

## Original Article

# Investigating the Multifaceted Aspects that Affect Interns' Competence and Performance in Arterial Blood Gas Sampling Technique in Emergency Department Settings

Vijay Kumar S S<sup>1</sup>, Shabbir Shekhli<sup>2</sup>, Anila Jose<sup>3</sup>

**Background :** Arterial Blood Gas (ABG) sampling is a critical clinical procedure commonly performed by Junior Residents and Interns in teaching hospitals, particularly in the Emergency Department for critically ill patients. Improper technique can lead to a range of complications, such as local hematoma, pain and infection, compromising patient care and outcomes. It is therefore essential for interns to have the necessary skills and expertise to perform the procedure correctly. This descriptive cross-sectional study aims to identify the specific challenges that Interns face when performing ABG sampling and develop targeted training programs to address these challenges. The study results can help develop evidence-based guidelines for ABG sampling in emergency department settings.

**Materials and Methods :** A validated questionnaire containing questions on the competency and understanding of ABG sampling was distributed to 200 Interns affiliated with our institution. The collected data was analyzed using descriptive statistics in the form of frequencies and percentages. The analysis was performed using SPSS version 21.0 software.

**Results :** In this study, among 200 interns we found that the radial artery was the preferred site for ABG sampling (91%), with 86.6% preferring a 2 ml heparinized needle. Most recognized local infection (90.5%) and hematoma formation (96.5%) as potential complications. 87.5% of participants had performed the procedure at least once on a patient with 39% being supervised by a nurse during their first attempt. Only 31% of participants expressed confidence in performing and 25% documented the procedure. The majority adhered to aseptic precautions (66% hand washing, 78% skin antisepsis, 74% gloves and 62% sterile towel). Almost all palpated the pulse prior to insertion (89.5%) and applied local pressure for hemostasis (86%) but only 56% properly disposed of the needle. Notably none had received training in the skill lab during the undergraduate programme.

**Conclusion :** The study revealed significant gaps in the competency and understanding of ABG sampling among interns which underscore the need for a training program before the commencement of the internship to provide adequate knowledge about the technique, complications and management. Such a program could help improve the quality of ABG sampling and minimize complications associated with the procedure.

[J Indian Med Assoc 2024; 122(2): 45-8]

**Key words :** Arterial Blood Gas, Hand Disinfection, Asepsis, Education Medical Undergraduate.

**A**rterial Blood Gas (ABG) sampling is a crucial bedside procedure commonly practiced in the Emergency Room (ER) and critical care settings. It is used to assess acid-base balance, gas exchange and respiratory, metabolic and renal function<sup>1</sup>. The procedure is considered the most reliable determination of ventilation and successful oxygenation and is the only way to determine the alveolar-arterial oxygen gradient<sup>2</sup>. With relatively low complications, ABG sampling has become an essential tool in guiding

<sup>1</sup>MD, DNB, Assistant Professor, Department of Emergency Medicine, KS Hegde Medical Academy, Karnataka 575018 and Corresponding Author

<sup>2</sup>MD, Assistant Professor, Department of Emergency Medicine, S Nijalingappa Medical College, Karnataka 587102

<sup>3</sup>MD, DNB, Assistant Professor, Department of Medicine, Sree Narayana Institute of Medical Sciences Chalakkal, Kerala 683594

Received on : 31/03/2023

Accepted on : 08/06/2023

### Editor's Comment :

- This study emphasizes the intricate factors influencing interns' proficiency in arterial blood gas sampling in emergency departments. By addressing both technical skills and contextual elements, healthcare educators can enhance training programs to ensure interns are adept at this critical technique in high-pressure settings, ultimately improving patient care.

treatment plans for patients and its demand is increasing due to the rising prevalence of ICU care and ventilator settings.

Prior knowledge of the technique and potential complications is necessary to select the patient and site of arterial puncture and avoid the risks of local hematoma, arterial occlusion, and laceration<sup>3</sup>. Critical components of ABG sampling include the angle of needle insertion, heparin flush of the syringe and infection control measures to reduce complications.

In our institute, Interns commonly perform ABG sampling. Therefore, we conducted a study to assess their knowledge and clinical skills based on the training they received during their undergraduate (MBBS) course and their experience practicing on mannequins and patients. The results of this study will help identify the gaps in their training and improve the quality of care provided to patients undergoing ABG sampling.

