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Assessment of Knowledge and Interpretation Skill on Arterial Blood Gas and its Associated Factors among Emergency and Critical Care Medicine Residents at Selected Ethiopian University Hospitals

A Thesis submitted to the College of Health Sciences, Department of Emergency Medicine and Critical Care, for partial fulfillment of the specialty certificate in emergency medicine and critical care

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DEC, 2024
Addis Ababa, Ethiopia

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ACRONYMS

AAU	Addis Ababa University
ABG	Arterial Blood Gas
AG	Anion Gap
AGMA	Anion Gap metabolic acidosis
AP	Arterial puncture
BE	Base excess
BLH	Black lion Hospital
ECCM	Emergency and Critical Care Medicine
ED	Emergency Department
EM	Emergency Medicine
EMRs	Emergency medicine residents
ETB	Ethiopian Birr
EUHs	Ethiopian University Hospitals
GP	General Practitioner
HAGMA	High anion gap metabolic acidosis
ICU	Intensive care unit
IRB	Institutional Review Board
JU	Jimma University

MoH	Minister of Health
NAGMA	Normal anion gap metabolic acidosis
PAJECC	Pan African Journal of Emergency Medicine and critical care
PaCO2	Partial pressure of carbon dioxide
PaO2	Partial pressure of oxygen
PGY	Postgraduate year
POCT	Point of care testing
SPHMMC	Siant Pauls Hospital Mellenium Medical College
TASH	Tikur Anbesa Specialized Hospital
TRH	Training/research hospitals
UH	University Hospitals
VBG:	Venous blood gas
v-TAC	Venous to arterial conversion
Y12HMC	Yekatit 12 Hospital Medical College

Acknowledgments

I would like to sincerely thank Dr. Merahi Kefyalew and Dr.Birhanu Tesfaye for their invaluable assistance and enlightening criticism in helping to shape this thesis. For his tremendous help in standardizing the questionnaire, I would like to thank Dr. Menbeu Sultan. For their involvement in this study, I am also grateful to the Emergency and Critical Care Medicine Residents. Finally, I want to express my gratitude to the Department of Emergency and Critical Care Medicine for providing me with the opportunity to conduct this research.

Contents

List of Tables

List of figures

ABSTRACT

Background: Arterial Blood Gas analysis is a critical tool in the assessment and management of critically ill patients. It provides information about the patient's acid-base status, oxygenation, and ventilation. Correct interpretation of Arterial Blood Gas results is essential for making appropriate clinical decisions. Studies have shown that residents often have difficulty interpreting Arterial Blood Gas results. This can lead to misdiagnosis and inappropriate treatment. In Ethiopia, it is not currently known how accurately emergency and Critical care medicine residents interpret arterial blood gases. The present study explores this question.

Objectives: To assess knowledge and interpretation skills on Arterial Blood Gas and its associated factors among emergency and critical care medicine residents at selected Ethiopian University Hospitals.

Methodology: An institution-based cross-sectional study was conducted from July 1 to September 30, 2024, among senior emergency and critical care medicine residents in five Ethiopian University Hospitals. Data were collected using a pretested self-administered questionnaire designed according to American Thoracic Society guidelines. The questionnaire was delivered through the Kobo Toolbox. The collected data were cleaned, coded, and entered into STATA SE (ver. 14) for analysis. Bi-variable and multivariable logistic regression models assessed associations between variables.

Results: 102 study residents participated in this study, giving a response rate of 89.5%. The mean age of the study participants was 31 ± 2.6 years. Male residents accounted for 71.5% of the participants while 54.9% were third-year Residents. The study found that 47.06 % of participants had poor knowledge and 50.98 % had poor interpretation skills. Residents who lacked exposure during the internship period (AOR: 2.8, 95% CI: 1.42, 19.3), residents who did not have a blood gas analyzer in their institution (AOR: 5.6, 95% CI: 3.96, 13.04.) and residents with poor interpretation skills on Arterial blood gas (AOR: 3.8, 95% CI: 2.40, 20.47) were significantly associated with poor knowledge towards Arterial blood gas analysis. Residents who had no training/lecture on Arterial blood gas interpretation (AOR: 11, 95% CI: 12.30, 16.4), residents who had poor knowledge of Arterial blood gas (AOR: 6.3, 95% CI: 4.82, 15.88) were significantly associated with poor interpretation skills towards Arterial blood gas as compared to good interpretation skills.

Conclusion and Recommendation: This study found that ECCM residents' overall level of poor knowledge and poor Interpretation skills towards ABG was 47.06% and 50.98%. Lack of experience with arterial blood gas (ABG) analysis during internships, lack of blood gas analyzer in the institution, and poor Interpretation skills were significantly associated with poor knowledge. Residents' lack of training in arterial blood gas and poor knowledge was significantly related to poor interpretation skills. Therefore, enhancing educational frameworks and resources is crucial for improving the competencies of ECCM residents in ABG knowledge and interpretation.

Keywords: Knowledge, Interpretation skill, Arterial blood gas, Residents

1. Introduction

1.1 Background

Arterial Blood Gas (ABG) analysis is a crucial tool for evaluating the acid-base balance, oxygenation status, and ventilation adequacy in critically ill patients. It assesses parameters like pH, PaO2, PaCO2, HCO3-, and SaO2, indicating respiratory and metabolic status, aiding in identifying imbalances and disorders. ABG analysis provides essential information about the patient's respiratory and metabolic status, aiding in clinical decision-making and treatment strategies. In emergency and critical care settings, ABG analysis is vital for determining the need for interventions like oxygen therapy, mechanical ventilation, or medication adjustments. It also detects electrolyte disturbances, impacting cardiac function. Interpreting ABG results accurately can be challenging, particularly for residents with limited exposure to ABG analysis cases [1.]

The healthcare system in Ethiopia, particularly in emergency and critical care settings, faces unique challenges and resource limitations that affect the accurate interpretation of arterial blood gases (ABGs) by emergency and critical care medicine residents. These challenges include limited services, shortage of trained professionals, and lack of access to laboratories, high patient load, and insufficient resources [2]. Limited exposure to ABG cases and the complexity of interpretation pose challenges to residents. However, adequate training and education are vital for developing proficiency in ABG interpretation. It is important for medical professionals, especially residents, to receive comprehensive instruction on ABG analysis principles, including sample collection, result interpretation, and correlation with clinical signs, ultimately mastery in ABG interpretation is attainable, ensuring optimal patient care [3].

Moreover, studies show inadequate knowledge of ABG interpretation globally, with deficiencies in understanding acid-base disorders, anion gap calculation, and oxygenation parameter interpretation. In resource-constrained settings like Ethiopia, challenges in ABG interpretation are exacerbated among residents, due to limited education, limited exposure to critically ill patients, and inadequate teaching materials. Areas needing investigation include acid-base disorders, anion gap calculation, oxygenation parameter interpretation, and clinical application of ABG results. Improving ABG interpretation skills through targeted training is vital for better patient care, especially in resource-constrained settings [4].

Enhancing the ability of Ethiopian emergency and critical care medicine residents to read ABG results can significantly improve patient care outcomes by lowering rates of morbidity and death in critical care settings. Better diagnosis and treatment of critically ill patients are made possible by accurate interpretation of ABG data, which improves patient outcomes. The creation of focused educational initiatives is hampered by the current lack of knowledge regarding the ABG interpretation proficiency of Emergency and Critical Care Medicine residents in Ethiopian university hospitals. The purpose of this study is to evaluate the ABG interpretation abilities of residents at a few university hospitals in Ethiopia that offer emergency medicine residency programs. The study aims to determine areas for growth and create successful teaching strategies by assessing their proficiency and determining affecting factors.

