019**).

Self-learning package (SLP) is essential in assisting nurses to meet the challenges presented in today's health care environment. Nurses' educators have an important role to play in assisting nurses to acquire the skills for self – learning package, and to do this they need to understand the concept of self-learning package. Self-learning is that instead of instructor centered learning, it takes learner at the center. Also control and learning responsibility is at the students and he/she determines what, how, where and when to learn (**Yossif & Elsayed,2014**).

Self – learning package (SLP) is a learner initiate process. It involves identification of learning needs, formulation of objectives, choice of resources, accomplishment of strategies, and assessment of learning outcomes regarding to reward of SLP, it offers elasticity and accessibility to suit nurses schedule, and promotes additional participation in ongoing education as nurses gain knowledge to define their own learning needs and search for resources (**Bertino, 2011**).

Significance of the study

Arterial blood gas sampling is one of the most common laboratory tests in ICUs. It is made daily for all patients at ICU that allows the objectives evaluation of a patient's oxygenation, Ventilation and acid – base balance; the results from ABG will indicate how well a patient's respiratory system is working. However, ABG can offer more than just knowledge about respiratory system they

also indicate how well a patient kidney and other human body organs are functioning. Because nurses are often the first members of the health care team to see ABG results and play an important role to eliminate problems that interfere with the accuracy of test results and may lead to life threating medical decisions. Therefore the purpose of this study was to see how self-learning package affected nurses' knowledge and practice regarding arterial blood gases analysis for critically ill patients.

The study's aim

To evaluate the effect of self-learning package on nurses' knowledge and practices regarding arterial blood gases analysis for critically ill patients.

Objectives:
1. Assess nurses' knowledge level regarding arterial blood gases analysis
2. Assess nurses' practice level regarding arterial blood gases analysis
3. Design, implement, and evaluate self-learning package on nurses' knowledge, and practice regarding arterial blood gases analysis and its interpretation

Research hypotheses:

The researchers hypothesis that, self-learning package would improve knowledge and practices of studied nurses regarding arterial blood gases analysis among critically ill patients as indicated by difference between pre and posttests scores.

Subjects and methods

Research design:

Quasi experimental research design was used for one group of nurses with pre/posttest to achieve the aim of the study.

Setting

This study was conducted at the critical and ICUs affiliated to Zagazig University Hospitals and consisted of three units, the first unit was the Surgical ICU, its capacity was 22 beds, that unit encompassed three ABGs analyzer machine. The second unit was the Anesthetic ICU, its capacity was 21 beds also it encompassed two ABGs analyzer machine.

The last unit was the Cardio and Chest ICU, its capacity was 10 beds and encompassed one ABGs machine.

Sample

Convenience sample of all available nurses 60 nurses, 15 nurses from Surgical ICU, 26 from Anesthetic ICU and 19 from Cardio and Chest ICU**.**

Tools of data collection:

Tool I- Interviewing Questionnaire: Was written in simple Arabic language to avoid misunderstanding. It was designed by the researcher after reviewing of related literature **(Silvestrio & Angela, 2019)** and opinion of expertise for content validity to assess nurses' knowledge regarding ABG analysis among critically ill patients and determined factors affecting ABGs results. It included two parts as follow**:**

Part I: Personal Characteristics data of the nurses: Which were composed of seven closed ended questions including: Age, sex, marital status, educational level, years of experience, years of experience in ICU and attendance any training courses related to ABGs analysis.

Part II: Nurses' Knowledge Assessment Questionnaire: to assess their knowledge regarding ABG analysis. Total items were 51 included in the list. These items were classified into six different sections include:

First section: Nurses knowledge regarding definition and sites of ABG sampling; it composed of seven multiple questions.

Second section: Nurses knowledge regarding parameters of ABG, it composed of eight multiple choice questions.

Third section: Nurse's knowledge regarding indications, contraindications and complications of ABG analysis, it composed of five multiple choice questions.

Forth section: **Nurses knowledge regarding nursing role before, during and after ABGs puncture** it composed of eight multiple choice questions.