### MATERIALS AND METHODS

This descriptive study was conducted over a period of twelve months at a tertiary care teaching hospital. Ethical clearance was obtained from the Institute's Ethical Committee and verbal and written consent was obtained from all 200 participants selected using a convenience sampling method among medical interns who had completed their compulsory rotation in Department of Emergency Medicine.

The sample size was calculated using the formula

$$n = (Z^2 \times p \times q) / e^2$$

Where N is the minimum required sample size, Z is 1.96 at 95% Confidence Interval (CI), P is prevalence taken as 50% for maximum sample size, Q is 1-p and E is margin of error, 8%.

Before beginning the study, six experts from various departments of our hospital validated the questionnaires and those with a Content Validity Ratio (CVR) of >0.6 were included in the study. The study participants were provided with a structured, validated, and pre-tested questionnaire in English to evaluate their understanding, practices, and perception of ABG sampling. The principal investigator collected the questionnaires from all participants and the data was later entered in Excel. Statistical analysis was conducted using SPSS version 21.0, and results were expressed in frequencies and percentages.

### RESULTS

#### Assessment of Knowledge of ABG Sampling among Interns :

The preferred arterial sites for ABG sampling among the Interns were the radial artery (91%), followed by the femoral artery (89%) and the brachial artery (66%). The majority of participants (86.6%) preferred a 2ml heparinized needle for sampling. In terms of contraindications, the most commonly recognized was local infection (90.5%), followed by severe peripheral vascular disease (73%). Regarding complications, all participants recognized local pain as a potential adverse event, while infection at the puncture site was recognized by 45% of participants. Hematoma formation (96.5%) was also commonly recognized,

while arterial vasospasm/occlusion/laceration (60%) and needle-stick injuries to healthcare personnel (80%) were also acknowledged as potential complications. (Table 1).

	Yes n (%)	No n (%)
<b>Site :</b>		
Radial artery	182 (91)	8 (9)
Femoral artery	178 (89)	22 (11)
Brachial artery	132 (66)	68 (34)
<b>Contraindication :</b>		
Abnormal modified Allen test	114 (57)	86 (43)
Local infection	181 (90.5)	19 (9.5)
Arteriovenous fistulas	91 (45.5)	109 (54.5)
Severe peripheral vascular disease	146 (73)	54 (27)
Severe coagulopathy	129 (64.5)	71 (35.5)
<b>Complication :</b>		
Local pain	200 (100)	0 (0)
Local Hematoma	193 (96.5)	07 (3.5)
Arterial vasospasm / occlusion / laceration	120 (60)	80 (40)
Embolism	64 (32)	136 (68)
Infection at the puncture site	90 (45)	110(55)
Vasovagal response	80(40)	120 (60)
Needle-stick injury to healthcare personnel	160 (80)	40(20)

#### Assessment of Attitude of ABG Sampling among Interns :

Only 25% of the participants documented the ABG sampling procedure. 87.5% of the participants performed the procedure on patients, but none of them had ever performed the procedure on a mannequin (Table 2).

Questions	Yes n (%)	No n (%)
During your MBBS course, was any formal training given on ABG Sampling procedure ?	0 (0)	200 (100)
Have you performed an ABG Sampling on a mannequin ?	0 (0)	200 (100)
Have you ever performed ABG Sampling on a patient ?	175 (87.5)	25 (12.5)
Was the procedure documented ?	50 (25)	125 (75)

Regarding supervision during ABG sampling, 39% of the participants were supervised by a nurse and 35.5% were supervised by postgraduates during their first attempt at the procedure (Fig 1).

31% of the participants were confident, 10.5% were very confident, 28% were neutral, 11% were not confident and 19.5% were not at all confident in performing the procedure (Fig 2).