1.2 Statement of the problem

In Ethiopia, the lack of research on ABG interpretation can be attributed to the limited availability of the necessary materials and resources. A survey carried out that involved 10 chosen public hospitals in Ethiopia, revealed that nine of them conducted CBCs, electrolyte tests, and various other tests, while only one institution offered ABG [5]. A study conducted in Turkey showed that only 54% of doctors correctly identified the normal range of values of ABG [6]. Such results are alarming since poor ABG interpretation abilities might result in incorrect diagnoses and ineffective treatments, which can have detrimental effects on patients. Ethiopia's healthcare system has distinct difficulties and resource constraints that affect how well arterial blood gases (ABGs) are interpreted, especially in emergency and critical care settings. There is no thorough study evaluating the ABG interpretation abilities of emergency and critical care medicine residents in Ethiopian universities offering emergency medicine residency programs, despite the significance of ABG interpretation in delivering the best possible patient care and prompt and appropriate clinical decisions. Additionally, the factors associated with ABG interpretation proficiency among residents in Ethiopian university hospitals remain poorly understood. Therefore, there is a need to assess the ABG interpretation skill and explore the associated factors among emergency and critical care medicine residents at selected Ethiopian university hospitals [7)].

1.3 Significance of study

ABG interpretation is crucial for diagnosing and managing various conditions, such as respiratory failure, metabolic acidosis, and alkalosis. Accurately interpreting ABG results enables residents to identify the underlying cause of symptoms and develop appropriate treatment plans. Proficiency in ABG interpretation is essential for optimal care of critically ill patients, guiding the management of acid-base imbalances, respiratory disorders, and oxygenation status. Improving ABG interpretation skills among residents enhances patient care, facilitates timely interventions, and improves outcomes in emergency and critical care settings. This study will contribute to curriculum development, ensuring comprehensive training in ABG interpretation. It will also aid in quality assurance by evaluating residents' competence and identifying areas for improvement. Benchmarking and comparison with international standards provide insights into training programs and encourage collaboration. Research on ABG interpretation promotes research capacity-building and evidence-based practice. Enhanced ABG interpretation skills have long-term implications, improving emergency care quality, reducing morbidity and mortality rates, and enhancing healthcare system efficiency. This study will have meaningful impacts on patient care, education, quality assurance, and research in emergency medicine. It will provide valuable data and insights that can be used in future research studies.

2. Literature review

A web-based survey conducted by Langenau E, et al. in 2012 gathered responses from residency program directors, revealing the significance of evaluating advanced communication and certain procedural tasks. The study highlighted the following procedures as 'important' or 'extremely important' for assessment: sterile technique, advanced cardiovascular life support (ACLS), basic life support (BLS), interpretation of electrocardiogram, and ABG interpretation [8].

A survey that was carried out by Ertok I et al. in 2013 in Ankara, Turkey, involving EMRs in university hospitals (UH) and EMRs in training/research hospitals (TRH) indicated that there was no statistically significant difference in the number of correct answers between training/research hospitals and university hospitals. The duration of residency did not have an impact on the number of correct answers; however, residents who received training in ABG analysis during their residency period provided more correct answers [9].

A descriptive study conducted by Apsara N et al. in 2019 among nursing officers at a selected Hospital in Puducherry, India found that 2% had inadequate knowledge, 36% had moderate knowledge, and 62% had adequate knowledge of ABG Analysis and its Interpretation. Therefore, the study's results suggest that working experience in critical care units contributes to improved knowledge in this area [10].

In 2008, Austin K. et al. conducted a prospective cross-sectional research in New Zealand that involved EM trainees and consultants. The consultants' and trainees' ABG interpretation scores were 31 and 29, respectively, with the predefined 'expert level' being 40. Consultants scored better than trainees for knowledge of ABG equations, but neither group performed to the predefined 'expert level' [11].

In 2016, Padma K. et al. carried out a descriptive cross-sectional study at Narayana Medical College and Hospital, Nellore, India, about ABG analysis and interpretation the results showed that among nurses, 13.3% had an ‘A’ grade, 23.3% had B+ grade, 40% had B grade, 16.7% had C grade and 6.7% had D grade knowledge [12.]

A study conducted by AlJamal Y et al.in 2018, involving interns at Mayo Hospital, revealed that surgical interns begin residency training with limited proficiency in arterial blood gas interpretation and emergent cricothyrotomy. However, their skills and understanding improved after 6 months of clinical and simulation training [13].

In a survey conducted by Sullivan O. and colleagues in 2002 at a hospital showed that 54% of doctors correctly identified the normal range of values, while 71% correctly described the abnormality shown in each example. Additionally, 27% of participants correctly produced two appropriate differential diagnoses [14].

Cross-sectional study conducted by Lella M et al. in 2015, among medical students about their Perceptions towards the skills they acquired. Three-quarters of interns felt they could independently carry out venous blood sample collection, arterial blood gas interpretation, Pap smear specimen collection, and digital rectal examination. Still, only half felt that they could do a lumbar puncture, cervical dilatation, and collection of throat swabs [15].

A questionnaire-based study conducted by Cikman O et al. in 2014 was carried out in Turkey, involving physicians from different medical specialties. The study found that the intensive care unit experience of participant doctors during their intern periods was considered a crucial factor. However, it was observed that most of the specialist physicians who took part in the study performed the Allen test before radial artery puncture. Additionally, they often chose the femoral artery as their first option for puncture, and they did not give proper attention to the transportation of the samples [16].

A descriptive study conducted by Sehrawat V et al. in 2018 among staff nurses at a hospital in Gurugram, Haryana, India revealed that a significant association between knowledge scores on ABG analysis and selected demographic variables such as age, gender, educational status, and years of experience [17].

The study conducted in different countries revealed that venous blood gases can serve as substitutes for arterial measurements when assessing pH, bicarbonate, base excess (BE), and lactate levels in the initial evaluation of an adult patient population presenting to the ED and ICU. Calculated arterial blood gas values from a venous sample and pulse oximetry (v-TAC) were similar to ABG values. This could potentially lessen the need for arterial sampling, make screening and follow-up processes more efficient, and reduce patient discomfort [18-22].

An observational study was conducted by Chandran J et al. in 2018 in a specialized hospital in India. The study involved 985 arterial blood gas (ABG) tests performed on 173 patients over two months. Following the review of the ABGs, interventions were carried out in response to 259 ABGs (26.29%). The major interventions included adjustments to ventilator settings, correction

of electrolyte abnormalities, correction of hypoglycemia, oxygen administration, and other interventions such as fluid administration, intubation, extubation, and blood transfusion [23.]

Observational study conducted in 2019 by Watts at Royal Brisbane and Women's Hospital, Bridgeman Downs, Australia, during the 1-week study period 507 Point of Care testing (POCT) was taken from 49 patients. Of this, data were collected from 81 POCT samples from 33 patients. Primary reasons for POCT included; routine, intervention assessment, and new admission baseline, POCT were used to measure electrolytes, arterial blood gases; metabolites, and acid-base status [24].