Fifth section: Nurses knowledge regarding signs and symptoms of acid- base imbalance, it composed of four multiple choice questions.

Sixth section: Nurse's knowledge regarding interpretation of ABG results, it included 11 multiple choice questions**.**

The scoring system:

Scoring system for the knowledge items was graded according to the items of interviewing questionnaire. The answers of nurses were evaluated using model key answer prepared by the researcher. The total score of the knowledge was 51 grades (100%); the correct answer was scored 1 and the incorrect zero. For each area of knowledge, the scores of the items was summed- up and the total divided by the number of the items, giving a mean score for the part. These scores were converted into percent scores. Knowledge was considered satisfactory if the percent score was equal or above 75% and unsatisfactory if less than 75% based on statistical analysis and nurses knowledge regarding ABGs analysis.

Tool II: Observational checklist for nurses:

It was used to assess level of nurse's practice in relation to ABG sampling technique for critically ill patients. Attenuated observational checklist was developed by the researcher. It consisted of two different methods:

1- Direct arterial blood sampling method via three sites as guided by **(Perry, etal., 2017)**.

a- **Radial artery site (46 items)**: Preparation before obtain blood sample 17 items, during obtaining blood sample 22 items, and after obtaining blood sample 7 items.

b- **Brachial artery site (43 items) :** Preparation before obtain blood sample14 items, during obtaining blood sample 23 items**,** and after obtaining blood sample 6 items).

c- **Femoral artery site (43 items) :** Preparation before obtaining blood sample 14 items, during obtaining blood sample 22 items, and after obtaining blood sample 7 items.

2- Arterial blood sampling observational checklist by indirect puncture from arterial lines which included53 items as guided by **Wiegand (2016).**

- Preparation before obtain blood sample 14 items.

- During obtaining blood sample 33 items.

- After obtaining blood sample 6 items.

The scoring system:

For observational checklist items was given one score if done correctly and zero score if done incorrectly, the scores of the items were summed- up and the total divided by the number of the items giving a mean score for the part. These scores were converted into percent scores. The nurses had satisfactory level of practice when the total score was equal or above 75%, and unsatisfactory if it below 75% based on statistical analysis and importance of nurses practice regarding ABGs sampling technique.

Content validity and reliability:

Once the tools of data collection were prepared, their face and content validity were ascertained by a panel of three experts (two professor of medical surgical Nursing and one professor of surgical medicine), who revised the tools for clarity, relevance, applicability, comprehensiveness, and ease of implementation. The agreement percentage was between 80-100%. In light of their assessments, minor modifications were applied. Reliability was measured by Alpha Cronbach for knowledge questionnaire was 0.83. Reliability of practice checklist was 0.92. Reliability of factors affecting ABGs analysis was 0.86

Pilot Study:

A pilot study for tools of data collection was carried out in order to check and ensure the clarity, applicability, relevance and feasibility of the tools. For this study, the researcher selected six nurses representing (10%) of the study subject selected randomly to participate in the pilot study. The nurses who were included in the pilot study were excluded from the sample because minimal modifications were done after conducting pilot study**.**

Field work

The study was executed from the first week of August, 2020 to March 2021 which classified as follow: 2 months for pretest from beginning of August to the end of September, 6 months for implementation of self - learning package and posttest from October 2020 to March 2021, where the researchers were available four days/ week. The study was conducted into four phases: 1 Assessment phase, 2 Planning phase, 3 Implementation phase, and Evaluation phase.

1- **Assessment phase**: It was carried out before implementing SLP. During this phase, using the two tools: nurses' knowledge questionnaire, and observational checklist. The researchers collected personal characteristic data of the nurses under study, and assessed nurse's knowledge regarding ABG analysis and its interpretation and observational checklist to assess nurses' practice in relation to ABG sampling technique for critically ill patient which was filled during the nurses work. The data obtained during this phase constituted the baseline (pretest) for further comparisons to evaluate the effect of self-learning package. Average time for the completion of each Nurse interview was around (20-45 minutes). The self-administered questionnaire was carried out to assess knowledge of studied nurses regarding ABG analysis and its interpretation that was filled in by nurse, while the observational checklist was to assess level of nurses' practice in relation to ABG sampling technique for critically ill patients that was filled in by the researcher by direct observation which consisted of two different methods 1) direct arterial blood sampling, and indirect puncture from arterial line were carried out before implementation of SLP (pre phase). The time required to complete the checklist ranged between 30-45 minutes.