#### Assessment of Practice of ABG Sampling among Interns :

The majority of participants reported adherence to

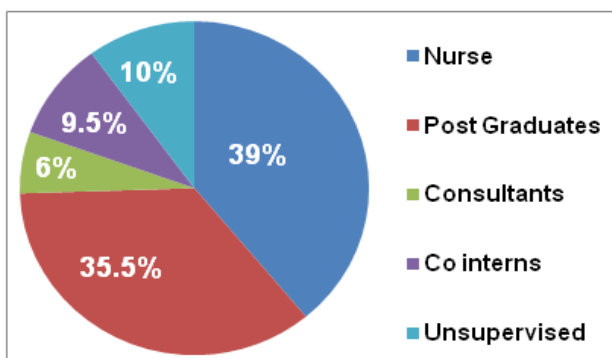


Fig 1 — Supervision during ABG sampling

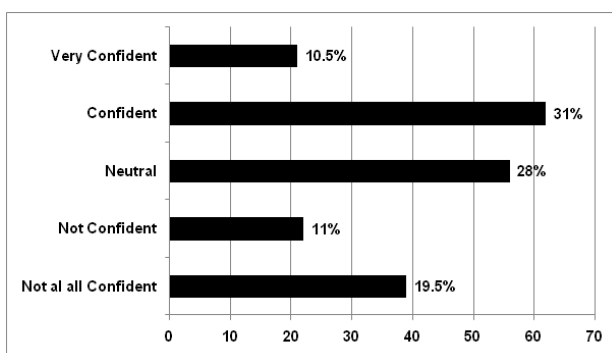


Fig 2 — Level of confidence to perform ABG sampling

aseptic precautions during ABG sampling, with 66% reporting hand washing prior to the procedure, 78% reporting skin antiseptics, 74% using gloves and 62% using a sterile towel.

In terms of the technique used during ABG sampling, 89.5% of participants reported palpating the pulse prior to insertion and 76% reported placing their hand in extension. Additionally, 74.5% of participants reported using proper needle insertion technique, 86% applying local pressure for hemostasis, 66.5% removing air bubbles from the syringe and 56% capping the syringe. Finally, 60% of participants reported properly disposing of the needle (Table 3).

	Yes n (%)	No n (%)
<b>Aseptic Precaution :</b>		
Hand wash before the procedure	132 (66)	68 (34)
Skin Antiseptics	156 (78)	44 (22)
Gloves	148 (74)	52 (26)
Sterile Towel	124 (62)	76 (38)
<b>Technique :</b>		
Palpate Pulse	179 (89.5)	21 (10.5)
Placement of hand-in extension	152 (76)	48 (24)
Needle insertion technique	149 (74.5)	51 (25.5)
Application of local pressure	172 (86)	28 (14)
Removal of air bubbles from syringe.	133 (66.5)	67 (33.5)
Capping of the syringe.	112 (56)	88 (44)
Disposal of needle	120 (60)	80 (40)
2ml syringe	173 (86.5)	27 (13.5)

### DISCUSSION

The purpose of this study was to evaluate the level of competency and understanding of Arterial Blood Gas (ABG) sampling technique among Interns. Interns were selected as study participants, as they are responsible for conducting various basic medical procedures, including ABG sampling, securing intravenous cannulas and urinary catheterization, which are commonly performed in healthcare settings.

In our study, we observed that the majority of interns demonstrated a good level of knowledge about the site selection, contraindications and complications associated with ABG sampling. However, their adherence to aseptic precautions and procedural technique was found to be inadequate. This suggests that while Interns possess a good theoretical understanding of the procedure, they may lack the practical skills necessary to ensure the procedure is conducted safely and effectively.

It is worth noting that 91% of the Interns in our study preferred to use the radial artery for ABG sampling, citing its superficial location and relatively lower level of pain compared to other sites. Interestingly, only few of participants opted for the brachial artery, which could be due to the knowledge of increased likelihood of nerve damage and more painful procedure<sup>5</sup>.

Furthermore, the use of a heparinized 2ml syringe was preferred by majority of Interns, as it caused less discomfort and was adequately sized for accessing the vessel<sup>6</sup>. However, the majority of Interns in our study were unaware of contraindications, such as abnormal modified Allen’s test, arterio-venous fistula in the limb and severe coagulopathy, which could impact the accuracy and safety of the procedure<sup>7,8</sup>. This could be attributed to inadequate formal training during their undergraduate course.

While Interns demonstrated good knowledge of common complications associated with ABG sampling, such as local pain, hematoma, and needle stick injuries, they were less aware of rare complications such as arterial vasospasm, occlusion, laceration, embolism, vasovagal response, and infections. Notably, coagulase-negative staphylococci and Staphylococcus aureus were identified as the most common agents for infection at the puncture site.<sup>9</sup> This suggests that there may be a need for more comprehensive training on the potential risks associated with ABG sampling.