A multicenter cohort study conducted by Rowling S et al. in 2013 at three hospitals in southern Denmark investigated the complications of arterial puncture during arterial blood gas (ABG) procedures. The study included 473,327 arterial punctures, and 669 of these punctures resulted in major complications, such as embolisms or thrombosis, aneurysms, nerve damage, arteriovenous fistulas, or other complications. The study found that the major complication rates were higher in patients on antithrombotic medication. However, the overall conclusion was that arterial punctures for ABG analyses are safe procedures [25].

Observational study conducted by Kumar A., et al. in 2015 at the Department of Anaesthesia, A.J., institute of Medical Sciences, Mangalore, India concluded that the amount of heparin is an important variable factor for arterial blood gas analysis sampling. An extra amount of heparin can cause alteration in pH, PO2, PCO2, HCO3, electrolytes, and other parameters. Syringes should be flushed with heparin or should contain less than 0.1ml of heparin during analysis [26].

A study conducted by Hajiseyedjavady H, et al. in 2011 at Imam-Reza Hospital in Tabriz, Iran, found that Lidocaine jet injection is beneficial for providing rapid anesthesia, leading to less pain and a higher success rate for ABG sampling. As a result, it is recommended to use Lidocaine jet injection before ABG sampling to reduce patient pain, minimize unsuccessful attempts, and improve patient satisfaction [27].

A study conducted in 2019 by Mauliandari R, et al. at Yogyakarta’s largest hospital in Indonesia demonstrated that the peer learning method leads to a more significant improvement in nurses' ability to interpret ABGs. Peer learning is considered suitable as one of the methods in clinical education for nurses [28].

A randomized controlled trial was carried out in 2018 by Yadav S, et al. at Selected Colleges of Nursing, Moradabad, India. The study aimed to assess the effectiveness of concept mapping

compared to conventional teaching methods in terms of knowledge regarding ABG analysis. The results indicated that the mean post-test knowledge score of the experimental group was higher than the mean pretest knowledge score, suggesting the effectiveness of concept mapping over conventional teaching methods [29].

A Prospective Cross sectional study conducted by Xafis P in 2014 at Western Cape Division of Emergency Medicine, South Africa among EM registrars and EM consultants revealed that the average ABG questionnaire score for the group was 63% [30].

A prospective cross-sectional study conducted by Musa Hussain et al in 2024 at Aswan University Hospitals in Egypt involving 273 healthcare professionals, including house officers, medical officers, registrars, and residents revealed significant improvements in ABG interpretation skills between two cycles. The accuracy in verifying ABG results increased from 71.8% to 90.2%, distinguishing acidemia and alkalemia improved from 82.9% to 95.4%, and differentiating respiratory and metabolic disturbances rose from 82.1% to 96.7% [31].

Conceptual Framework

The conceptual framework which is adopted and modified from the literature shows factors that affect the level of Knowledge and interpretation skills on ABG (10, 11, 12, 16, 19, 20).

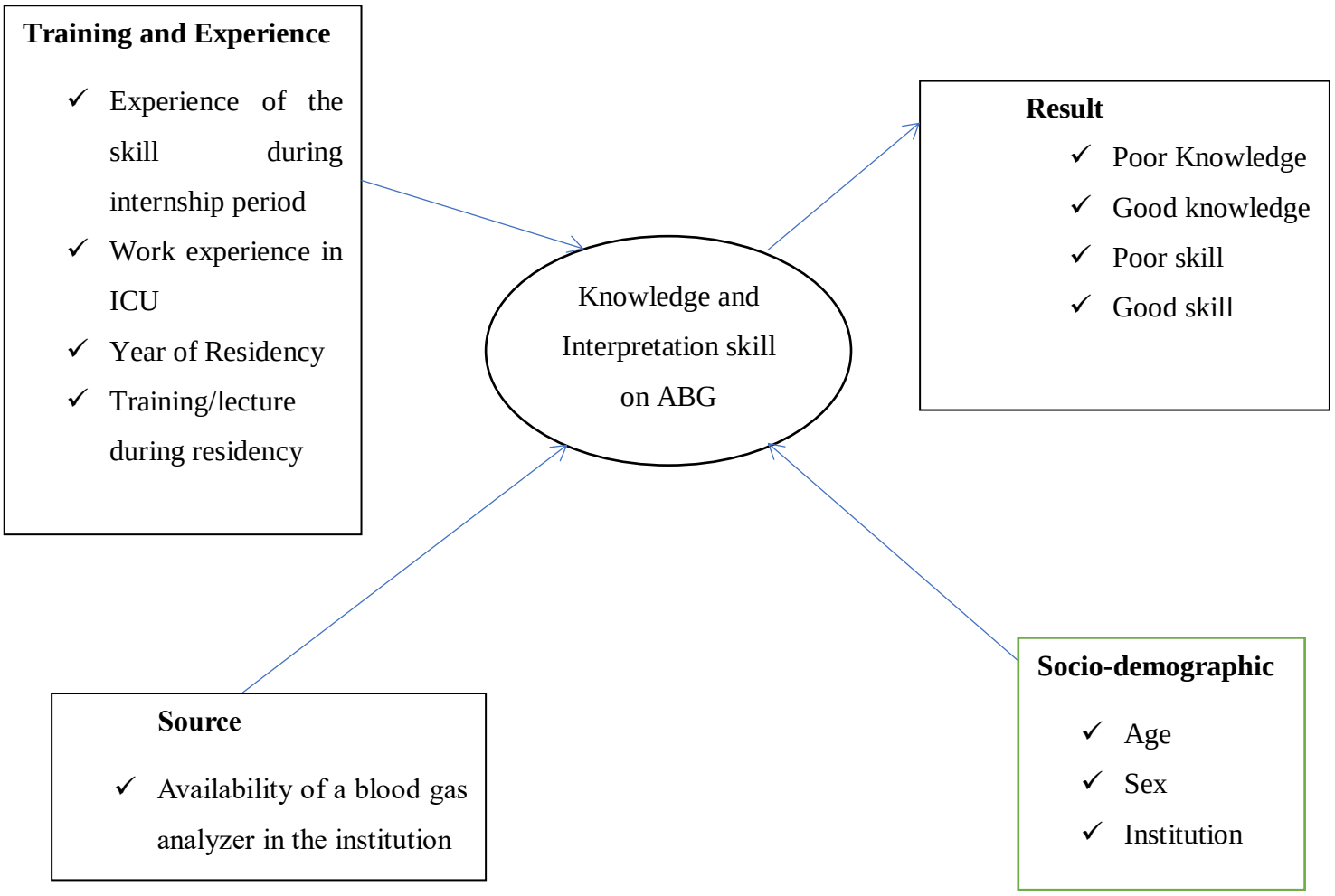

Figure 1: Conceptual Framework of Knowledge and Interpretation Skills on Arterial Blood Gas and its Associated Factors among Emergency and Critical Care Medicine Residents at Selected Ethiopian University Hospitals, 2024.

3. Objectives

3.1 General Objective

- To assess the knowledge and interpretation skills on arterial blood gas (ABG) and its associated factors among emergency and critical care medicine residents at selected Ethiopian University Hospitals, 2024

3.2 Specific Objectives:

- To assess the knowledge on arterial blood gas (ABG) among emergency and critical care medicine residents at selected Ethiopian University Hospitals, 2024
- To determine the level of interpretation skills on arterial blood gas (ABG) among emergency and critical care medicine residents at selected Ethiopian University Hospitals, 2024
- To identify associated factors with level of knowledge and interpretation skills on arterial blood gas (ABG) among emergency and critical care medicine residents at selected Ethiopian University Hospitals, 2024

4. Methods and Materials

4.1. Study setting

The research conducted in AAU, SPHMMC, Hawassa University, JU, and Haramaya University. TASH is Ethiopia's largest general public hospital and one of the University Hospitals in the country under AAU. At TASH there is no ABG analyzer in the laboratory. SPHMMC is located in Addis Ababa, specifically in the Gulele Subcity, Woreda 04. Hawassa is situated at a distance of 220 kilometers from Addis Ababa. Jimma is a city located in the southern part of Ethiopia, situated 350 kilometers from Addis Ababa. Haramaya is a town located in the Oromia region of Ethiopia, approximately 40 kilometers southeast of Harar city and about 510 kilometers east of Addis Ababa.