2- **Planning the self – learning package**: The self – learning package was designed in Arabic language based on relevant recent literature review and nurse's needs assessment from the results of the data analysis of the pretest. This package was

tested by an exam for each unit and model answer at the end of unit. The designed SLP included nursing guidelines regarding arterial blood gases analysis, enclosing the following items (definition, ABG parameters, sites, contraindications, complications, sampling techniques, and its interpretation, and CD about these guidelines. Educational principles were reviewed for the development of the self-learning package.

3- **Implementation of self- learning package:** The actual field work for the process of data collection of this study was started and completed within eight months from the first week of August, 2020 to March 2021. During morning shift and afternoon shift, four days/week. The assessment was done on the first month for the entire study sample (60), they were divided into small groups (4-5 nurse for each group, it was carried out in previously mentioned setting. After one month from studying package (post phase) and finally after three months (follow up phase) Self - learning package distributed to all nurses both hard and soft copy, with clarification related to how the package is to be used throughout setting directions including;

1. Each chapter should be read carefully, and did not cancel any page in the package.

2. The questions after each chapter should be answered.

3. Nurses can go to the model key answer after finishing the reading carefully.

4. Nurses can return to the researchers in order to clarify the vague points and answer any questions via email, telephone numbers and meeting the nurses in their setting

- These were given in 30 minutes to every unit separately. The time allowed to study the package was three months for all nurses. After one month of the implementation post assessment of practice were applied and follow up test were performed after three months. Contacts with nurses were done through an e-mail and telephone number were given to all nurses for any additional explanation.

4- **Evaluation of self- learning package**: this phase includes evaluating the effect of self – learning package on the nurse's knowledge and practice regarding arterial blood gases analysis among critically ill patients by comparing the results pre/post self –learning package and after three months in the follow up test , using the same tool.

Ethical consideration

An approval was obtained from directors of hospitals included in this study after a comprehensive explanation of study aim, benefits and methods. Additionally, before data collection, oral consent was taken from each nurse after explaining the study aim, and process. Confidentiality and anonymity of any obtained information were ensured through coding all data. The researcher reassured participants that the data collected would be used only for the purpose of the study and to improve patients' health. No harm could be anticipated from any maneuver in the implementation of the study.

Statistical Analysis

All data were collected, tabulated and statistically analyzed using SPSS 20.0 for windows. Quantitative data were expressed as the mean $\pm$ SD & (range), and qualitative data were expressed as absolute frequencies (number) & relative frequencies (percentage). Percent of categorical variables were compared using Chi-square test or Fisher's exact test when appropriate. Pearson's correlation coefficient was calculated to assess relationship between various study variables, (+) sign indicate direct correlation & (-) sign indicate inverse correlation, also values near to 1 indicate strong correlation & values near 0 indicate weak correlation. All tests were two sided. P-value < 0.05 was considered statistically significant (S), and p-value $\geq$ 0.05 was considered statistically insignificant (NS).

Results

Table **1** shows that 80% of the studied nurses their age were less than 30 with mean $\pm$SD 26.5$\pm$4.3, 88.3% of them were females, 73.3% of them were single. In relation to nurses' education, 61.7% of them had technical institute. As regards to years of experience in ICU the results revealed that 60% of the

studied nurses had experienced less than 5 years in ICU with Mean ±SD 4.9±4.3, ranged between 1- 24 years and it also founded that 73.3% of the studied nurses didn't receive any training courses about ABG analysis.