It is worth noting that hand washing remains an essential step before conducting any clinical procedure and the use of sterile gloves, chlorhexidine-based antiseptic solutions, and sterile towels can significantly

reduce the risk of infective-related complications<sup>10</sup>. In our study, the majority of Interns were aware of the importance of aseptic procedures. However, it is worth mentioning that 68% of Interns were not aware of rare complications, such as embolism, when compared with a similar study by Rowling S, *et al* which showed results of 49%<sup>11</sup>.

Previous research on ABG sampling technique has mainly focused on the Knowledge, Attitude and Practice of nurses. However, we decided to assess the level of understanding and proficiency of Interns in this procedure and our study aimed to provide an in-depth analysis of Interns' level of competency and understanding related to ABG sampling, which could serve as a foundation for developing effective training programs to improve the quality and safety of this procedure in our Institution. Our findings highlight the need for structured training programs and skill labs to strengthen the procedural skills and knowledge of Interns, ultimately ensuring the safe and effective delivery of patient care.

#### CONCLUSION

The results of our study indicate that Interns possessed sufficient theoretical knowledge of ABG sampling, including artery selection and contraindications. However, our findings also revealed a deficiency in their practical skills related to aseptic precautions, technique and complications of the procedure. Based on these results, it is essential to emphasize the need for supervised practice on

mannequins before the commencement of the Internship and formal training during the Undergraduate course. Such measures will aid in improving the Interns' clinical skills and ensure the safety and quality of ABG sampling in our Institution.

#### REFERENCES

- 1 Puri S, Paul G, Sood P — Interpretation of arterial blood gas. *Indian Journal of Critical Care Medicine* 2010; **14(2)**: 57-64.
- 2 Evans L, Rhodes A, Alhazzani W, Antonelli M, Coopersmith C, French C, *et al* — Surviving sepsis campaign: international guidelines for management of sepsis and septic shock 2021. *Intensive Care Medicine* 2021; **47(11)**: 1181-247.
- 3 WHO guidelines on drawing blood: best practices in phlebotomy [Internet]. Who.int. 2022 [cited 27 July 2022]. Available from: <https://www.who.int/publications/i/item/9789241599221>
- 4 Lawshe C — A quantitative approach to content validity. *Personnel Psychology* 1975; **28(4)**: 563-575.
- 5 Berger A — Brachial artery puncture: the need for caution. *Journal of Family Practice* 1989; **28(6)**: 720-2.
- 6 Nigam P — Correct Blood Sampling for Blood Gas Analysis. *Journal of Clinical and Diagnostic Research* 2016; **10(10)**: 1-2.
- 7 Gillies I, Morgan M, Sykes M, Brown A — The nature and incidence of complications of peripheral arterial puncture. *Anaesthesia* 1979; **34(5)**: 506-9.
- 8 Mortensen J — Clinical Sequelae from Arterial Needle Puncture, Cannulation, and Incision. *Circulation* 1967; **35(6)**: 1118-23.
- 9 Fleming W, Bowen J — Complications of Arterial Puncture. *Military Medicine* 1974; **139(4)**: 307-8.
- 10 Robert J, Custalow C, Hedges D — Clinical procedures in emergency medicine. 5th ed. Philadelphia: Pennsylvania: Saunders, an imprint of Elsevier Inc.; 2022.
- 11 Rowling S, Fløjstrup M, Henriksen D, Viberg B, Hallenberg C, Lindholt J, *et al* — Arterial blood gas analysis: as safe as we think? A multicentre historical cohort study. *ERJ Open Research* 2022; **8(1)**: 00535-2021.

***If you want to send your queries and receive the response on any subject from JIMA, please use the E-mail or Mobile facility.***

### **Know Your JIMA**

**Website** : <https://onlinejima.com>  
[www.ejima.in](http://www.ejima.in)

**For Reception** : **Mobile** : +919477493033

**For Editorial** : [jima1930@rediffmail.com](mailto:jima1930@rediffmail.com)  
**Mobile** : +919477493027

**For Circulation** : [jimacir@gmail.com](mailto:jimacir@gmail.com)  
**Mobile** : +919477493037

**For Marketing** : [jimamkt@gmail.com](mailto:jimamkt@gmail.com)  
**Mobile** : +919477493036

**For Accounts** : [journalaccts@gmail.com](mailto:journalaccts@gmail.com)  
**Mobile** : +919432211112

**For Guideline** : <https://onlinejima.com>