Emergency Medicine is a relatively new field of medicine beginning in the 1960s in the United States and the United Kingdom. In Africa, specifically South Africa, emergency medicine became a recognized specialty in 2003 with the African Federation for Emergency Medicine being established in 2009. In partnership with AAU, the University of Wisconsin, and the University of Toronto, TASH created the Department of Emergency Medicine (later renamed Emergency and Critical Care Medicine) in 2010. The department launched a three-year residency program in October 2010 [32]. Currently, there are 8 universities with emergency and critical care specialty programs these are AAU, SPHMMC, JU, Haramaya University, Hawassa University, Bahir Dar University, Gondar University, and Y12HMC. A total of 195 Emergency and Critical Care physicians graduated from AAU, SPHMMC, Jimma University, and Haramaya University.

4.2. Study design and period

The research design used for this study was an institutional-based cross-sectional study. The data was collected from July 1 to September 30, 2024.

4.3. Population

4.3.1 Target Population: All ECCM residents in EUHs.

4.3.2 Source population**:** ECCM residents in the selected EUHs.

4.3.3 Study population: All senior ECCM residents in the selected EUHs.

4.4. Eligibility criteria

4.4.1 Inclusion criteria**:**

All senior ECCM residents who were willing to participate in this study are included.

4.4.2 Exclusion criteria**:**

Participants who were absent during the data collection period were excluded from the study

4.5. Sample size determination and sampling technique

4.5.1 Sample size:

The sample size will be determined using single population proportion formula by considering Confidence level = 95%, Critical value Zα/2 = 1.96, Degree of precision d =0.05. The proportion (p) is the best estimate since we don't have a previously done study in our country, we took 50%

$$n = \frac{Z\alpha/2^2\, p\,(1-p)}{d^2} = \frac{(1.96)2*(0.5)*(0.5)}{(0.05)^2} = 384$$

Since the actual sample population is less than the calculated sample size and study population don't have significant differences all ECCM residents who were on training were enrolled.

4.5.2 Sampling technique:

The teaching hospitals (AAU, SPHMMC, JU, Hawassa University, and Haramaya University) were selected because they comprise second—and third-year ECCM residents. All 120 residents were enrolled.

Table 1: Allocation of the study participants

	AAU	SPHMMC	Hawassa	Haramaya	Jimma	Total
R2	18	18	7	7	7	57
R3	25	20	5	3	10	63
Total	43	38	12	10	17	120

4.6. Study variables:

4.6.1 Dependent variable: level of Knowledge and Interpretation skill on ABG

4.6.2 Independent variables:

- Socio-demographic characteristic:
- ✓ Age
- ✓ Sex
- ✓ Institution
- Availability of ABG analyzer in the institution
- Experience and Training (Experience of the skill during internship period, Work experience in ICU, Year of Residency, Training/lecture during residency)

4.7. Operational definitions:

Senior residents -: Third and Second year (completed the first 6 months of their 2nd year) residents.

Knowledge: Refers to respondents' understanding of indications, contraindications, complications of ABG sampling, factors that affect ABG results, normal values of ABG, physiology understanding of ABG, and, the difference between VBG and ABG. The participant's understanding was measured by 10 MCQ items.

Interpretation skill: Refers to respondents' understanding of anion gap, differentials of High anion gap, simple acid-base disorder, mixed acid-base disorder, understanding of compensation, and case management based on ABG result. The participant's understanding was measured by case-based 10 MCQ items.

Result: Poor knowledge if score less than 50%

Good knowledge if a score greater than 50%

Poor interpretation skills if score less than 50%

Good interpretation skills if score greater than 50%

4.8. Data collection tool, methods, and procedures:

Data was collected using a pre-tested self-administer questionnaire. The questionnaire was developed based on the American Thoracic Society guidelines [33] and adopted from previously published papers [7, 11-14, 17, 19-20, 28-29] and then organized and prepared in English for the ease of the data abstraction process; it contained 32 questions and comprised four parts. Part A included

socio-demographic variables such as age, gender, year of residency, institution, years of experience, and whether they have received any ABG training or attended a seminar or class. Part B contained questions related to factors that affect ABG interpretation skills and procedures of ABG Sampling. Part C comprised 10 multiple-choice questions on ABG Knowledge. Part D comprised 10 multiple-choice questions on the interpretation skill of ABG which comprises both simple and mixed acid-base disorders. The assessment of knowledge involves understanding of acid-base balance, normal reference ranges, and the physiological basis of ABG values. The assessment of interpretation skills focuses on evaluating the residents' proficiency in analyzing ABG reports, compensatory mechanisms, potential underlying causes, and appropriate interventions based on ABG interpretation. A correct answer carried one mark and a zero for a wrong answer. The total possible score was 20. Informed consent, in written form, was obtained before data collection. It was presented to each resident after being prepared by kobotoolbox.org through online links in the same order. We assigned a data supervisors for each site. A pilot study was performed on 5% of the study population (6 residents) one week before data collection and the results were excluded from the study. The data collection procedure includes obtaining prior permission from the relevant authority. The data study was conducted over 12 weeks and involved collecting data from residents in the selected five university hospitals. The level of knowledge and skills were compared based on the socio-demographic variables, availability of source, and training and experience.

4.9. Data quality

Before administering the questionnaire for target population, face validity assessment by experts (1 critical care specialist and 2 ECCM consultants) and a pretest for a small group were conducted. A Clear and concise instruction was provided at the beginning of the questionnaire to guide respondents on how to answer the questions accurately. The principal investigator was primarily handling the data collection, ensuring that responses were complete before inputting them into STATA SE (ver. 14). The data collection supervisors were assigned to each site. One day of training was given to orient data supervisors on the questionnaires.

4.10. Data processing and analysis

The questionnaire was delivered through KoboToolbox and administered online in a structured order. Data was Exported from down loaded excel sheet. The collected data were cleaned, coded, and entered in to STATA SE (ver. 14) for analysis. Different frequency tables, graphs, and

descriptive statistics such as frequencies, percentages, means, and standard deviations were used to display the study results. Bi-variate and multivariate logistic regression were used to show the association between independent variables and outcome variable .Variables with a p-value of <0.25 in the bivariate analysis were taken to multivariate analysis. Crude odd ratio (COR) and adjusted odd ratio (AOR) with a 95% confidence interval for both models were calculated to determine associations. A p-value of <0.05 was considered statistically significant.

4.11. Ethical considerations:

Institution review board of AAU department of Emergency Medicine (ethics reference number: /MS/196/2016) on June 2024 approved this study. All residents were informed that participation in this study was optional, and they could withdraw from the study without giving reasons. Data confidentiality was assured during the implementation of the study. Informed consent was taken from participants upon filling out the questionnaire. Confidentiality of the information was ensured by filling out the questionnaire anonymously.