It is clear from table **2** that only 6.7% of studied nurses had total satisfactory level of knowledge about ABG analysis at pre implementation of self-learning package, while in post implementation their level of knowledge increased to 91.7%, and decreased to 86.7% in follow –up phase. In the same table there was statistically significant difference between pre/post, pre/follow –up and between pre/post/follow –up implementation regarding total knowledge about ABG with P value was 0.000.

As can be seen from table **3** that 13.3% of studied nurses had total satisfactory level of practice regarding ABG analysis pre implementation of self- learning package. The total satisfactory practice increased to 93.3% at post implementation and decreased to 86.7% at follow-up. On the other hand there was statistically significant difference between pre/post, pre/follow-up, and pre/post/follow-up as regarding to total level of nurses practice with P value was 0.000.

It is apparent from table **4** that there was statistically significant relation between studied nurses total knowledge level and their age (P=0.000**) at post and follow-up implementation self- learning package. Moreover there was statistically significant relation between their personal data (educational level, years of experience, training courses and total knowledge level at pre, post and follow-up implementation of self- learning package(P=0.001,0.003,0.007,&0.000)

It is evident from table **5** that there was statistically significant relation between studied nurses total practice level and their age at post and follow –up implementation self - learning package(P=0.000 &0.005). While there was statistically significant relation between their personal data (educational level, years of experience, training courses and total practice level at pre, post and follow-up implementation of self- learning package(P=0.001,&0.000)

It is obvious from table **6** that there was statistically significant positive correlation between studied nurses total knowledge scores and total practice scores throughout phases of self-learning package (P=0.005&0.000)

Table 1: Number and Percentage Distribution of the Studied Nurses According to their Personal Characteristics Data (n=60).

Personal characteristics data	N	%
Age (Year)		
20-<30	48	80
30-<40	11	18.3
≥ 40	1	1.7
Mean±SD	**26.5 ± 4.33**	
Sex		
Male	7	11.7
Female	53	88.3
Marital status		
Single	44	73.3
Married	16	26.7
Education level.		
Diploma	7	11.7
Technical institute	37	61.7
Bachelor	16	26.7
Nursing experience (Year)		
<5	30	50
5-<10	20	33.3
≥ 10	10	16.7
Mean±SD	**5.58 ± 4.34**	
Nursing experience in intensive care unit (Year)		
<5	36	60
5-<10	16	26.7
≥ 10	8	13.3
Mean±SD	**4.89 ± 4.33**	
Training courses		
Yes	16	26.7
No	44	73.3

Table 2: Comparison Between the Studied Nurses Regarding their knowledge about Arterial Blood Gases Analysis throughout study phases (n=60).

Knowledge about arterial blood gases analysis	Pre				Post				Follow-up				Test of Sig. (p₁)	Test of Sig. (p₂)	Test of Sig. (p₃)
	Satisfactory		Unsatisfactory		Satisfactory		Unsatisfactory		Satisfactory		Unsatisfactory				
	N	%	N	%	N	%	N	%	N	%	N	%			
Definition	14	23.3	46	76.7	60	100	0	0.0	58	96.7	2	3.3	t=14.30 0.000**	t=13.17 P=0.000**	f=24.59 .000**
ABG Parameter	5	8.3	55	91.7	56	93.3	4	6.7	55	91.7	5	8.3	t=17.54 0.000**	t=16.37 P=0.000**	f=41.07 .000**
ABG indication	8	13.3	52	86.7	60	100	0	0.0	56	93.3	4	6.7	t=15.01 0.000**	t=12.56 P=0.000**	f=26.47 .000**
Nursing Role	10	16.7	50	83.3	58	96.7	2	3.3	54	90	6	10	t=13.85 0.000**	t=13.00 P=0.000**	f=43.81 .000**
Disturbance	11	18.3	49	81.7	58	96.7	2	3.3	54	90	6	10	t=14.22 0.000**	t=12.74 P=0.000**	f=37.69 .000**
ABG interpretation	0	0.0	60	100	55	91.7	5	8.3	52	86.7	8	13.3	t=16.41 0.000**	t=14.61 P=0.000**	f=25.40 .000**
Total Knowledge about arterial blood gases analysis	4	6.7	56	93.3	55	91.7	5	8.3	52	86.7	8	13.3	t=25.30 0.000**	t=22.11 P=0.000**	f=32.48 .000**

t: t. test   f= Friedman test   p= p-value
P₁: p value for comparing between **pre and post** self- learning package   **P₂:** p value for comparing between the in **pre and follow-up** self- learning package
p₃: p value for comparing between the **three session**.   ******: Highly statistically significant at p ≤ 0.01.