5. Results

5.1. Responses:

A total of 114 invitations were sent via the online web with a link provided from the Kobo toolbox to all senior ECCM residents of 5 selected university hospitals 102 responded making a Response rate of 89.5%.

5.2. Characteristics of study participants

The mean age of study participants was 31±2.6 years. Male residents accounted for 71.5% of the participants while 54.9% were third-year Residents. 40 (39.2%) of residents were from AAU, 31 (30.5%) were from SPHMMC, 15 (14.7%) were from Jimma University, 8 (7.8%) were from Hawassa University and 8 (7.8%) were from Haramaya University. 56 (54.9%) were 3rd year residents. 41(40.2%) of residents have worked in the ICU as a general practitioner, but most of them 22 (53.7%) only had less than 6 months of experience. Most participants 82(80.3%) had ABG lectures/training during their residency program. Only 23(22.6%) of respondents replied that their institution had a blood gas analyzer. Only 21(20%) of residents had ABG interpretation skills during their internship period. 42(41.2%) of respondents had experience with the ABG sampling. Among those with experience with ABG sampling, the majority 33(78.5%) did the Allen test.

Table 2: Background characters of study participants (n=102)

Variable	Category	Frequency (Percentage)
Sex	Male	73 (71.5)
	Female	29 (28.5)
Age	25-30	59 (57.84)
	31-35	34 (33.33)
	≥ 36	9 (8.82)
Year of Residency	Three	56 (54.9)
	Two	46 (45.1)
Institution	AAU	40 (39.2)
	SPHMMC	31 (30.5)
	Jimma University	15 (14.7)
	Haramaya University	8 (7.8)
	Hawassa University	8 (7.8)
ICU experience	Have	41 (40.2)
	Have not	61 (59.8)
ICU experience in months	0-6	22 (53.7)
	7-12	6 (14.6)
	>12	13 (31.7)
Year of experience as GP	0-3	69 (67.6)
	4-6	27 (26.4)
	> 6	6 (6)
Training /Lecture on ABG	Have	82 (80.3)
	Have not	20 (19.7)
Blood gas analyzer availability	Available	23 (22.6)
	Not available	79 (77.4)
Practice during internship	Have	21 (20.6)
	Have not	81 (79.4)
ABG Sample taken	Yes	42 (41.2)
	No	60 (58.8)
Allen test done from the yes group	Yes	33 (78.5)
	No	9 (21.5)
Local Anesthesia was given from the yes group	Yes	9 (21.5)
	No	33 (78.5)

5.3. Distribution of residents according to the number of correctly and incorrectly answered questions.

Of the questions posed, residents demonstrated the highest level of knowledge regarding normal ABG values, with 81 respondents (79.4%) answering correctly. Additionally, 80 respondents (78.4%) accurately distinguished between venous and arterial blood gases, and 80 (78.4%) correctly identified simple acid-base disorders. However, the physiology understanding of ABG proved to be a significant challenge, with only 30 (29.4 %) answered correctly. Similarly, mixed acid-base disorders and a case-based question on hypoalbuminemia were answered correctly only by 34 respondents (33.3%).

Table 3: Distribution of residents according to the number of correctly and incorrectly answered questions

	Correctly answered		**Incorrectly answered**	
ABG Questions				
	Frequency	**Percentage**	**Frequency**	**Percentage**
Indications	51	50	51	50
Absolute contraindication	44	43	58	57
Preferred site	80	78	22	22
Complications	40	39	62	61
Factors Affect ABG result	54	52.9	48	47.1
VBG Vs ABG	80	78.4	22	21.6
Anticoagulant	56	54.9	46	47.1
Henderson-Hasselbach equation	30	29.4	72	72.6
Compensation mechanism	32	31.3	70	70.7
Normal values of ABG	81	79.4	21	22.6
Anion Gap	75	73.5	27	28.5
Etiologies of High AG	68	66.7	34	35.3
Simple Acid-base disorder	80	78.4	30	21.6
Fully compensation	39	38.2	63	61.8
Expectation from ABG result	72	70.6	30	29.4
Mixed Acid-base disorder	34	33.3	68	66.7
If hypoalbuminemia included	34	33.3	68	66.7
Management	56	54.9	46	45.1

5.4. Overall Resident's Knowledge, and Interpretation skill on ABG at the selected public University hospital

This study has found that 47.06% of residents had poor knowledge (95% CI=37.1, 57.2), whereas 50.98% of residents had poor interpretation skills (95% CI =41.2, 60.7).

5.5 Factors associated with ECCM resident ABG knowledge at selected Ethiopian University Hospitals

In bivariate analysis age, sex, year of experience, training/lecture on ABG, Allen test, ABG experience during the internship period, Blood gas analyzer availability, and interpretation skill were significant at p-value <0.25 and included in multivariate analysis. In the multivariate analysis, ABG experience during internship, Blood gas analyzer availability, and Interpretation skills were statistically significantly associated with poor knowledge.

Multivariate analysis revealed that residents not having ABG experience during the internship period were 2.8 times more likely to have poor knowledge of ABG as compared to those who had ABG experience during the internship (AOR: 2.8, 95% CI: 1.42, 19.3).

Residents who did not have a blood gas analyzer in their institution were 5.6 times more likely to have poor knowledge than those who had a blood gas analyzer in their institution. (AOR: 5.6, 95% CI: 3.96, 13.04.).

Residents with poor interpretation skills in ABG were 3.8 times more likely to have poor knowledge than those with good interpretation skills. (AOR: 3.8, 95% CI: 2.40, 20.47).

Table 4: Bivariate and Multivariate Analysis of Factors Associated with Knowledge of ECCM Residents towards ABG at Selected Ethiopian University Hospitals (n =102).

	Category	Knowledge of Participants on ABG		COR(95% CI)	AOR(95% CI)	P-value
		poor (N)	Good (N)			
Age	25–30years	30	28	1	1	
	31–35years	12	21	0.56(.24, 1.32)	0.19(.03, 1.27)	0.087
	>36years	6	5	0.72(.18, 2.96)	0.25(.008, 7.29)	0.418
Sex	Male	36	37	1	1	
	Female	12	17	.73(.30,1.73)	1.36(.25,7.38)	0.723
Year of experience	0-3	30	30	1	1	
	4-6	13	12	.92(.36, 2.34)	0.21 (0.17,2.70)	0.233
	> 6	5	12	.38(.10, 1.41)	0.40 (.001,0.47)	0.080
Training on ABG	Yes	35	47	1	1	
	No	13	7	2.49(.90, 6.90)	2.3 (0.27, 19.9)	0.445
Allen test	Yes	10	23	1	1	
	No	17	5	7.82(2.26, 27.1)	8.4(.97, 73.1)	0.054
ABG experience during internship	Yes	5	16	1	1	
	No	43	38	3.62(1.21, 10.8)	2.8 (1.42, 19.3)	**0.0245**
Blood gas analyzer availability	Yes	42	37	1	1	
	No	6	17	3.21(1.14, 9.01)	5.6(3.96, 13.04)	**0.035**
Interpretation skill	Poor	29	42	.17(.072, .40)	3.8(2.40, 20.47)	**0.004**
	Good	19	12	1	1	

5.6 Factors Associated with Arterial blood gas interpretation skill among Emergency and critical care medicine residents at Selected Ethiopian University Hospitals

In bivariate analysis age, sex, year of experience, training/lecture on ABG, Allen test, ABG experience during the internship period, Blood gas analyzer availability, and interpretation skills were significant at p-value <0.25 and included in multivariate analysis. In the multivariate analysis, training/ lecture on ABG and knowledge were statistically significantly associated with Poor interpretation skills. Multivariate analysis revealed that residents who had no training/lecture on ABG were 11 times more likely to have poor interpretation skills than those who had training/lectures (AOR: 11, 95% CI: 12.30, 16.4). Residents who had poor knowledge of ABG were 6.3 times more likely to have poor interpretation skills than those with good interpretation skills. (AOR: 6.3, 95% CI: 4.82, 15.88).