Table 3: Comparison Between the Studied Nurses of Their Practice about Arterial Blood Gases Analysis Throughout study phases (n=60).

Practice regarding arterial blood gases analysis	Pre				Post				Follow-up				Test of Sig. (p₁)	Test of Sig. (p₂)	Test of Sig. (p₃)
	Satisfactory		Unsatisfactory		Satisfactory		Unsatisfactory		Satisfactory		Unsatisfactory				
	N	%	N	%	N	%	N	%	N	%	N	%			
Radial	5	8.3	55	91.7	55	91.7	5	8.3	52	86.7	8	13.3	t=12.66 0.000**	t=14.30 P=0.000**	f=30.49 P=.000**
Brachial	10	16.7	50	83.3	57	95	3	5	54	90	6	10	t=15.08 0.000**	t=12.37 P=0.001**	f=33.74 P=.000**
Femoral	10	16.7	50	83.3	57	95	3	5	54	90	6	10	t=15.47 0.000**	t=14.06 P=0.000**	f=29.29 P=.000**
Indirect	12	20	48	80	58	96.7	2	3.3	56	93.3	4	6.7	t=16.64 0.000**	t=14.37 P=0.000**	f=25.92 P=.000**
Total Practice regarding arterial blood gases analysis	8	13.3	52	86.7	56	93.3	4	6.7	52	86.7	8	13.3	t =23.38 0.000**	t=20.91 P=0.000**	f=45.88 P=.000**

t: t. test   **f= Friedman test   p= p-value**
P₁: p value for comparing between **pre and post** self- learning package   **P₂:** p value for comparing between the in **pre and follow-up** self- learning package
p₃: p value for comparing between the **three session**.
**: Highly statistically significant at p ≤ 0.01.

Table 4: Relation between Nurses' Total Knowledge level Regarding Arterial Blood Gases Analysis and Their Personal Data Throughout study phases (n=60).

Items		Satisfactory (n=4) N	Satisfactory (n=4) %	Unsatisfactory (n=56) N	Unsatisfactory (n=56) %	X2	P-Value	Satisfactory (n=55) N	Satisfactory (n=55) %	Unsatisfactory (n=5) N	Unsatisfactory (n=5) %	X2	P-Value	Satisfactory (n=52) N	Satisfactory (n=52) %	Unsatisfactory (n=8) N	Unsatisfactory (n=8) %	X2	P-Value
Age (year)	20-<30	1	25	47	83.9	6.301	.099	44	80	4	80	22.42	.000**	41	78.8	7	87.5	20.63	.000**
	30-<40	3	75	8	14.3			11	20	0	0.0			11	21.2	0	0.0		
	≥ 40	0	0.0	1	1.8			0	0.0	1	20			0	0.0	1	12.5		
Sex	Male	2	50	5	8.9	1.630	.216	6	10.9	1	20	2.663	.119	5	9.6	2	25	1.971	.151
	Female	2	50	51	91.1			49	89.1	4	80			47	90.4	6	75		
Marital status	Single	2	50	42	75	1.214	.297	42	76.4	2	40	1.932	.147	40	76.9	4	50	1.777	.160
	Married	2	50	14	25			13	23.6	3	60			12	23.1	4	50		
Education Level	Diploma	0	0.0	7	12.5	20.05	.000**	2	3.6	5	100	33.62	.000**	1	1.9	6	75	18.63	.003**
	Technical institute	0	0.0	37	66.1			37	67.3	0	0.0			35	67.3	2	25		
	Bachelor	4	100	12	21.4			16	29.1	0	0.0			16	30.8	0	0.0		
Nursing experience (Year)	<5	0	0.0	30	53.6	15.34	.007**	26	47.3	4	80	50.00	.000**	23	44.2	7	87.5	41.00	.000**
	5-<10	0	0.0	20	35.7			20	36.3	0	0.0			20	38.5	0	0.0		
	≥ 10	4	100	6	10.7			9	16.4	1	20			9	17.3	1	12.5		
Nursing experience in intensive care unit (Year)	<5	0	0.0	36	64.3	16.50	.001**	32	58.2	4	80	19.60	.000**	29	55.8	7	87.5	26.01	.000**
	5-<10	0	0.0	16	28.6			16	29.1	0	0.0			16	30.8	0	0.0		
	≥ 10	4	100	4	7.1			7	12.7	1	20			7	13.4	1	12.5		
Training courses	Yes	4	100	12	21.4	29.30	.000**	16	29.1	0	0.0	44.97	.000**	16	30.8	0	0.0	50.39	.000**
	No	0	0.0	44	78.6			9	0.9		00			6	9.2		00		