Table 5: Bivariate and Multivariate Analysis of Factors Associated with Interpretation Skill of ECCM Residents towards ABG at Selected Ethiopian University Hospitals.

Variable	Category	Interpretation skill		COR(95% CI)	**AOR(95% CI)**	**P-value**
		Poor(N)	Good(N)			
Age	25-30	31	28	1	1	
	31-35	16	17	1.2(.53, 2.9)	2.7(.20, 36.3)	0.450
	>36years	5	5	.89(.22, 3.6)	.22(.0002,30.7)	0.682
Sex	Male	40	33	1	1	
	Female	12	17	1.7(.718, 4.1)	.189 (.013, 2.7)	0.221
Year(s) of experience	0-3	27	33	1	1	
	4-6	16	9	2.1(.83, 5.69)	1.89 (.006, 58.6)	0.828
	>6	9	8	1.6(.45, 5.5)	.26 (.0006, 110.3)	0.660
Training in ABG	Yes	40	42	1	1	
	No	12	8	.63(.23, 1.7)	11(12.30, 16.4)	**0.029**
Allen test performed	Yes	18	17	1	1	
	No	14	6	.21(.06, .75)	1.33 (.096, 18.3)	0.829
ABG experience during the internship period	Yes	8	13	1	1	
	No	44	37	.52(.19, 1.38)	.066(.004, 1.09)	0.057
Blood gas analyzer availability in the institution	Yes	38	9	1	1	
	No	14	41	1.68(.65, 4.3)	7.78(.71, 84.9)	0.093
knowledge	Poor Knowledge	17	37	.17(.07, .4)	6.30(4.82,15.88)	**0.004**
	Good Knowledge	35	13	1	1	

COR, Crude Odds Ratio; CI, Confidence Interval; AOR, Adjusted Odds Ratio

6. Discussion

This study aims to assess the knowledge and interpretation skills and associated factors on ABG among emergency and critical care medicine residents at selected Ethiopian University Hospitals. This study found that the overall poor knowledge and poor interpretation skills of ABG were 47.06% (95% CI=37.1, 57.2) and 50.98% (95% CI =41.2, 60.7) among ECCM residents respectively.

In this study, ECCM residents with a poor level of knowledge of ABG were 47.06% (95% CI = 37.1, 57.2). The finding was higher than the study conducted in India (38%) [10].This variation could be due to inadequate training, limited clinical exposure, insufficient educational resources, and differences in assessment methodologies, study periods, sample sizes and cultural factors affecting learning.

Regarding interpretation skills, this study has shown that 50.98% (95% CI =41.2, 60.7) of ECCM residents had poor interpretation skills on ABG. This finding was higher than the study conducted in South Africa (63%) [30] and Egypt (71.8%) [31]. these variations could reflect differences in educational standards, clinical practice environments, sample size, and selection criteria or the complexity of cases encountered by these groups.

In this study, lack of experience with arterial blood gas (ABG) analysis during internships was significantly associated with poor knowledge levels among ECCM residents. This study is consistent with the study conducted in Turkey (16). The association between lack of experience with ABG analysis during internships and poor knowledge levels among ECCM residents likely stems from limited practical exposure, inadequate training programs, cognitive challenges, insufficient feedback mechanisms, variability in clinical settings, and the stress associated with residency training.

This finding showed that ECCM residents' lack of training in arterial blood gas (ABG) analysis was statistically significantly associated with a poor level of interpretation skills. This study is consistent with the study conducted in Turkey (9). This could be likely stems from insufficient educational curriculum, limited hands-on experience, cognitive overload, lack of feedback, variability in training quality, and the stress of residency training.

The result indicates that poor knowledge among ECCM residents is statistically significantly associated with a poor level of interpretation skills. The significant association between poor knowledge and poor interpretation skills among ECCM residents highlights the need for

improved educational strategies that emphasize comprehensive training, practical experience, continuous feedback, and a supportive learning environment.

7. Strength and Limitation of study

The strengths of this study are multicenter and primary data was used, which can better represent the study participants and the generalizability of the results. This study has several limitations. First, residents were evaluated through an online survey conducted outside of a clinical setting, which may introduce bias due to the potential for guessing and the lack of time constraints. Second, we cannot be certain if the professionals relied on additional resources when responding to the questions. Third, the study's cross-sectional design captures data at only one point, restricting our ability to monitor changes in knowledge and skills during the residency program or to draw causal inferences.

8. Conclusion

This study found the overall level of poor knowledge, and poor Interpretation skills among ECCM residents towards ABG were 47.06% and 50.98%. Lack of experience with arterial blood gas (ABG) analysis during internships, lack of blood gas analyzer in the institution, and poor Interpretation skills were significantly associated with poor knowledge. Residents' lack of training in arterial blood gas and poor knowledge were significantly related to poor interpretation skill.

9. Recommendations

A Collaborative effort from different stakeholders to further enhance the knowledge and interpretation skill on ABG is needed among ECCM. Based on the finding of the study, we recommend:

- ✓ Incorporate Comprehensive ABG Training curriculum module focused on ABG analysis that covers both theoretical concepts and practical applications.
- ✓ Integrate Interdisciplinary Learning with other medical disciplines (e.g., respiratory therapy, internal medicine) to provide a multidisciplinary approach to ABG training, enhancing understanding through diverse perspectives.
- ✓ Organize regular, Structured Hands-On Workshops that allow residents to practice ABG sampling and interpretation under the supervision of experienced clinicians.

- ✓ Improve Access to Blood Gas Analyzers by Advocate for the procurement of sufficient blood gas analyzers within training institutions to facilitate regular practice and exposure for residents.
- ✓ Implement a system for continuous evaluation of the training program's effectiveness in improving knowledge and skills related to ABG analysis.

10. References

1. Yee, Jerry, Stan, Mohiuddin, Naushaba, Uduman, et al. Fundamentals of Arterial Blood Gas Interpretation.Kidney360 2022; 3(8):1458-1466

2. Debie A, Khatri RB, Assefa Y. Contributions and challenges of healthcare financing towards universal health coverage in Ethiopia: a narrative evidence synthesis. BMC Health Services Research, 2022; 22:866

3. Spencer SA, Adipa FE, Baker T, Crawford AM, Dark P, Dula D ,et al. A health systems approach to critical care delivery in low-resource settings: a narrative review. Intensive Care Med, 2023; 49:772–784

4. Njie AE, Nyandiko WM, Ahoya PA, Moutchia JS. A comparative analysis of APGAR score and the gold standard in the diagnosis of birth asphyxia at a tertiary health facility in Kenya. PLoS ONE, 2023; 18(5): e0285828.

5. Sultan M, Waganew W, Beza L, GebreMedihin Y, Kidane M. The Status of Facility Based Emergency Care in Public Hospitals of Ethiopia Using WHO Assessment Tool. Ethiop J Health Sci.2022; 32(6):1093

6. Sullivan O, Jeavons R. Survey of blood gas interpretation, Emerg Med J 2005 22: 391-392

7. Ayele Y, Tesfaye ZT. Drug-related problems in Ethiopian public health care settings: Systemic review and meta-analysis. SAGE Open Med.2021; 20503121211009728

8. Langenau EE, Zhang X , Roberts WL, DeChamplain AF ,Boulet JR. Clinical skills assessment of procedural and advanced communication skills: performance expectations of residency program directors, Med Educ Online 2012, 17: 18812

9. Ertok I, Çelik GK, Kavakl HS, Doğan NO, İçme F, Becel S, et.al. Evaluation of Emergency Medicine Residents' Level of Knowledge of Arterial Blood Gases. JAEM. 2014; 13: 100-3

10. Apsara N, Nivedhitha K, Chitra A.F., Dash M. ABG Analysis and its Interpretation, Acta Scientific Paediatrics 2.10, 2019: 108-111

11. Austin K, Jones P. Accuracy of interpretation of arterial blood gases by emergency medicine doctors, Emergency Medicine Australasia,2010 22, 159–165

12. Padma K, Priya A, Subhashini N, Indira S. A study to assess the knowledge regarding ABG analysis and interpretation of ABG results among staff nurse in NMCH, Nellore, International Journal of Applied Research 2017; 3(1): 06-08

13. AlJamal Y , Prabhakar N , Saleem H, Baloul M, Farley DR. Surgical interns in 2018: Objective assessment suggests they are better but still lack critical knowledge and skill, Surgery xxx (2019) 1-7)

14. Sullivan O, Jeavons R. Survey of blood gas interpretation, Emerg Med J 2005 22: 391-392

15. Lella M, Narayana S, Chinnaiyan S. Perception of medical interns towards the skills they acquired, The National Medical Journal of India 2020, 33(4)

16. Cikman O., Ozkan A., Kiraz HA., Karacae MA., Ocakli M.M. , Hanci V. , et.al. A questionnaire study evaluating the knowledge and approach by physicians about arterial blood gas. Clin Ter, 2014; 165 (3):e194-198

17. Sehrawat V, Shokeen J, Saharan K. Assessment of knowledge regarding Arterial blood gas analysis among staff nurses working in selected hospital ,SGT hospital Gurguram ,Haryana , 2019; 8 (11)

18. Chauvin A , Javaud N, Ghazali A, Curac S, Altar A, Ali T, et .al .Reducing pain by using venous blood gas instead of arterial blood gas (VEINART): a multicenter randomized controlled trial, Emerg Med J 2020;0:1–6.

19. Ekstrom M, Engblom A, Ilic A, Holthius N, Nordstrom P, Vaara I. Calculated arterial blood gas values from a venous sample and pulse oximetry: Clinical validation,2019 PLoS ONE 14(4): e0215413

20. Schütz N, Roth D, Schwameis M, Röggla M , Domanovits H. Can Venous Blood Gas Be Used as an Alternative to Arterial Blood Gas in Intubated Patients at Admission to the Emergency Department? Open Access Emergency Medicine, 2019:11 305–312

21. Malatesha G, Singh NK, Bharija A, Rehani B, Goel A. Comparison of arterial and venous pH, bicarbonate, PCO2 and PO2 in initial emergency department assessment, Emerg Med J 2007;24:569–571.

22. Zeserson E, Goodgame B , Hess D, Schultz,K , Hoon C, Lamb K .Correlation of Venous Blood Gas and Pulse Oximetry With Arterial Blood Gas in the Undifferentiated Critically Ill Patient, Journal of Intensive Care Medicine, 2016

23. Chandran J. , D'Silva C. , Sriram S , Krishna B. Clinical Utility of Arterial Blood Gas Test in an Intensive Care Unit: An Observational Study, Indian Journal of Critical Care Medicine, 2021, 25 (2)

24. Watts S. Intensive care point of care testing for arterial blood gas analysis: A prospective Observational study, Australian Critical Care 33, 2020 S1-S48

25. Rowling SC., Fløjstrup M, Henriksen DP, Viberg B., Hallenberg C., Lindholt JS,et.al. Arterial blood gas analysis: as safe as we think? ERJ Open Res 2022; 8: 00535-2021

26. Kumar A, Kushwah S, Sahay S. Effect of extra amount of heparin in syringe and its effect on arterial blood gas analysis, ejpmr, 2015, 2(6), 290-293

27. Hajiseyedjavady H , Saeedi M,, Eslamib V , Shahsavarinia K , Farahmand S. Less painful arterial blood gas sampling using jet injection of 2% lidocaine: a randomized controlled clinical trial, American Journal of Emergency Medicine ,2012 30, 1100–1104

28. Mauliandari R, Sumarwati M, Upoyo AS. Peer Learning: An Effective Teaching-Learning Method for Improving Ability in Arterial Blood Gases Interpretation, Nurse Media Journal of Nursing, 2020; 10(3), 330

29. Malatesha G, Singh NK, Bharija A, Rehani B, Goel A. Comparison of arterial and venous pH, bicarbonate, PCO2 and PO2 in initial emergency department assessment, Emerg Med J ,2007;24:569–571.

30. Xafis P, Arterial Blood Gases in Emergency Medicine: how well do our registrars and consultants currently enrolled in the Western Cape Division of Emergency Medicine interpret them? UCTD, 2014-12

31. Musa Hussain EY , Sidahmed Abdullah AM , Mahgoub Idris RM , Hashim Gabir ZT, Mohammed Diab RA, Mustafa Ahmed RN, et.al. Evaluation and Improving the Quality of Arterial Blood Gas Interpretation among Junior Doctors in Aswan University Hospital: A Clinical Audit. Cureus, 2024; 16(12): e74906. DOI 10.7759/cureus.74906

32. Azazh A. Emergency and critical care development in Ethiopia: a lot is achieved and yet further to go, PAJEC, 2023; 1(1):50-59.

33. Interpretation of ABG, (2024). Accessed: June1, 2024: https://www.thoracic.org/professionals/clinical-resources/critical-care/clinical-education/abgs.php

APPROVAL

This is to approve the thesis entitled by Assessment of Knowledge and Interpretation Skill on Arterial Blood Gas and its Associated Factors among Emergency and Critical Care Medicine Residents at Selected Ethiopian University Hospitals by Dr. Ephrem Basazinew for partial fulfillment of requirements for the degree specialty of emergency medicine and critical care compiles with regulations of the university and meets the accepted standards with respect to originally and quality and it was carried out under Dr. Merahi Kefyalew and Dr. Birhanu Tesfaye.

Name of advisers: Dr. Merahi Kefyalew _____

Dr. Birhanu Tesfaye _____

Date _____

ANNEXES

Annex 1: Information and Consent form

Dear residents,

My name is Dr. Ephrem Basazinew and I am a 3rd year Emergency and Critical Care medicine resident at TASH. I am currently doing my research on "Assessment of Knowledge and Interpretation Skill on Arterial Blood Gas and its Associated Factors among Emergency and Critical Care Medicine Residents at Selected Ethiopian University Hospitals". The purpose of this study is to assess the level of knowledge and interpretation skills on ABG among ECCM residents by using a structured questionnaire.

The questionnaire is designed to collect data regarding your ability to interpret ABG and is strictly for academic purposes. To the researchers' knowledge, this will be the first study done on

this topic in our country and will have a significant impact on patient care. The data collected will only be used for the purpose of this study. Confidentiality will be strictly protected, and none of your responses will affect you in any way. Your participation will significantly help to increase the body of knowledge in this area and is vital for the success of this study, but it is purely voluntary. You may decline to participate in the study at any point if you choose to do so. I would like to thank you in advance for your participation. If you have any questions or need to get in touch with the researcher, please use the following contact information.