No significant at p > 0.05. *significant at p ‹ 0.05. **highly significant at p ‹ 0.01.

Table 5: Relation between nurses' Total Practice level Regarding Arterial Blood Gases Analysis and Their Personal data Throughout study phases (n=60).

Items		Satisfactory (n=8) N	Satisfactory (n=8) %	Unsatisfactory (n=52) N	Unsatisfactory (n=52) %	X2	P-Value	Satisfactory (n=56) N	Satisfactory (n=56) %	Unsatisfactory (n=4) N	Unsatisfactory (n=4) %	X2	P-Value	Satisfactory (n=52) N	Satisfactory (n=52) %	Unsatisfactory (n=8) N	Unsatisfactory (n=8) %	X2	P-Value
Age (year)	20-<30	2	25	46	88.5	5.014	.091	45	80.4	3	75	20.91	.000**	42	80.8	6	75	15.20	.005**
	30-<40	6	75	5	9.6			11	19.6	0	0.0			10	19.2	1	12.5		
	≥ 40	0	0.0	1	1.9			0	0.0	1	25			0	0.0	1	12.5		
Sex	Male	3	37.5	4	7.7	1.917	.196	6	10.7	1	25	2.063	.120	4	7.7	3	37.5	1.114	.219
	Female	5	62.5	48	92.3			50	89.3	3	75			48	92.3	5	62.5		
Marital status	Single	3	37.5	41	78.8	1.444	.240	42	75	2	50	1.550	.161	40	76.9	4	50	1.617	.163
	Married	5	62.5	11	21.2			14	25	2	50			12	23.1	4	50		
Education Level	Diploma	0	0.0	7	13.5	21.99	.000**	3	5.3	4	100	30.90	.000**	0	0.0	7	87.5	23.69	.000**
	Technical institute	0	0.0	37	71.1			37	66.1	0	0.0			36	69.2	1	12.5		

Items		Levels of total practice at pre implementation of self-learning package				X2	P-Value	Levels of total practice at post implementation of self-learning package				X2	P-Value	Levels of total practice at follow up implementation of self-learning package				X2	P-Value
		Satisfactory (n=8)		Unsatisfactory (n=52)				Satisfactory (n=56)		Unsatisfactory (n=4)				Satisfactory (n=52)		Unsatisfactory (n=8)			
		N	%	N	%			N	%	N	%			N	%	N	%		
	Bachelor	8	100	8	15.4			16	28.6	0	0.0			16	30.8	0	0.0		
Nursing experience (Year)	<5	0	0.0	30	57.7	33.01	.000**	27	48.2	3	75	44.30	.000**	24	46.1	6	75	24.91	.001**
	5-<10	0	0.0	20	38.5			20	35.7	0	0.0			20	38.5	0	0.0		
	≥ 10	8	100	2	3.8			9	16.1	1	25			8	15.4	2	25		
Nursing experience in intensive care unit (Year)	<5	0	0.0	36	69.2	29.30	.000**	33	58.9	3	75	22.85	.000**	30	57.7	6	75	26.01	.000**
	5-<10	0	0.0	16	30.8			16	28.6	0	0.0			16	30.8	0	0.0		
	≥ 10	8	100	0	0.0			7	12.5	1	25			6	11.5	2	25		
Training courses	Yes	8	100	8	15.4	33.00	.000**	16	28.6	0	0.0	49.71	.000**	16	30.8	0	0.0	51.08	.000**
	No	0	0.0	44	84.6			40	71.4	4	100			36	69.2	8	100		

No significant at p > 0.05. *significant at p ‹ 0.05. **highly significant at p ‹ 0.01.

Table (6): Correlation between Total Nurses' Knowledge level and Their Total Practices level Regarding Arterial Blood Gases Analysis Throughout study Phases.

Variables		Total practice		
		Pre- self- learning package	Post- self- learning package	Follow-up - self- learning package
Total knowledge	r	.305	.449	.575
	p	.005**	.000**	.000**

**highly significant at p ‹ 0.01.

Discussion

As regards to nurses' characteristics, finding of the present study revealed that that more than two thirds of the studied nurses their age were less than thirty years old with the mean age 26.5±4.3 and were at age group 21-45years. This result may be due to that; most of those nurses were newly graduated, and tolerate the nature of the work in ICU units. These findings are consistent with **Safwat & Khorais (2018),** who reported in their study about "Effectiveness of A Computer- Based Learning Module on Arterial Blood Gas Interpretation Among Staff Nurses in Critical Care Units" affiliated to Ain Shams University hospital, Egypt and found that more than half of the studied sample their age were less than thirty years old with the mean age 28.67±4.23.

As regard to sex, the current study results revealed that; majority of the studied nurses were females. This could be due to the fact that the profession of nursing in Egypt was mostly feminine, additionally male nurses prefer to travel abroad or working in private hospitals for high salary out come and leave governmental hospital for females nurses especially at morning and afternoon shifts. This finding was in the same context with **Padma et al., (2017),** who conducted a study to assess the knowledge regarding arterial blood gases sampling among staff nurses in selected hospital in India and found that, the majority of staff nurses were female.

Concerning educational level, the present study results showed that, two third of the studied nurses had technical institute of nursing, This result may be related to that the technical institute of nursing provide the community with large number of nurses and now the administration trend is to employ the bachelor's degree in critical care unit in the step of change to make all the staff nurses in the ICU bachelor's degree. This is in the same line with **Abd Elkader, et al., (2020).** Who reported in their study entitled "Effect of Applying Program Based Learning on Nurse's Performance and Self-efficacy Regarding Arterial Blood Puncture at Port Said University, Egypt" that; the majority of the studied nurses graduated from technical institute.

Regarding years of experience in ICU units, the current study results showed that three fifths of the studied nurses had experience less than five years. This finding may be due to work stress, severity of patient condition and occupational hazards that facing nurses in ICU, all of these factors prevents nurses from continuing work in the critical care unit. This finding is agree with **Begum, et al., (2019)** in their study about "Assess The Effectiveness of Structured Teaching Programme on Knowledge of ABG Analysis Among Staff Nurses of ICU In Selected Private Hospitals of Guwahati" and founded that majority of the studied nurses had one to five years of experience in ICU.

As regards training courses about ABGs analysis test the present study finding displayed that; about three quarters of the studied nurses reported that they didn't receive any training courses regarding ABG. This may be due to shortage of staff, work load, lack of training courses about the ABG and lack of time ICU. This finding was supported by **Padilla, et al., (2017),** whose stated in their study about "The Effect of Simulation- Based Workshop on Nursing Students' Competence in Arterial Puncture in London" and found that the majority of nurses didn't' receive any form of training regarding arterial puncture.

The current study has highlighted the majority of studied nurses had unsatisfactory knowledge pre implementation of self- learning package This could be due to this topic was not integrated in the nursing education curricula for nursing students as well as nursing working in ICU are overloaded by increased number of patients which makes the nurse do not have enough time to develop themselves or update their knowledge. This finding was congruent with **Subin, (2017)** who carried out a study to assess the effect of video –assisted of Bhopal in India and found that the majority of staff nurses had inadequate knowledge regarding ABGs at the pre- test phase.