Respectfully,

Dr. Ephrem Basazinew

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E-mail; ephrembasaznew@gmail.com

Annex 2: Questionnaire:

Section One: Socio-demographic variables:

1. Age:
2. Sex: A. Male B. Female
3. Institution: A. AAU B. SPHMMC C. Hawassa University D. Jimma University E. Haramaya University
4. Year of residency: A. Two B. Three
5. Year of experience as GP:
6. Did you work in the ICU when you were a GP? A. Yes B. No

Section Two: Questions related to factors that affect knowledge and interpretation skill on ABG and questions on procedures of ABG Sampling

1. Have you ever received/attend training or lecture on ABG? A. yes B. No
2. Is there a blood gas analyzer available at your institution? A. Yes B. No
3. Did you have a chance to practice ABG interpretation during internship period? A. Yes B. No
4. Have you ever taken ABG Sampling before? A. Yes B. No
5. If yes for question 6, did you perform Allen test before puncture the artery? A. Yes B. No
6. If yes for question 6, did you use local anesthesia during the procedure? A. Yes B. No

Section Three: Knowledge Assessment Questions on ABG

1. Select indication for performing ABG? (More than 1 choice possible)

   A) Arrhythmias

B) Assessment of the response to therapeutic interventions

C) Detection and quantification of the levels of abnormal hemoglobin

D) Drug Overdose

E) None

2. One is not an absolute contraindication for ABG sampling?

A) Failed modified Allen's test

B) Local infection

C) Coagulopathy

D) Active Raynaud syndrome

E) Severe Peripheral vascular disease

3. A Preferred site for ABG sampling is?

A) Radial artery, from non-dominant upper extremity

B) Radial artery, from dominant upper extremity

C) Femoral artery

D) Brachial artery

4. Select complication of ABG sampling? (More than 1 choice possible)

A. Pain

B. Hematoma

C. Fainting

D. Local nerve injury

E. None

5. Select factor that affect ABG results? (More than 1 choice possible)

A. Heparin overuse

B. Air bubbles

C. Leukocytosis

D. Delays in sample analysis

E. None

6. In some situations, a venous blood gas (VBG) will provide adequate information. As compared to an ABG, the VBG results will:

A. Show a different hemoglobin level

B. Show all values the same as the arterial values

C. Show a different oxygenation level

D. Show a different potassium level

7. For 1ml of blood how much ml of anticoagulant (Heparin) is required?

A. 0.5ml

B. 0.05 ml

C. 1ml

D. 2 ml

8. In ABG result, which one of the following is calculated from the Henderson-Hasselbalch equation?

A) pH

B) PaO2

C) PaCO2

D) HCO3

9. Which of the following is the primary mechanism for compensating for a respiratory acidosis?

A) Increased renal bicarbonate (HCO_3^-) reabsorption

B) Increased alveolar ventilation

C) Increased red blood cell 2, 3-diphosphoglycerate (2, 3-DPG)

D) Increased plasma protein concentration

10. What is the normal range for serum bicarbonate (HCO_3^-) in arterial blood?

A) 18 - 22 mEq/L

B) 22 - 26 mEq/L

C) 26 - 30 mEq/L

D) 30 - 34 mEq/L

Section Four: ABG interpretation skill Questions

1. What is the anion gap (AG) for the following ABG result? pH=7 ,PaO2=90, PaCo2=23 ,HCO3=12 ,Na=126 ,K=5 ,Cl=95 ?

A. 19

B. 24

C. 21

D. 14

2. A young male presents to the ED but unable to give a history. As part of the work up, you find an anion gap of 38. All of the following are possible etiologies of the patient's problem EXCEPT:

A. Lactic acidosis

B. Ethylene glycol

C. Diabetic Ketoacidosis

D. Isopropanol

3. An 87 year old man presents with severe central abdominal pain, vomiting and Hypertension for 6 hours. He has a past history of atrial fibrillation and ischemic heart disease.

Arterial blood gas analysis shows: pH =7.2, PCO2=30, HCO3=14, Na=142, K=5.5, Cl=106. What will be the delta ratio?

A. 0.4

B. 0.8

C. 1

D. 2

4. A patient with a pH of 7.48, PaCO2 of 30 mmHg, and HCO3 of 23 mEq/L. Which one best describes the patient's acid-base disorder?

A. Uncompensated metabolic alkalosis

B. Uncompensated Respiratory alkalosis

C. Partially compensated respiratory alkalosis

D. Partially compensated metabolic alkalosis

5. Which one shows a fully compensated Acid-base result?

A. pH=7.42, PaCO2=50, HCO3= 32

B. pH=7.51, PaCO2=51, HCO3=42

C. pH=7.29, PaCO2= 51, HCO3=7

D. None

6. A 21-year-old college student is brought to the ED by her roommate who states that the patient has been very sleepy today. She has a history of diabetes and has not refilled her medication in over a week. Her BP is 95/61 mm Hg, HR is 132, RR is 30, and temperature is 36.7. Her point-of-care glucose is 530 mg/dL. Which of the following choices most closely matches what you would expect to find on her arterial blood gas (ABG) with electrolytes and urinalysis?

A. pH 7.57, anion gap 21

B. pH 7.47, anion gap 12

C. pH 7.26, anion gap 12

D. pH 7.26, anion gap 21

7. A 68 years old man is brought to the ICU after being dyspneic and tachypneic for 5 days. Laboratory studies revealed: Sodium=135 meq/L, potassium =3.9 meq/L, chloride =115 meq/L, bicarbonate =11meq/L, pH=7.49, Paco2=15mmHg, Pao2=67 mmHg, which one best describes the patient's acid-base disorder?

A. Mixed anion gap metabolic acidosis and respiratory acidosis

B. Mixed anion gap metabolic acidosis and respiratory alkalosis

C. Mixed metabolic alkalosis and respiratory alkalosis

D. Mixed non-anion gap metabolic acidosis and respiratory alkalosis

8. Analyze the acid-base disorder in this patient: pH=7.38, PCO2=24 mmHg, PO2=70 mmHg, HCO3=15. Na=137meq/L, K=3.2 meq/L, Cl=100 meq/L, serum albumin =2 g/dl

A. Metabolic acidosis, respiratory alkalosis

B. Metabolic acidosis

C. Metabolic acidosis, metabolic alkalosis, respiratory alkalosis

D. Normal acid-base balance

9. A 54 year-old woman a known hypertensive, obesity, and bilateral knee osteoarthritis patient presented with altered mental status and tachypnea. She also has been complaining of nausea and tinnitus for one day. Her medications include amlodipine and topical oil of wintergreen. Her ABG result showed as follows: pH=7.55, pCO2=20, p02=84, HCO3=18. Which of the following is the most appropriate next step in management?

A. PO activated charcoal

B. IM glucagon 1 mg

C. IV Atropine 2 mg

D. IV NaHCO3 infusion

10. A 68 year old diabetic woman presents with respiratory distress and severe thirst after a recent diarrheal illness. Her ABG from the resuscitation area is shown: pH=6.98, PCO2 =14, HCO3=3, Na=138, k=7, Cl=114. Which one best describes the patient's acid-base disorder?

A. Pure NAGMA

B. Pure AGMA

C. HAGMA+ AGMA

D. AGMA + Metabolic Alkalosis