After implementation of the self- learning package there was a significant improvement in total level of nurses achieved satisfactory level of knowledge. However, the knowledge level was slightly decreased in the follow-up. This improvement indicated that self -learning

package was a successful method in improving nurses' knowledge, and this could be attributed to the clarity of the package materials, the use of simple language, and instructional media, nurse's interest and their need to acquire knowledge. This finding was consistent with **Adhikari &Thapa (2019)** who conducted to a study to "Effectiveness of Structured Teaching Program on Knowledge Regarding Arterial Gas Analysis among Nursing Students" revealed that the majority of respondents had adequate knowledge regarding ABG analysis on post – test.

On investigating nurses' practices regarding ABGs, the present study indicated that, the majority of studied nurses had unsatisfactory level of practice in pre implementation SLP. This could be attributed to that nurses felt that ABGs is the responsibility of doctors not the nurses, nurses didn't feel competent enough to perform ABGs and majority of them depend on random repetition and limitation during withdrawing ABGs samples. This result is in the same line with **Sabaq, et al., (2019)** who conducted a study on "Effect of Educational Program on Improving Nurses' Performance Regarding Arterial Blood Gases Sampling for Critically Ill Children" and found that the majority of nurses had incompetent practice in the pre- program phase.

After implementation of SLP, there was an improvement in total practice regarding ABGs in post and follow- up phase in which there was statistically significant differences between pre/post, pre/ follow-up and post/follow-up phase of SLP. One possible factor might explain this finding that the self-learning package enriches nurses' knowledge which in turn leads to increase their practice. This result matched with the result found by **Kaur and Charan (2018)** who carried out a study in India to assess the effectiveness of structured teaching program on knowledge and practice regarding ABGs among ICU nurses and reported that the majority of nurses had competent level of practice in the post – test phase.

It was evident from the present study that, there was a significant relation between nurses' knowledge, practice scores and the value of personal characteristics for educational level, years of experience, and training courses at pre / post and follow-up phase of SLP. This might be related to nurses who have high educational level, and more experience, and receiving training courses with ABG sampling are more likely to have a favorable knowledge and higher efficiency of clinical practice. This finding was disagreement with **Thulasimani, (2010)** who assess "The Effectiveness of Structured Teaching Program on Knowledge Regarding Arterial Blood Gases Sampling among The Staff Nurses Who Are Working in ICU of Vinayaka Mission Hospital At Salem In India" and reported that none of the demographic variables were significantly associated with the level of nurses knowledge in pretest and posttest.

Finally, the current study indicated that, there was statistically significant positive correlation between the studied nurses total knowledge scores and total practice scores throughout phases of self-learning package. This result might be positive effect of SLP which could help nurse to enhance their knowledge and improve their abilities to perform ABG competent. This finding on the same line with **Mohamed &Said(2020)** who revealed that there was a significant positive statistical correlation between total nurses' knowledge and total practices post-intervention.

Conclusion

Based on the results of the present study, it can be concluded that, implementation of self- learning package had highly statistical positive effect on improving nurses' knowledge and practice scores to attain research hypothesis. While there was statistically significant relation between educational level, years of experience, training courses regarding total knowledge, and practice scores at pre, post and follow-up implementation of self-learning package As there was statistically significant improvement throughout three phase (pre/post and follow-up) of self –learning package.

Recommendation

On the light of the current study findings the following recommendations are

suggested: The importance of conduction the SLP in a wider field including all hospitals to raise the efficiency of nursing care provided, continuous training program should be organized for critical care nurses on ABGs analysis to enhance their performance, and consequently improve outcome of care, critical care unit in hospital should be supplied with Arabic SLP for improving nurses' performance for caring critically ill patients, a further study to be carried out in different settings on a larger sample for a wider utilization of the SLP, in order to achieve generalization of the results.

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